MACHINERY

Index to Vol. XVI

September, 1909, to August, 1910

Engineering and Shop Editions

Index to Vol. IX

September, 1909, to August, 1910

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Index to MACHINERY

Index for engineering, shop and railway editions, inclusive. Page numbers of respective editions in columns headed "Eng. Shop Ry."

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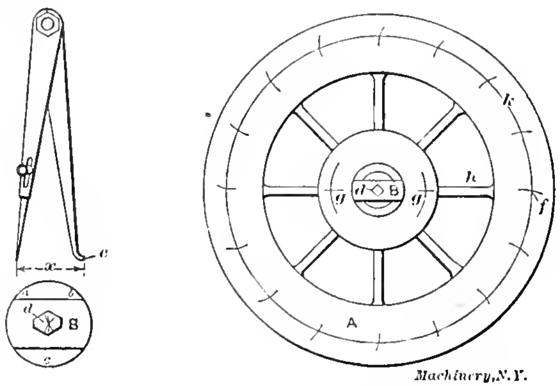
Supplement to MACHINERY, September, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Laying out Work—II"

SHOP OPERATION SHEET NO. 109.

Oscar E. Perrigo. MACHINERY, September, 1909.



To Lay Out a Cylinder Head for Drilling

NOTE.—The crank-end head is taken as an example, and the holes are to be laid out for the studs by which it is secured to the cylinder, the studs by which the stuffing-box gland is adjusted and secured, and the holes for the set-screws for use in removing the head. The laying out is to be done entirely by hand.

1. Across the central hole of the cylinder head *A*, fit the brass piece *B* tightly. Force it down until its top is level with the surface of the stuffing-box boss.

2. With a pair of hermaphrodite calipers set to a distance *x* equal to about half the diameter of the hole, and with one leg located successively at the points *a*, *b*, *c* at the sides of the hole, scribe arcs cutting each other near the center. At the intersection of these arcs make a light center-punch mark. Set the pointed leg of the calipers in the center *d* and test its accuracy by swinging the leg *e* around to different points in the bore. If the center is correct the calipers will touch the bore (near the top) at all points.

3. With dividers set to one-half the diameter of the circle *k*, for the stud-hole centers, scribe this circle lightly on the surface. In the same manner scribe the circle for the gland studs *g*, *g*.

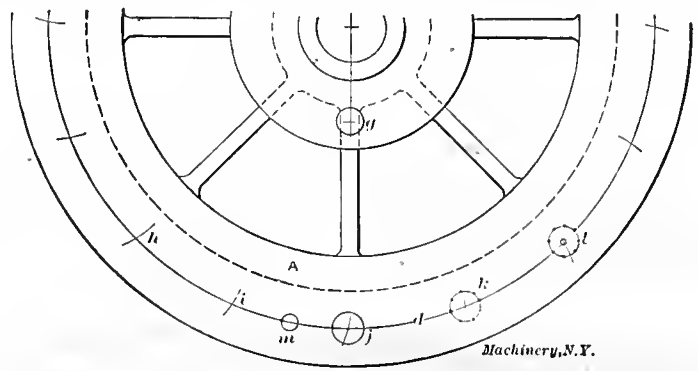
4. With a center square and scriber locate the hole *f*, opposite the center of one of the ribs *h*. As there are to be sixteen cylinder stud holes in the head, set a pair of dividers to about one-sixteenth the circumference of the circle *k*, and then "walk" the dividers around the circle to ascertain if they are correctly set. When they divide the circle into sixteen equal divisions scribe arcs as shown.

5. With a scale and scriber locate the holes *g*, *g*, exactly opposite the center *d* and at such points that when the cylinder head is in place they will be in a horizontal line.

NOTE.—To divide a circle into a given number of equal parts, particularly when the required number of divisions is large, is often a tedious and time-consuming operation. By the use of a table such as the one found in MACHINERY'S Data Sheet for February, 1903, the dividers may be set to the correct distance without any preliminary trials.

SHOP OPERATION SHEET NO. 110.

Oscar E. Perrigo. MACHINERY, September, 1909.



To Lay Out a Cylinder Head for Drilling

NOTE.—The centers of the holes to be drilled have been located in the previous operation by short lines scribed by dividers across the stud-circle at the proper points as determined by the spacing of the cylinder studs, as at *h*.

1. With a well-ground prick-punch having a point with an angle of somewhat less than 60 degrees, prick-punch each of these intersections.

2. Set the dividers carefully to half the diameter of the holes to be drilled. At each prick-punch mark scribe circles plainly, as at *j*.

NOTE.—In order that lines which are scribed on metal surfaces will be plainly visible, the surfaces are first coated with some suitable preparation. Chalk or a mixture of whiting and alcohol are often used for rough surfaces, while finished parts can be prepared either by rubbing them with a piece of moistened sulphate of copper (blue stone) or by applying a solution of the same substance. When sulphate of copper is used, all oil should first be removed from the surface to which it is to be applied. The thin film of copper which is then deposited will make all lines show plainly because of the difference in color between the copper and the iron or steel.

3. At nearly equal intervals, lightly prick-punch eight points on the circle for each hole, as at *k*.

4. Enlarge the center prick-punch mark by a heavy blow of the hammer, so as to furnish a better starting point for the drill, as at *l*. After each hole in the circle has been finished, as at *l*, mark the holes *g* in the same manner.

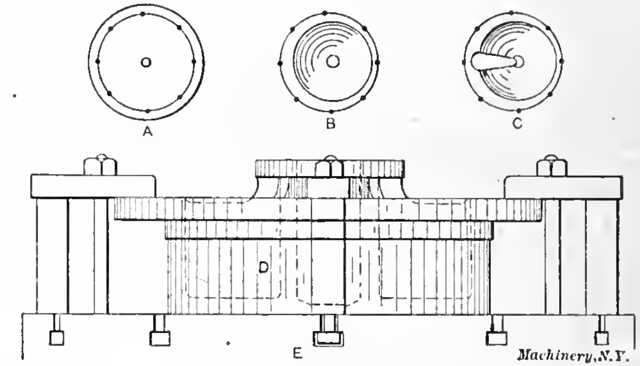
5. On opposite sides of the center of the cylinder head and equidistant between the stud holes of the outer circle, lay out two holes *m*.

NOTE.—The holes on the outer circle are for the fixed studs which secure the head to the cylinder. The holes *g* are for the stuffing-box gland studs. The holes *m* are for set-screws which are used to start the head when it is to be removed.

Where it is necessary to lay out the holes in a cylinder head or other part quite frequently, a thin metal templet is sometimes made with the holes properly located in it so that when it is laid upon the work the holes can easily and quickly be transferred by the use of a scriber.

SHOP OPERATION SHEET NO. 111.

Oscar E. Perrigo. MACHINERY, September, 1909.



To Drill the Holes in a Cylinder Head.

NOTE.—The centers of the holes to be drilled should have been laid out as described in the previous sheet, and circles equal in diameter to the holes scribed, each of these circles being marked by eight prick-punch marks. The center prick-punch mark should also have been made deeper and larger for conveniently starting the drill.

1. Upon the table *E* of an upright drill-press, place the cylinder head casting *D*, and clamp it firmly with the straps and bolts as shown. Locate the straps between the holes to be drilled so as not to interfere with the drilling operations.

2. Place in the drill-holder a twist drill of the diameter of the holes given on the drawing.

3. Adjust the work until one of the circles indicating the position of a hole is in position under the drill and start the hole. When the drill has cut nearly to its full diameter, raise it and note if it has cut concentric with the prick-punched circle. Usually the drill will "run" to one side, as indicated at *B*. It will then be necessary to chip a slight radial slot with a round-pointed chisel on the side where the prick-punched circle is furtherest from the drilled spotting, as shown at *C*. Start the drill again and note the effect. Repeat this operation until the drill cuts exactly to the circle. Throw in the power feed and continue the drilling until the hole is entirely through the piece.

NOTE.—It is the practice in some shops, when laying out work, to scribe, in addition to the lines indicating the location of a hole or finished surface, other lines concentric with or parallel to the first, as the case may be, as shown at *A*. These are known as "witness" lines and act as a check upon the accuracy of the finished work.

4. Change the position of the work by swinging the arm supporting the drill table, and by rotating the table as may be necessary, and successively drill all the holes of the outer circle as described in Step 3.

5. Replace the drill by one of suitable diameter, and drill the set-screw holes *m*, as described in Step 3.

6. Again replace the drill by one of suitable diameter and drill the stuffing-box stud holes *g*.

I.—CAPACITIES OF HOT WATER MAINS

Capacities of Hot Water Mains.

The curves in diagrams I, II, and III give the size of mains for hot water gravity circulation and forced circulation when the gallons of water per minute and the head in feet are known. To find the gallons per minute use equation: $G_1 = \frac{E \times H}{8.3 \times (T-T_1) \times 60}$ *in which* G_1 *= gallons per minute, E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1000 for hot blast heating), H = square feet of heating surface, T = initial temperature of water (commonly 180 degrees F.),* T_1 *= final temperature of water (commonly 160 degrees F.), The head to produce flow is found from the equation: H = D x h x 0.000365 in which H = head, in feet producing flow, D = difference in temperature between supply and return, h = height or elevation of the heating surface above the boiler.*

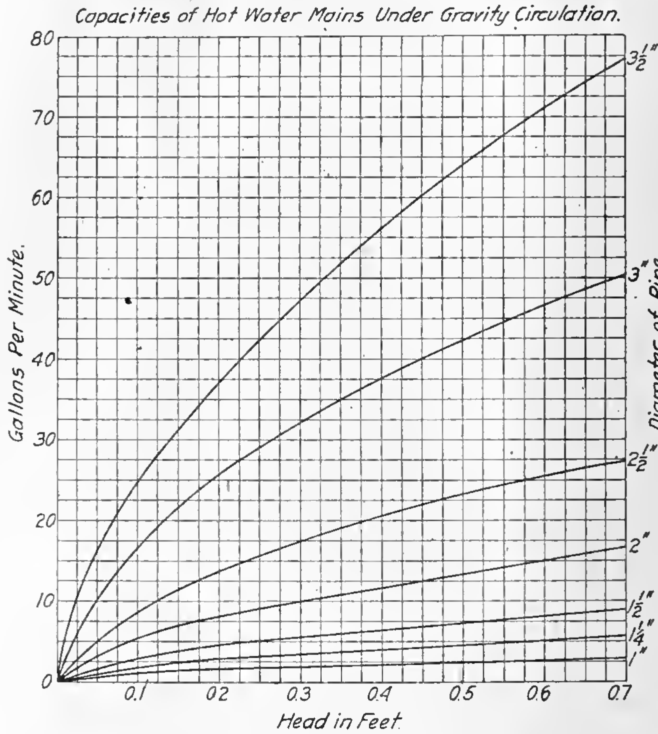
Capacities of Pipes at Different Velocities of Flow.

Velocity, feet per second	Gallons discharged per minute						
	2" pipe	3" pipe	4" pipe	5" pipe	6" pipe	7" pipe	8" pipe
3	29	66	117	184	264	360	470
4	39	88	157	245	352	480	627
5	49	110	196	306	440	600	783
6	59	132	236	367	528	719	940
7	68	154	275	428	616	839	1097
8	78	176	314	490	706	959	1253
9	88	198	352	551	794	1079	1410
10	98	220	391	612	882	1199	1567

When the radiation is all on the same floor h equals vertical distance between center of radiators and center of boiler. If radiation is equally distributed on several floors it may be taken as though located on the central floor. If unequally distributed, the average elevation is found by the equation: $h = \frac{A \times h_A + B \times h_B + C \times h_C}{A+B+C}$ *in which A, B, and C equal square feet of radiation on the several floors,* h_A, h_B, *and* h_C *equal corresponding elevations of radiators on the several floors.*

In all cases the capacities are for pipe lengths of 100 feet. If the run of pipe is 200 feet, for instance, the available head for this length will be divided by 2 before the size of pipe can be found from the diagrams.

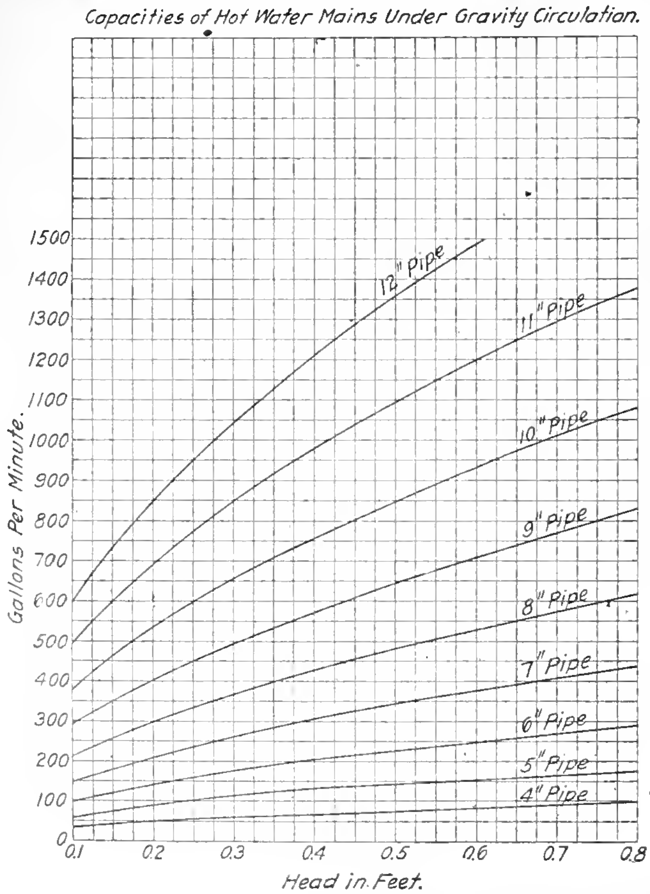
Capacities of Hot Water Mains Under Gravity Circulation.



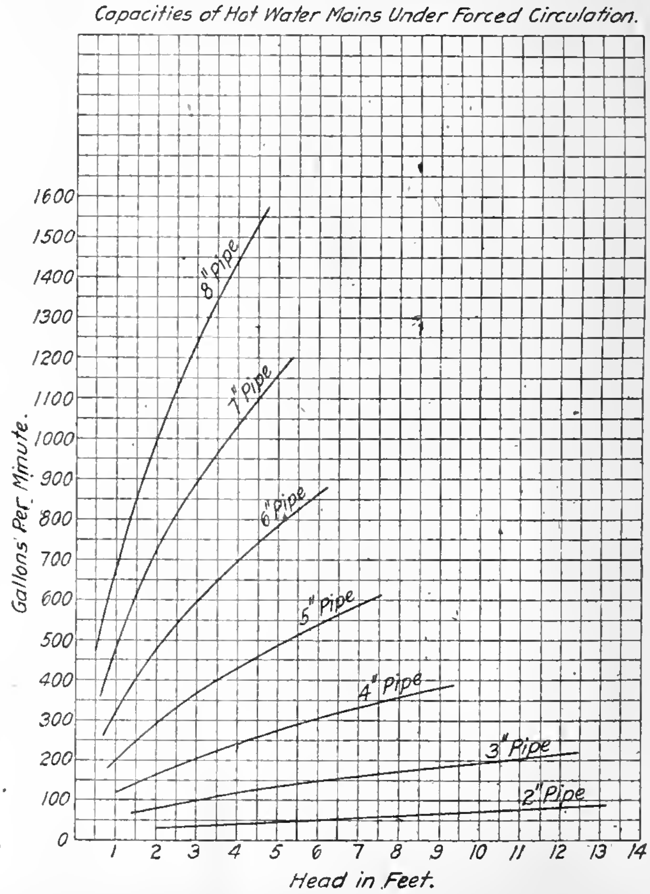
Contributed by C. L. Hubbard

II.—CAPACITIES OF HOT WATER MAINS

Capacities of Hot Water Mains Under Gravity Circulation.



Capacities of Hot Water Mains Under Forced Circulation.



Contributed by C. L. Hubbard

PITCH OF BOLTS IN WATER AND STEAM JOINTS

Thickness of Flange for Through Bolts = 1 1/4 to 1 1/2 Bolt Diameters
Thickness of Flange for Through Studs = 1 1/2 to 2 Stud Diameters
Width of Flange = 2 3/4 to 3 1/2 Bolt or Stud Diameters

Diameter of Bolt, Inches	50 lbs. and under 7 diam. Inches	50 to 90 lbs. 6 diam. Inches	90 to 125 lbs. 5 1/4 diam. Inches	125 to 150 lbs. 4 1/2 diam. Inches	150 to 175 lbs. 4 diam. Inches	175 to 200 lbs. 3 1/2 diam. Inches
1/2	3 1/2	3	2 5/8	2 1/4	2	1 3/4
5/8	4 3/8	3 3/4	3 1/4	2 3/4	2 1/2	2 1/4
3/4	5 1/4	4 1/2	4	3 1/2	3	2 3/4
7/8	6 1/8	5 1/4	4 1/2	4	3 1/2	3 1/8
1	7	6	5 1/4	4 1/2	4	3 1/2
1 1/8	7 7/8	6 3/4	5 7/8	5	4 1/2	4
1 1/4	8 3/4	7 1/2	6 1/2	5 5/8	5	4 3/8
1 3/8	9 5/8	8 1/4	7 1/4	6 1/4	5 1/2	4 7/8
1 1/2	10 1/2	9	8	7	6	5 1/4
1 5/8	11 3/8	9 3/4	8 1/2	7 1/2	6 1/2	5 3/4
1 3/4	12 1/4	10 1/2	9	8	7	6 1/4
2	14	12	10 1/2	9	8	7

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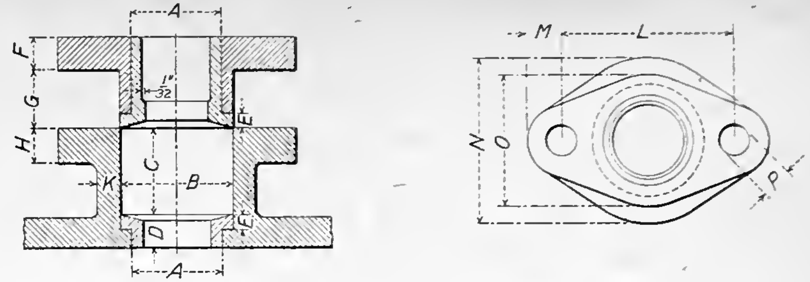
DIMENSIONS OF STUFFING BOXES AND GLANDS



Diam. of Rod Inches	A Inches	B Inches	C High Press. Inches	C Low Press. Inches	D Inches	E Inches	F Cast Iron Inches	F Brass Inches	G Inches	H Inches	K Inches	L Inches	M Inches	N Inches	O Inches	P Inches
1/2	3/4	1	1 1/2	1 1/8	7/16	3/16		3/8	3/4	7/16	5/16	1 13/16	7/16	1 3/4	1 5/16	3/8
9/16	13/16	1 1/16	1 1/2	1 1/8	7/16	3/16		3/8	3/4	7/16	5/16	1 13/16	7/16	1 7/8	1 5/16	3/8
5/8	7/8	1 1/8	1 1/2	1 1/8	7/16	3/16		3/8	3/4	7/16	5/16	1 15/16	7/16	1 7/8	1 7/16	3/8
11/16	15/16	1 3/16	1 1/2	1 1/8	7/16	3/16		3/8	3/4	7/16	5/16	1 15/16	7/16	2	1 7/16	3/8
3/4	1 1/16	1 3/8	1 7/8	1 1/4	9/16	1/4		3/8	7/8	1/2	3/8	2 5/16	1/2	2 1/4	1 3/4	7/16
13/16	1 1/8	1 7/16	1 7/8	1 1/4	9/16	1/4		3/8	7/8	1/2	3/8	2 5/16	1/2	2 3/8	1 3/4	7/16
7/8	1 3/16	1 1/2	1 7/8	1 1/4	9/16	1/4		3/8	7/8	1/2	3/8	2 7/16	1/2	2 3/8	1 7/8	7/16
15/16	1 1/4	1 9/16	1 7/8	1 1/4	9/16	1/4		3/8	7/8	1/2	3/8	2 7/16	1/2	2 1/2	1 7/8	7/16
1	1 5/16	1 3/4	2 1/4	1 1/2	11/16	5/16		7/16	1 1/8	5/8	7/16	2 3/4	9/16	2 3/4	2	1/2
1 1/8	1 7/16	1 7/8	2 1/4	1 1/2	11/16	5/16		7/16	1 1/8	5/8	7/16	2 7/8	9/16	2 7/8	2 1/8	1/2
1 1/4	1 5/8	2	2 1/4	1 1/2	11/16	5/16		7/16	1 1/8	5/8	7/16	3	9/16	3	2 1/4	1/2
1 3/8	1 3/4	2 1/4	2 5/8	1 3/4	3/4	5/16	5/8	9/16	1 1/4	3/4	1/2	3 1/2	3/4	3 3/8	2 5/8	5/8
1 1/2	1 7/8	2 3/8	2 5/8	1 3/4	3/4	5/16	5/8	9/16	1 1/4	3/4	1/2	3 5/8	3/4	3 1/2	2 3/4	5/8
1 5/8	2	2 1/2	2 5/8	1 3/4	3/4	5/16	5/8	9/16	1 1/4	3/4	1/2	3 3/4	3/4	3 5/8	2 7/8	5/8
1 3/4	2 1/8	2 3/4	3	2	7/8	3/8	3/4	9/16	1 1/2	7/8	5/8	4 1/4	7/8	4 1/8	3 1/8	3/4
1 7/8	2 1/4	2 7/8	3	2	7/8	3/8	3/4	9/16	1 1/2	7/8	5/8	4 3/8	7/8	4 1/4	3 1/4	3/4
2	2 3/8	3	3	2	7/8	3/8	3/4	9/16	1 1/2	7/8	5/8	4 1/2	7/8	4 3/8	3 3/8	3/4
2 1/8	2 1/2	3 1/8	3	2	7/8	3/8	3/4	9/16	1 1/2	7/8	5/8	4 5/8	7/8	4 1/2	3 1/2	3/4
2 1/4	2 5/8	3 3/8	3 3/8	2 1/4	1	7/16	7/8	5/8	1 5/8	1	3/4	5 1/8	1	5	3 3/4	7/8
2 3/8	2 3/4	3 1/2	3 3/8	2 1/4	1	7/16	7/8	5/8	1 5/8	1	3/4	5 1/4	1	5 1/8	3 7/8	7/8
2 1/2	2 7/8	3 5/8	3 3/8	2 1/4	1	7/16	7/8	5/8	1 5/8	1	3/4	5 3/8	1	5 1/4	4	7/8

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MACHINERY

September, 1909

CHAPTERS IN THE EARLY HISTORY OF MACHINE TOOLS*—1

JOSEPH HORNER†

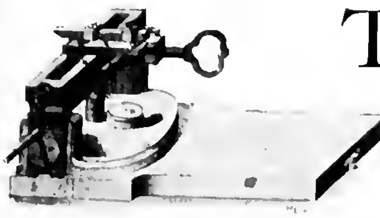


Fig. 1. French Lathe Slide-rest, 1772

THE first machine tools were the drills and the lathes, the first named being the descendants of the ancient fire drills of the archaeologists, and the second derived from the reciprocating cord-driven lathes. The drill dates from neolithic times, and the crude lathe in the form of the potter's wheel is as old, but the origin of the horizontal lathe is unknown, though its home appears to have been in Asia. The drill and the lathe were merely hand operated tools until the latter part of the eighteenth century, at which period two events occurred that were fraught with immense results. One was the placing of the steam engine on a practical basis by James Watt, the second the development of the slide-rest by Henry Maudslay. The first supplied a source of power, and the second embodied the mechanical guide principle in place of that of the human hand, which being rendered self-acting, and operated by power, has become the most essential element in all the later machine tools besides the lathes in which it had its origin.

Before the invention of the planing machine, the lathe was the only engineer's machine tool in existence, unless we except rude drill presses, and trip and helve hammers. All machine operations performed then were of necessity done in the lathe, just as they might have been done to-day but for the subsequent invention of the machines derived from the lathe and planing machine. The lathe has been the parent of the boring mill, of the bolt cutter, and of dozens of special lathes large and small. From the planing machine have been developed the slotter and the shaper, and reciprocating tool arms in their numerous forms, so that the lathe, the drill and the planer are the cardinal types of modern machine tools.

Somewhat over 100 years ago (1791) there was but one English slide-rest in existence. It was in Joseph Bramah's shop, and was invented by Henry Maudslay. That plain tool carriage, "Maudslay's go-cart," has influenced the world's history far more than the great French revolution, then in its most terrible throes. That slide-rest was like no other made before or since, and it could only have been suitable for the very shortest, lightest pieces of work. It formed a part of the back poppet, on the base of which it was mounted. A frame carried a long tool bar, sliding horizontally in ways at the front of the poppet mandrel, operated by a long screw and handle, and of course overhanging a good deal to reach the work. It was provided with cross traverse, and a swivel base. But it marked an advance over the hand work, and was a link in the history of progress, though inferior to the French slide-rests of 1772 and earlier, with which apparently neither Maudslay nor Bramah were acquainted. Maudslay commenced business in 1797 on his own account, and made a slide-rest for his own shop which was in use at the beginning of the nineteenth century. He separated the rest from the poppet, retaining the three movements, but clamping the base to the triangular bar bed. One of the first great works in which its utility was demonstrated was in the manufacture of Brunel's block making machinery, begun in 1808. His works at Lambeth became a training school for engineers, and it is significant that some of the greatest mechanicians of the first half of the nineteenth century received their training there under Maudslay. In that school, and under such a master, Nasmyth, Whitworth, Roberts, and Muir learned their craft, and these with others improved and extended the applications of the sliding tool holder. Previous to the application by these men of the slide-rest principle to other classes of machines, nearly all work that is now done in these machines was performed either in the lathe or by hand.

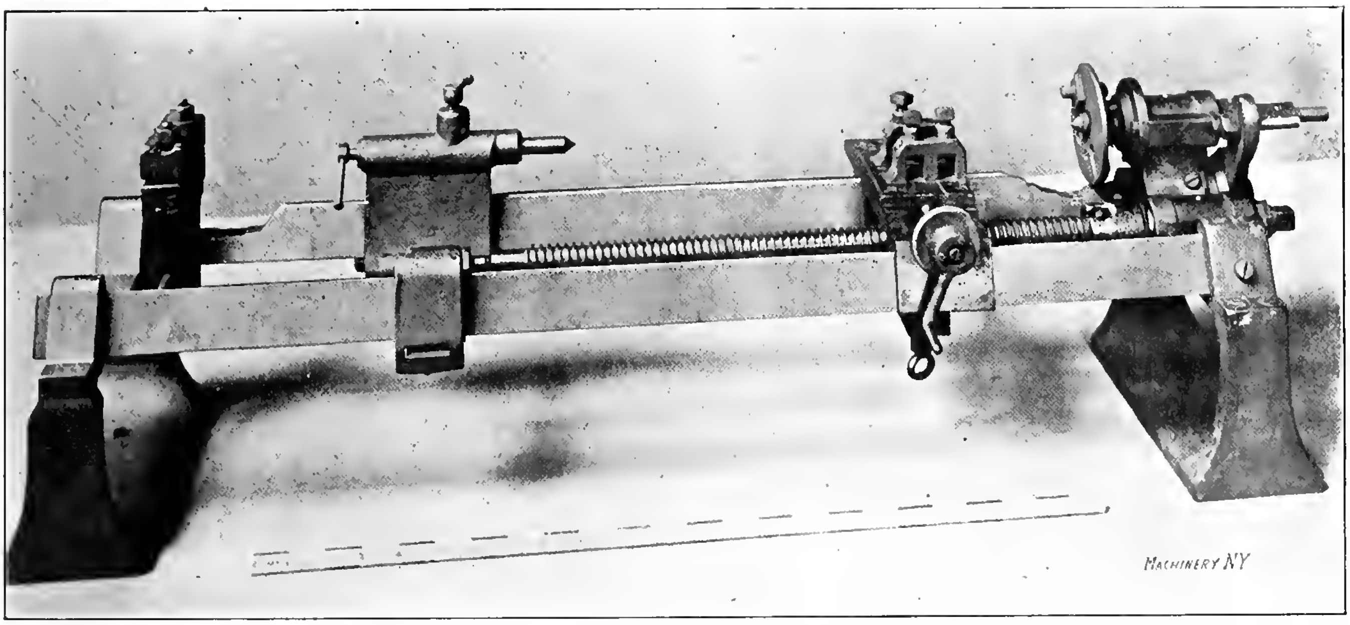


Fig. 2. Maudslay Screw-cutting Lathe, Latter Part of Eighteenth Century, South Kensington Museum

But the mechanical guide, though invented and developed by Maudslay, had been in use by French opticians more than a hundred years previously, and slide-rests had been illustrated in French works. Very curious they appear to us now. In the tenth volume of plates of the French Encyclopedia (1772) several slide-rests are shown. In these, as in Maudslay's, the saddle was clamped upon the lathe bed. The tool could be operated within the limit of range of the sli[illegible] only,

* For previous articles on early machine shops and development of machine tools, see "Chronology of the Nineteenth Century," December, 1900; "Early Machine Shops and Mechanics," October, 1902; "Talk on Lathe Spindles," by F. Emerson, May, 1904.

† Address: 15 Sydney Building, Bath, England.

and also, to a limited extent, for surfacing. Provision was made for elevating the tool point, by means of a screw, which on being turned, lifted the horizontal slide which carried the tool holder. It was capable of a swiveling movement. The construction was much simpler than that of Maudslay's. The bed or saddle, being flat, was bolted to the lathe. The swiveling plate was clamped to this by means of a single screw. The plate carried two uprights or horns recessed to receive legs from the horizontal slide. The slide carried the tool holder. The swiveling plate carried the elevating screw, and the horizontal slide the traversing screw, and the tool holder was moved by the surfacing screw. This must have been an unsteady structure. One of these slide-rests is shown in Fig. 1. The broad base has a T-groove, seen in the end, to receive the bolt which holds it to the bed. Upon this base a swiveling plate is mounted, which has two grooved horns on which the slide is carried by its horns, thus making of it an elevating rest. It is raised and lowered by a screw which has tommy-holes by which it is turned. Screws are provided for locking the slide after adjustment. The tool rest is traversed along the slide by a plain block fitting therein, by means of the screw and handle shown. The cross feed screw, which fits in a nut at the front of the slide, is capable of drawing the tool slide backwards as well as forwards.

Maudslay made a lathe previous to 1800 which was wholly self-acting for screw cutting and sliding, Fig. 2, now in South Kensington Museum. He put the change wheels at the rear of the headstock (not mounted in the illustration), and thence traversed the slide-rest through the medium of a lead-screw and split clasp nut on the under side of the saddle, the screw being carried down the center of the bed. The screw could be used also for sliding. The bed, instead of being a single bar of triangular section, comprised two such bars, secured at their ends in brackets bolted to standards. The headstock and poppet fitted on one bar only, but the slide-rest spanned both of them. The slide-rest was of gun-metal, the remainder of iron.

Another lathe of the same date, about 1800, also at South Kensington, was of a special character for cutting the fine threads for optical work. It may be mentioned that much of Maudslay's work was done in collaboration with the leading optical instrument makers of the time, who anticipated the engineers in screw cutting and gear cutting. The lathe bed, Fig. 3, is made of three bars, two of which carry the headstock and poppet, while the carriage of the rest is supported on all three. The screw to be cut is carried between centers, as seen. The lead-screw is just visible, being situated low down in the bed, and the sliding carriage is connected with it by a split nut adjustable from below. A stay at the back of the carriage steadies the work. A handwheel at the front has its edge graduated for the exact adjustment of the depth of cut. The lead-screw has 30 threads to the inch. It carries a wheel of 24 teeth which gears through an intermediate with one of 45 teeth on the lathe axis. Twenty-eight change gears are provided, ranging from 15 to 50 teeth. The intermediate wheel, as seen, has a wide face and is carried on a swinging adjustable arm to connect gears of various diameters with those on the fixed centers. A collection of threading tools is seen in a tray in front of the lathe, both single pointed ones and chasers being represented. Some samples of screws are seen in the rack in front. There is also a wide jawed caliper, looking like pincers, for measuring the diameters of screws. The long legs of the calipers are proportioned to increase the reading in the proportion of four to one.

Later, Maudslay made lathes for other firms, which save for their rather skeleton-like appearance were much like many which have been in operation until within the present generation—beds with flat ways, the hand slide-rest with three movements, the hand T-rests, the boring plate steady, and the back gear. The latter was not like that at present used, but was driven independently from a three-stepped cone on the back gear spindle, this being independent of the stepped cones on the mandrel. The back gear was put into engagement by a sliding pinion which then engaged with a wheel on the mandrel cones. It was therefore a single back gear only. There were several developments in back gears before they assumed the present form.

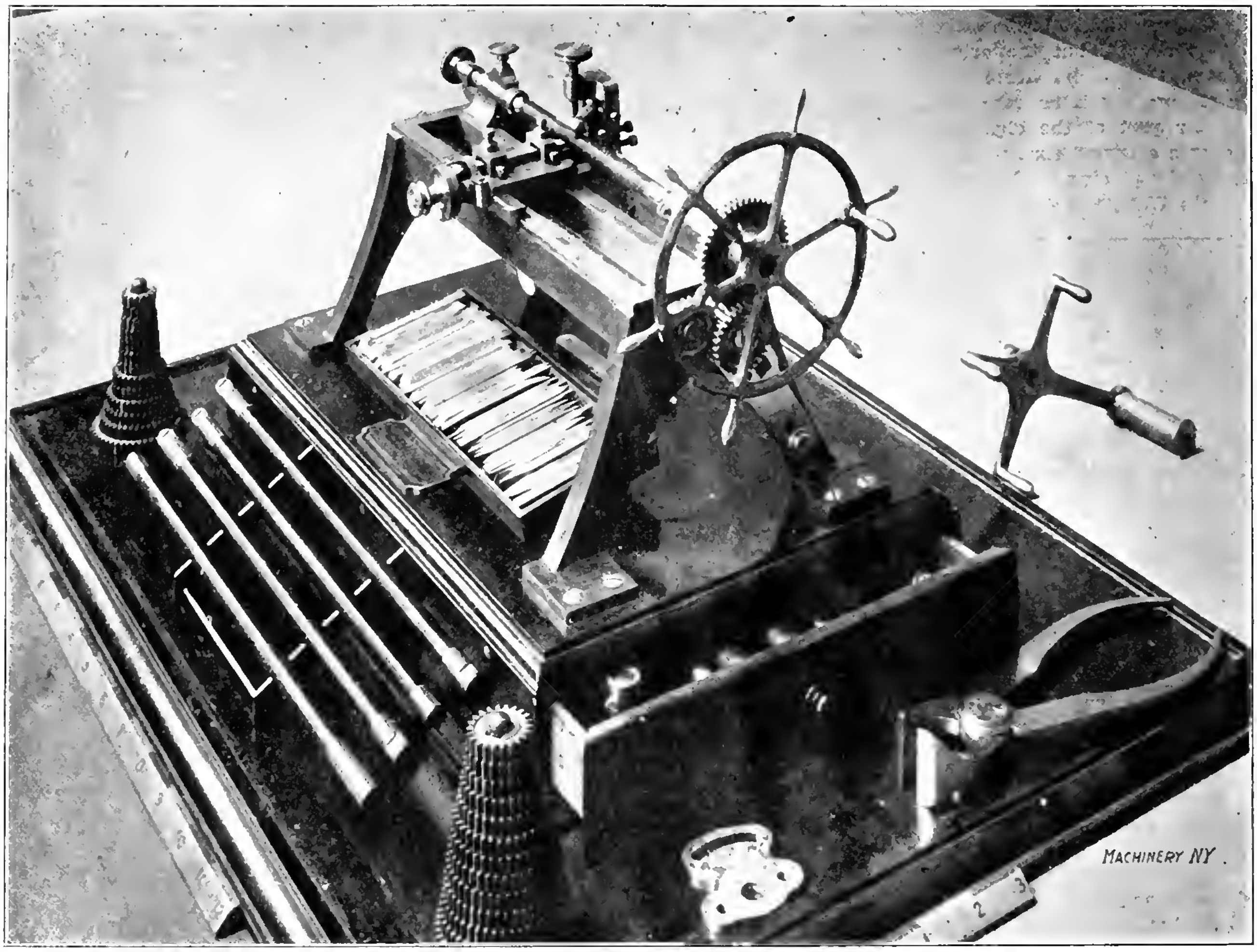


Fig. 3. Maudslay Screw-cutting Lathe, about 1800, South Kensington Museum

Nasmyth has illustrated an early method of screw cutting in the lathe, in which change wheels were placed, one on the work, the other on the end of the longitudinal feed screw of the slide-rest.

The earliest lathes were of dead center type, a principle which survives in watchmaker's turns, axle turning lathes, and in cylindrical grinding machines. The rotation of the work was at first effected by a cord, which survived in the fiddle drill, followed by a spring pole and cord operated from a treadle. The bow can be traced in works published in 1568-1569. Moxon shows it in 1703, and Bergeron in 1792. It is also illustrated in the French Encyclopedia under date 1772. The movement was necessarily one of reciprocation. But the wheel driven lathe was also in existence, and illustrated in 1624, 1677, 1701; and in the French Encyclopedia, combination lathes were in use, employing either bow or wheel.

The development of the running mandrel was slow. The first occurs in 1568. The earliest were of wood, followed by those of iron running in wooden collars, whence the traversing mandrel for cutting screws was developed, with divided bearings of lead or tin cast in dovetailed recesses in the head. The crude lathe heads passed through many stages of development, as did also the loose poppets. The beds, originally of wood, their faces protected later with iron plates, came to be made as triangular bars of wrought iron, or as separate bearers of cast iron. To this period, about the beginning of the nineteenth century, is traceable the veed edges which survive to-day. Afterwards these were cast together with ends. The writer well remembers as an apprentice some old lathes of this kind still at work, driven with ropes on veed pulleys, though of 8-inch or 10-inch centers, and old men of between 70 and 80 operating them, often using heel tools, though slide-rests were fitted.

The modern machine shop owes its existence to the development of the steam engine by Watt. The second Soho Foundry, started in 1795, was probably the first shop in which machine tools other than the lathe were constructed, and employed on an extensive scale. Many of these tools were recently still in existence—venerable relics, more than a century old. At that early period a notable feature was the massiveness of the machines which were designed and constructed, necessarily capable of dealing with the large pumping and marine engines of the later years of the eighteenth century and the early years of the nineteenth century. One of the old double geared face lathes at Soho would take a diameter of 26 feet and a width of 12 feet from the faceplate. It had back gears, the driving taking place on an internal spur ring bolted to the back of the faceplate. It had also five slide-rests, rendered self-acting by means of chain and ratchet feed actuated from the mandrel through an overhead. Some of the old lathes at Soho were like the modern break lathes, having a transverse bed on longitudinal bases.

A heavy faceplate at Soho was driven by worm gear, double threaded, the wheel being a mortise with cogs of 2 inches pitch and 6 inches length of face. The worm was driven by a four-stepped cone. A pit in front of the faceplate took large work, and a massive slide rest opposite it was power-driven from a shaft overhead, belted from the lathe mandrel. At that time square threaded screws were cut with chisel and file by hand, and specimens of these, 2 inches diameter and 10 feet long, were recently in existence.

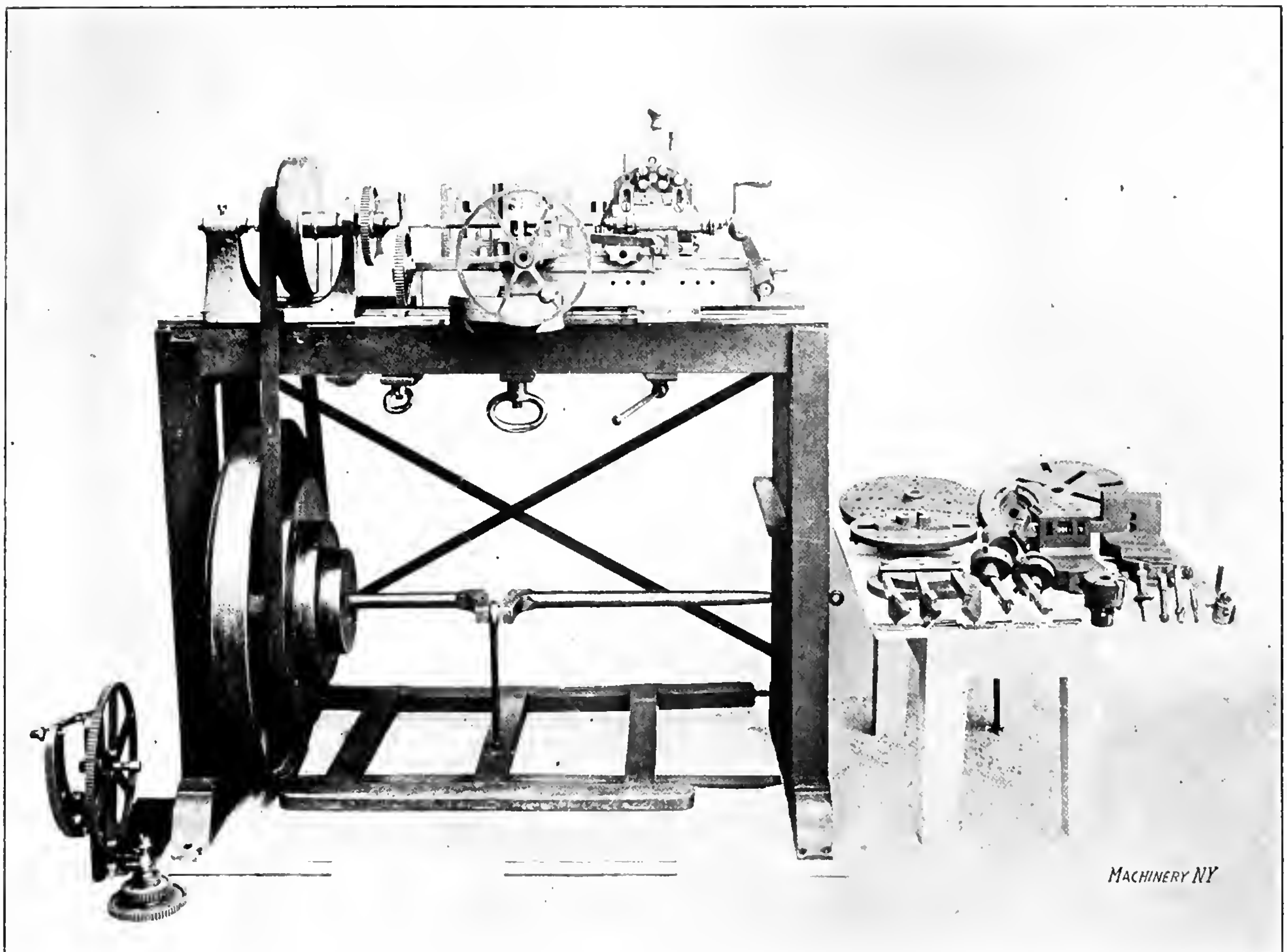


Fig. 4. Lathe used by Babbage in Experimental Work, South Kensington Museum

A very large face lathe constructed by Henry Maudslay was until a few years ago in existence at the Lambeth works, now dismantled. It was capable of facing up to 40 feet diameter, and had been used to turn the rims of flywheels. It had been employed also as a boring lathe by the substitution of a boring bar, and had bored cylinders up to 10 feet in diameter. The mandrel was $9\frac{1}{2}$ inches diameter in the larger bearing.

An interesting old lathe in the South Kensington Museum is shown in Fig. 4—interesting for three reasons; it was the one on which Babbage performed his experimental work, it contains the second compound slide-rest made by Clement, and it is an example of a machine tool in which all operations were performed that could be performed, in accordance with the practice of that period.

The bed is of cast iron carried on wooden supports. A

single pulley is driven from a three-stepped driving wheel, and the headstock was shifted along when the pulley had to be brought into line with either step. A division plate on the pulley has circles of holes of 200, 180, 112, and 12 holes each. The slide-rest has three slides, the lowest being shallow to be clamped in any position transversely to the bed. On this is bolted a long slide with a lead-screw of nine threads to the inch, the threads being of vee section, and the slide being capable of rotary adjustment through an angle of about 45 degrees. The screw operates the uppermost slide which has alternative positions for the tool holder. Babbage, it will be remembered, designed the first tool holder, which was a model not essentially different from several that are in use now. One of these is seen lying on the slide-rest. The slotted bracket seen behind the rest, and which is fixed on the lowest slide, is used for the attachment of work which has to be planed, shaped,

wide ranges in diameter beyond the capacity of the comparatively short traverse slide, the socket was carried on a sole plate movable across the saddle, to which it could be tightened with bolts. With the disuse of hand turning, the socket has been discarded in favor of the more substantial and more accurate arrangement which is embodied in the modern lathes. The tool "post" survived long as a post, because it was so conveniently used alternatively for receiving a tee rest for hand turning, and a slide-rest. It can be traced from the French Encyclopedia, 1772, down to the period of the writer's apprenticeship. In a

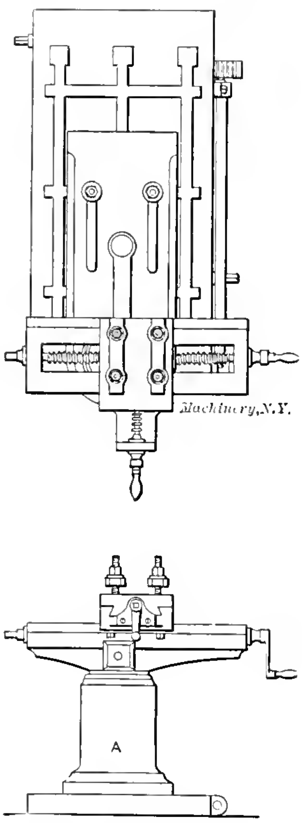
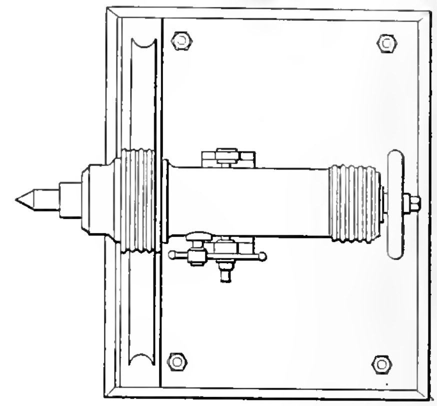


Fig. 5. Slide-rest of Boring and Turning Machine



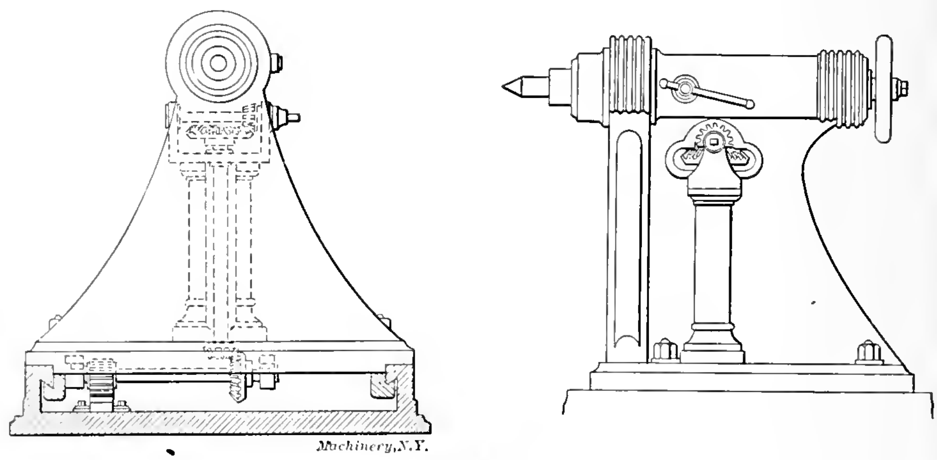
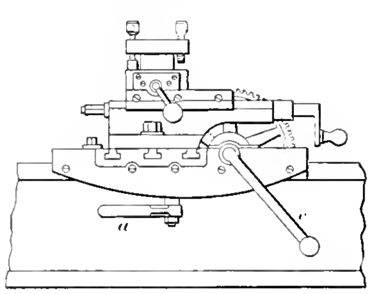


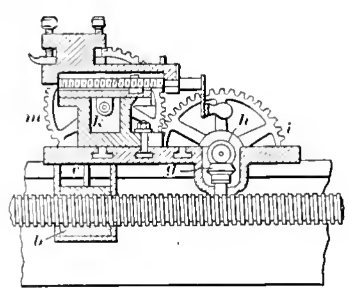
Fig. 6. Poppets of Boring and Turning Mill, Kinmonds, Hutton & Steel, Dundee, Scotland. About 1847

or slotted. The lathe is also rigged up for screw cutting. A chuck with the first change wheel is put on the mandrel, and a suitable train of gears, held by a quadrant bolted to the lathe bed, terminates in a wheel keyed on the end of the lead-screw of the slide-rest. Several appliances were added between 1824 to 1830, including various faceplates and chucks.

rather disguised form the same design exists in the present wheel lathes in which the post is fixed and the sliding given through a ratchet feed.

The slide-rest in its present essential design was due to Whitworth. An early form is illustrated in Fig. 7. There is no provision as yet for angular turning, and no separation





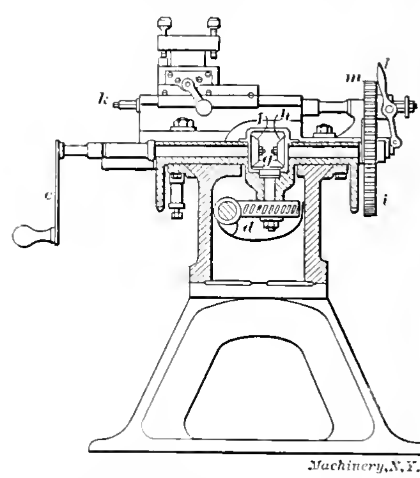


Fig. 7. Early Whitworth-Slide-rest

A two-jaw self-centering chuck is one of these, centered by means of a right- and left-hand screw. There is an adjustable face milling cutter, a large facing cutter, and a machine vise. Wood turning tools are points, gripped in holders by means of a strap, seen on the table to the right.

Many of the slide-rests in use sixty or seventy years ago, Fig. 5, were evidently variations or modifications of the older tee rests employed for hand turning; that is the sliding arrangement involved the use of a socketed pillar *A* such as was used for the tee rests. The two slides for longitudinal and cross traverse were mounted upon and screwed in the pillar, and being removable, the tee rest could be substituted for hand turning. To effect an extent of movement such as would be required for setting the tool to suit work having

between the feed rack and lead-screw. But in other respects it resembles, in the main, present-day rests.

The design shows the carriage with guide strips embracing a bed with veed edges, the carriage being clamped with the handle *a*. The guide screw lies within the bed, and is placed to one side for protection. The body of the rest is fitted and clamped with tee head bolts to the carriage. It supports the transverse slide, which is actuated by a hand-

screw, or by power, and this again receives the tool holder similarly actuated. The details of these are obvious without special references. The curious part of this design is the method of utilizing the lead-screw for screw cutting through the nut *b*, which is disengaged by the pin *c*; and for feeding through the tangent wheel *d*. When the clasp nut is out, and the lead-screw not being rotated, the threads of the screw are made to fulfill the function of rack teeth. This is done by turning the handle *e* which drives the bevel wheels *f* and *g*, the latter being on the spindle which carries the tangent wheel *d*.

The cross feed is derived from the same bevel wheels, being transmitted through *h* to the wheel *i*, which is always running when the rack feed is in. The cross-feed screw *k* is put into action by the lever *l* and wheel *m*.

Fox of Derby was using a rack and pinion for traversing the slide-rest about 1830.

The early loose poppet which had the mandrel screwed along its length and was turned in a block of wood, or a metal nut, was superseded by the plain cylindrical mandrel as we know it to-day, the invention of Joseph Clement, and it is said simultaneously by M. Collas, a Frenchman. The transverse adjustment of the headstock for taper turning is old, being certainly in use before 1847.

As lathes increased in weight, provision had to be made for effecting the movements of the loose poppet by power. The present simple device of a rack and pinion in front of the bed or at front and back, was not so obvious as it seems now. In a drawing of an old heavy lathe (1847), Fig. 6, by a defunct Dundee firm, a roundabout way was adopted. A rack ran along within the bed, having its teeth uppermost. A vertical shaft within the poppet turned by a pair of bevels and winch handle at the top actuated another pair of bevels in the base, the last of which on a transverse shaft carried a spur pinion which engaged with the rack.

Long after the adoption of metal mandrels and metal collars or bearings these were divided longitudinally. Whitworth designed the conical form of solid bearing, with the front cone much steeper than the rear one, which has remained standard Manchester practice for all except the heaviest lathes.

This outline brings the subject of the lathe down to living memory. In the next article it is proposed to outline the history of some of the other machine tools.

* * *

A project is on foot for building an international dam across the Niagara River to maintain the water level of Lake Erie at not less than a certain minimum height, the year round. Every Autumn the level falls so as to seriously interfere with shipping, and it is for improving the present condition that the dam is considered. If built, the dam could be used for another purpose equally laudable and valuable. There has been much agitation against the defacement of the natural beauty of Niagara Falls because of the amount of water used by the power companies which materially reduces the volume of flow over the falls in low water periods. The dam could be used to impound water at night, practically cutting off all flow for certain hours through the night and storing it up for use in the daylight hours. In this way it would be possible for the power development of Niagara Falls to be materially increased for daylight service without decreasing the normal volume of flow, the daylight flow being sufficiently in excess of the normal flow to compensate for that used by the power concerns.

* * *

Cheaper radium is promised by the discovery that the ash of lignite found in Sweden contains radium which can be extracted by an inexpensive process devised by Dr. Gustaf Hellsing. A company has been formed for exploiting the invention. According to *Engineering* it is expected to extract about 0.075 grain troy from each ton of the raw material. The technical side of the problem is fully solved and there is no doubt as to where and how the radium can be obtained, but there is, of course, the risk that the present enormously high price of radium may be reduced through fresh discoveries.

OBSERVATIONS ON THE MAKING OF HIGH-SPEED STEEL TOOLS

O. M. BECKER*

The collection and orderly preservation of data as a basis for subsequent rational deduction and intelligent procedure has long been considered an essential concomitant of the scientific method; and it is now coming to be pretty generally understood that the scientific method is also the successful business method, whether the end sought be the perfection of technical processes or the organization of a business system. The preservation of appropriate data as a guide to the production of superior high-speed steel tools by the simplest efficient methods, should, therefore, need no arguing. The sneer of the small man in a small place at "red tape"

TOOL RECORD

Tool Name.........Size ....No.....Lot No.....
For Piece No.......Operation No.......Department ....

Steel ....Analysis: C...T...Cr...Mo...
Critical Point .... S...Si...V... ....
C. P. Determined.............Analysis Determined ....

Forging Temperature.........Forge No.......Smith.........
Hardening Temperature.......Furnace No.....Operator......
Tempering Temperature.......Furnace No.....Operator......
Ground before Hardening?....Finish Grinding by..........
Date Finished................Checked by ....

Memoranda ....
....
....
....
....
(Signed)

and "over-refinement" is not heard nearly so much as formerly; and this is as it should be, especially as regards the manipulation of the new steels. The question under consideration concerns not alone the keeping of data, but, more particularly, the kind of data to be kept.

Kind of Data to Preserve

Within moderately well established limits the precise treatment best calculated to develop the highest efficiency in a tool intended for a special purpose is usually found by the "cut-and-try" method. It is desirable, therefore, that besides the record of the performance of the tool, there should be data showing the precise conditions under which the tool was treated while in process of manufacture. These conditions are comprehended in the tool record shown herewith;

DIRECTIONS TO TOOL-MAKERS

1. Lot No..
2. Kind of Tools.......................................
3. Steel to be Used....................................
4. Class of Work on which Used.........................

5. Hardening Furnace ....
6. Temperature ....
7. Method of Cooling...................................

....

8. Temperature of Bath.................................

9. Method of Tempering.................................
10. Tempering Furnace ....
11. Temperature ....

12. Memoranda ....
....
....

Completed ....
(Signed)

once definitely known, they can be varied from time to time as may be indicated by the results obtained from the tool at work. Obviously, when a set of conditions is found which yields just the proper excellence, it is necessary only to duplicate these conditions to obtain satisfactory results. The proper conditions will then be definitely indicated in the directions accompanying each subsequent lot of tools of the kind. It will be understood, of course, that there is small value in such data and directions unless the tool manufacturing plant is equipped so as to take advantage of this information; that is, unless the plant has a variety of fur-

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naces and other apparatus suitable for obtaining accurate information as to conditions, and for meeting the requirements indicated upon the direction cards. Time spent in experimenting intelligently—that is, experimenting with adequate appliances, materials and data—to fit the tool most nearly to its work, and to give it treatment which will produce the highest attainable efficiency in its special work, is well and profitably spent.

Hardness or Temper of High-speed Steel Tools

Of the elements involved in tool efficiency, hardness or temper formerly was considered the most important, the design and conditions of use being little regarded. At the

Fig. 1 Planer Roughing Tool with Machine Steel Shank and High-speed Steel Cutting Edge composed of a Comparatively Thin Piece of High-speed Steel brazed to the Shank Used in the Shops of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio

present time, the intelligent making of high-speed tools involves a consideration of all these and other elements, relegating to hardness or temper its appropriate place. The extreme hardness of many of these tools has frequently led to the inference that a tool has been properly treated if it is very hard, so hard that a good file will not "touch" it. However, extreme hardness is not always an indication of the efficiency of a high-speed tool; although it is necessary in certain classes of work (cutting refractory stock, for instance), in others it not only is unnecessary, but perhaps even undesirable. As a matter of fact the largest users of the best makes of high-speed steel find that for many purposes tools do the best work and give the most efficient service when soft enough to be "touched" by a good file, and even when so soft that it will "take hold." However that may be, the file test for high-speed tools is quite valueless even in those cases where it is desirable that the degree of hardness be determined. Such tests, to be of value, would require that the files must be absolutely uniform in temper. Even the best of files, however, vary more or less in temper and hardness; and a tool passed as "hard enough," when tested by one file might easily fail to pass the test when tried by another, presumably of the same temper.

Allowances to be Made for Variations in Sizes of Tools After Hardening

Usually it is of no particular consequence, in tools of the lathe or planer type, whether the stock is exactly sized or not, so long as there is enough material to withstand the enormous strains and to prevent vibration, and consequently inferior and inaccurately sized work. In other types of tools, however, as in drills and mills, it is necessary, when ordering stock, to make allowance for the burnt skin which must be removed after hardening. While the effect on high-speed steel is apparently much less marked than in the case of the carbon steels, nevertheless the long-continued high heat in annealing affects the surface of the bars enough to make it necessary to remove the same to a depth varying more or less according to the size of the bar. In stock above an inch in thickness one-eighth inch should be added to the required size, and in large sizes, the proportionate allowance decreases rapidly.

The allowance for shrinkage of finely-sized tools during the hardening process is distinct from the allowance just mentioned. Loss in size is almost invariably the result of exposure to the air while the tool is very hot. The loss due to actual shrinkage is so small, except in large tools, as to be scarcely appreciable, and is usually negligible when the barium chloride process is used. If the hardening is done by the customary methods, a slight allowance is possibly desirable in certain cases, say in the arbor holes in milling cutters, the diameter of taps, etc. With care in hardening, even by the customary processes, the variation in a 1-inch diameter will scarcely exceed 0.0005 inch, and more likely will be less, though indeed it may be as great as 0.001 inch and even more—so much depends upon the care exercised and the method employed. It should scarcely need to be added that the holes in all mills intended for very accurate work should be ground after hardening, the mills having been first carefully centered in a chuck.

It might also be mentioned that apparent variations in the size of tools like threading dies and taps and other tools which cannot be ground after hardening, are frequently only the effects of the roughening of the surface during the treatment. The barium process very largely overcomes this difficulty and does so entirely, unless, as is generally the case, the defect is present before the hardening. This roughness usually arises from the method of cutting the threads, or teeth, as the case may be. Such threads or teeth are best, and of course most quickly, cut by milling, lubricating the cutter with thin oil. Next to this it is best to rough out the threads with a chaser, as close to size as may be, without lubricant, and then to re-cut or finish with a single-point tool held in a spring-thread holder, the threads being kept slightly lubricated with very thin oil. To compensate for the roughness often present in high-speed tools of this class, it is customary to give rather more relief than in the case of those made of ordinary steel. The increased relief minimizes the lodging of particles of steel in the surface of the cutter behind the cutting edge, which tend to act as cutters, sometimes very appreciably increasing the cut.

Extreme smoothness is also a desirable quality in high-speed drills, but it seems impossible to obtain by present methods of cutting a smoothness of surface like that of the carbon steel drills; to secure this it is necessary to polish the flutes. If the hardening is by the barium process, the polishing may be done before hardening, for that process leaves the surface absolutely unimpaired.

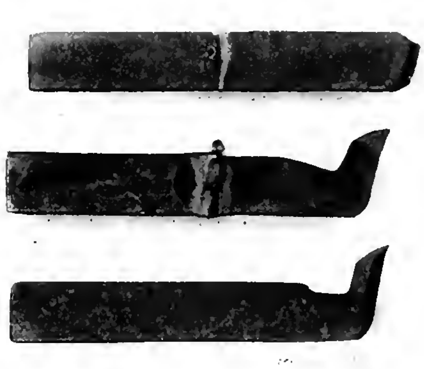

Fig. 2. Diamond-point Lathe Tool made with High-speed Steel Cutting End electrically welded to a Mild Steel Shank. Courtesy of the Thompson Electric Welding Co.

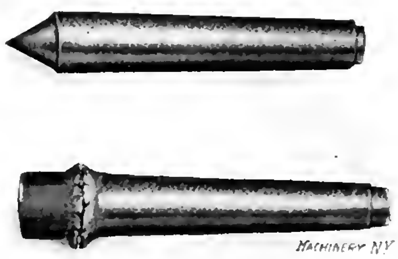

Fig. 3. Lathe Center made with High-speed Steel Point electrically welded

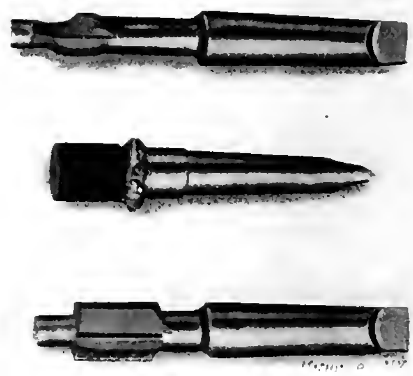

Fig. 4. Broken Counterbore Repaired by Electric Welding

Disadvantages of High-speed Steel Tool-holders

The early method of economizing in steel by using tool-holder stock rather than making the entire tool of high-speed steel, in the case of those tools whose cutting edges or points work without intermission (as those used for turning, planing and similar operations) is open to criticism, and is not

now so generally followed as formerly. A characteristic of the operation of high-speed tools is the rapid generation of heat in the cutting edge. In the case of milling cutters and kindred tools this is of small consequence, because the cutters are intimately attached to a relatively large mass of metal which conducts the heat away very efficiently. Furthermore, these cutters work intermittently, each for a very brief space of time, and for the remainder of the revolution are exposed to the air and cooled by it. The cutting edges are not allowed, therefore, to get exceedingly hot, as is the case with the edge of a turning tool run at the same speed. It is necessary that the body of such a turning (or similar) tool be large enough to conduct away a considerable portion of the heat generated at the cutting edge; and in order to do this effectively the tool must be continuous; that is, there must be no appreciable separation between the part of the tool which does the cutting and the body from which most of the heat radiates, as there is ordinarily when a small piece of steel is held in a tool-holder. There are indeed tool-holders which minimize this difficulty; but even these are not satisfactory in large sizes.

Methods of Uniting High-speed Steel with the Tool Body*

From the first, methods were sought whereby high-speed steel cutting points could be intimately combined with tool bodies of ordinary and much cheaper steels. For the most part the methods tried were ineffective and impracticable. The reasons are not well understood. The disinclination of the two steels to unite probably is due to a difference in their coefficients of expansion. There is, however, no trouble in brazing them together; and when this does not involve placing a great strain upon the brazed joint, this method does very well. Obviously the cutters are hardened before being brazed into place. A successful example of such a combination is a lathe or a planer tool made with practically no forging and with a relatively thin plate of high-speed steel brazed to the front and top to form the cutting edge. Rose and other forms of reamers and mills have been made in a similar way, the body of machinery steel being machined with recesses for high-speed blades, which are brazed into place. Such tools have been in use for several years, with satisfaction. The latter, especially, are as good as if of solid high-speed steel except when it is essential that they be re-annealed or re-hardened—which is seldom necessary.

Almost as soon as the new steels made their appearance the writer suggested and demonstrated the possibility and feasibility of welding, electrically and autogenously, a high-speed cutting point and a machinery steel tool body, the latter of such proportions, of course, as to give the requisite strength to the tool. Such tools conform to the requirement of being perfectly continuous, and the weld is practically as strong as the rest of the tool. It is feasible to forge the end to any required shape as if the entire tool were of high-speed steel; and, since in hardening only the nose is heated to a high heat, the machinery or tool steel body is in nowise impaired. The method of electrical welding, as used in this connection, is exceedingly simple. The two pieces to be welded are attached to the terminals of a circuit of suitable voltage, and the edges brought together. The resistance to the passage of the current offered by the imperfect contact sets up enough heat to melt the metal and forms a perfectly homogeneous junction. The autogenous (oxygen and acetylene blow-pipe) method is almost as simple; the flame is directed into the crevice where the two pieces are brought together, and melts the adjacent metal so as also to form a homogeneous joint.

Another method (patented) recently brought forward, somewhat resembling brazing, is asserted to give a joint fully as strong as the rest of the tool. A thin film of copper is placed along the line of the joint, and the parts to be welded are surrounded by a reducing compound and then placed in a furnace raised to a temperature of about 1,200 degrees C. (2,200 degrees F.). The copper flows freely into the interstices and is said to produce actual cohesion between the adjacent molecules, making a perfect joint, so strong that a fracture will follow a new break rather than pass through the joint.

* See MACHINERY, October, 1908, "Electric Welding of Tools."

These methods are available for all classes of tools made partly of high-speed and partly of machinery steel or other materials. Reamer and mill blades, die faces, shear blades, jack knives, etc., all are readily welded to supporting forms or backs and make tools quite as efficient as if of solid high-speed steel—and generally much more so than if the cutters or faces were attached by screws, bolts, rivets, or similar methods. Long-shank and extension drills, reamers, etc., can readily be made with the cutting parts of high-speed steel and the shanks of cheaper steel. The processes mentioned, especially the electrical, are available also for the repair of broken tools, many of which can thus be saved for further use. The repairing may involve the welding of the broken parts or the replacing of an old part by a new, as may be most expedient.

Cutting High-speed Steel

Only an expert can nick and break high-speed steel from the bar without damage to the structure adjacent to the fracture—and even an expert cannot be sure of doing so with safety; the best way, where the end is to be used for working purposes, is to cut the bar. The circular saw most frequently used does very well, though a band saw works better and rather more rapidly. Small bars can readily be cut in bundles, if held very rigidly. The saws, obviously, should, themselves, be of high-speed steel. Complaints have been made that it is impossible to saw these steels. The complaints probably originated in the use of improperly hardened saws; for there is no difficulty whatever in cutting them with suitable saws. A singular but most effective method has been employed to some extent. It consists in the use of a highly-speeded disk of tough steel. When an unused disk is first forced against the high-speed steel, the disk does not take hold well; but after being run in contact with the high-speed steel for a time it cuts perfectly and rapidly, leaving a clean burless kerf. The disk may be of any steel tough enough to withstand the tremendous centrifugal (and other) stresses set up by the pressure and the terrific speed required. Just why such a disk cuts is not exactly clear. The periphery is usually found studded with particles of the steel being cut, and the "sawdust" appears to be the result of true cutting.

Detecting Cracks in High-speed Steel Tools

Fine cracks in tools are most difficult to discover. Even the microscope often fails to disclose them. Generally they can be detected, if present, by the very simple expedient of moistening the suspected surface with petroleum, rubbing clean, and then wiping off with chalk. Some petroleum enters the cracks and afterwards sweats out, moistening the overlying chalk. The nature and extent of the cracks are thus rendered visible. This frequently is of great importance in testing lots of high-speed steel tools.

Re-forging of Worn-down Tools

Tools which have worn down so as to be useless can usually, when made of solid high-speed steel, be forged or machined down and worked into tools of smaller size, if ordinary care is exercised. It is necessary always to re-anneal prior to attempting to machine such old tools; and it is also expedient when forging them to smaller shapes. In passing, it might be mentioned that re-annealing is desirable after machining and before hardening all sorts of intricately-shaped tools, in order to relieve any possible machine-caused strains. In re-forging high-speed tools, whether for reduction in size or merely in re-fettling, it is desirable that they be heated rather slowly at first; they should not be thrust cold into a very hot fire.

* * *

An alloy of iron and thorium which possesses remarkable properties has been produced by Mr. Welsbach, the well-known inventor of the incandescent gas mantel. When struck lightly against a piece of iron this alloy emits exceedingly bright sparks, and sufficient heat is developed to ignite tinder instantaneously without the repeated efforts required with the old-fashioned flint and steel. The new thorium flint may be called an everlasting match, and will undoubtedly be very useful to explorers and tourists and for the ignition of explosives.

CALCULATION OF PILLAR CRANES*

CHARLES A. SCHRANZ†

The maximum stresses in the different parts of a pillar crane are due to the maximum load lifted (the live load) and the weight (dead load) of the crane parts themselves. Fig. 1 shows a conventional design of a hand pillar crane, and assuming, for an example, the maximum load $Q = 5$ tons, the height $H = 12\frac{1}{2}$ feet, and the radius $A = 13$ feet, the stresses in the different parts of the crane are calculated as shown in the following.

Stresses in the Boom

Fig. 1 shows plainly that the stresses in the boom and tie-bars are not due to the live load only, but that the weight

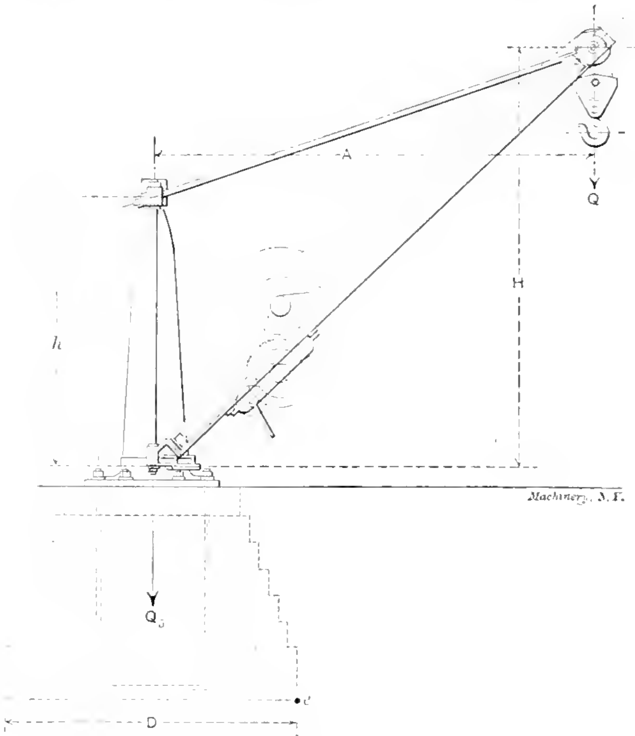

Fig. 1. General Layout of Pillar Crane

of the eccentric parts of the crane (*i. e.*, boom, tie-bars, hoist, sheave wheels, crane hook and hoisting rope) and the pull of the hoisting rope must also be considered. As it is not possible to determine the dead load accurately before the crane is calculated and designed, it must be assumed. A practical method is to assume the weight of the above mentioned eccentric parts of the crane as half of the maximum live load, and its center of gravity at a distance equal to one-fourth of the radius of the crane from the center line of the pillar. These assumptions expressed in formulas read:

$$Q_1 = \frac{Q}{2};\ \text{or}\ Q_1 = \frac{10{,}000}{2} = 5{,}000 \text{ pounds.} \qquad (1)$$

$$a = \frac{A}{4};\ \text{or}\ a = \frac{13}{4} = 3\frac{1}{4} \text{ feet.} \qquad (2)$$

in which Q_1 = the weight of the eccentric parts of the crane, and a = the distance of the center of gravity of Q_1 from the center of the crane. If the actual figures, determined after the crane is calculated, differ considerably from these assumptions, corrections have to be made.

The next step is to determine the height h of the pillar, a practical rule being to make h about 0.6 of the radius of the crane:

$h = 0.6\,A$; or $h = 0.6 \times 13 = 8$ feet, approximately. (3)

The frame diagram shown in Fig. 2 can now be drawn. According to the law of equilibrium the sum of moments of the external forces must be equal to the sum of moments of the internal forces about the same center. The moment M_i of the internal force in the boom is the product of its compressive stress C and its lever arm e ($5\frac{3}{4}$ feet) about center K:

$$M_i = Ce \qquad (4)$$

The moments of the external forces about center K are:

The moment of $Q = M = Q\,A$ (5)
The moment of $Q_1 = M_1 = Q_1 a$ (6)
The moment of $Q_2 = M_2 = Q_2 b$ (7)

Dimension b is found to be 4 feet by scaling.

Substituting the values:

$M = 10{,}000 \times 13 = 130{,}000$ foot-pounds.
$M_1 = 5{,}000 \times 3\frac{1}{4} = 16{,}250$ foot-pounds.
$M_2 = 5{,}000 \times 4 = 20{,}000$ foot-pounds.

The sum of above moments is:

$$M_s = M + M_1 + M_2 = 130{,}000 + 16{,}250 - 20{,}000 = 166{,}250 \text{ foot-pounds.} \qquad (8)$$

As explained above

$$M_i = M_s \qquad (9)$$

or

$Ce = M_s$ and transposing

$$C = \frac{M_s}{e} = \text{the compressive stress in the boom.} \qquad (10)$$

Substituting the values in above formula

$$C = \frac{166{,}250}{5\frac{3}{4}} = 28{,}910 \text{ pounds.}$$

The unsupported length of the boom scales about 17 feet, and as in this case it is made up of two channels the load on each channel is $\frac{C}{2}$ or 14,455 pounds. The inclination of the two channels towards each other need not be taken into consideration as the increase of load is very small. Consulting any handbook of information relating to structural steel we find that a 6-inch × 8-pound channel has a section area of 2.38 square inches and a radius of gyration with respect to an axis perpendicular to its web of 2.34 inches. Only this radius of gyration need be considered as the flanges of the two channels are latticed together. For the ratio of the length L of the boom in feet to the radius of gyration r in inches

$$\frac{L}{r} = \frac{17}{2.34} = 7.2,$$

which is not excessive. The elastic limit for soft steel may be taken at 30,000 pounds per square inch. Dividing the

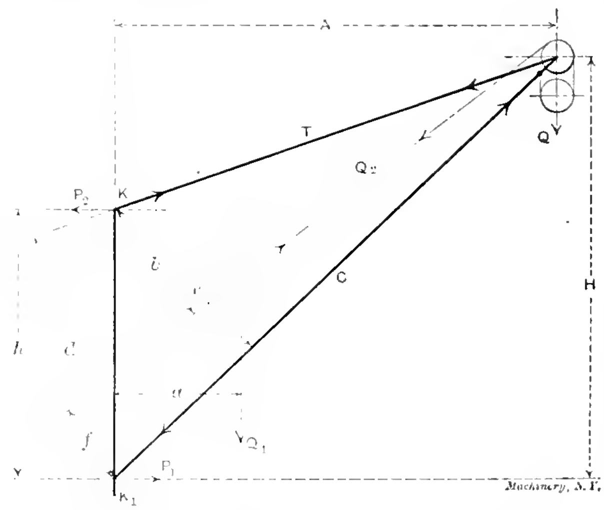

Fig. 2. Diagrammatical View of Pillar Crane

load on one channel by its sectional area the actual unit stress will be

$$\frac{14{,}455}{2.38} = 6{,}075 \text{ pounds,}$$

which shows that two 6-inch × 8-pound channels are quite sufficient to stand the load.

Stresses in the Tie-bars

To find the tensile stress in the tie-bars the same method as just explained will be used. Taking K_1 as a center of

* For previous articles on cranes, crane design, and efficiency of crane mechanism, see MACHINERY, January, 1909, engineering edition: Design and Construction of Electric Over-head Cranes, and also the articles there referred to; see also MACHINERY'S Reference Series No. 23, Crane Design.

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moments and referring again to Fig. 2, the moments of the external forces are:

Moment of $Q = M = QA$. (5)

Moment of $Q_1 = M_1 = Q_1 a$. (6)

Moment of $Q_2 = M_2 = -Q_2 f$. (11)

Dimension f is found by scaling to be $2\frac{1}{2}$ feet.

Substituting the values in these formulas:

$M = 10,000 \times 13 = 130,000$ foot-pounds,

$M_1 = 5,000 \times 3\frac{1}{4} = 16,250$ foot-pounds,

$M_2 = -5,000 \times 2\frac{1}{2} = -12,500$ foot-pounds,

and the sum M_s of these moments is

$$M_s = 130,000 + 16,250 - 12,500 = 133,750 \text{ foot-pounds.} \quad (12)$$

The moment M_1 of the internal stress T in the tie-bar is

$$M_1 = Td. \quad (13)$$

Dimension d scales $7\frac{1}{2}$ feet.

Since M_1 must be equal to M_s

$$Td = M_s \quad (14)$$

and transposing:

$$T = \frac{M_s}{d} \quad (15)$$

Substituting the values in formula (15) the tensile stress in the tie-bars is: $T = \dfrac{133,750}{7\frac{1}{2}} = 17,830$ pounds.

As there are two tie-bars the load on one is $\dfrac{17,830}{2} = 8,915$ pounds. Using a safe fiber stress of 10,000 pounds per square inch, the area of one bar $= \dfrac{8,915}{10,000} = 0.892$ square inch with the corresponding diameter of 1 1/16 inch.

Stresses in Pillar

The stresses in the pillar are due to the bending moments of the loads Q and Q_1 and to the direct vertical loads Q and Q_1. The bending moment of Q and Q_1 was found by formulas (5) and (6) to be 130,000 foot-pounds and 16,250 foot-pounds, respectively. The sum of these moments is

$$M_s = M + M_1 = 130,000 + 16,250 = 146,250 \text{ foot-pounds} \quad (16)$$

or 1,755,000 inch-pounds. This bending moment in inch-pounds must be equal to the product of the section modulus of the pillar cross-section, times the safe unit fiber stress. Considering the sectional area of a hollow cylinder for the cast iron pillar, the section modulus is

$$S = \frac{\pi (D^4 - d^4)}{32D} \quad (17)$$

in which $D =$ the outside diameter of the pillar, and

$d =$ the inside diameter of the pillar.

Using a safe fiber stress $s = 3,000$ pounds per square inch, the above mentioned equation reads:

$$M_s = \frac{\pi (D^4 - d^4)}{32D} \times s \quad (18)$$

Assuming an outside diameter of 24 inches, the inside diameter d is found by transposing the formula (18):

$$d = \sqrt[4]{D^4 - \frac{32 M_s D}{s \pi}} \quad (19)$$

and substituting the values:

$$d = \sqrt[4]{24^4 - \frac{32 \times 1,755,000 \times 24}{3000 \times 3.14}} = 20\tfrac{7}{8} \text{ inches.}$$

As mentioned before, not only the bending moment, but also the direct vertical loads Q and Q_1 must be considered. As the bending moment produces a tensile stress on one side of the column and a compressive stress on the other side, the additional vertical loads Q and Q_1 naturally increase the compressive and reduce the tensile unit stress somewhat.

The unit stress in the pillar caused by the vertical loads is

$$s_2 = \frac{Q + Q_1}{\text{Area}} = \frac{15,000}{110} = 137 \text{ pounds per square inch.} \quad (20)$$

110 square inches is the sectional area of the pillar at the dangerous section

The sectional area of the pillar was calculated for a bending stress of 3,000 pounds. Adding the unit stress for the bending moment and the unit stress for the vertical loads, the actual compressive unit stress is found to be:

$$3,000 + 137 = 3,137 \text{ pounds per square inch.} \quad (21)$$

Subtracting the unit-stress produced by the vertical loads from the unit bending stress the actual tensile stress s_t in the pillar results:

$$3,000 - 137 = 2,863 \text{ pounds per square inch.} \quad (22)$$

Vertical Tie-rods

The vertical tie-rods, connecting the crosshead with the lower end of the boom, receive the vertical component of the tensile stress T in the ties, and the vertical component of the compressive stress C in the boom, or what is the same, the added loads Q and Q_1.

$$Q_3 = Q + Q_1 = 15,000 \text{ pounds.} \quad (23)$$

in which $Q_3 =$ the stress in the two vertical tie-bars.

Each of the two tie-rods receives half of this load or 7,500 pounds. Using a safe unit fiber stress of 10,000 pounds, the area of one tie-rod is $\dfrac{7,500}{10,000} = 0.75$ square inch, with a corresponding diameter of one inch.

Pintle

The reaction P_2 on the pintle (see Fig. 3) is caused by the loads Q and Q_1, whose moments about K must equal the moment of P_2 about the same center:

$$QA + Q_1 a = P_2 h = P_1 h \quad (24)$$

and this formula transposed and the values substituted

$$P_1 = P_2 = \frac{10,000 \times 13 + 5,000 \times 3\frac{1}{4}}{8} = 18,280 \text{ pounds} \quad (25)$$

The reaction P_2 produces a bending moment on the pintle, and referring to Fig. 3, this bending moment

$$M_b = \frac{P_2 L}{2} \quad (26)$$

in which $L =$ the length of the pintle. Assuming the length $L = 1\frac{1}{2} D_1$, the formula (26) reads:

$$M_b = \frac{P_2 \times 1\frac{1}{2} D_1}{2}.$$

This moment has to be equal to the product of the section modulus of the sectional area of the pintle times the safe unit stress. The section modulus for a circular section being $\frac{\pi}{32} D_1^3$, and assuming the safe unit stress $s = 8,000$ pounds the equation reads:

$$\frac{P_2 \times 1\frac{1}{2} D_1}{2} = \frac{\pi}{32} D_1^3 s \quad (27)$$

and transposing

$$D_1 = \sqrt{\frac{P_2 \times 1\frac{1}{2} \times 32}{2 \pi s}} \text{ or} \quad (28)$$

$$D_1 = \sqrt{\frac{18,280 \times 1\frac{1}{2} \times 32}{2 \times 3.14 \times 8000}} = 4\tfrac{1}{4} \text{ inches approx.}$$

and $L = 1\frac{1}{2} \times 4\frac{1}{4} = 6\frac{3}{8}$ inches.

Besides the bending moment produced by the reaction P_2 the direct vertical loads Q and Q_1 also produce stress, and this stress per square inch is found by dividing the sum of the vertical loads by the sectional area of the pintle in square inches:

$$s_4 = \frac{10,000 + 5,000}{14.19} = 1,060 \text{ pounds per square inch.} \quad (29)$$

The maximum unit stress on the pintle is then:

$$8,000 + 1,060 = 9,060 \text{ pounds per square inch.} \quad (30)$$

Foundation Bolts

Considering an axis A-A in Fig. 4, which shows a plan of the base of the pillar, the sum of the moments of the overturn-loads Q and Q_1 about this axis must be equal to the sum of the resisting moments. The latter are due to the stress in the foundation bolts and to the weight of the pillar. This weight can easily be calculated as the cross-section of the

pillar is already known, and in this case is found to be: $Q_4 = 5{,}000$ pounds. The moments of the overturning loads with respect to axis A-A are:

$$M_4 = Q\,(A - n) \tag{31}$$

or

$M_4 = 10{,}000\ (13 - 1\tfrac{1}{2}) = 115{,}000$ foot-pounds,

$$M_5 = Q_1\,(a - n) \tag{32}$$

$M_5 = 5{,}000\ (3\tfrac{1}{4} - 1\tfrac{1}{2}) = 8{,}750$ foot-pounds,

in which n = distance of the foundation bolts from the center of the crane. In this case n is found by scaling to equal $1\tfrac{1}{2}$ foot.

The sum of the overturning moments =

$$M_4 + M_5 = 123{,}750 \text{ foot-pounds.}$$

The resisting moments of the foundation bolts are:

$$M_6 = 2P_3 n + (2P_3 \times 2n) \tag{33}$$

in which P_3 equals the stress in one foundation bolt. The resisting moment of the weight Q_4 of the pillar is:

$$M_7 = Q_4 n = 7{,}500 \text{ foot-pounds.} \tag{34}$$

The sum of the resisting moments is therefore equal to

$$M_6 + M_7 = 2P_3 n + (2P_3 \times 2n) + Q_4 n \tag{35}$$

and transposing

$$P_3 = \frac{(M_4 + M_5) - M_7}{6n} \tag{36}$$

Substituting the value s, the stress on one foundation bolt

$$P_3 = \frac{123{,}750 - 7{,}500}{6 \times 1\tfrac{1}{2}} = 12{,}910 \text{ pounds.}$$

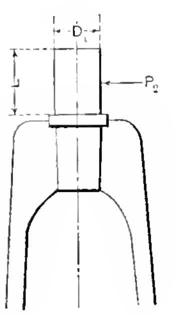

Fig. 3. Pintle of Pillar Crane

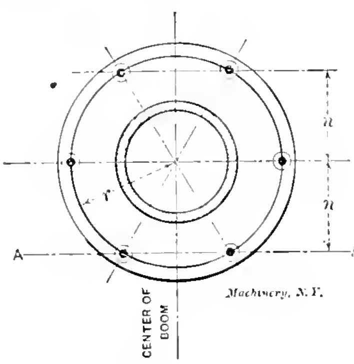

Fig. 4. Layout of Arrangement of Flange Bolts

Using a safe unit stress of 12,000 pounds, the area of one bolt is $\frac{12{,}910}{12{,}000} = 1.08$ square inch with a corresponding diameter of $1\tfrac{1}{4}$ inch.

[The calculation of the foundation bolts as here given is correct only on the assumption that the base flange of the crane and the bolts are made of inelastic materials. For a more fundamental treatment of the subject of foundation bolts, see MACHINERY, December, 1906, engineering edition: Flange Bolts (reprinted in MACHINERY'S Reference Series No. 22). For an article on the Working Strength of Bolts, which should also be considered in this connection, see MACHINERY, November, 1906, engineering edition. (Also reprinted in Reference Series No. 22).—EDITOR.]

Foundation

Referring to Fig. 1, we find the moments which tend to overturn the crane with its foundation about an axis passing through c to be:

sum of overturning moments =

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) \tag{37}$$

This sum of the overturning moments is resisted by the moment of the combined weights Q_5 of the foundation and the pillar:

$$\text{sum of resisting moments} = Q_5 \frac{D}{2} \tag{38}$$

The equation of moments therefore reads:

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) = Q_5 \frac{D}{2} \tag{39}$$

and transposing

$$Q_5 = \frac{Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right)}{\frac{D}{2}} \tag{40}$$

assuming the diameter D of the foundation to be 9 feet and substituting the values:

$$Q_5 = \frac{10{,}000\ (13 - 4\tfrac{1}{2}) + 5{,}000\ (3\tfrac{1}{4} - 4\tfrac{1}{2})}{4\tfrac{1}{2}} = 17{,}500 \text{ pounds.}$$

Deducting from this combined weight of foundation and pillar the amount for the latter, we get the theoretical weight of the foundation:

$$17{,}500 - 5{,}000 = 12{,}500 \text{ pounds.}$$

Using a factor of safety of 3, the weight of the actual foundation must be:

$$12{,}500 \times 3 = 37{,}500 \text{ pounds.}$$

Having calculated the different parts of the crane as described it is good practice to test the pillar for its rigidity, as the amount of deflection must not be too great. The load on the unsupported end of the pillar was found by formula (25) to be $P_2 = 18{,}280$ pounds. The deflection X in inches is:

$$X = \frac{P_2 h^3}{3\,EI} \tag{41}$$

in which

h = the height of the pillar in inches = 96 inches.

E = the modulus of elasticity = 12,000,000 for cast iron.

I = the moment of inertia $= \frac{\pi}{64}\,(D^4 - d^4) = 7{,}257.$

Substituting these values we find the deflection

$$X = \frac{18{,}280 \times 96^3}{3 \times 12{,}000{,}000 \times 7{,}257} = 0.062 \text{ inch,}$$

or about 1/16 of an inch, which is not excessive.

* * *

INTELLIGENT USE OF LABOR-SAVING MACHINERY

It is one thing to use labor-saving machinery in order to permit rapid production and to conserve the energies of workmen, so as to produce a better product with greater rapidity, and quite another thing to use labor-saving machinery simply to avoid work. In one case there is economy of production, while in the other case there is wastefulness of production. An illustration came to our attention not long ago in the building of a fence in City Hall Park, New York. This fence is made of one-inch heavy pipe, supported in suitable posts. To prevent it being made a roosting place by loafers "anti-sit-downs" were fastened to the top rail with one-quarter inch stove bolts. To drill these holes, a portable gas engine and electric motor were provided to drive an electric drill. The cost of the outfit and a suitable charge for its depreciation undoubtedly made the cost of drilling the holes considerably greater than it would have been had they been drilled by improved breast drills, with power feed and chain support. These useful little tools are capable of putting a hole through a one-inch pipe in a very short time, and the cost of equipment is very low. Labor-saving machinery should be something more than "labor-saving"; it should be production-increasing and economical as well.

* * *

When the De Laval steam turbine was first brought into the market, the units were small and there was no condensing, and the result was a high steam consumption. Subsequent improvements, however, have tended to reduce the steam consumption so materially that this type of steam turbine now claims a place among the most economical motors. In referring to the figures below it should be borne in mind that the steam consumption refers to effective horse-power, while in many cases it is customary to give the steam consumption per indicated horse-power. One 500 horse-power turbine installed at Stockport, Great Britain, shows a steam consumption per effective horse-power of $13\tfrac{1}{2}$ pounds per hour; another of 330 horse-power installed in St. Petersburg, Russia, shows a consumption of $12\tfrac{1}{2}$ pounds per hour.

LOCOMOTIVE REPAIR SHOP PRACTICE—2

THE C. M. & ST. P. R. R. SHOPS AT MILWAUKEE

ETHAN VIALL*

In this article, which is a continuation of the one published in the August number, the practice in the tool-room, boiler, and blacksmith shops will be specifically treated, and in addition descriptions of the tools and methods employed in connection with other branches of locomotive repair work will be given.

In the tool-room, which is in charge of Gust. Gstoettner, everything is neat and up-to-date as is evident by the illustration, Fig. 38, which shows the arrangement of the gear and milling cutter rack which is a model for any shop. Flue expander segments are all made in the tool-room, and the special mandrels used to hold the segments while they are being turned, are shown at *A*, Fig. 39; some of the unturned segments are shown at the right. At *B* is shown the way the segments are held together while being placed on the mandrel.

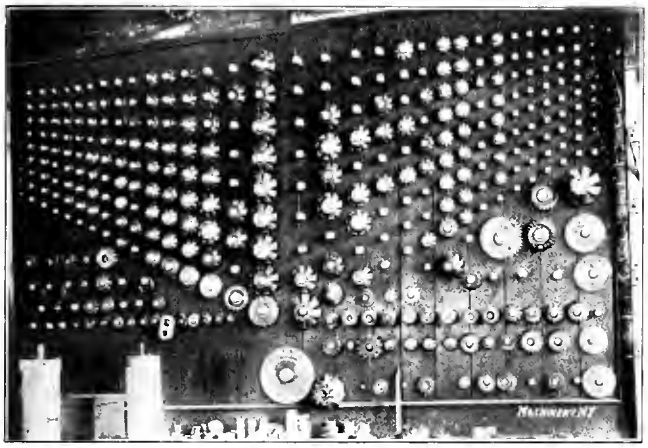

Fig. 38. Gear and Milling Cutter Rack in the Tool-room

The clamping collar shown is removed as soon as the mandrel nut is tightened enough to hold the parts securely. At *C* are shown three sets of finished segments held together by heavy rubber collars until wanted for use. The steel from which these segments are made is bought already drawn to the right sectional shape. It is then cut up into the right lengths and the ends, beveled sides and narrow edge ground on the grinder shown in Fig. 40. A special clamping device, *A*, holds the parts while the ends are being ground and another clamp *B* holds them while the narrow edge is ground. The device used to hold them while grinding the bevel, is out of sight behind the wheel.

Boiler Shop Kinks

In the boiler shop the common pneumatic flue swage used in most railroad shops, has a rapid-stroke pneumatic welding swage or die, placed on one side as shown at *A* and *B*, Fig. 43. After a new end has been placed on the flue and welding heat taken, it is placed in this die and the air turned on by means of the hand lever shown. The rapid blows complete the job in a hurry, and apparently do it just as well as the usual rolling device used for welding.

Fig 39. Flue Expander Segments and Tools used in making them

Ends of flues are cut off in the pneumatic trimmer, Fig 41, and repair ends are cut off and one end beveled in the machine shown in Fig. 44. This machine has a two-jawed pneumatic chuck *A*, for holding the flue which is being cut into short pieces. The principle of the operation of this machine can be understood by examining this and the following engraving. The bevel on one end of the pieces is obtained by using a wide cut-off tool straight on one side and beveled at about 45 degrees on the other.

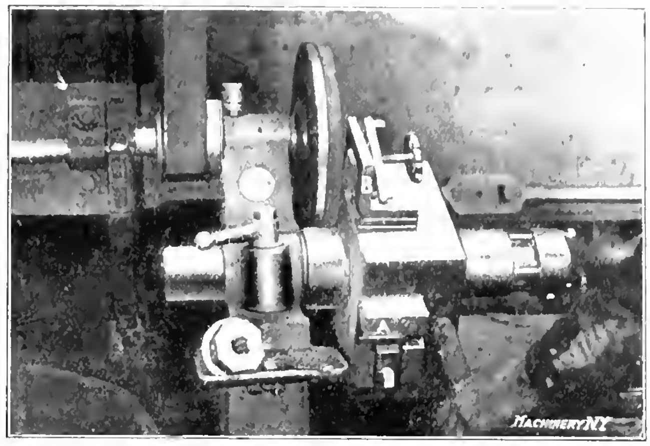

Fig. 40. Special Grinder for Flue Expander Segments

Fig. 45 is the same machine with a taper reamer placed in the pneumatic chuck *A*, for the purpose of beveling and removing the burr from the inside of the short piece of flue held by the hand clamping levers *C* and *D*. A large number of flue end repair pieces can be cut off and one end reamed in this machine in a very short time.

Assembling Springs

In the spring department of the blacksmith shop, springs are assembled and compressed ready for the band by the clamps shown in Fig. 46. After the hot band has been slipped into place, the clamp is removed and the band and spring compressed in the steam bulldozer shown in Fig. 47. While the pressure is on, the sides of the band are hammered down closely onto the spring with sledges. Pressure is kept on the band until it is cool enough to hold the spring leaves firmly together.

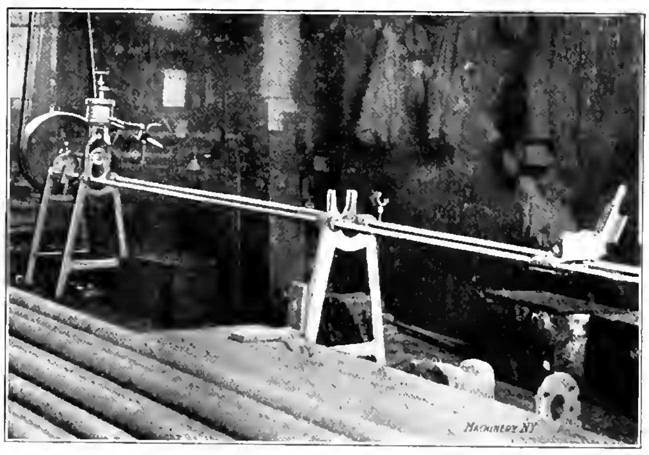

Fig. 41. Pneumatic Flue-cutter

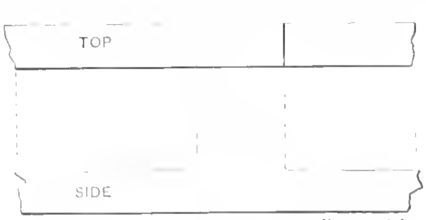

Fig. 42. The Way a Bar is upset in the Middle by a Bulldozer

Scrap metal is "baled" and then welded and forged into billets or slabs and then a number of these slabs are welded together, and forged into various locomotive parts. Fig. 48 shows nine of these slabs ready to be heated, welded and forged into a driving-axle under one of the big steam hammers.

* Associate Editor of MACHINERY.

Special Bulldozer Formers

Charles G. Juneau, who has charge of the blacksmith shop of the new car department, has some very unusual bulldozer forging and bending forms. The first piece of work here shown is really a forging job, but Mr. Juneau has contrived to do it in good shape on a bulldozer. The operation consists in upsetting the metal at the middle of a bar of iron which is afterward bent into a U-shape, the object being to give the piece more strength at the bend than would otherwise be the case, and allow for the stretching of the metal on the outside at this point. Fig. 42 shows the manner in which the bar is upset and shaped at the middle, and Fig. 49 shows how it is done, the piece in this case being intended for an axle hanger. To start with, the bar is heated at the middle for seven or eight inches; then it is placed in the machine and formed at one stroke by the ram shoving the bar against the stop *A*, which upsets it, after which the arm *B* wedges die *C* over against the other half *D*, completing the shape.

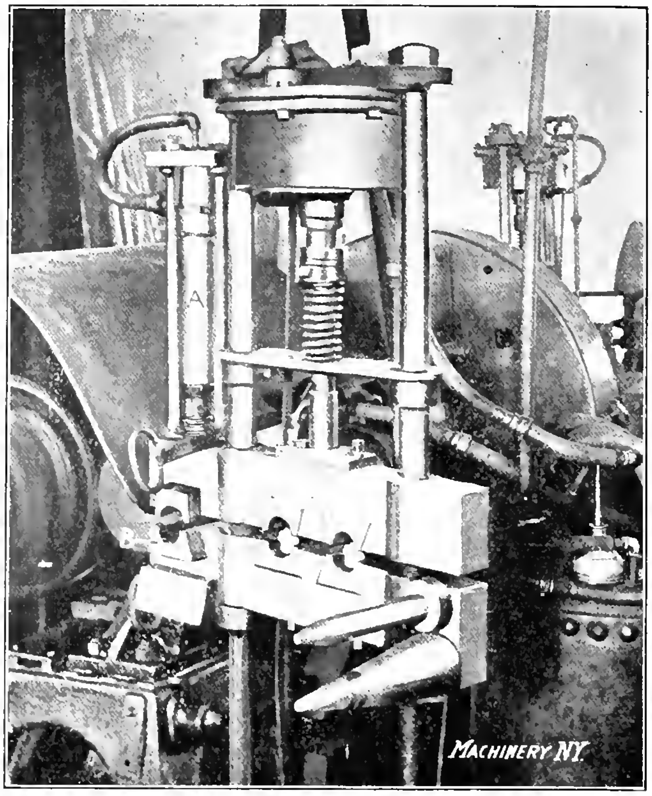

Fig 43 Pneumatic Flue-swage and Welding Die

The bars used for swing hangers, are upset in the same way, and are then bent as shown in Fig. 50, the bar being shown at *F* just as the former is starting to bend it, and at *G* is shown the way it looks at the end of the stroke. The partially made swing hanger is now placed in the former shown in Fig. 51. This engraving shows the part with one end bent around and the forming ram in position for the bending of the other end. On the first stroke in this bender the end that is farthest from the ram, is bent up far enough to be out of the way as the other end is bent around. As the metal is red hot, this bending up of the one end is easily done and as easily tapped back into place with a hammer, before placing it on the form for the final bend. The construction of this former is too clearly shown to need explanation, except that the part of the end of the forming ram, that is under the guard plate, is of practically the same shape as the part that shows, a roller being used on the contact parts of both sides of the end. The coiled spring is, of course, to keep the ram against the forming guide during the entire stroke. After the ends are bent to place, they are welded in the dies shown in Fig. 52, which are also used in a bulldozer.

Cylinder carrier brackets are cut to length, drilled and then shaped on the former, Fig. 54. A finished bracket is shown leaning against the end of the truck on which the former is placed. The bracket is located correctly in the bending form, by means of a hole drilled in the middle of the bar into which a pin in the form, operated by the small hand lever *A*, is inserted.

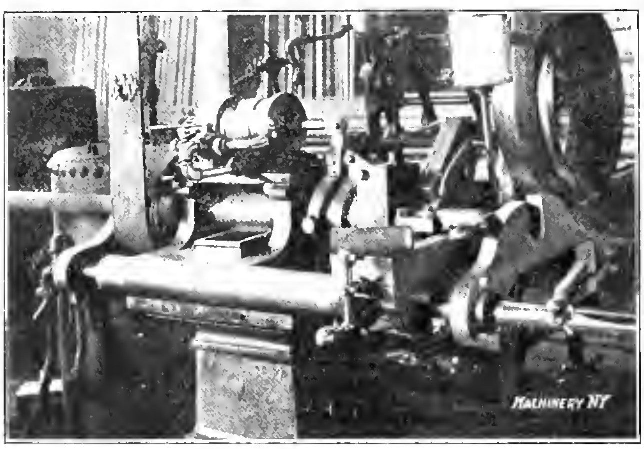

Fig. 44. Machine for Cutting and Beveling Flue Repair Euds

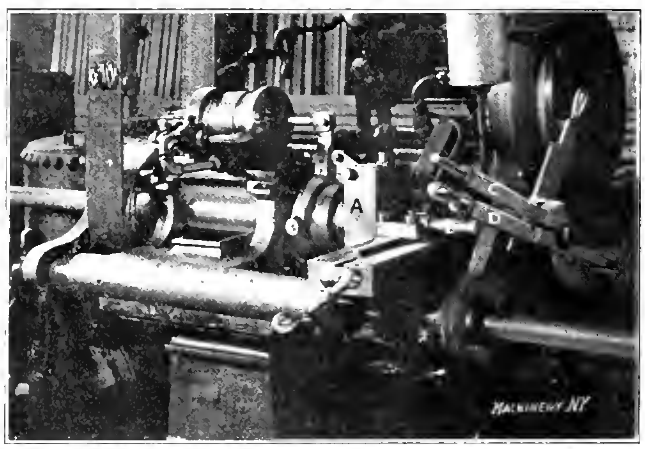

Fig 45. Reaming out tne Flue Repair Euds

Fig 46. Compressing a Locomotive Spring before the Band is put in Place

Fig 47. Compressing Spring Bands in a Steam Bulldozer

Eye-bolts are formed at one stroke, in the former shown in

Fig. 48. Steel Slabs to be welded and forged into a Driving Axle

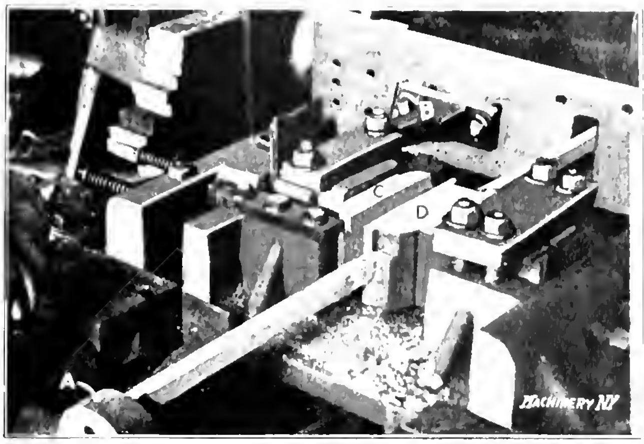

Fig. 49. Bulldozer for Upsetting a Bar, as indicated in Fig. 42

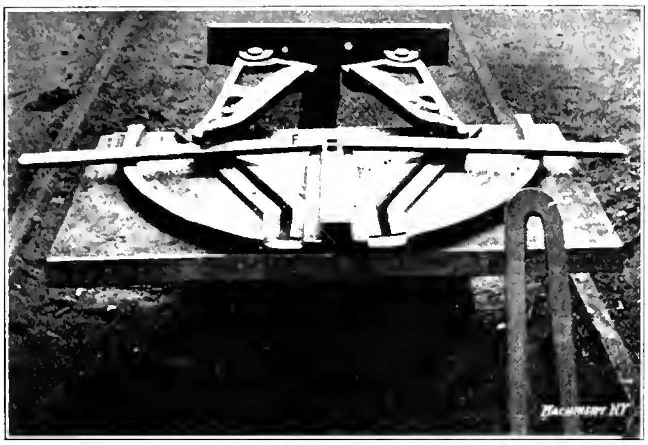

Fig. 50. Former for Making Swing-hangers

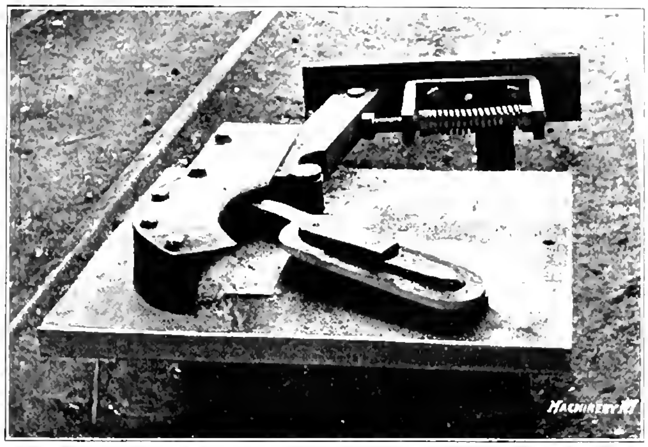

Fig. 51. Completing the Bending Operation on a Swing-hanger

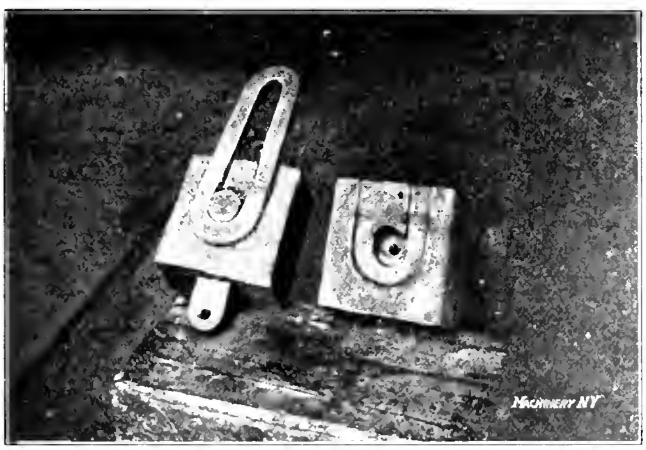

Fig. 52. Die used in Welding the Ends of Swing-hangers

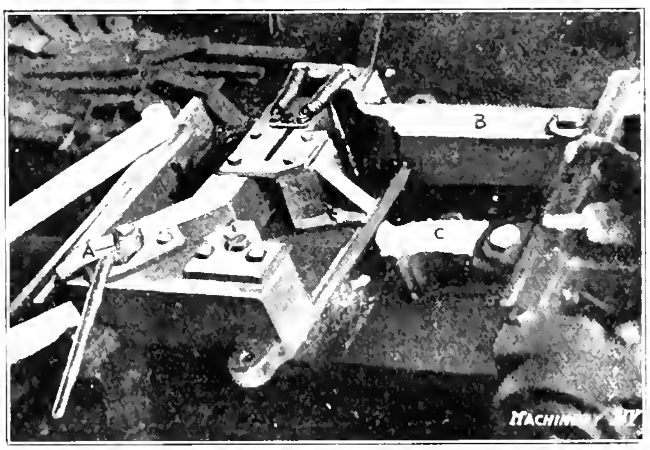

Fig. 53. Machine for Forming Hinges

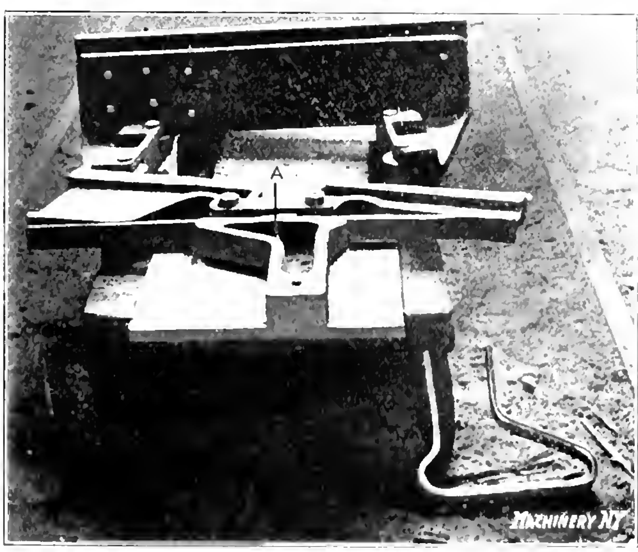

Fig. 54. Forming a Cylinder Cradle Bracket

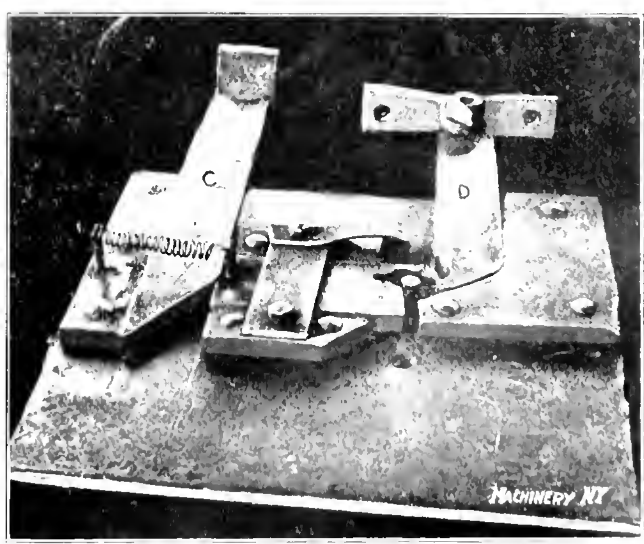

Fig. [illegible] An Ebolt Former

Fig. 55. The rod from which the eye-bolt is to be made, is heated and thrust in against the stop *A*, and on the stroke of the bulldozer ram, the part *C* being longest, pushes or wedges

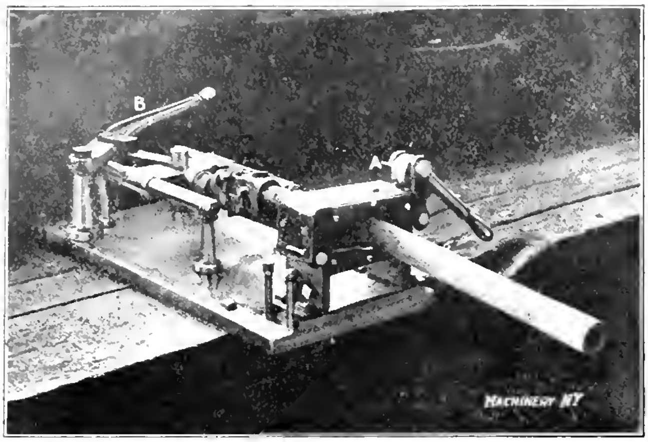

Fig. 56. Tool for Pressing Air Hose Couplings into Place

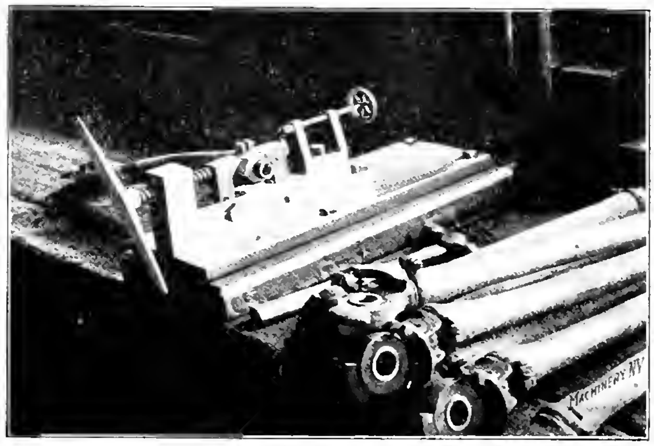

Fig. 57. Tool for Compressing Air Hose Clamp Collars

the part *B* over, forming a part of the eye. Part *D* next strikes the projecting end of the rod, bends it part way around and then coming in contact with the bevel, shoves it over, completing the eye. The recess *E* is intended to be

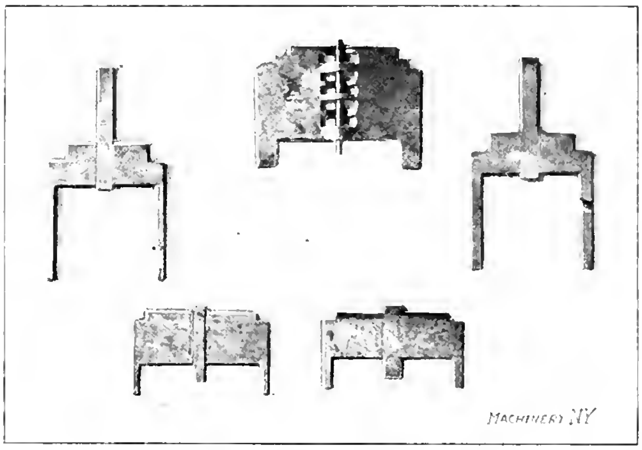

Fig. 58. Air Valve Lift Gages

Fig. 59. The Babbitting Room

used when connecting a chain to the eye-bolt, the end link of the chain being slipped into the recess and the end of the rod passed through it and bent as usual.

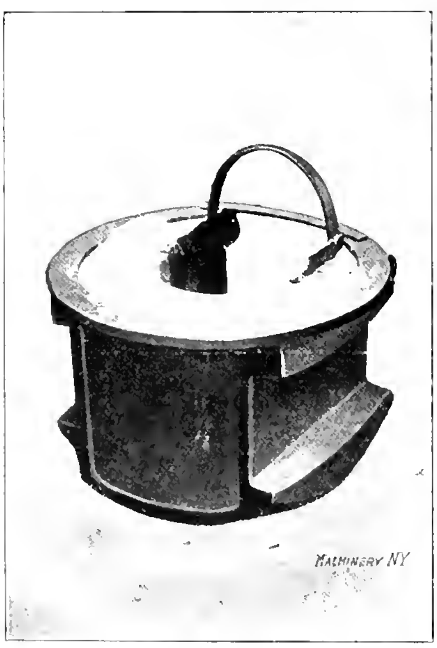

Fig. 60. Babbitting the Side of a Driving box to Compensate for Wear

Fig. 61. Heating the Driving-box preparatory to Babbitting

Fig. 62. Heating a Cross-head preparatory to Babbitting

Fig. 53 shows how hinges are made, which is very similar to the forming of an eye-bolt. The bar heated on the end, is placed in the former and locked by the eccentric hand lever *A*. On the stroke of the ram the hinged piece *B* shoves the cross-slide over, pushing the end of the bar around the form pin far enough for the part *C* to catch it and complete the bend, the final motion of the part *C* being exactly the same as that of the corresponding piece on the eye-bolt bender.

Repairing Air-brake Couplings

Air-hose couplings are forced into the ends of the new hose lengths in the little device shown in Fig. 56. The hose is held and locked by the eccentric lever *A* and the coupling is shoved into place by pulling on the lever *B*. The locking collars are compressed, while the bolt and nut are put in place and tightened, in the clamping device shown in Fig. 57.

The gages used to measure the amount to take off of the

plugs in a Westinghouse air pump, in order to allow the proper valve lift, are shown in Fig. 58. These gages are of a simpler form, but made on the same principle, as those shown in Fig. 33 (page 662), of the May number. The movable slide in the center is made of such a length, that when the shouldered end is placed in the plug opening and the center piece pushed down on top of the valve, the distance from the other end of the slide, to the ends of the fork, indicates the length the plug should be from its shoulder to its end, in order to allow the valve to lift just right. Friction alone is depended upon to hold the slide of the gage in whatever position it is set.

Babbitting Jigs

The babbitting room, Fig. 59, is a very complete little department all by itself, but under the general supervision of the machine shop foreman. Fig. 60 shows the way the sides of the driving-boxes are faced with babbitt. A special ring is laid on the box, and two pieces held in place by a loop spring, completes the "mold." Babbitt is then poured into this mold and the job is done. Before using this mold,

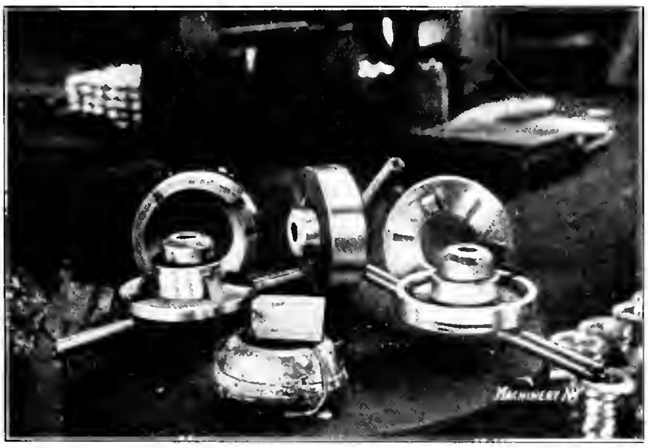

Fig. 63. Metallic Packing for Piston-rods and Molds in which it is cast

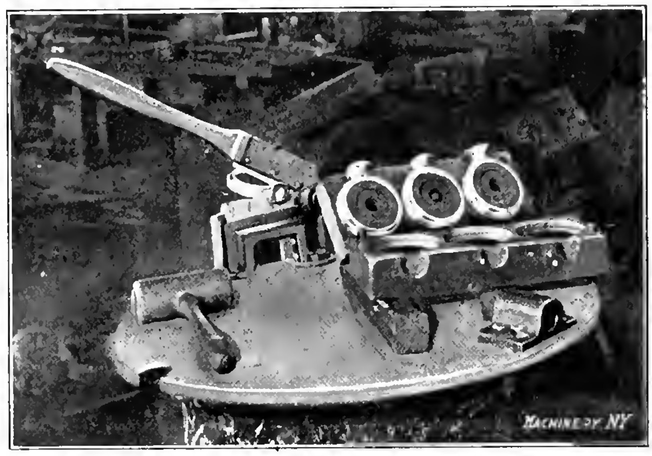

Fig. 64. Other Packing Molds and a Sprue Cutter

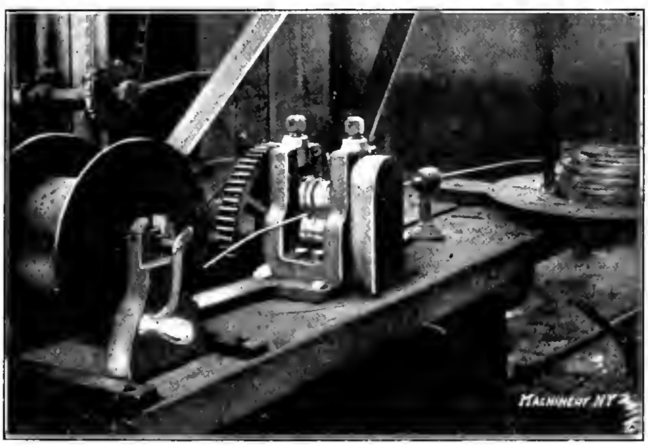

Fig. 65. Rolls for Flattening and Sizing Copper Wire for Gaskets

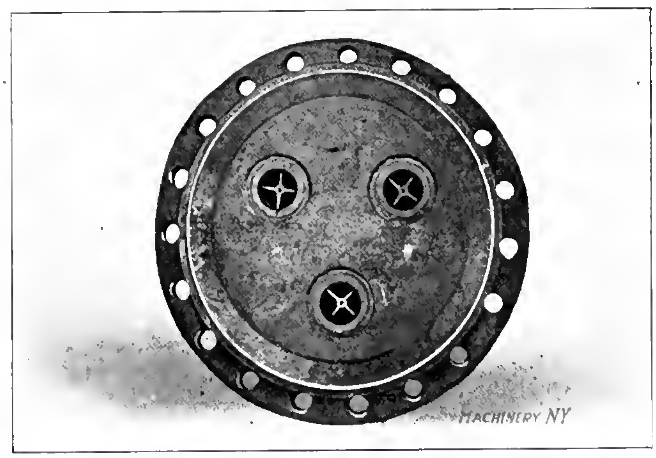

Fig. 66. A Dome Cover with Copper Wire Gasket in Place

however, the box must be heated and tinned on the side in order to make the babbitt stick properly. The heating is done as shown in Fig. 61. The driving-box is placed on a little four-wheeled iron truck and run under a big hood. A pan containing burning coke is then set on top and the heat forced down onto the side of the box by an air blast as shown. After being sufficiently heated, the coke pan is removed, the truck pushed along a short distance, and the end of the box tinned with solder and the babbitt put on as already shown.

Fig. 62 shows the heater used to heat crossheads previous to putting on the babbitt liners. These liners are molded by clamping an iron band around the edge of the surface to be babbitted, which has been previously tinned, the whole process being similar to the way the driving-boxes are babbitted.

Metallic packing is made in a department in charge of Mr. Edwards, who has been with the company nearly forty years and has patented a number of things now in common use on railroads. Fig. 63 shows a set of Edwards piston-rod packing rings, and the three molds used to produce them. Another set of packing molds and a sprue cutter are shown in Fig. 64.

Wire Gasket Practice

Considerable difference of opinion exists in various railroad shops as to the best method of making or applying copper wire gaskets for dome covers and steam chests, some lapping and brazing the ends and others just butting them together. Mr. Edwards' method is to first run the wire through flattening rolls, Fig. 65, in order to give it a uniform thickness, and then to force the wire edgewise into a groove cut for the purpose. Fig. 66 shows a dome cover in which a gasket has been inserted in this way. The ends of the gasket are beveled to about 45 degrees and are fitted closely together in the groove, but not brazed or soldered in any way.

* * *

PURE AIR LAW FOR WORKMEN

C. M. RIPLEY*

The new labor law requiring a supply of fresh air for employes of work-shops and factories, reads as follows: "The owner, agent or lessee of a factory shall provide, in each workroom thereof, proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as is practicable."

Mr. William W. Walling, chief factory inspector for the state of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold. How much air is required to meet these conditions? Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed whether for light, heat or power."

* Address: 45 W. 34th St., New York City.

Is this Amount Arbitrary?

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor is an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

The Architects' and Builders' Pocketbook, compiled by Mr. Frank E. Kidder, states that 1,800 cubic feet per hour per child should be the standard for school buildings, this amount being required by law both in Massachusetts and New York. It further states that in buildings more closely packed, and occupied for a longer period, the air supply should be from 2,000 to 2,500 cubic feet per hour per person. In giving an example of a school-room of certain dimensions, he shows that the standard amount of air would result in the air in the room being changed about eight times per hour, which certainly does not appear to be an excessive amount.

Since the above applies only to buildings where people sit quietly, or for buildings where only children congregate, it is difficult to see how the New York Department of Labor can justly be accused of an "arbitrary" action.

Mr. Percival Robert Foses, consulting, heating and ventilating engineer of New York City, states that he has found the rate of 2,000 cubic feet per hour per person a satisfactory and conservative working basis. This was used in designing the ventilating equipment of the large department store of B. Altman & Co., in the Rikers Island Penitentiary, in the Baltimore Stock Exchange, and in the new Hearst Building at San Francisco, as well as in others; and he stated that the operating expense for a system laid out on this basis has not been found excessive, and will not be if due care is taken at the time of installation.

Example of a Loft Building

In a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times 2,000 = 160,000 cubic feet per hour. This amount of air per hour would move at the rate of about 1/4 mile per hour, and would be sufficient to change the air in the loft six times per hour, assuming a ten-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour and since some authorities recommend even 50 per cent in excess of this, it appears that the action of the factory inspector hardly comes within the definition of the word "arbitrary."

Gas Lighting

Dr. Daniel R. Lucas of New York City states that it is a well-known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting, thanks to the new high efficiency lamps, has been reduced in cost 50 per cent or more, it appears that the easiest way to comply with the labor law regarding ventilation would be to abandon gas lighting. In New York City especially this would seem advisable, as electricity can be bought by meter from the street or from the power plant downstairs.

Since the vitiating effect on the air of the average gas light is equivalent to that of five persons, it can be readily seen that the ventilation required will be reduced 5/6 by abandoning gas light, assuming one gas jet to each workman, or, stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation is also based upon conditions where one gas jet is provided for each workman.

Operating Costs

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) Additional heat for incoming air. In a loft building where the tenant will pay for the power, and the landlord will pay for the extra heat required, since heat is included in the rent, the expense will be divided automatically. It will here be noticed that the adoption of electric lighting will cut down the operating expenses to a remarkable degree. This cut in expense will benefit the tenant, since a much smaller ventilating motor will be required, and it will also benefit the landlord because less air will have to be drawn in, and hence the cost for heating will be diminished.

In large systems the services of an expert heating and ventilating engineer would probably prove valuable, and it is possible to so design the equipment that a judicious "recirculation" of the air from halls and basements will effect an economy in the fuel bill. This air is seldom impure and requires much less heat than if cold air were brought in from outside. It is also possible in buildings where high pressure steam is available, or where boilers which have been run at low pressure steam can be run at a high pressure, to adopt the following policy: Provide steam engines to operate the fans and turn the exhaust steam into the heating coils, thus getting a double use out of the steam and cutting down the electricity bill. This idea could be carried still further in many instances, and economies could be made (especially in the winter) by abandoning electric pumping, and again reducing the expense for electricity. This is the stock argument of the advocates of isolated plants, who contend that great economies result in buildings of a million cubic feet or more, if engines are installed and electricity is made on the premises. It is a fact that steam at high pressure contains only about 6 per cent more heat than steam at low pressure. Thus the argument that electricity can be made and a building heated with exhaust steam, is advanced. The layman does not appreciate one very peculiar fact about steam: that at 5 pounds pressure it is only about 6 per cent cheaper to make than at 100 pounds pressure, showing that the cost does not increase in proportion to the pressure.

In the future it is probable that factories and loft buildings will be equipped with ventilating apparatus at the outset, with the ducts concealed in the walls and the fans located in the basement. A model building of this character has recently been completed at 37-43 West 26th St., New York City, in which the landlord at the time of construction had the ventilating system installed at his expense, after the design of a prominent consulting engineer. Thus the cost of operating a system and the responsibility of maintaining it in good condition does not rest upon the tenant. At the present writing (June 17) we are informed that the owners of the West 26th St. corporation, with offices at 725 Broadway, have already rented eight out of the twelve floors, a flattering reception and appreciation of the advantages they have to offer.

Importance of Pure Air in the Industries

In the report of the United States Bureau of Labor at Washington, D. C., it is shown that deaths among factory workers due to consumption were divided as follows:

Employes exposed to metallic dust	36.9 per cent
Employes exposed to mineral dust	28.6 per cent
Employes exposed to vegetable fiber dust	24.8 per cent
Employes exposed to animal and fiber dust	32.1 per cent

It was also shown that the highest consumption mortality existed among operators of grinders, and 49.2 per cent of all deaths were from that disease.

An ingenious conclusion was reached by Mr. Frederick L. Hoffman of the Prudential Life Insurance Co., based on this report. It is his opinion that by intelligent methods of ventilation and dust removal the consumption death rate among the wage earners could be so reduced as to result in an annual saving of 22,238 lives. This would add, quoting the *Engineering News*, "15.4 years of life for every death from consumption avoided by rational conditions of industrial life." Such a gain would represent a total of 342,465 years of additional life, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's life time at only $200, the total average gain to the nation would be $3,080 for every avoidable death of a wage earner from consumption, representing the enormous total of $68,493,000 as the annual financial value clearly within the range of practical attainment. Therefore, nothing within reason should be left undone as a national, state, individual, or social duty to prevent that needless but now enormous loss of human life from consumption due to the unfavorable conditions in American industry.

MAKING SOLDERLESS CANS FOR FOOD PRODUCTS

RALPH E. FLANDERS*

For a number of years, in riding out of New York on the "Shore Line," the writer has noticed on the right-hand side of the track, shortly after leaving Mt. Vernon station, an unusually neat and attractive group of shop buildings. The sign on the roof of the main building reads "Max Ams Machine Co." with some supplementary reference, which escapes the memory at the moment, relating to a process of manufacturing a sanitary, solderless can. While he has seen this sign for several years, and has always felt a twinge of curiosity at each passage, it was only within the past few weeks that he embraced the opportunity to become acquainted with the men who are working at this place and with the work which they are doing.

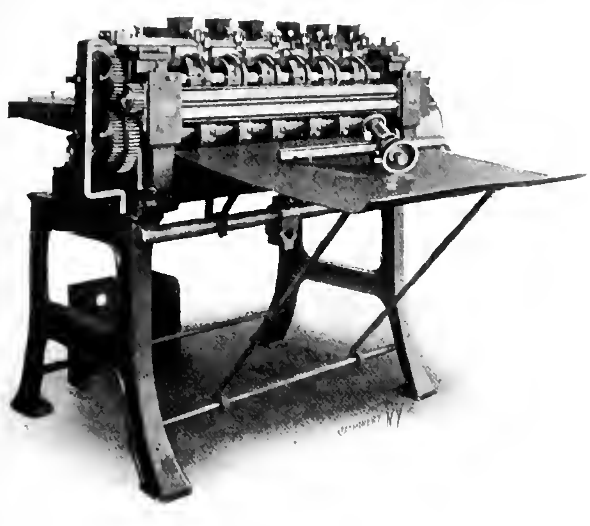

Fig. 1. Slitting Rolls with Double Cutting Edges and Self-contained Grinding Attachment

The product of the shop and the methods of manufacture were found to be fully as interesting as the exterior gave promise of. Besides the line of work indicated by the sign, which now forms but a small part of the firm's output, the shop was found to be building a general line of tools for sheet metal working. There was evidently also a lot of contract work of various kinds going through the shop, both special machinery and tools, and it was evident that the mechanics here stand ready to tackle any job in sight in the line of small and medium metal working, taking particular pleasure in undertaking stubborn problems that have long resisted solution.

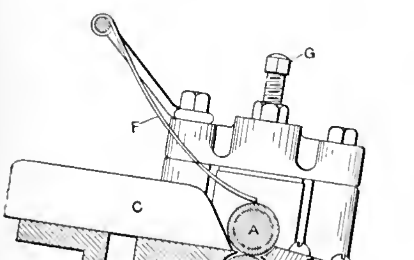

Fig. 2. Two-roll Bending Machine with Simple Adjustment for Radius of Curvature

The Ams Sanitary Can

But to get back to the sanitary cans. While this is now but a small portion of their work, it is a most interesting one, and with the permission of Mr. Ams some of the methods and machinery employed by this process are here illustrated and described. This system undertakes to make a can hermetically tight without the use of solder, brazing of any sort, or heat, the process being a cold one. This statement refers strictly to the sealing of the top and bottom of the can. The side seam is a new lock-seam which prevents any solder from the outside of the can body entering the interior of the can. The inside of the can is absolutely free from solder or acid, and a process which does not employ acids or other fluxes, or solder of any kind, has immense advantages from the sanitary standpoint.

* Associate Editor of MACHINERY.

Making the Body of the Can

The making of the body of the can will first be described. This does not differ materially from the process usually followed. Sheets of tinplate are first run through slitting rolls, such as shown in Fig. 1, and cut into strips of the proper width for the body of the can to be made. After thus being passed through lengthwise, the adjustment of the rolls may be altered, and the strips passed through again crosswise, thus cutting them into blanks of the size required.

Two or three improvements in the construction of these slitting rolls may be noticed. In the first place the cutters themselves are provided with cutting edges on both sides. This is an advantage oftentimes in setting them for work on narrow strips; and giving two edges in place of one doubles the life of the cutters as well. The principal improvement in the construction, however, relates to the sharpening of the cutting disks, which is done while they are in place in the machine. The attachment for performing the operation is seen on the receiving table in the illustration. It is a cup emery wheel, driven by a belt from an overhead drum and mounted on the swiveling holder seen on the bar beneath the table. By swinging this table down out of the way and dropping the delivery rolls, the disk cutters are exposed to the action of the emery wheel and the sharpening can be proceeded with expeditiously and effectively.

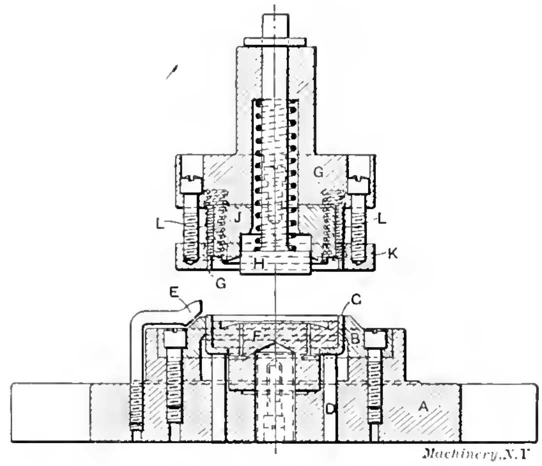

Fig. 3. Compound Punch and Die for Turning Can Cover shown in Fig. 4

After thus cutting the blanks to the proper dimensions, they are bent into cylindrical form by the rolling machine, shown in Fig. 2. This has but two rolls in place of the three often used for such work. The blank is fed from the table *C* between rolls *A* and *B*. After passing through, the edge passes the guide plate *D* and is by it turned up about roll *A*. The radius of the curvature thus produced is regulated by adjusting screw *E*, which rocks guide plate *D* about the axis of roll *B*. This machine takes the blanks as fast as a dexterous operator can feed them between the rolls.

The soldering of the side seam may be done by hand with special fixtures, or on any of the commercial machines provided for the purpose. The makers have developed an automatic machine for this work in which the cylindrical sheets are placed by hand on a series of forms, which are indexed about a vertical spindle. As they are being pressed on the forms the edges pass under brushes which lay on the acid flux. The next indexing of the spindle brings the work to the soldering iron, where strips of solder are laid along the seam, being cut off and smoothed on by a mechanically operated iron, heated by gas. In the third position the work is allowed to cool, and in the fourth it is removed from the form, leaving it ready for the next piece.

The final operation on the body of the can is that of flanging to the form shown in the sketch at *A* in Fig. 4. This flanging is done in a simple and obvious way by inserting the work in rolls, which rotate it and turn up the edge as it revolves.

Making the Covers

The can covers are blanked and formed from the sheet in a single operation by a double action die, shown in Fig. 3; the shape given to them is indicated in the upper left-hand corner in Fig. 4. A sheet is laid in the die against stop *E* in

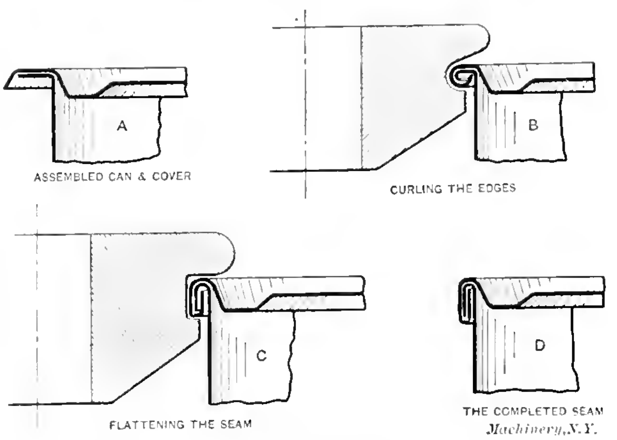

Fig. 4. The Sequence of Operations followed on the Double Seaming Machine

Fig. 3. The descent of the punch cuts out the blank between die *B* and punch ring *G*. The continued descent of the ram holds this blank firmly between *G* and pressure ring *C*, which is supported on pins *D*, which, in turn, are acted on by heavy rubber springs beneath the bed of the press. The spring plunger *H* also serves to hold the blank on the inside against

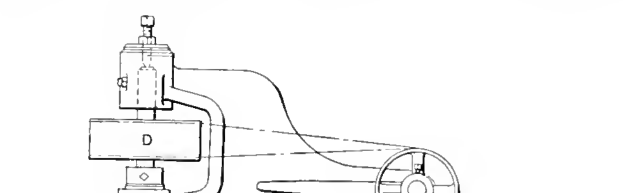

Fig. 5. Side Elevation of the Double Seaming Machine

forming die *F*. Pressure ring *K*, supported by springs *L*, has been holding the stock meanwhile. The blank thus cut out and held, is formed between dies *J* and *F* and ejected on the up stroke by the springs acting on members *C*, *H* and *K*.

As mentioned, the forming of the joint between the cover and the body is a cold process. It would be difficult to make this joint tight on a metal to metal fit, a leak being liable to occur near the seam of the body. To prevent this, the can covers are fed into an automatic machine, which deposits a very thin coating of an odorless and harmless compound in the groove of the cover, where the joint is made. This machine, which we are unable to show here, is simple and effective, and furnishes the means for rendering the can absolutely air-tight.

The Double Seaming Operation

The bodies and the covers are now ready for the seaming machine, in which is incorporated the basic feature of the process. In the old process, the can cover is made with a flange, fitting the body and soldered to it by an automatic process. In this case, however, the body and the can are rolled together into a double-lock seam by the series of operations indicated in Fig. 4. The can and cover are shown assembled at *A*. At *B* they are supposed to be held together and revolved rapidly in front of the first forming roller, which curls up the lips of the body and cover as shown. This roller then retreats and the second one comes up, flattening the seam firmly and neatly, as shown in progress at *C*, giving a result like that shown at *D*, where it is, however, shown somewhat loosely joined to more plainly indicate the construction. The seam is an exceedingly straight and neat one, and is rendered hermetically sealed by the lining process for the cap, previously described.

The machines for performing this seaming operation are shown in detail in Figs. 5 and 6, and in elevation in Figs. 7, 8

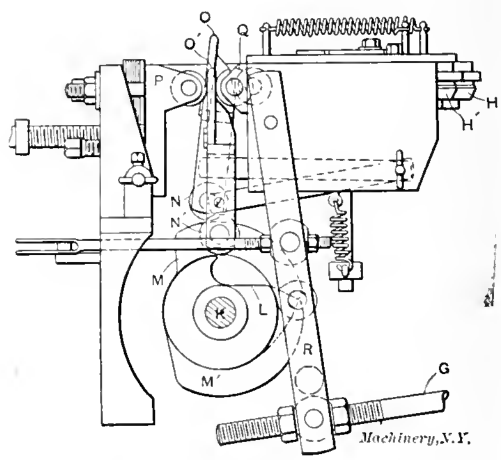

Fig. 6. The Cam Mechanism of the Seaming Machine

and 11. The can body is placed on a face-plate pivoted on spindle *E*, on which it loosely revolves. A similar face-plate is keyed to the upper spindle, driven by pulley *D* from driving pulley *A*. The cover and body are held together between these two face-plates, the pressure for this purpose being applied to spindle *E* either by hand or automatically, as will be described. As soon as this pressure is applied the can commences to revolve rapidly. The two rollers are in the position shown at *H* in Fig. 5, side by side. The mechanism for actuating them is shown more plainly in Fig. 6, which represents a view taken from the opposite side of the machine from that shown in the previous illustration.

The cam-shaft *K* (driven by worm-gearing *J* and pulley *C*, see Fig. 5) carries cams *L*, *M* and *M'*, which respectively operate levers *R*, *O* and *O'*. Lever *R*, by means of reach rod *G*, automatically raises spindle *E*, clamping the can and starting it to rotating. Levers *O* and *O'*, which are provided with wedge faces at their upper ends, as shown, enter one after the other between rolls mounted in back-stop *P* and slides *Q*. The latter furnish the support for rolls *H* and *H'*, which are thus brought successively into operation, forming the seam as shown in Fig. 4. The cam mechanism stops at the completion of the operation, and is started again by the operator when the work has been removed and new pieces placed in the machine.

In Fig. 7 is shown a machine of the same construction, but provided in addition with an automatic feed, the nature of which will be readily understood from the engraving. The cans are fed between guides on the work-table, as shown, from which they are advanced step by step by a pair of holders on each side, which advance, seize the cans, move them up into place between the spindles, open out and retreat for an-

other hold. An automatic ejector is also provided for removing the work from between the face-plates.

By the means just described, the cans are provided with a body and a bottom. They are now filled with the product for which they are to be used. It should be noticed that this

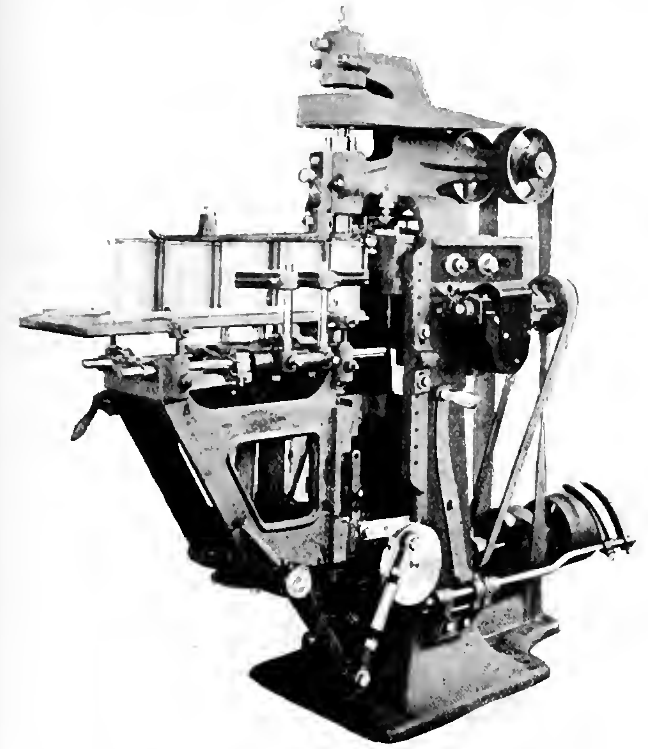

Fig. 7. Automatic Double Seamer for Cans for Food Products, from the One Pound to the One Gallon Size

filling is done through the full opening in the top of the can, instead of through a small opening in the cover, as is usual in soldered cans. This permits filling without special machinery, and without waste from slopping over outside of

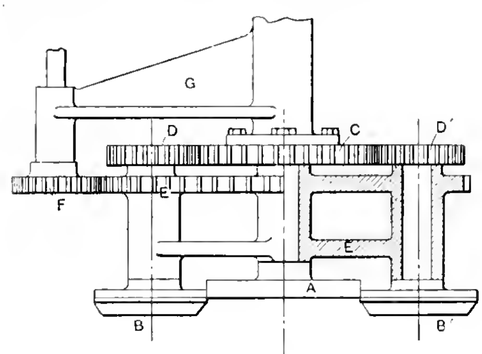

Fig. 9. Principle of the Machine shown in Fig. 8, when used for Square Cans

small openings. It also permits the easy canning of bulky materials, such as large fish, fruit, etc. After filling, the cans are again put through the same machine, and the cover is rolled and seamed into place by the same process, without the use of acids and solders, as previously described.

Seaming Machines for Square and Irregular Cans

A modification of this seaming machine is shown in Fig. 8. This operates on the principle illustrated in Fig. 9. In this machine, the can, instead of revolving, is held stationary, while the rolls are rotated and run around the edge. This is done sometimes for round cans where it is not desired to rotate the can, and it is the method always followed for square and irregular shapes of cans. The principle of the device as applied to a square can is shown in Fig. 9. A is the stationary can, and B and B' are the first and second rollers. It will be seen that these are of a contour to match the outline of the can A, when their centers are rolled about it in a circle. The face-plate A, which presses down on the can, is stationary. The frame E is revolved about it by the pinion F, meshing with gear teeth E. Journals are formed

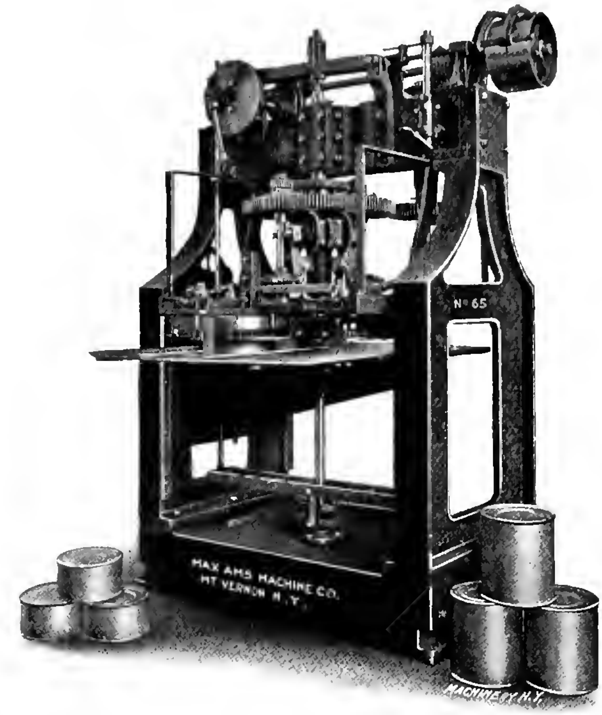

Fig. 8. Automatic Double Seamer for Large Cans for Meat, Fruit, or Paint, up to Five Gallon Size

in E for the spindles, which carry rolls B and B'. The upper ends of these spindles carry gears D and D', meshing with stationary gear C. It will thus be seen, that as frame E is revolved, rollers B and B' will also be revolved following the contour of the can and face-plate at A. The pitch lines of gears D, C and D' are shown in the lower diagrammatic view of Fig. 9.

Suitable means are provided in the machine shown in Fig. 8 for forcing first roll B and then roll B', successively in against the work, and withdrawing them at the completion of the operation. A feed of somewhat similar construction to that of the machine shown in Fig. 7 is used. These machines work with surprising rapidity, tossing the cans off so

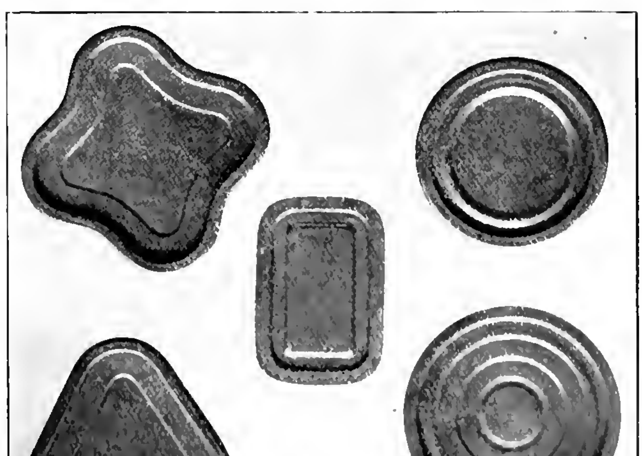

Fig. 10. An Assortment of Can Covers sealed by the Cold Process

fast that it would seem to be hard work to take care of them as they are delivered.

This last machine is not only adapted to round and square cans, but to irregular shapes of the greatest variety. A few of these are shown in Fig. 10. The American cans have been standardized to definite dimensions and capacities, and few

fancy shapes are found among them nowadays. The two covers shown at the left of Fig. 10 are of Italian origin, and doubtless exemplify the artistic instinct of the race, which will show itself in a can of preserved fish as readily as in

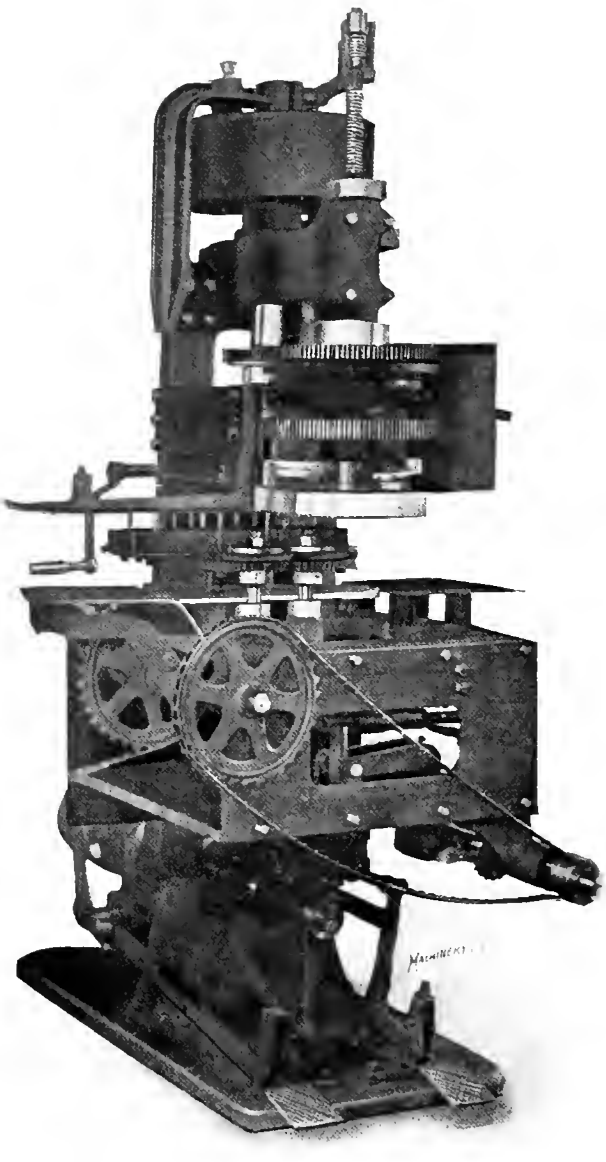

Fig. 11. Automatic Double Seamer for Condensed Milk Cans or Food Products

a marble statue or in an opera. This artistic instinct gives some difficulty to the man who lays out the rolls for forming the seam; but the job can be done to the queen's taste nevertheless, with care and experience on the part of the designer.

* * *

In the manufacture of the best grades of leather belting, a comparatively small section of a hide is used, this being a strip about 30 inches wide extending from the tail to a point just back of the shoulder, its length being about four feet. On account of the ignorance of most users of belting, and the difficulty of telling the grade of a belt except by use, certain leather belt makers are not over scrupulous as to the grades of leather entering their product, and we find not only is the section mentioned used, but flanks and other undesirable parts which are doubled with first grades in double belting. A belt made up in this manner may not in appearance be inferior to a belt made only from first-class parts, but in use it is bound to give inferior service. The use of the poorer grades with the best grades of leather belting is particularly bad. The inferior grades soon stretch, throwing almost the entire stress of belt pull on the superior grade. The result of this uneven tension is to quickly deteriorate the belt. Probably a belt made up in this manner is inferior to that made of the poorer grades throughout. Making the belt of inferior grades throughout has the merit of equalizing the stretch, keeping both parts in even tension.

A NIGHT-SCHOOL COURSE IN BLUE-PRINT READING

GEORGE A. HEPKE*

From time to time there have appeared in technical magazines and journals articles pertaining to courses as taught in night schools, in which the best way to present such courses in order to get the desired results, was discussed. I have followed these articles rather closely, but I do not remember having seen one in which the method of teaching blue-print reading is treated. No doubt, many of MACHINERY'S readers will be interested in the plan I followed in teaching the subject to a night-school class composed of pupils who were working in the different manufacturing establishments and who were handicapped by not being able to read blueprints.

The idea was to cover about the same ground as a course in mechanical drawing, but in a much shorter period of time. The pupils desired to be able to read a blue-print correctly, but they did not want to spend the time necessary to become proficient in drawing. Nevertheless, they were desirous of understanding how projections, etc., are derived. At first a temporary schedule of instruction was arranged, but this had to be departed from during the course in order to meet the conditions. The course, as originally planned, was to include twelve lessons, one each week of 1½ hour duration. On the opening night there were ten pupils in the class-room, who ranged in age from 20 to 35 years. They were all followers of mechanical trades in local manufacturing establishments, working as molders, machinists, pattern-makers and core-makers. It was evident after questioning the pupils that it would be necessary to start with elementary work. They understood an object in the plan view, but as soon as it was turned and another view projected, they were at a total loss as to what the different lines then represented. In order to present this subject of projection as clearly as possible, wooden blocks were made as shown in the different illustrations, the construction of which will be explained in the descriptions of the lessons. These blocks, together with blackboard illustrated lectures, aided greatly in making things appear simple and clear.

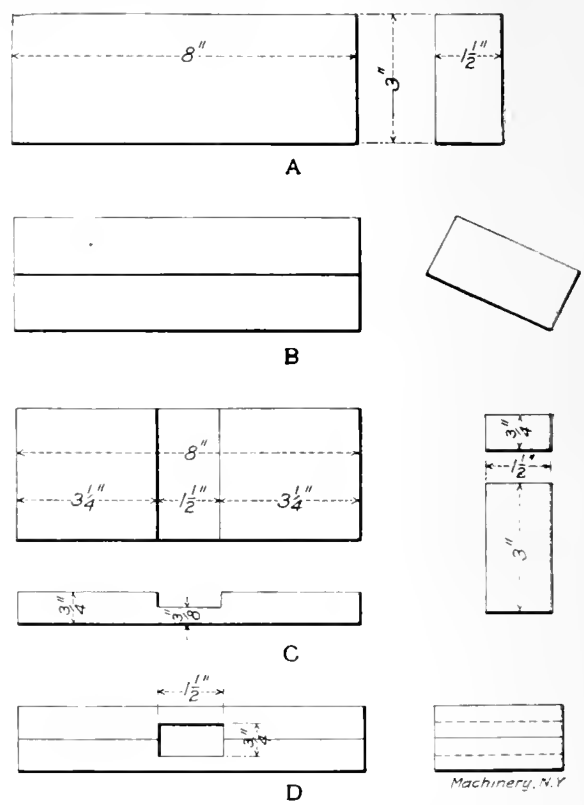

Fig. 1. Built-up Rectangular Prism used in teaching Projection

In the beginning, the difference between perspective and mechanical drawing, and why the former cannot be used extensively in mechanical lines, was explained. In begin-

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ning the instruction in projection, a drawing of an assembled rectangular prism (built up of three parts) showing all the full lines but no dotted lines whatever, was made as shown at *A*, Fig. 1. As no dotted lines were shown, the prism appeared as though it were made of one piece, but in reality

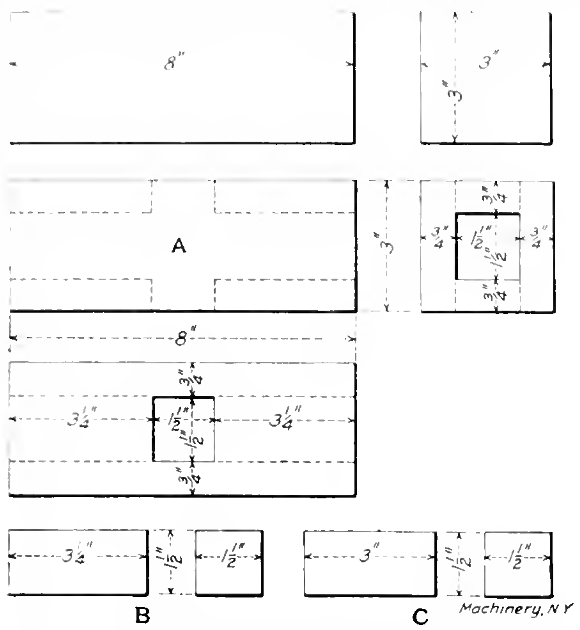

Fig. 2. Another Built-up Block with which Various Forms can be obtained for teaching Projection

it was composed of the three pieces. This prism was next projected as shown at *B*, after which it was taken apart and the pieces which formed it, projected as shown at *C*. This was done to illustrate how the channel through the center would be indicated on a drawing. Two of the three parts which form the prism were then placed together, as shown at *D*, which made it appear like a solid block with a hole cut through it. This hole gave dotted lines in the end view as shown. To illustrate the need of dotted lines, I used clear

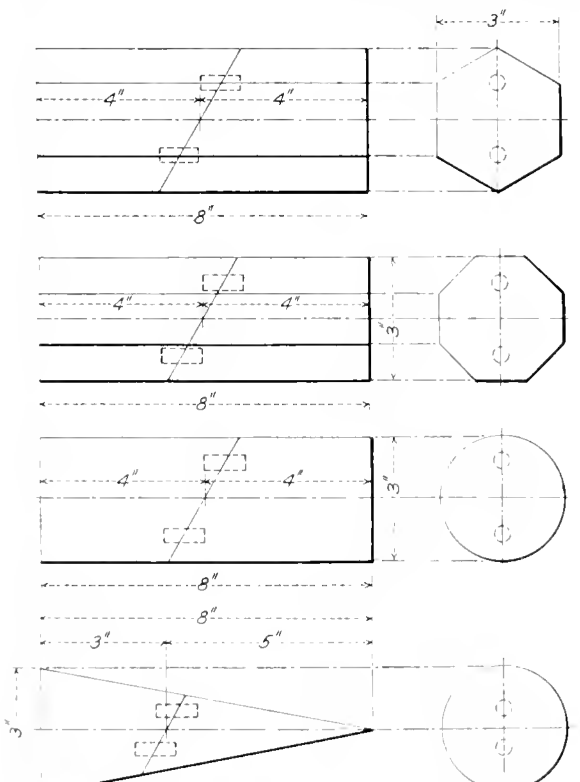

Fig. 3 Prisms, Cylinder and Cone, which were also used in teaching Projection

glass as an example, and the pupils were told that if the piece as assembled were made of glass, the lines representing the hole cut through the prism would appear full, but as the piece was made of a non-transparent substance, dotted lines were used to represent lines that did not appear to the eye.

The square prism shown in Fig. 2 was the next object used, and about the same instruction was given as with the rectangular block. This prism was composed of one piece *A*, two pieces *B*, and one piece *C*. When these pieces were put together we had a solid square prism and by taking them out, projections in which dotted lines appeared were obtained. The next objects drawn were the hexagonal and octagonal prisms, after which cylinders and cones followed in the order mentioned. With the different prisms made as shown, we were able to get quite a number of combinations and projections.

At first, only projections of the complete solid bodies were taken as shown in Fig. 3. The blocks which were held together by dowels, were then taken apart so that the projecting of angular surfaces could be practiced. As shown in Fig. 4, all the lines were designated by letters, so that the corresponding lines in different views could be easily located. These letters were found to be a great aid. The idea in giving the pupils the angular projections was to fit them so that when they encountered round bosses or pads of other shapes shown at an angle on a drawing, they would readily see how the projections in the plan or other views were derived.

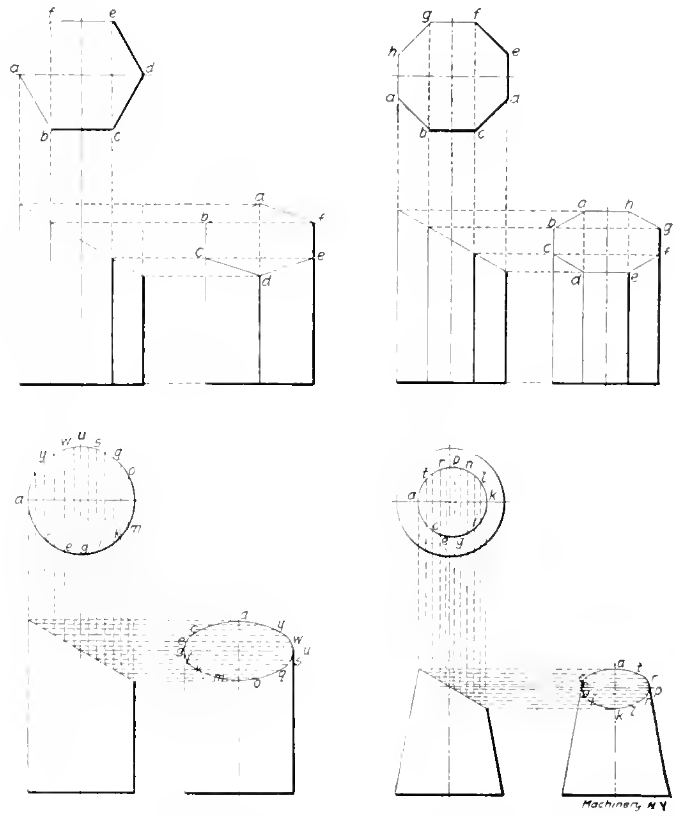

Fig. 4. The Blocks shown in Fig. 3 taken apart and used to teach the Projection of Angular Surfaces

Five lessons were devoted to the routine just mentioned and projections were covered quite thoroughly, but this work had to be supplemented by practice still to follow. It was during these five lessons that I discovered that the pupils had the most difficulty in learning in what direction the object was turned or set up to get a given view. The wooden blocks proved very effective in overcoming this difficulty, as they could be turned in whatever direction was necessary so as to correspond with the different views on the blackboard. During the five lessons mentioned the pupils were given the task of making drawings on the board of the different blocks, after a cut-out or something of that sort had been indicated upon the blocks with chalk. They did fairly well with this work, which enabled the judging of their progress, and also whether or not they understood projections.

The next step was to acquaint them with sections and sectioning. Different sections of simple objects, such as the blocks, for example, were drawn, and instructions given in following up a drawing in order to tell at just what point the section was taken when this was not indicated by letters. The type of sectioning for the different metals was also brought up, because in a great many assembly drawings

the kind of metal is not specified, the type of sectioning taking care of that.*

Taps and threads were next discussed, and the different ways of showing threads was explained. Thread pitch and lead were also brought up, and it was explained that where the number of threads and pitch are not given, it could be taken for granted that it was a United States standard thread or whatever standard the firm recognized. In brief, all of the kinks and short cuts that are in general use were explained, such as showing shafts, etc., broken, driving fits, and the method of designating bearings on shafts, with cross lines. The object in explaining all these points was to familiarize the pupils with such things, as I have discovered that the majority of mechanics have not the least idea what these short cuts and kinks represent and are often confused by them.

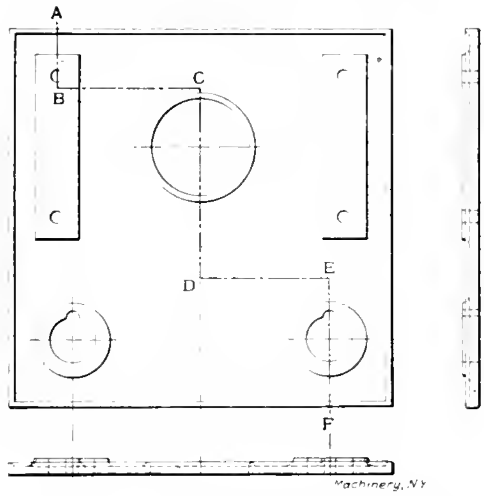

Fig. 5. Type of Drawing used for the Elementary Exercises in Blue-print Reading

The next subject treated was gearing. The different kinds of gears were described and the meaning of pitch diameter, outside diameter, pitch angle, turning angle, cutting angle, and the words addendum and dedendum, were thoroughly explained. We then took up the drilling and tapping of flanges, and all the terms of abbreviations generally used for this work, such as B. C. for bolt circle, D. C. for diameter circle, 2 Up for staggering center line, 1 Up for on center line were given. After that the method of indicating center lines and dimension lines was explained, and also that the arrows at the intersecting lines show that the piece is of the shape given on the drawing for the length between the arrows. Scaling of drawings was also treated, and the method of getting the approximate dimensions of a piece with an ordinary 2-foot rule when the dimensions are not given, and the drawing is made to scale, was explained.

Up to this point a blue-print had not been touched, for my object was to so acquaint the pupils with the various points mentioned that they would make rapid progress when the blue-print reading began. The first blue-print used was that of an engine cylinder sole-plate, as shown in Fig. 5. This simple drawing puzzled the pupils a little because of questions asked them, all the points of the preceding lessons serving as a basis for the questions. Other blue-prints of sole-plates of different types were thoroughly covered by taking sections at different points and showing these on the blackboard. As the students wanted to do a little work at home, I had them draw a section of the sole-plate through *A, B, C, D, E, F*. They did this work very well though they were somewhat confused at first.

The next lesson consisted of engine disk cranks, a governor gear-box, and other prints which were a little more difficult than those of the preceding lesson. The same tactics were followed with these prints, and the pupils were also given more home work, with the result that a decided improvement was soon noticed in their sketches. More and more difficult prints were used as the course continued, with the result that at the end of the twelve lessons, the students had a very good idea how to read a blue-print correctly, but the thing still needed was practice in order to develop this knowledge.

They were now greatly interested and demanded that the course be continued for twelve more lessons, which was granted. We resumed our studies where we had left off, always taking up something more difficult. Some of the lessons consisted of drawings of large pieces, such as engine beds and cylinders, fly-wheels and other large castings. Another line of blue-prints used were those of a 300-ton hydrostatic wheel-press. All the different parts of this press were located in the assembly drawing from the details, and the work was conducted the same as if the class were machining and erecting the complete machine. The pupils were also required to draw sections of the various parts, such as the one illustrated in Fig. 6. After finishing with the press prints, assemblies were dealt with, some of which were rather complicated drawings, until the end of the term.

I do not claim that any of the pupils were experts at the end of the course, but I think that they had a good foundation for development. Had the pupils been familiar with projections we could have covered the same course of study in a much shorter period, and also would have gained considerably more ground. Nevertheless, I am perfectly satisfied with the results when the conditions under which we started are taken into consideration. The course as outlined in the foregoing would probably not work so well in another case, as everything depends upon the men and the conditions, but it will doubtless have suggestive value.

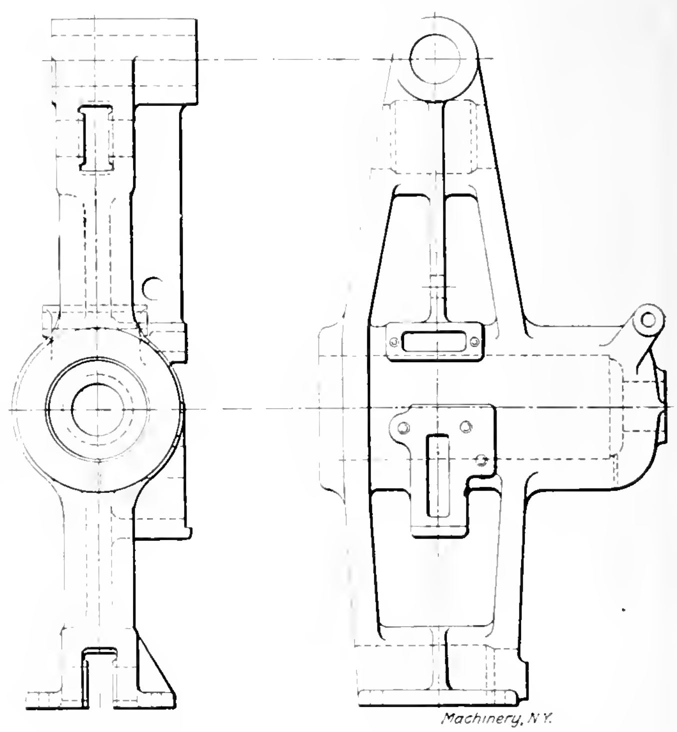

Fig. 6. Detail Drawing used in connection with more Advanced Work

* * *

Referring to the item published in the July number of MACHINERY on the use of "victimized power" in operating penny-in-the-slot machines, in which it was made apparent that the action of the operator was a necessary element in the success of such machines, attention is called to an article in the July 3 number of the *Saturday Evening Post* by Mr. Frederick Thompson, in which he points out that this is a prime factor in the success of all amusement enterprises. Those enterprises are most popular in which the people amuse themselves, the apparatus, game or device being such that the chief factors in the sport are the people taking part. The tickler, witching waves, shoot the chutes, and other devices that have proven enormously popular afford as much or more amusement to the onlookers as to those who participate in the games.

* The practice of indicating the character of materials by cross-sectioning should be abolished. There are no generally accepted forms of cross-sectioning for the common materials even, and as for the less common materials, almost every draftsman feels free to use the form that appeals most to his fancy. In all cases the material should be plainly specified by name.—EDITOR.

ELEMENTS OF ASSEMBLING OPERATIONS*

ALFRED SPANGENBERG†

The machine shop operations usually discussed by various writers have been almost entirely associated with machine work. Aside from this, and a factor of equal importance, is the subject of assembling. In its broadest sense, assembling may be defined as the operation of combining and adjusting the separate parts of each unit in such a manner that these units, when in combination, will properly perform a predetermined function. The operation of fitting is often included in the work of assembling; under ideal conditions, however, a distinct line of demarcation can be drawn, so that the term "fitting" will only apply to the operation of machining.

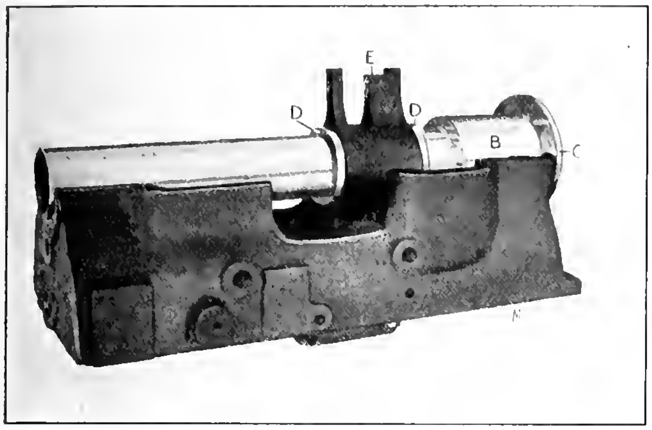

Fig. 1. Method of Gaging Clearances for Spindle Gears in a Lathe Headstock

The purpose of this article is to show the possibilities that lie in developing methods of assembling that will ensure accuracy, economy and standardization, but before giving any concrete examples, it will be well to consider briefly the elements that directly affect the cost of assembling operations. The determination of proper methods and processes of assembling are peculiarly difficult, since the elements of human judgment and skill enter so largely into this work. It is a far more puzzling proposition than that of analyzing and determining the best method for machining any particular part. For this reason, the study of assembling work requires particular care and especially keen analysis.

The Three Factors Leading to Economical Assembling

Accurate drawings, accurate machine work and the use of jigs and gages, are at the foundation of economical assembling. Without these factors, the term "manufacturing," used in its limited sense, really does not apply to the scheme of production. Much has been written on methods of dimensioning drawings and the use of limits as tending to accurate and at the same time cheap production, so that little need be said here on the subject. The system of giving all unimportant dimensions in inches and common fractions thereof, and expressing precise dimensions in thousandths of an inch with the permissible limit of variation, is worthy of wider application. This, coupled with a thorough system of inspection, will insure that the parts function properly when assembled, besides preventing a choice of methods in machining that may entail a vast amount of work when less elaborate methods will produce a job that is good enough for the purpose. While the use of limits on drawings has been unsuccessful in many cases, the principal cause of its failure probably has been due to an injudicious selection of the maxima and minima for different classes of work.

In order to insure the accuracy of the machine work, it is absolutely necessary to provide for a thorough system of inspection in the machine departments. Some manufacturers only provide for inspection of the finished product and refuse to admit the advisability of adopting the broader plan. To state an important point which the author shall want to emphasize, we must always keep in mind not only the possibility of wasted money through excessive time in having to "fit" the parts in the assembling department due to poor machining, but *especially* the waste of valuable time in having to wait for parts to be replaced that have been spoiled in machining, the error not being discovered until ready for use. In brief, it is short-sighted to imagine for one moment that anything like economical results will be obtained in assembling unless this provision is made.

The great value of, and necessity for, jigs and fixtures on duplicate work and their bearing on the cost of assembling is too well recognized to need any further comment here.

Method of Investigation and Analysis

First of all, a careful analysis of the assembly drawings should be made in order to thoroughly understand the purpose of every part of a machine. This is an important consideration and will lead to the adoption of methods that will prevent undue accuracy and unnecessary expense consequent thereto. It is a mistake to accurately align and fit parts that may be said to "fit a hole in the air." The time needed for this can be more profitably spent on those parts that require accuracy and refinement. The purpose of every part should be studied; the operation necessary to produce it can then be regulated accordingly.

A matter that should receive careful attention is the question of rigidity in fits. Those of us who have "been through the mill" are painfully aware of the fact that most workmen fail to distinguish the difference in rigidity required in the fit of a lathe spindle from that necessary in the case of a shaft for operating a clutch lever. An illustration in support of this statement is afforded in the case of an automatic machine that recently came under the writer's observation. The machine in question was built by a manufacturer having a reputation for turning out very accurate work; in fact, the fits were so tight that at times certain members of the feed-stop mechanism would fail to function properly with the result that a part of the machine would be wrecked. After these members were fitted free enough, no further trouble was experienced.

Varying conditions make the determination of proper fits and adjustments in assembling work a question of experience and judgment. As a general proposition, sliding or revolving machine elements that do not affect the accuracy of the machine's product should be fitted perfectly free, so that there will be no indication of the parts working stiff. This applies especially to spring- or hand-operated mechanisms. Sometimes,

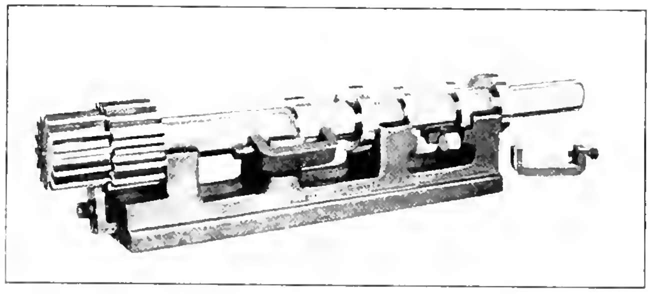

Fig. 2. Jig for Drilling Pin-holes in Collars on their Shaft, to insure Interchangeability

however, the fact that these elements are apparently fitted or adjusted too tight can be attributed to their being out of proper alignment.

The next logical step in the study of the drawings will be to map out systematic and well-defined methods and processes of assembling so that the parts may be quickly and cheaply assembled, all will be in their proper relation to each other, and that the alignment of the various parts will be perfect within the required limits. Various ways of accomplishing the object sought will present themselves successively; unless special considerations prevent it, the process that will accomplish the object sought in the most direct manner is the one to be chosen. This consideration shows the importance of a thorough knowledge of modern methods, the facilities at command, the organization itself, and special tools and appliances.

General Requirements for Efficient Work

The drawings must always be followed. No deviations should be permitted. If any mistake is discovered or change found necessary in the interest of economical assembling, then

* For additional information on this subject, see MACHINERY for February, 1909, "Application of Lifting Devices to Assembling Work," and April, 1909, "Labor-Saving Devices for Scraping Operations."
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these corrections should be approved by responsible parties and made on the drawings. The importance of this is at once apparent. Standardization without observing this rule is impossible, and neglect of it will result in lax, inaccurate, and totally misleading metheds of production. Again, in case of repairs, the new parts can be finished to the drawings with the assurance that they will fit properly. The drawings should always indicate the method of oiling a mechanism, as this matter, if left to the judgment of the assembler, may result in an inefficient system of lubrication.

If any errors are found to exist as a result of mistake in patterns or fault in casting, then these mistakes should be taken care of at once, so as to prevent a repetition on succeeding pieces. In the case of clearances this will prevent unnecessary "carving" to be done either by chipping or machining. In many instances, however, when the clearance allowed on rough castings is small and the design will not permit a change, it is unreasonable to expect avoidance of "carving."

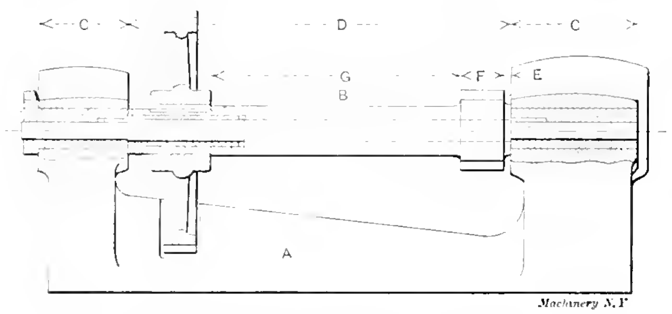


Fig. 3 Illustrating a Case where the Micrometer can be used advantageously for Length Measurements

Such cases should be anticipated before any assembling operations are commenced, and the necessary clearance made by chipping or machining so as to prevent having to take the work apart.

This principle is clearly illustrated in Fig. 1, which shows a lathe head-stock. For special reasons the clearance allowed in the head-stock casting for certain gears that run on its main spindle is very small. The gage for testing this clearance consists of a hollow arbor *B* having a locating flange *C*. Mounted on this arbor and free to turn between the collars *D* is the gage casting *E*, which has a contour 1/16 of an inch larger than that of the gears above referred to. By turning the gage it is very quickly determined whether there are any irregularities on the head-stock casting to be chipped off. The

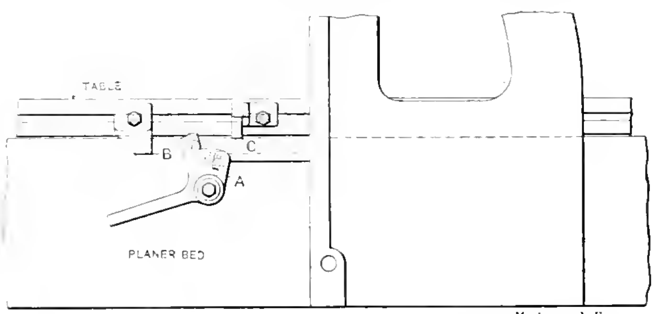


Fig. 4 Example of Work where some Fitting is left for the Assembler

advantages of using this gage are that the irregularities can be more easily seen than by using the gears and spindle; any necessary chipping is done before the assembling operations are commenced; and the gage, being light, is quickly and easily handled.

Much profitable study can be given the question of substituting the machining process for operations that are usually performed by hand, such as chipping, filing, etc. Oil grooves should be machine cut on all pieces that can conveniently be handled on a machine; tap holes can be tapped cheaper on a machine than by hand, except in the case of very small holes in large pieces; set-screw holes in shafts should be drilled on a drill press. The halftone, Fig. 2, illustrates the method of locating and drilling collars on a shaft in interchangeable work.

One example will suffice to show the possibilities of saving time in this direction. For many years it had been the practice of a certain machine tool builder to chamfer the threads on all split-feed screw nuts by chipping and filing. It will be understood that this is necessary in the case of split nuts so as to permit their opening and closing on the feed screw, the chamfer being at the joint. On a certain size nut it formerly took twenty minutes per pair by the hand method. The same size is now milled, using two cutters simultaneously, in one minute per pair, which includes clamping and removing the work.

It is, of course, unreasonable to expect to entirely do away with these hand operations, but in many instances to-day much of the chipping, filing and scraping could be avoided if proper attention was given to the matter. Probably the most notable example of the tendency in this direction is afforded in the manufacture of automobiles, where the hand operations consist merely in combining and adjusting the various elements.

Standardization

Standardization, as already pointed out and emphasized, is one of the "secrets" of economical assembling. It is a matter of common knowledge that interchangeable manufacturing is really economical manufacturing, and yet in many instances its fullest possibilities are not realized. There are many shops to-day that still cling to the old custom of "making every piece like itself." The practices of leaving stock for adjustment on the hubs of bevel gears, facing off the ends of bearings to no particular dimension, planing taper packings to fit slides that are not planed to gage and adjusting parts to fit others that are not standard, must be eliminated if economical results are expected. Some very simple form of gage, such as an inside or outside micrometer, will enable work of this character to be machined standard and made practically interchangeable at a fraction of the cost in assembling.

An example is given in Fig. 3 to illustrate this point; *A* represents an engine lathe head-stock having a back-gear quill *B* running between the eccentric-shaft bearings as shown. The length *C* of the bearings and the eccentric bushings can be made to an outside micrometer, while an inside micrometer is used to measure the length *D* between the bearings, the proper allowance being made on the quill for a running fit. An ordinary scale is used to take the measurements *E*, *F* and *G*, and, if care is exercised, the gear and pinion on the quill will line up with those on the main spindle, if the same precautions are taken in the case of the spindle shoulders and gears.

The experienced man will smile at the idea of these quills having to be adjusted by the assembler, but the author recently visited a shop building small engine lathes where this practice was still in vogue.

Errors in measurements of length are far more likely to occur and cause trouble in assembling than errors in diameter. This is probably due to the fact that in the latter case instruments of precision, such as the micrometer or limit gage, are in more common use. Standard length gages are indispensable on interchangeable work, although in instances similar to that referred to in Fig. 3 scale measurements are accurate enough. The fact is that few workmen can, or really do, work nearer than 1/32 inch with a scale.

However, there are cases met with in assembling where it is not practicable to machine all the parts standard, owing to the fact that a number of conflicting elements enter into the problem, and make it advisable to leave stock for adjustment on certain pieces. A concrete example is afforded in the case of a planer reversing mechanism, which is illustrated in Fig. 4. It is obvious that the rocker *A* must swing through a certain definite arc, the amplitude being limited by the movement of the belt shifter cam (not shown) and controlled by the lengths of the dogs *B* and *C*. It is at once apparent that there are a number of measurements which must be considered; a discrepancy in any one of them would make a difference in the working of the mechanism, and the easiest and quickest way to fit the dogs is to swing the rocker in one extreme position and scribe a line on the corresponding dog representing the cam face on the rocker; then repeating the operation in the other extreme position of the rocker. The dogs are then taken off and sawed close to the line, after which the surfaces are smoothed with a file and the steel members removed for the purpose of hardening.

Duplication

The duplication of parts in quantities is another step in economical manufacturing. For special reasons it may not be advisable to build the complete machine for stock, but in nearly every instance the standard parts can be assembled in lots and kept in stock ready to be placed on the bed of the machine when ordered. The advantages are many. First, a large reduction in initial cost results because of this production in quantities. This is due to the fact that the same operations can be performed on a number of pieces in succession. Again, the possibility of always having these parts on hand when wanted means quicker deliveries.

Methods and Processes of Assembling

The methods and processes of assembling will, of course, vary with the character of the work and the design of the machine, so that it is impossible to outline any comprehensive system with the thought that it could successfully be applied

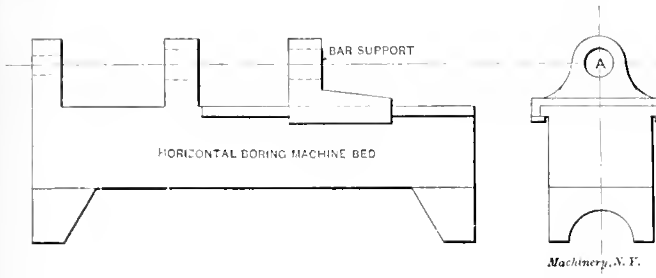


Fig. 5. A Case where some Machine Work is done after the Work is partly assembled

to all conditions alike. Indeed, a blind adherence to certain rules is liable to be a serious detriment. It is possible, however, to lay down a few fundamental principles which can safely be followed and which are adaptable to many differing conditions.

As was previously stated, the design and construction of a machine are intimately correlated, as becomes apparent when special methods needed for its construction have not been taken into account. For this reason, the designer should continually be impressed with the importance of bringing out the best possibilities of manufacture, both as to ease and cheapness of assembling, as well as machining. The tendency of modern machine design is toward the unit system of construction in which the various units comprising the driving members, feed members, etc., are self-contained, being placed in gear-boxes and bolted to the bed of the machine. This feature enables the various units to be assembled independently and simultaneously, and is an important consideration, since the shortest possible time in which any particular machine can be assembled depends upon the number of operations that can be carried on at the same time. The most notable examples of the unit system of design are afforded in modern drilling and milling machines.

On the other hand, when the design is such that the parts are more or less interdependent, it is possible to separate or classify into groups the various members so that the unit system of assembling can be followed to a certain extent. This is especially true of interchangeable manufacturing where the necessity of adjustment is eliminated.

This important feature should be emphasized that, in assembling work, it is highly advisable to provide for the same rigid sub-division of labor that exists in the modern machine department. Thus, the operations involved in assembling the units should be separated from the erecting process on the beds. In large shops these processes are carried on in different departments.

The operations involved in assembling, such as chipping, filing, scraping and fitting, are usually performed either at the vise and bench or on the floor, depending on the size or weight of the work; hence the name vise, bench and floor work.

Bench work is of a lighter nature than floor work, though it may, and often does, include the entire assembling process when the detail is small, and in case of large work many of the smaller parts are assembled at the bench and are then taken to the floor and adjusted to the other parts.

Floor work includes the erecting and assembling of heavy machines, and the machining of parts too heavy or too large to be operated on in the stationary machine tools.

In general, the sequence of operations is somewhat as follows: Work coming into the assembling department from the various sources should have all the machining operations completed, the only exceptions being in cases where it is absolutely necessary to leave stock for adjustment and where, owing to the fact that some parts are interdependent, it is not possible to carry on all the operations of machining at one time. A concrete example illustrating the latter case is shown in Fig. 5. It is obvious that it would not be practicable to bore the shaft hole A until the scraping operation is completed on the bed and carriage. In this particular case the support is bored in place on the bed.

The preliminary assembling operations of such parts as are interdependent consist of the chipping, scraping and aligning operations. Should chipping be necessary on parts that require scraping, then the chipping must be performed first in order to avoid having to take the work apart and to prevent the possibility of springing the pieces. Next in order are the scraping operations on such members as slides, carriages, ways on beds, spindle bearings, etc. This is to facilitate the lining up operations. On small work, the use of special surface plates enables the pieces to be scraped and made practically interchangeable without having to try the pieces together, while on large work the element of spring in large surface plates, besides other considerations, precludes their use. Special lifting and pulling devices such as those described in the writer's articles in the February and April issues of MACHINERY will greatly facilitate the work of scraping.

The determination of methods for quickly and easily lining up the various brackets, shafts, etc., is a matter that should receive careful thought. Whether or not jigs and fixtures are used will determine to a large extent the processes employed, although the final alignment of the brackets and bearings before the dowel pin holes are reamed, will be much the same in either case, the use of jigs saving the laying out of the screw holes. The halftone, Fig. 6, illustrates this principle and shows the method of aligning the brackets and feed-box on the head end of a turret lathe bed. Separate jigs are

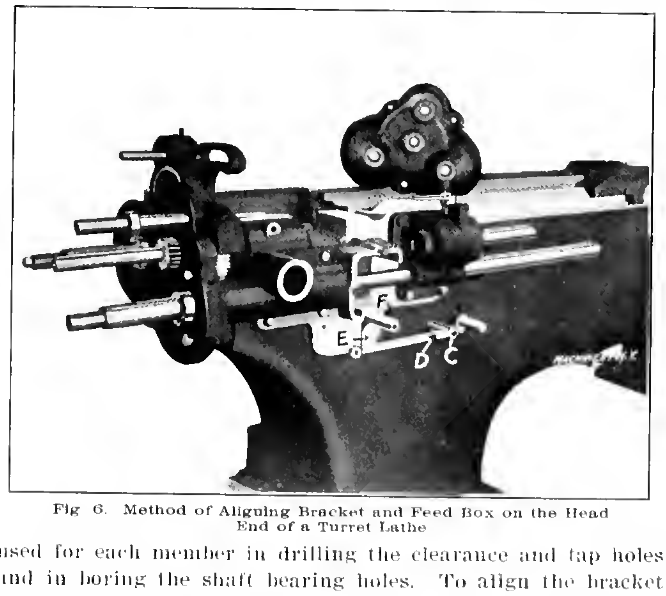


Fig. 6. Method of Aligning Bracket and Feed Box on the Head End of a Turret Lathe

used for each member in drilling the clearance and tap holes and in boring the shaft bearing holes. To align the bracket members on the bed for the purpose of drilling and reaming the dowel pin holes, special arbors are used to bring the shaft bearings in the brackets and gear-box in line with corresponding bearings in the bed. With the clamping screws only tightened sufficiently to hold the various members in place, the brackets are shifted slightly to permit the arbors to be turned freely by hand, which indicates that all the bearings are in proper alignment. The clamping screws are then tightened down, and the pinning operations completed. It should be explained that the gear-box cover is in place on its base during these operations; in Fig. 6 it is shown on top of the bed for the purpose of showing the arbors more clearly.

If jigs were not used, as explained above, the brackets and gear-box would have to be lined up and held by clamps for

the purpose of marking off the screw holes in the bed. Incidentally, the method of setting the stud C with reference to its slot for the connection D is shown. The sheet-iron gage E supports and locates the connection from the stud F.

In cases similar to that in Fig. 6 where it would be necessary to remove the shafts and gears in order to line up the brackets, it is advisable to perform this operation first. Otherwise, the units can be assembled complete, and then lined up on the bed.

The operation of assembling the individual units merely involves the chipping of oil grooves, hand reaming, fitting of keys, etc., and combining the various elements. Whether the units are sent to the storeroom or directly to the erectors, all operations of fitting and adjusting should be completed as far as possible. This will prevent the erectors from losing time by having to run to the vise and bench to fit the parts. Thus, in the manufacture of lathes, the head-stocks, tail-stocks, rests, aprons, etc., are assembled as complete units and are then sent to the erector to be fitted onto the lathe bed.

All work on the beds and such as cannot be performed when the units are fitted, is, of course, done by erectors. This includes the scraping of the larger pieces, the lining up operations as already explained and the final adjustments and testing of the complete machine.

The principal point to be observed on erecting work is to plan the method of combining and adjusting the various units on the bed of the machine so as to avoid having to take the work apart, due to neglect of some vital point. The practice of taking the work apart unnecessarily shows lack of forethought in planning the methods and processes of assembling and emphasizes the principle already outlined of mapping out the sequence of operations before hand.

A very careful consideration of all these problems and a serious attempt to solve them scientifically will bring surprising results. It hardly seems necessary to argue in favor of the adoption of the methods and processes advocated, since the experienced man will at once recognize them as being the most natural to follow. Yet the lack of effort to accomplish these results in most well-run shops (to say nothing of the poorly managed) is as singular as it is prevalent. In place of haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation.

* * *

A German professor in a lecture on the chemical relations of aerial navigation pronounces helium to be the ideal gas for lighter-than-air airships. The professor points out that the gas is uninflammable and that it can stand a cold of —268.5 degrees C. without liquefaction. The first quality would, of course, be valuable, but as regards the second quality, its value is doubtful, as aerial navigation is not likely to put such a test on the gas used, and it would be interesting to know where the professor expects that the airships would be subjected to such a temperature, and also how he would expect the navigators to survive. Besides, the professor ought to have pointed out how to get the helium. The small quantity of one hundred gallons possessed by the Leyden University is not intended for public consumption. The professor, therefore, realizing the impracticability of helium, cheerfully advises the making of experiments with superheated steam!

* * *

The first steel plant south of Mexico is being built at Corral, Chile, and is expected to be ready for operation early in 1910. The daily capacity will be 200 tons. The machinery for this steel plant is principally of French manufacture. A fine quality of iron ore is found in large quantities within five miles of the plant, and for fuel will be used charcoal produced from the extensive forests in the vicinity; it is proposed to produce iron and steel of the highest quality. It is expected that the opening of the steel plant will encourage the development of many other industries that are dependent upon the iron and steel industries for raw materials. This will open a market for industrial machinery, and American manufacturers should keep in close touch with Chilian development for the next few years. Machinery enters the country free of duty.

THE MANUFACTURE OF GAGES*

T-Square

The introduction of our present gage system was made necessary by the development of our modern methods in the manufacture of interchangeable parts; a complete system of gages is absolutely essential to the accurate and economical production of interchangeable parts in large quantities. Some manufacturers have been slow to recognize the necessity of absolute interchangeability in their products. This has been particularly true of some machine tool makers; who

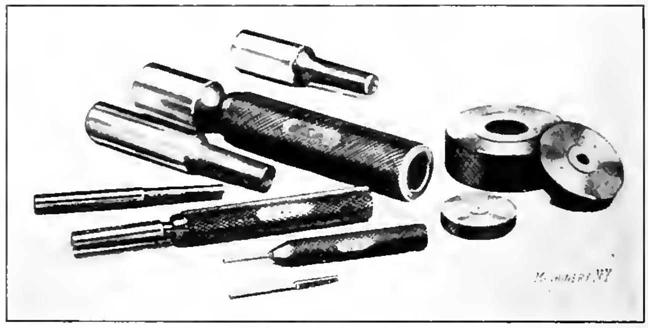


Fig. 1. Plug and Ring Gages of Approved Construction

has not seen half a dozen lathes of one make and pattern in the same shop where not even chucks were interchangeable?

Probably no class of manufacturers has more fully realized the necessity of absolute interchangeability than the makers of small firearms, and to gun makers is due much of the credit for the development of gaging systems and the training of highly efficient gage-makers. The standard methods adopted by them can, with slight modifications, be adjusted to fill the requirements of any manufacture; but the slow adoption of gaging systems is largely due to the manufacturer's prejudice which is often strengthened by ignorant or incompetent foremen who decry anything that savors of improvement, impelled by motives of fear that any innovation might carry beyond the narrow groove of their capabilities.

Principles of Development of a Gaging System

The manufacturer who contemplates the establishment of a gaging system must use the greatest care in the selection of his designer, for the question of economy hinges on the experience, foresight and ingenuity of the latter. The designer should be a man familiar with shop methods, and must be on good terms with the men with whom he must

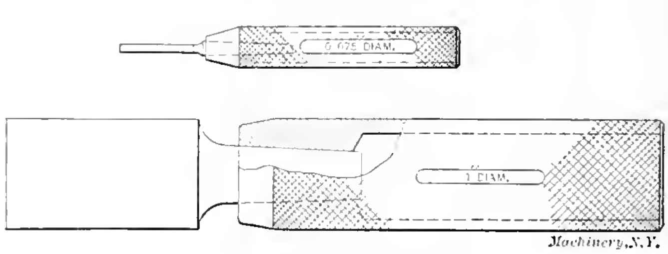


Fig. 2. Plug Gages and Handles

cooperate. In this way he will be able to gather considerable information which will be of great assistance to him in the production of efficient results.

The designer must satisfy himself that each piece being machined is handled to the best advantage, and that each cut or operation is in proper sequence. Having done this he can then lay out his gages in such a manner that each operation will have its own equipment, independent of other operations, thus insuring uninterrupted progress of the work.

In machining parts intended to be interchangeable it is necessary first to establish certain working points which are maintained throughout the entire series of operations. In some cases the working point must be shifted during the progress of the work, through the creation of a more important point after the taking of some cut, or the necessity of cutting away the original point. Very often two holes (not always neces-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Few Suggestions in Tool-Making, May, 1904; Lapping Flat Work and Gage Jaws, November, 1907; Making Thread Gages, February, 1908.

sary to the completion of the work), drilled and reamed in the piece, are used for locating it on pins inserted in the various jigs and fixtures, thus bringing each piece in like relation to the cutting tool after the proper setting has been established. And, again, it is sometimes found expedient to use one hole, and one surface, or one end and one side as holding points, and the designer must ever bear in mind that he must gage from the same point from which the piece is located or held, whenever it is possible to do so, although, of course, there are exceptions to this rule.

Should the parts on completion of the machining operations be required to pass through a system of inspection, before being assembled as a whole, which is the custom in some lines of manufacture, the gage designer is confronted by an entirely different set of conditions. He has then to do with the finished piece, and does not consider the intermediate stages. He should study the mechanism of the assembled machine, and must understand the function of each piece, and the relation it bears to all other parts; then will he first be

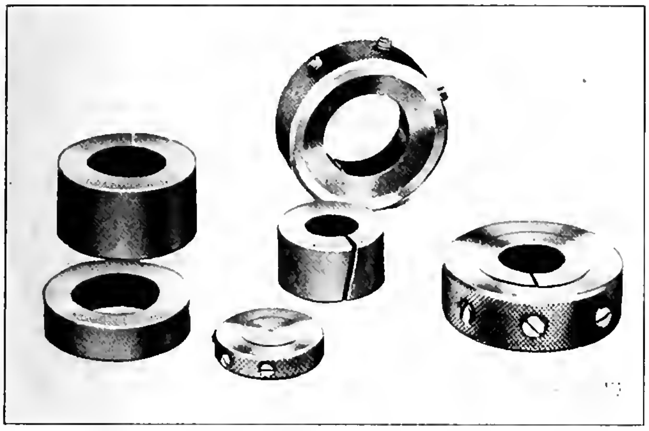


Fig. 3. Lap and Lap-holders used for Making Plug Gages

able to produce gages which will correctly test the vital points, with accurately established limits of tolerance.

The next essential to the economical inspection of parts is to limit the number of gages to as few as possible; when considering that parts are often made in lots of from 5,000 to 50,000, and each piece is to be inspected, the importance of this will be readily understood. It is *common* practice to combine gages of the simpler forms, such as a series of snap gages; or snap and profile gages, on the same plate; or a number of ring gages inserted in a plate also bearing snap or even profile gages. It is not, however, *good* practice to combine profile gages with any other type, as their longevity is much greater than that of any other form.

It is on the manufacture of the simple, but much used plug and ring gages we shall treat in this article, not with the old time machine shop conception of a gage, as something unquestioned (but often questionable) as to accuracy,

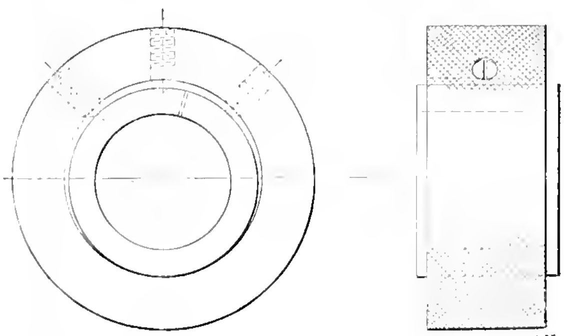


Fig. 4. Design of Lap and Lap-holders for Making Plug Gages

to be locked up in the boss' desk and brought forth only on state occasions, and given out with many solicitations for its care, and its safe return; but as something made in quantities, to be used, worn out and replaced.

The Making of Plug Gages

Our earliest, and in some cases, our latest, recollection of a plug gage is an unwieldy affair, either knurled or fluted on the handle end, and made of solid tool steel throughout, expensive to make and clumsy to handle, requiring much valuable stock in the making, and extreme care in the tempering (although the latter is always commendable as the danger of water cracks is always imminent). However, we now have a much improved design not only convenient to handle and symmetrical in form but comparatively inexpensive to make, and with the risk of loss in hardening reduced

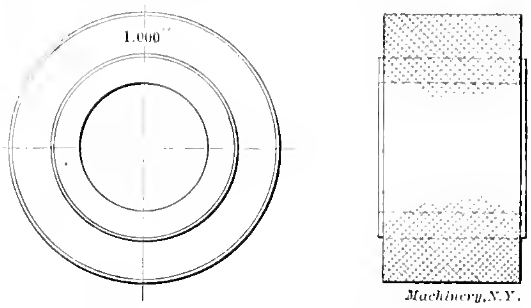


Fig. 5. Approved Construction of Ring Gages with Holders

20 to 50 per cent. This last depends first on the compact design, separate from the handle, and secondly, on the small amount of time expended up to the point of hardening, thus reducing the pecuniary loss when breakage does occur.

Although the designs of these gages, as produced by various makers, differ slightly, the fundamental principle is the same, *i. e.*, to insert the plug proper into a handle from which it can be easily removed, and replaced by another if desirable. The most popular, cheapest and best form, adaptable to plugs from 0.075 inch diameter upwards, is that with the taper shank. These plug blanks are made on a screw machine from drill rod or bar stock, by simply turning the taper shank and cutting off to any desired length, usually ranging from ¾ inch to 2 inches on the straight part. They are then centered for turning, grinding and finishing the straight portion, no further work being necessary on the shank. A number of such gages are shown in Fig. 1.

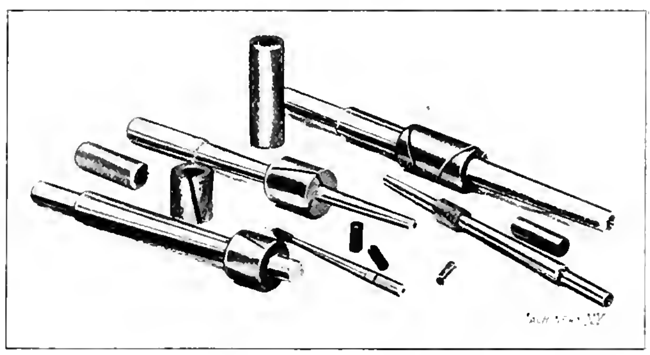


Fig. 6. Lap and Lap Arbors used in making Ring Gages

Knurled handles as shown in Fig. 2 are made in standard sizes, each accommodating a certain range of plugs. These handles, being of machine steel, can be turned out very cheaply on a hand or automatic screw machine, when, after stamping size or other desirable marking on spot flatted for that purpose, they can be blued if desired. They are then ready to receive the plug, which is simply driven lightly into the taper end, and when necessary, can be easily driven out from the rear.

Plugs ranging in diameter from 0.075 inch down, should be made from straight hardened wire, which need not be ground, but simply lapped to size, and sweated into the handle, which can be made in the same manner as for the taper shank plugs, but with the front end left solid, and afterwards drilled to suit any desired size. This method of inserting in the handle obviates the necessity of centering, turning or grinding, and the solder will be found sufficiently strong to withstand the torsional strain on a plug of small diameter. As the breakage of these small plugs is quite frequent, this will be found a very cheap and satisfactory means of production. The wire can be bought in a great variety of sizes, and for any given size of plug, wire should be used 0.001 inch larger in diameter, which will be sufficient allowance for the lap to clean up any surface irregularities

The taper shank plugs ranging in diameter from 0.075 inch upwards, are handled differently. When the blanks are made from bar steel, they should be at least 0.080 inch larger in diameter than the required finished size, as this will insure turning off the decarbonized surface of the bar, and reaching the more uniform structure beneath. In the case of those made from drill rod but half of this amount is necessary. After centering with a small center reamer (large centers should be avoided as they sometimes induce water cracks), the plugs are turned smoothly to within 0.005 inch to 0.010 inch of the finished size, according to length, and carefully hardened.

As plugs require extreme hardness, it is only necessary to reheat them sufficiently to relieve the strain after hardening, excepting those of slender diameter, which should be drawn reasonably low—about spring temper—at the intersection of the shank and body, to prevent them from snapping off while inserted, should any side strain be exerted on the handle. With the use of a little fine emery mixed with sperm or lard oil applied to a simple cast iron or copper lap, pointed similar to a lathe center, and held in the chuck of a hand lathe, the centers are then lapped preparatory to grinding.

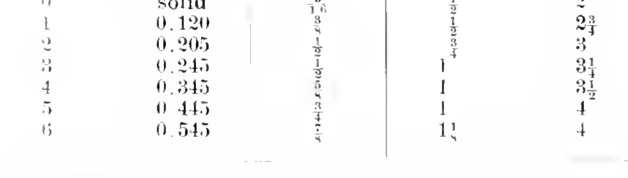
The three most desirable results in grinding are straightness, smoothness of surface, and closeness to finished size.

Fig. 7. Design of Lap and Lap Arbors for Making Ring Gages

When a good regular grinder is available the best results can be obtained, particularly if it is equipped for wet grinding; for then a piece can be ground to within 0.0002 inch of the final size, with the assurance of a perfectly smooth and even surface. An emery wheel of about No. 80 grade, with the cutting surface reduced to 1/8 or 3/16 inch in width, and kept from glazing or clogging, gives very satisfactory results.

For the benefit of those wishing to do work of this kind, and not having a regular grinding machine at their disposal,

TABLE I. PLUG GAGE HANDLES



No.	A	B	C	D
	Inch	Inch	Inch	Inch
0	solid	$\frac{5}{16}$	$\frac{1}{2}$	2
1	0.120	$\frac{3}{8}$	$\frac{1}{2}$	$2\frac{3}{4}$
2	0.205	$\frac{1}{2}$	$\frac{3}{4}$	3
3	0.245	$\frac{1}{2}$	1	$3\frac{1}{4}$
4	0.345	$\frac{5}{8}$	1	$3\frac{1}{2}$
5	0.445	$\frac{3}{4}$	1	4
6	0.545	$\frac{7}{8}$	$1\frac{1}{8}$	4

it might be said that usually 0.001 or even 0.0015 inch is not too much allowance for lapping when the work is ground in a bench lathe or other contrivance not made specially for this work. Under such conditions it is difficult to get any but a rough and uneven surface. Before grinding, the piece should be looked over carefully for cracks; those not discernible on the closest scrutiny will make their presence known in the process of grinding or lapping, but at whatever stage they develop, the piece should be immediately scrapped. Should the piece develop a tendency to run eccentric after the surface has been once trued or cleaned up by the grinding wheel, it evidently is cracked.

The object of lapping work after grinding is to give the extreme smoothness necessary to a lasting surface, and the minimizing of friction, and to correct any slight irregularities caused by the grinding wheel or due to imperfections in the grinding machine, as well as to perfect its straightness.

For plug and ring gage work, cast iron makes the best lap, and although it cannot be charged with abrasive as readily as copper or lead, it gives much better results, besides wearing much longer than the other metals. Laps for lapping plugs are made from disks ranging from 3/16 to about $1\frac{1}{2}$ inch in thickness, are drilled and reamed to a sliding fit on the ground plug, and split on one side to allow of adjustment, as shown in Figs 3 and 4. The holders, made in a few standard sizes to accommodate the different disks, are of machine steel, knurled, and having three adjusting screws to enable the operator to regulate the tension of his lap.

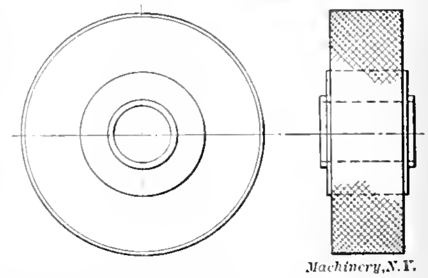


Fig. 8. Master Ring Gage with Small Collar at Mouth of Hole, which is ground off just before completing the lapping

The piece to be lapped should be running at the speed required in grinding, which varies according to diameter, and the lap adjusted at all times to grip firmly on the surface, but sufficiently free to allow its being held by the fingers. In the case of large work a wood clamp can be used. As the piece revolves, the lap is slowly drawn back and forth from end to end, and under no circumstances should this oscillation cease while the plug is in motion.

The proper abrasive to use in this operation is flour of emery, or a very fine grade of carborundum; the latter, being the faster cutter, seems more desirable. It is mixed with sperm or lard oil, to the consistency of molasses, and applied sparingly to the surface being treated, from whence it is taken up by the lap, which becomes charged as it passes over after each application.

As the operation is almost completed, however, this is discontinued, and a drop or two of oil charged with the finest particles of flour emery is substituted. This is obtained by sifting as from a pepper shaker about a tablespoonful of flour emery into a tumbler of lard oil, when, after standing an hour, the oil should be poured off, and will be found charged with the finest emery, the coarse particles having settled to the bottom. This abrasive is applied a drop at a time from the end of a small pointed stick or wire, and will make a remarkably smooth and bright finish. To the practiced hand, it requires very little time to lap a piece in this manner.

Should it be necessary to remove any quantity of metal by the lapping process, much faster methods can be employed, such as lead or copper laps charged with a coarse abrasive liberally applied; but the results will be found hardly satisfactory if accuracy is desired.

Should there be any hitherto undiscovered soft spots in the piece, they will invariably show up in the lapping, as their duller color is contrasted with the rest of the harder surface. However, it is possible for a piece to be slightly soft throughout, and finish up uniformly bright, but the softness should be discovered by file or other test at an earlier stage. In either case the piece can only be rehardened, and reworked for some smaller size, as a plug gage with a soft spot on its surface is useless.

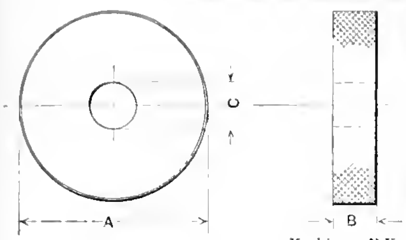
Ring Gages

When ring gages are to be made in quantity even when the quantity is small, they should be made from tool steel disks turned to certain standard diameters and cut from the bar. These blanks can be kept in stock, as well as the holders (see Figs. 1 and 5) into which they are forced after being drilled, reamed and hardened. The holders are made on a screw machine, of machine steel, requiring only to be turned, knurled, drilled and reamed with a slightly smaller hole than the diameter of the corresponding gage blanks, and cut off to length. They can be treated similarly to plug handles as to marking and bluing, as occasion demands; they can be used indefinitely by replacing the ring bushing when worn.

The gage blanks are drilled and reamed, or bored, to within 0.002 or 0.003 inch of the finished size, care being taken to have the hole as straight as possible. In handling for harden-

ing they are wired around the outside with a short piece of soft iron wire, to afford a means of handling and avoid the contact of tongs, or the necessity of passing a rod through the hole in dipping, as this latter has a tendency to cause bell mouth by retarding the action of the water within the hole. After hardening they are at once reheated sufficiently to relieve the strain, as in the case of plug gages. They are then ground on an arbor, allowing about 0.0015 inch to insure a tight fit in the holder, and are then rough lapped within 0.0005 inch of the finished size, pressed into place,

TABLE II. RING GAGE HOLDERS



Machinery,N.Y.

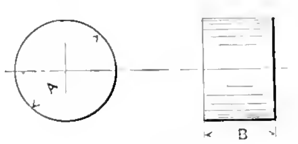
No.	A	B	C
	Inch	Inch	Inch
1	$1\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$
2	$1\frac{1}{4}$	$\frac{5}{16}$	$\frac{7}{16}$
3	$1\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$
4	$1\frac{1}{2}$	$\frac{7}{16}$	$\frac{5}{8}$
5	$1\frac{7}{8}$	$\frac{11}{16}$	$\frac{7}{8}$
6	$2\frac{1}{8}$	$\frac{11}{16}$	$1\frac{1}{8}$

and finish lapped. The ends can be ground while on the arbor or on a surface grinder when in the holder, but before the finish lapping.

If the rings are sufficiently large to require grinding they should first be ground on the periphery to the proper diameter, and then on the inside to within about 0.001 inch of the finished size. As holes ground with a wheel are liable to be slightly tapering, they cannot safely be worked as close as a plug, in the grinding. It is an unnecessary expense to wheel grind rings up to ¾ inch diameter, as simple lapping gives equally good results and requires much less time.

The form of lap used (Figs. 6 and 7) is a cast iron cylinder with a taper hole, split diagonally on one side to allow of expansion as it is forced on a taper arbor, to compensate for the gradual enlarging of the hole being lapped. The lap should be about three times the length of the ring it is intended to be used in. The same rules regarding abrasive, speed, etc., apply as in the lapping of plug gages, but care should be exercised to avoid a too generous application of the abrasive as the process nears completion, for, if applied too lavishly the particles have a tendency to crowd under the edges and cause a bell mouth effect. This latter trouble is sometimes eliminated by making the rings with a slight

TABLE III. PLUG GAGE BLANKS



Machinery,N.Y.

No.	A	B	C	D	No of Handle
	Inch	Inch	Inch	Inch	
1	$\frac{1}{8}$	0.100	$\frac{5}{8}$	$\frac{3}{4}$ to $1\frac{1}{4}$	1
2	$\frac{3}{16}$	0.150	$\frac{7}{8}$	1 to $1\frac{5}{8}$	2
3	$\frac{1}{4}$	0.200	$1\frac{1}{4}$	1 to 2	3
4	$\frac{3}{8}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	1
5	$\frac{1}{2}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	4
6	$\frac{3}{4}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
7	$\frac{7}{8}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
8	$1\frac{1}{8}$	0.400	$1\frac{1}{4}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	5
9	$1\frac{3}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
10	$1\frac{5}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
11	$1\frac{7}{8}$	0.500	$1\frac{3}{8}$	$1\frac{3}{4}$ to $2\frac{1}{2}$	6

collar on each end (see Fig. 8), which is ground off after the rough lapping has been completed; but this is somewhat expensive, and except for master rings, hardly necessary.

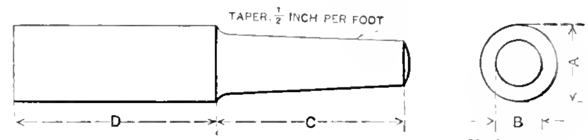
In the making of small ring gages which do not allow the insertion of a substantial cast iron lap, a tool steel lap charged with diamond dust can be used. This abrasive, which is not extensively used outside the watch factories and concerns doing work of like nature, must be used to be appreciated. It can be purchased as Brazilian bort, in a pebbly form; crushed in a suitable mortar, and graded to suit requirements; it is particularly applicable to hand or form laps, or laps for delicate or sharp corners. It is also a very rapid and smooth cutter, economical and lasting, and is readily taken up and retained on the surface of a tool steel lap to which a very small quantity is applied mixed with sperm oil, and rolled in with an extremely hard roll. Occasional rechargings are necessary as the work progresses, but in the intervals a drop of sperm oil is used on the lap.

Should it be required to make master or reference plug and ring gages, a somewhat different course should be followed than for gages intended for continual use. The method is about the same in each case, but with the former, after hardening, the work should be carried along at intervals, over a considerable time. First the rings should be cleaned up on the grinder and laid away, and later ground again, and so on during the course of a year, or even longer, where future requirements are being anticipated. This allows the metal to set, or as called by some, to season.

The Measuring and Fitting of Plug and Ring Gages

In factories not equipped with a measuring machine, some sort of standard should be adopted to which each and every workman can adjust his measuring tools. As few men measure alike, the disadvantages of varied adjustment are added, and the result is hardly conducive to uniformity. A first-

TABLE IV. RING GAGE BLANKS



Machinery,N.Y.

No.	A	B	Finished Hole	No. of Holder
	Inch	Inch	Inch	
1	0.350	0.300	0 to 0.150	1
2	0.475	0.350	0.150 to 0.300	2
3	0.600	0.400	0.300 to 0.400	3
4	0.725	0.500	0.400 to 0.500	4
5	0.975	0.750	0.500 to 0.750	5
6	1.225	0.750	0.750 to 1.000	6

class gage maker has in his kit reserve micrometers, which are properly adjusted to the standard of his employer, and used only for reference or final measurements. This allows him to work to a remarkable degree of closeness before presenting his work for test, should a measuring machine be employed for that purpose; and where it is not, the work is usually inspected by one man, equipped with no better means of measuring than the maker's, but who serves to unify the element of touch which varies with different workmen.

Where master plug and ring gages are desired in pairs, the plug is first made to measurement, and the ring is then made and fitted to the plug. When trying the ring on the plug during the final fitting, both should be wiped perfectly clean and allowed to acquire like temperature, by lying together on a bench, or machine, or for a few seconds in cold water. The plug is then given a slight coating of rancid oil, and inserted in the ring, into which it should be a close wringing fit. When fitted properly this way, it will be found impossible to insert the plug, should the oil be removed, or even when some other kinds of oil are substituted. This rancid oil is simply the drippings of animal oil that has been used many times on some drilling or cutting operation; the older it is the better.

Should a number of plug gages of one size be required for manufacturing purposes, they should all be made to machine or micrometer measurement. It is utter folly to try fitting any quantity of plugs to one master ring if absolute uniformity is essential, particularly if they are of any considerable length, owing to the tendency of the ring to wear in the fitting. One of each lot can be tested to the ring to make sure that it conforms to the proper standard.

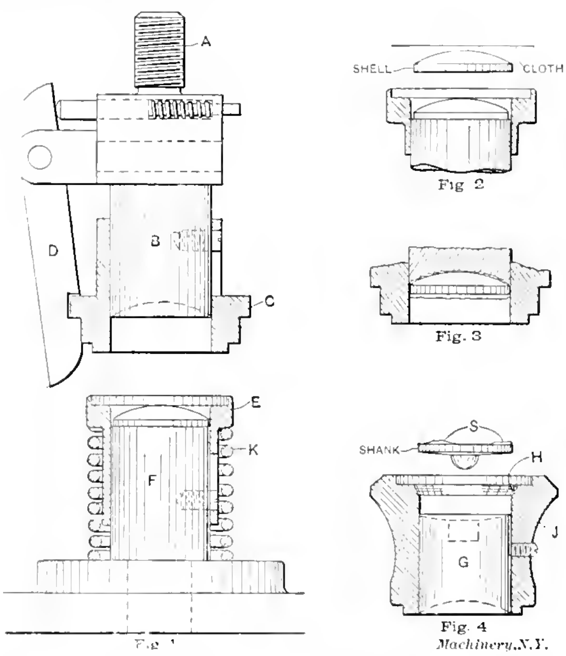
Ring gages, whether made singly or in quantity, are fitted to a master plug, which, as it wears, is comparatively inexpensive to replace, the wear being easily detected by occasional reference to the master ring.

DIES FOR COVERING BUTTONS

CHARLES WESLOW*

Charles Weslow

The dies and tools used in the manufacture of cloth covered buttons are shown in the accompanying illustrations. The particular tools shown are for covering and binding together the two parts of what is known as a "fifty line unlined tablet button." One "line" on a button gage is equivalent to 0.025 inch or forty lines to the inch. The dies are used in a foot press of simple construction, this machine being adapted for this work. The ram of the press is tapped for the threaded shank *A*, Fig. 1. The case-hardened part *B* is finished to a diameter of 49¾ lines or 1.243 inch, and its lower end is concaved according to the style of shell or button. The sleeve *C*, which is bored 0.001 inch larger than part *B*, is made of machine steel and also case-hardened. This sleeve is supported by a lever *D*, during part of the time required for the covering operation, and it is provided with an elongated slot which fits the head of a small screw, as shown. Another case-hardened machine steel sleeve *E*, similar to *C*, fits over the part *F* which is likewise similar to the part *B* except that it is convex on the upper end to conform to the shape of the inner part of the button shell. This spring-supported sleeve *E* is the lower die. The diameter of *F*, except the small shoulder at the upper end, is 0.002 inch larger than the shell, the size of which depends on the thickness of the cloth used, which in this case is ¼ of a line or approximately 0.006 inch. This size shell is made of 36-gage stock. The largest bore of sleeve *E*, which is known as "the nest," is the same diameter as the cloth blank which is computed according to the style of the button. In this case it is 69 lines in diameter.



Figs. 1 to 4. Die and Thimble for Covering Buttons and Binding Shank and Collet together

The different parts of a button are shown in Fig. 5. The cloth blank in the upper left-hand corner of the engraving, covers the shell to the right, and this covered part is locked to the collet shown below after a piece of cardboard and canvas has been placed in position as subsequently described.

In Fig. 2 the shell and cloth blank are shown ready to be placed in the lower die. When they are in position the upper die descends and picks them up, as shown in Fig. 3. The part shown in Fig. 4 is known as a thimble. This thimble, which is of tool steel, acts as a closing or curling die, at *H*, and it not only curls the cloth between the shell and the shank, but it also closes in the shell thus binding or locking the two parts together. The radius of the surface *H* is found by experiment. The shank is shown in Fig. 4 ready to be placed in the thimble. When in position it rests on the plunger *G*, which is a sliding fit in the thimble. This plunger is prevented from dropping out by a set-screw, which engages an elongated flat spot on it. The largest bore of the thimble is the same diameter as the lower outside diameter of sleeve *C*, which is the same as the recess in part *E*, which, as stated, corresponds to the diameter of the cloth blank.

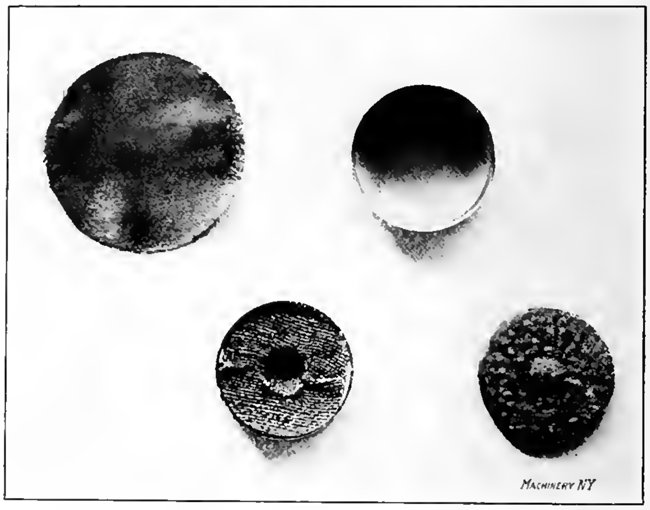


Fig. 5. The Parts of a Cloth-covered Button

Figs. 6 and 7 show the thimble in position for the second downward movement of the plunger. The thimble is put in place by hand after a shell and cloth cover have been picked up by sleeve *C* during the first stroke of the press, as shown in Fig. 3. The parts *C*, *J* and *E* are supported by the spiral spring *K*. When the upper die descends during the second stroke, lever *D* is disengaged from sleeve *C*, as shown in Fig. 7, so that the latter is free to move on part *B*, which continues to move downward when *C* rests on thimble *J*. In so doing, it forces the cloth cover to curl in as shown. Then the cylindrical part of the shell, which is now covered, strikes the curling section of part *J*, but the spiral spring now gives way to this pressure, so instead of the metal shell curling in as might be supposed, it acts in connection with part *B* to force thimble *J* down, which, in turn, acts likewise upon the sleeve *E*, which moves down until its lower end strikes the die-bed. By this time the shank will have entered the shell and carried the surplus of cloth cover with it. When sleeve *E* stops on the die-bed, part *B* continues to descend until the shoulder on it strikes the upper end of sleeve *C*; then there is nothing else for the invisible shell to do but curl in and embrace the shank, thereby locking them together and completing the button. Sufficient expansion takes place in the button, when the dies are released, to cause it to float on the top of the thimble. So it will be seen that two "kicks" or strokes of the press are required to cover a plain button.

In considering the manufacture of the five parts necessary in a plain button, we will first take up the shell and collet. These are blanked and drawn up in a combination die, known as a collet die, with a double action press, but not necessarily so. Stock of from 36 to 38 gage is used to make them, which comes in sheets of various sizes in much the same manner as tin. Some manufacturers get the 14 by 28-inch size and square shear them in half for convenience. The material used for shells is given a thin coat of japan to prevent rusting, but the material used for the collets is japanned black for appearance.

The stock is fed by hand up to a knife-edge stop, which is instrumental in separating the scrap stock from the sheet.

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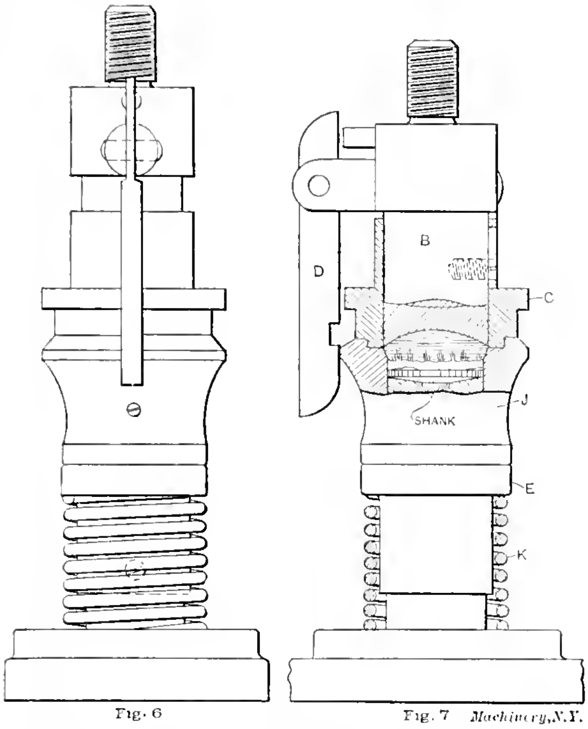
Chas. Weslow was born in Harrison, N. J., in 1876. He began work at the age of 11 years, out of necessity, and since that time he has been employed in a great many machine shops and manufacturing establishments in the East, as machinist, tool-maker, and tool designer. In this journeying, he has acquired a broad practical experience, which has been supplemented by the correspondence and night schools. The following are a few of the numerous establishments where he has been employed as tool-maker or executive: Noble & Hunt, Newark, N. J.; Western Electric Co., New York; Sloan & Chase, Newark, N. J.; Domestic Sewing Machine Co., Newark, N. J.; F. H. Richards Engineering Co., New York; Pike Adding Machine Co., Orange, N. J.; American Calculating Machine Co., Newark, N. J.; Crown Button Co., New York; Hyatt Roller Bearing Co., Harrison, N. J.; Premo-Hall Novelty Works, Newark, N. J.

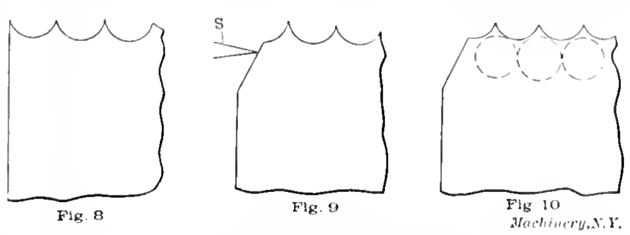
The edge of the stock, after one row of blanks has been cut, is made up of half-circular forms, as shown in Fig. 8. This rough edge, however, is placed against the gage on the press when blanking to the succeeding rows, to guide the stock as it is being fed through, the gage being long enough to make it easy for the operator to hold the stock squarely against it. The press runs about 250 revolutions per minute, and the shells are blown from the die by a strong air blast. Some use an inclined press, relying upon gravity to remove the shell, but an air blast does the work quicker, thereby allowing a speedier action of the press. This blast comes through a 2½-inch tin pipe, which is nozzled at the die. After the first row of blanks is cut from the new edge of



Figs 6 and 7. Die shown in Fig 1, with Thimble, Fig. 4, in Place

stock, the operator snips off the corner with a pair of scissors to prepare the stock for blanking the next row of holes. By carefully trimming the corner, the stock is so located by the knife-edge stop *S*, Fig. 9, that the blanks are cut as indicated by the dotted lines in Fig. 10, which, of course, effects a considerable saving in material. The first blank is cut singly to locate it properly and then the balance are cut out at a speed depending on the speed of the press. By referring to the engraving, Fig. 10, it will be noticed that no stock remains between the blanked holes. As the stock is fed forward a knife-edge stop effects a separation of the scrap from the sheet.

Another part to the button is the cloth cover. These are cut with a hand punch, which looks like a large size belt



Figs 8 to 10. The Way the Stock is located with Reference to the Stop to effect Economical Blanking

punch, and a mallet on a hardwood block. Several thicknesses of cloth are cut at one blow, and about ½ gross of the blanks are removed from the punch at one time. A good plan is to keep the cloth blanks in the position in which they are taken from the punch, in a receptacle for this purpose, instead of throwing them loosely into an open box. If the button is to be covered with a damask material, or fancy centers, as shown in Fig. 11, then the blanks are cut singly in a foot press.

The cardboard disks, which are inserted between the shell and collet, are cut on the single action power press in much the same manner as the shells are made, but they are forced through the die, while the shanks are knocked out. These "cardboards," as they are called, are rushed out "a mile a minute," no particular care being exercised, for if they crack or break, they are used anyhow, but they must be a certain

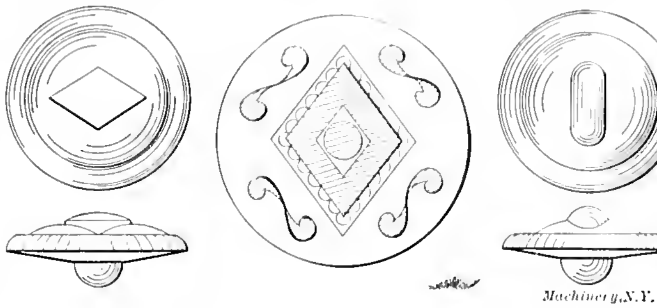


Fig. 11. Fancy Covers which are blanked singly

size to drive into the collet, to hold the canvas in position. The canvas pieces are blanked in much the same way as the cloth covers are. These parts are assembled in what is called a "machine," but it is in reality a light foot press built on the lines of general hardware.

Fig. 12 shows the style of die used in assembling the shanks. Two strokes of the press are required for each shank. The illustration also shows the shell and the canvas blank ready to be placed in the "nest." The punch *P* is shaped the same as an ordinary drawing punch, excepting the hemispherical projection provided at the end. This end is what forms the canvas stem which is sewed to a garment. In use, the collet is first placed in the nest with the canvas on top. The plunger then descends and forces the canvas into the pierced hole in the collet forming the stem. The lower end of the knurled ring *R* is turned to fit the recess in the upper end of part *Q*. This ring contains a plunger,

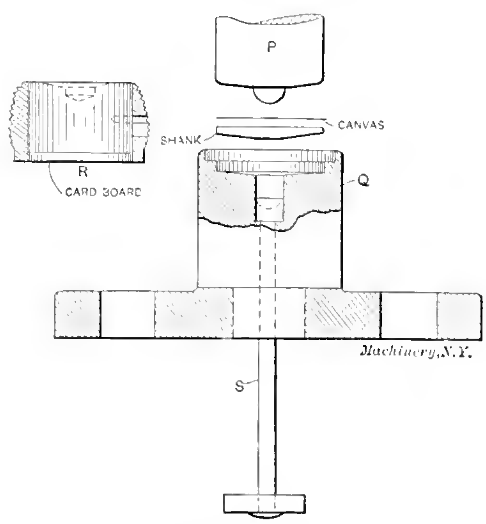


Fig. 12. Punch and Die for Forcing Canvas and Cardboard into the Button Shank

the top end of which is turned to fit the lower end of plunger *P*. The ring and its plunger are held together by a small dowel, as shown, which slides in an elongated slot in the ring. While the operator is forcing the canvas into place, this ring, which is held in the right hand, is being used to pick up a pasteboard disk, while the left hand secures another canvas and collet for the next button. After the first stroke of the plunger *P*, the knurled ring is inserted in the recess in *Q*. The second stroke, through the plunger in ring *R*, imparts a blow to the pasteboard, which is driven into the shank. The small plunger *S* is a simple form of knock-out for ejecting the shanks. Celluloid buttons are assembled in the same style die except that celluloid covers are first heated to make them pliable so they will curl and bend.

Good tool-makers are in demand for this work, and the writer knows of concerns who were offering $24 and $30 a week for competent men. As far as the writer knows, Williston of East Hampton, Mass., is the original covered button manufacturer, now known as the United Button Co.

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MACHINERY

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INVENTING AS AN OCCUPATION

From time to time our mail brings a woeful tale from a disappointed inventor who has devoted a number of years and considerable money to the perfecting of some device which the world has not duly appreciated. Many inventors spend years on the development of an idea which to them appears to be of great value. Often, too, they sacrifice the employment by which they earn their daily bread. It is but natural that the inventor who has thus devoted his time and perhaps all of his savings to the development of a new idea should be discouraged when he finds that he can realize little or no returns from his invention. As a rule he thinks that he has been unjustly treated by those to whom he has submitted his idea and often regards the manufacturer as an enemy because the compensation offered is from his point of view inadequate.

In many cases the inventor sees from one viewpoint only. He has not the advantage of wide experience and knows little or nothing of the costly organization necessary for marketing goods. Inventing should seldom be considered as an occupation to which a man can profitably devote all his time, except in cases where the inventor's genius is of an extraordinary degree. The inventors who succeed as a rule retain employment in regular occupations while they perfect their inventions during spare time, the inventions being incidents in their regular occupations, or by-products, as it were. When an inventor works under such conditions he is more likely to correctly estimate the value of his inventions, and not be bitterly disappointed because his inventive genius is not highly appreciated.

A man who has true inventive genius cannot help being an inventor, but he should avoid living in expectation that one brilliant idea will make his fortune and enable him to live ever after free from all pecuniary cares. The hope of "striking it rich" is a common fault of many inventors. If they must invent, let them content themselves with moderate returns for their ideas, placing each in the best market possible, but not feeling disappointed if a large fortune is not realized from an idea that to the inventor seems very valuable.

Advice is cheap and is generally disregarded by those who could best profit by it. But notwithstanding, we cannot help suggesting that inventors of ordinary ability should retain their regular occupations while developing their ideas. They will be happier and their chances for success will be greater than if they give up profitable occupations hoping to produce something which will make a large fortune. The trouble is that inventors as a class are a somewhat irresponsible lot to whom a steady job is distasteful. Steadiness of character and genius are rarely found combined in the same individual, and doubtless much that has been said here will be of little value to the class most in need of advice.

* * *

MACHINE SHOP INTERCOMMUNICATION

There is no trade or profession so closely identified with the development of new inventions as that of the machinist and the tool-maker. Embryonic ideas are gradually developed through a series of experiments with their assistance, and when the model is finally completed, the tools and machines for its manufacture have to be constructed. The position of the up-to-date machine shop, therefore, is of the first importance in industrial development. It is this importance which has made it absolutely imperative that the equipment of machine shops be of the highest type in labor-reducing machines and time-saving methods.

One of the many important time-saving devices developed within the past few years, which merits the careful attention of shop managers, is the automatic intercommunicating telephone. Its installation in a plant means that machine shop superintendents are no longer subjected to the many annoyances occasioned in the past by the crude methods of communication in use, such as unreliable hand-bells, buzzers, unsanitary speaking tubes, etc.

The very nature of the modern machine shop organization with its various departments covering a large ground area demands that some quick method of communication be installed that will put every department in close touch with any and every other department. It should not be necessary for the foreman of, say, the milling department to go to the foundry to ascertain why certain castings required for a rush order have not reached him. His time is too valuable to be thus wasted. Again, the shipping department, located perhaps in a remote part of the works, should be in as close touch with the superintendent as the drafting-room just outside his office.

The automatic intercommunicating telephone, of which various forms are now on the market, brings all the departments of the modern machine shop in close touch with each other without involving charges for attendants. With its use a higher standard of efficiency can be obtained, and almost all the benefits of personal interviews can be enjoyed without the necessity of leaving one's own department. The old walking-talking method of communication between the superintendent and subordinates may be abolished and the time thereby saved devoted to other details. Orders can be transmitted and received almost instantaneously, and mistakes practically eliminated, or at least reduced to a minimum on account of the facility provided for readily securing directions and checking up doubtful information. The telephone should not, of course, be used to transmit orders of which a record is required. All such orders, requisitions, data, etc., should be transmitted in writing only; but the telephone can be made a most valuable means for explaining points not clear in written communications or which perhaps need modification in some detail to fit a certain condition.

Another advantage of the telephone not unimportant is the ready means it gives for locating the superintendent or others who may be making a tour through the works. In a few moments all the stations can be called up if necessary, the desired persons located, and any communication transmitted or information obtained with promptness.

All the foregoing and much more is common knowledge in the works where the telephone is an indispensable fixture, but notwithstanding its manifest advantages we still find many plants, otherwise up-to-date, which are sadly deficient in modern means of intercommunication. The defect can be remedied at small expense, and the saving effected will soon more than pay the cost.

THE HUMAN ELEMENT

ANALYST

Among the potent factors that impel a manufacturing concern toward the goal of commercial supremacy, is one that is often overlooked, but more frequently ignored—the human element. Employers sometimes forget that there is such a thing as a moral law and that it does not pay to violate it, and some superintendents and foremen have been imprudent enough to take undue advantage of the recent industrial depression to enforce methods and policies vitally affecting the workman's daily life, without regard to the human element that enters into his makeup, and which of necessity must be reckoned with later on.

As a consequence the men usually "take it out" by giving the company a bad reputation among their fellow-workmen, and it is a fact that some of the concerns which complain of the difficulty of securing and keeping good men, owe their troubles largely to this cause. The reputation of a shop for being "white" or otherwise spreads far and wide, and good men usually know pretty accurately whether it is a desirable place to work in or not. This often materially affects the establishment concerned, especially when good men are scarce. Business men have their commercial agencies and reports for ascertaining the reputation and standing of other concerns. Workmen do it by a different, but just as effective a method, and the superintendent or foreman who thinks he can treat men unfairly and not suffer for it makes a great mistake. The foremen, especially, should always remember that they are the direct representatives of the firm to the workmen, and that the men base their opinion of the company largely upon their opinion of the foremen. The workmen's promotions and increases in pay depend upon the foremen's characteristics and knowledge; their daily life and career are subject to his control, his caprice and vagaries. The character and ability of the foremen affect the workmen more directly than any other factor in the shop organization, and as a result have a direct effect upon their efficiency and disposition toward the company. Of course there are always two sides to a story. Many of the complaints come from men who are chronic fault finders, and who never would be satisfied with any conditions, however advantageous; so that before giving credence to these reports, one should always be certain that the facts are substantiated by reliable evidence.

We often hear of the tendency of workmen to limit their output and effort, and of their neglect to work for the good of their employers. This is usually the complaint of the manufacturer who does not consider the human element of sufficient importance to merit his attention, and who refuses to put himself in the other fellow's place and to build up an organization along lines which would mean encouragement and inspiration to his employes.

Another factor of great importance in its effect upon the human element, is the question of handling men so as to get the most out of them without incurring their enmity.

Ignorance of details will sometimes cause the management of a concern to entrust the important position of superintendent to the man who can talk loudest and make the greatest show on a little knowledge. Such a man is apt to possess an exaggerated sense of his own importance, coupled with jealousy of those who suggest any improvement in method or process. Add to these failings surreptitious dealings with foremen and workmen, and you have three of the greatest causes of trouble in a shop, resulting oftener in a spirit of hostility than of cooperation between superintendent, foreman and workman.

It sometimes happens that a superintendent makes the serious mistake of ignoring his foremen to a certain extent in order to display his authority, and instead of entrusting the details of the work to the foremen, gives orders directly to the workmen; so that the workmen lose respect for and confidence in their foremen, and the latter become mere figure-heads, without any authority except in minor details. In some cases this is necessary because of the incapacity of the ordinary foreman, but it is always advisable when practicable to give instructions through the foreman, and if he is not competent to run his department without such assistance he should be replaced by one who is.

It frequently happens that a superintendent desiring to retain the full credit for an innovation, makes the mistake of refusing to confer with different members of his organization in regard to any suggestion they may be able to offer, and attempts to force his plans through. Such action usually meets with covert opposition. His assistants, perhaps familiar with some obstacle in practice which he has not considered, say nothing and allow the experiment to fail, "because they weren't asked." In this way the small jealousy that impels one man or group of men to underrate the work done by others, often works incalculable loss to the employer. The fact must be recognized that, nine times out of ten, the joint advice of several men conversant with a subject is superior to any plan developed from one man's brain.

In every organization there should be a head and a strong one; but singularly enough the method often adopted in manufacturing establishments is to place all the responsibility on one superintendent and neglect to surround and strengthen him with a body of efficient foremen, who might be advisers of great value. In adopting such a policy the management fails to recognize the great benefit to be derived from securing the advice of a number of the best qualified men upon important matters, and from giving the foremen an opportunity to show their value, which with most men means increased ability to handle the problems submitted to them.

In contradistinction to the method of management portrayed above, is the shop organized along lines that enlist the cooperation of the personnel, that develops the latent ability of each man; a shop where all plans are based primarily upon the human element of the men who are affected. The sympathetic support of the foremen and workmen *must* be secured. The best qualified superintendent will not achieve the degree of success that should be attained unless he is supported by the foremen, job-bosses and workmen. To enlist their support, they must be consulted frequently concerning the difficulties encountered, and encouraged to suggest ways of overcoming them; they must be made to feel that the methods are their own, and their interest in the work recognized. Thus difficulties will quickly disappear, and ways and means for overcoming unexpected obstacles will soon be discovered.

Nothing is more vital to the progress of an enterprise than that its executive force should work in unison. Then the balance of the shop will generally do likewise. Let there be discord and lack of harmony among the heads of a concern and there will be an instant lining up of forces in opposition, one against the other, which will cause the entire organization to disintegrate and lose much of its efficiency. The only cure is coöperation, since the work of each man is related to and interlaced with the work of all. The spirit of "getting together," if fostered, will be the chief factor in developing the strong men in the organization, and it should always be remembered that the habit of concerted action can be cultivated—gradually, perhaps, but easily—if proper attention is paid to it.

It must be conceded that the humanitarian, fair-minded policy of management is the greatest stimulus to the ambition of the workmen, and that a loyal, interested force of workers, impelled by a feeling of good fellowship to do their level best, constitutes the concern's best asset, and is the greatest and strongest factor making toward success.

* * *

It is evident that Bleriot's exploit in flying across the English Channel has stirred the imagination as has no land flight of equal distance, and that it has also greatly stimulated the progress and development of aviation.

The enthusiasts see in Bleriot's flight the beginning of a new era in which man will conquer the air, and in which the sea, "that parts nations asunder," will no longer be a hindrance to his movements. To us there is something essentially fine, heroic and conquering in the vision of the Frenchman's exploit; it shows man overcoming the seemingly insurmountable through his control of natural forces, made possible by the development of mechanical engineering. The machinist can rightly claim a large share in this latest triumph of mechanical flight.

THE TESTING OF FILES AND TOOL STEEL*

The following inquiry regarding files has been made not merely for the benefit of the file-maker, but quite as largely for the benefit of the buyer and user of files. The subject, therefore, is treated from the standpoint of a practical engineer without any special knowledge of file making.

The testing of files is accomplished by means of a special machine (see description in MACHINERY, December, 1907, engineering edition) which records the endurance and metal-removing qualities of the file on a piece of paper wound around a cylinder, thereby producing diagrams as shown in Figs. 1 and 2. In these diagrams the horizontal distances represent the number of strokes made by the file tested, and the vertical distances the number of cubic inches of metal removed during the life of the file. The curves drawn in Fig. 1 show the life history of two files from the time when they were new until they were completely worn out. It will thus be seen, for instance, that one file removed somewhat over eight cubic inches of steel in 108,000 strokes, after which the file was incapable of removing any more metal. The other file removed the same amount of material in the first 16,000 strokes, and was still in good condition, removing a total of 14 cubic inches in 42,000 strokes before worn out. In Fig. 2 is shown even a more striking comparison, and here the great variation in the amount of work possible from files of different quality is exhibited. The two sides of one file removed 10 and 3 cubic inches, respectively, of cast iron before becoming too blunt to cut, while one side of another file reduced to filings nearly 20 feet of a cast iron bar one inch square before unable to cut. These examples indicate that file testing is a matter of considerable importance in shop economy, particularly in the assembling department where a great deal of time may be wasted by using inferior files.

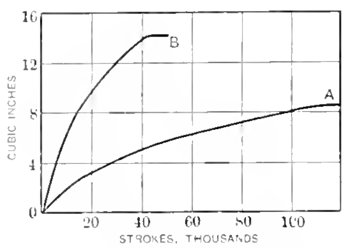


Fig. 1. Diagram resulting from File Tests on Steel, made on the Herbert File Testing Machine

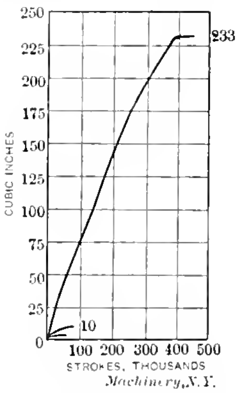


Fig. 2. Diagram resulting from File Tests on Cast Iron

The files are tested until they slip over the surface of the test bar without cutting, this condition being shown by the curves taking a horizontal course. Tests which are stopped before this point is reached may give a false impression as to the relative merits of files. It may happen that two files cut equally well during the first 50,000 strokes, and if the tests were stopped at this point the files would be considered equal. If the tests were continued, one file might cease cutting at 60,000 strokes, and the other continue for 400,000 strokes, thus showing a great difference in their durability.

Results and Conclusions of File Testing

Among the results obtained by the file-testing machine, perhaps none is of more interest than the discovery that the two sides of a file are seldom equal in efficiency and durability. Fig. 3 shows the curves for the two sides of the same file, one of which accomplished three and one-half times as much work and made four times as many strokes as the other. Such results are common. File-makers generally explain this difference as due to a variation in the sharpness of the chisel used in cutting the files. If a great variation is thus found between the sides of a file, it is likely that equally great variations will be found between individual files in the same lot, this being an evidence of lack of uniformity in the manufacturing process. One of the most important services, therefore, that is rendered by the file-testing machine to makers and users of files, is that of showing the great difference caused by minute variations in the shape of the file teeth, variations which can scarcely be detected by examination, and which can only be eliminated by extreme care in all the processes of manufacture.

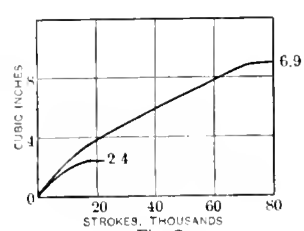
It has been assumed that a file made of good steel is a good file. The teeth, of course, are expected to feel sharp, but beyond this very little attention has been paid to their shape. The file-testing machine has shown that the shape has a far greater influence than the quality of the steel, not only on the rate of cutting, but also on the amount of work that can be got out of the file. Fig. 5 shows the curves obtained from tests where five files were worn out at practically the same number of strokes (110,000). The amount of iron filed away varied very greatly. These variations in rate of cutting are more marked on cast iron than on steel. The best file in Fig. 5 cut when new at the rate of 14 cubic inches per 10,000 strokes, while the poorest file cut hardly more than ½ cubic inch during the same number of strokes, the material being cast iron. On steel a rate of 6 cubic inches per 10,000 strokes is rarely exceeded.

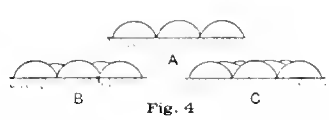
The rate of cutting is given by the slope of the curve and depends almost exclusively on the shape and sharpness of the teeth and on their relation to one another, and is not affected by the quality of the steel. As many files cut at a very slow rate when considerably worn, it is economical to reject files at a fairly early stage of bluntness.

Factors Determining Efficiency of Files

The chief factors by which the cutting efficiency of a file is determined are:

1. Sharpness of teeth.
2. Slope of the front face of the teeth, or rake.
3. Slope of the back face of the teeth, or clearance.





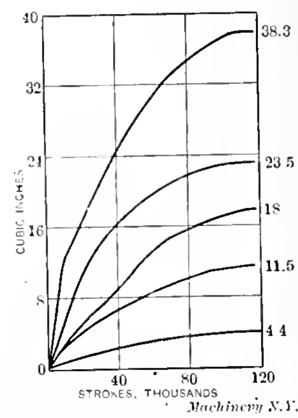


Fig. 3. Curves resulting from Tests of Two Sides of the Same File cutting the Same Material. Fig. 4. Arrangement of File Teeth, due to Variation in Ratio between "Up-cut" and "Over-cut." Fig. 5. Five Files of Equal Durability, but Unequal Capacity for Removing Metal

4 and 5. Angles of the two cuts relative to the axis of the file.

6. Pitch or coarseness of the cut.

7. Ratio between the pitch or number of cuts per inch in the "up-cut" and in the "over-cut."

At first sight it would seem that the sharpness of the teeth would be the most important factor in cutting efficiency, but the experiments indicate that this is not the case. Two files equally sharp, and thus cutting equally fast when new, do not show the same efficiency.

The slope of the front face of the teeth on commercial files as made at present is very rarely vertical, but in almost all cases there is a negative rake varying from 3 to 25 degrees. Experience with lathe and planer tools would lead one to expect that a tool with considerable negative rake would be exceedingly inefficient on almost all materials, and it is surprising that such a tool cuts at all under such light pressure as can be applied by hand on a file. Nevertheless it is a fact that files with considerable negative rake not only cut, but take off very satisfactory curled chips. The reason

* Abstract of paper by Edward G. Herbert, read before the Manchester Association of Engineers, March 27, 1909. For description of the file-testing machine referred to, see MACHINERY, December, 1907, engineering edition.

for this is probably that the file tooth is presented to its work at an angle, owing to the slope of the cut across the file. This gives a slicing cut, which probably accounts for this efficiency.

The slope of the back face of the tooth, or clearance, is very difficult to measure because it is not a plane surface, but the angle is very important in relation to the durability of the file. A file which is worn out has the tops of its teeth flattened or rounded. When the area of contact of the teeth with the work attains a certain value, great pressure is required to cause the teeth to "bite" the metal. The amount of work that can be obtained from a file, therefore, depends largely on the volume of teeth available for wear before this limiting area is obtained.

Examination of commercial files show that these angles are extremely variable, and it is certain that uniformly satisfactory results cannot be obtained unless correct angles are ascertained and maintained, leaving nothing for the variation of judgment on the part of the workmen. The pitch or coarseness of the cut does not seem to influence the efficiency of files to any great extent. Very coarse files, however, are almost always inefficient, probably because of the difficulty of raising very large teeth, which are at the same time sufficiently thin and sharp. Very smooth files, on the other hand, cut slower and do less work than those of somewhat coarser cut, but in some cases surprising results have been obtained from smooth files also.

It may not be generally known that the two cuts on a file differ in pitch. Suppose a file had 25 cuts in the chief or "up-cut." If it has also 25 cuts per inch in the secondary or "over-cut" a cross-section of the file would appear as at *A*, Fig. 4, each tooth standing immediately behind a tooth in the row in front, and all the teeth lying in straight rows parallel to the axis of the file. Such a file would leave on the surface of the work a series of furrows with ridges between them. Now suppose that there be 25 cuts per inch in the "up-cut," but the "over-cut" is made with 16¾ cuts per inch. Then the appearance of the cross-section would be as at *B*. Each tooth now lies opposite the space between the two teeth in the row in front. The teeth in the first row still make a series of furrows, and the teeth in the second row work on the ridges between these furrows, planing them off and leaving a fresh series of furrows, but the file would be inefficient because the ridge between any two teeth would be too large to be taken off at one cut by the teeth behind. If the number of teeth per inch in the "over-cut" is increased to 19, the effect will be as shown at *C*; the ridges between the teeth in the first row are divided between the teeth in the second and third rows behind. This subject of the ratio between the "up-cut" and "over-cut" is likely to be one of the most important factors in file efficiency, but it has not as yet been thoroughly investigated.

Efficiency of Files on Various Metals

It has generally been assumed that a good file is good for all classes of work, brass, cast iron or steel. Some difference of opinion on this subject has been expressed, and there has been a fairly general agreement that a file for brass should have the "up-cut" nearly at right angles to the axis, although this is by no means a general rule. In view of this a series of experiments was planned to ascertain whether there is one particular cut which is best for all metals, or whether each metal requires a special cut to produce the best results. For these tests a number of files were ordered from several makers who were asked to cut them in the manner which they considered most suitable for cast iron, steel, brass, and general work, respectively, each maker supplying a number of files for each purpose.

In the experiments each file was tested on brass, cast iron, mild steel, annealed tool steel and "normalized" tool steel, the last being subjected to heat treatment which would make it uniform in hardness throughout its length without actually annealing it. In one case a brass file gave the best result on brass, but this was the only instance where the best result on any metal was obtained by the file intended for that metal. On the test on cast iron, for instance, two files intended for steel cut more than three times as fast as the files intended for cast iron. On the "normalized" tool steel (not annealed) the cast iron file gave best results. The conclusions of these tests, therefore, showed:

1. The subject of files for specific purposes has practically received no thorough attention. As a rule, files cut for specific purposes gave poor results on the materials for which they were intended, and good results on materials for which they were not intended.

2. Files especially well adapted for any one metal did not give good results on other metals.

3. Files which showed average efficiency on all metals were rather inefficient on all.

4. The tests clearly show that the ductile metals, such as mild or annealed steel, are most easily worked with a sloping cut, which usually produces curled filings. Cast iron and hard brass require a much less sloping cut. Brass files, in fact, should have an "up-cut" almost at right angles to the axis of the file.

5. As a general conclusion, therefore, it appears that it would be advantageous to have files especially cut for various metals and keep them on the work for which they are intended. Most files intended to cut all metals are decidedly inefficient on them all.

It will rest with the user to make the first move in the matter. The file-maker is naturally reluctant to double or triple his stock and to make files for all the existing sizes, shapes and cuts in two or three distinct styles, suited to different metals. The difficulty may involve a slight increase in the price of files, but the increase in efficiency will be out of all proportion to the increase in cost.

Another evidence of the un-uniformity of files and the incomplete understanding of the subject, even by file-makers, is shown by the fact that sometimes files of two or three different qualities are sold by the same maker at different prices. In most, though not in all, cases where such files were tested, it was found that the cheapest grade gave the best result, and the most expensive the worst. This is probably explained by the fact that by a "good" file, the file-maker almost invariably means simply a file of expensive steel.

Most of the leading British file-makers are now investigating, with the aid of the testing machine, the various problems connected with file efficiency. This investigation is attended with special difficulty. Apart from the quality of the steel there are at least eleven important factors, all having an influence on efficiency: seven angles, the sharpness of the chisel, the force of the blow, the coarseness of the cut, and the ratio between the two cuts. It is possible to make an infinite number of combinations of these eleven variables, and an alteration in any one of them is likely to affect several of the others. The problem is, therefore, greatly simplified if a simple file tooth can be isolated and its cutting efficiency measured under constant conditions while progressive changes are made in its shape and in the angle of its presentation to the work.

A Tool Steel Testing Machine

The simplification of the problem mentioned is made possible by the use of a recently-designed tool steel testing machine.

The principle of the tool steel testing machine will be understood from the diagram, Fig. 6, in which *A* represents a tube of steel or other metal, suitably guided and rotating about a vertical axis, while its lower end rests on a fixed abutment *B*. A cutting tool *C* is held in a vise *D*. The vise is mounted on knife edges *E*, lying in the plane of the end of the tube. By means of a screw *F*, with a movable weight and scale, the tool can be caused to press upwards against the edge of the tube with any desired force, and cut it away with a turning action.

The tube is held in contact with the abutment *B* by means of a weight *G*, the downward pressure of which is always greater than the upward pressure of the tool. As the tube is turned away by the tool, it is fed downwards by the weight *G*, so that the end of the tube, though it is constantly being turned away, is constantly held in contact with the abutment *B*, and the point at which cutting takes place is therefore

stationary. A dashpot *H* is connected to the vise to prevent jarring or vibration.

Turning now to the illustration of the machine in Fig. 7, it will be seen that the tube is driven by a spindle, which receives its motion through cone and friction disk gearing, capable of giving it a wide and continuous range of speeds. A paper-covered drum, mounted beside the column of the machine, is driven from the spindle through worm and spur speed reducing gear. Vertical movements of the spindle are communicated through a fine chain to a pencil mounted on a vertical sliding bar.

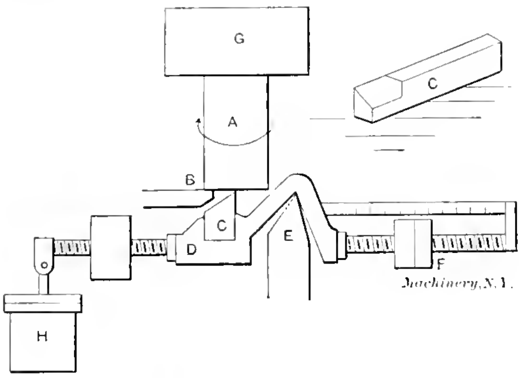


Fig 6. Diagrammatical View of Action of Tool Steel Testing Machine

When the machine is set in motion, the pencil draws a diagram, in which horizontal distances represent the number of revolutions made by the tube, and vertical distances represent vertical movements of the spindle—*i. e.*, the length of tube turned off by the tool. The slope of the line at any point represents the rate at which the tube is being turned away, which is conveniently expressed in inches per 1,000 revolutions. In practice the tube is ¾ inch diameter and ⅝ inch bore.

By means of this machine it will be possible to ascertain what is the theoretically correct shape for a single file tooth for any particular metal. This information having been obtained, it will rest with the file-maker to ascertain by means of the file-testing machine what combination of theoretically correct file teeth gives the best maximum efficiency and durability to the file.

In the machine shown, the cutting of metal is reduced to its simplest and most elementary form. A straight cutting edge is pressed with a known force against a metal surface of constant width and unvarying hardness, moving at known constant speed, and being cut away at a rate which is graphically recorded. It is evident that the tool continues to cut until it reaches a definite degree of bluntness, when the pressure against the teeth will be insufficient to cause it to penetrate the metal. At this moment it will slip over the surface without cutting, and on the diagram this condition will be shown by the curve becoming horizontal.

Results of Experiments with Tool Steel Testing Machine

The results of these experiments are not, as yet, definite, but so far the results serve to show the character of the information that may be expected, and its bearing on the file tests. A series of tests made to ascertain the effect of variations in the clearance angle or slope of the back of the file teeth, with the front without rake, confirmed in a striking manner the condition that mere sharpness is relatively an unimportant factor in file efficiency. A second conclusion to be drawn from the tests is that the clearance angle has very little influence on the rate of cutting. The most striking feature of the tests is, however, the great difference in the duration and in the total amount of metal removed, showing that 0.05 cubic inch could be cut away with 5 degrees clearance in 100 revolutions before the tool ceased cutting, against 3.7 cubic inches of metal removed in 3,800 revolutions with 25 degrees clearance. Considering that all these tests were made with the same tool, the conclusion previously arrived at that durability of the file and the amount of work it is capable of doing depends far more on the shape of the teeth than on the quality of the steel is confirmed, and it would appear that the chief factor influencing the durability and output is the clearance angle or slope of the back of the teeth. The tests, however, indicate that there is a limit beyond which the clearance angle cannot be increased with advantage. When the clearance angle was greater than 25 degrees, the output and durability began to decrease. This was due to the fact that the edge of the tool broke away, indicating that the tooth was too weak; but it must not, therefore, be assumed that a clearance of 25 degrees is a practical limit. The tests were made with a pressure of 25 pounds, and this pressure applied to a single file tooth probably represents usage more severe than a file would be subjected to.

The results obtained also indicate how files of superior steel may give poorer results than files of inferior steel. In the case above, a tool of the same quality of steel removed in one case seventy-four times as much metal as in another case, the difference being merely a difference in clearance angle. Now it is a well-known fact that a high-carbon steel is much less ductile than one of less hardness. Consequently the high-carbon steel does not flow so readily when struck with a chisel; the burr which forms the working part of every file tooth is much lower, or in other words, the clearance angle is less. Thus it may easily happen that the extra durability of the steel is far more than counteracted by the lack of clearance, and a file of very good steel may give exceedingly poor results as a cutting tool if not properly cut with a clear understanding of the requirements of the durability and efficiency of files.

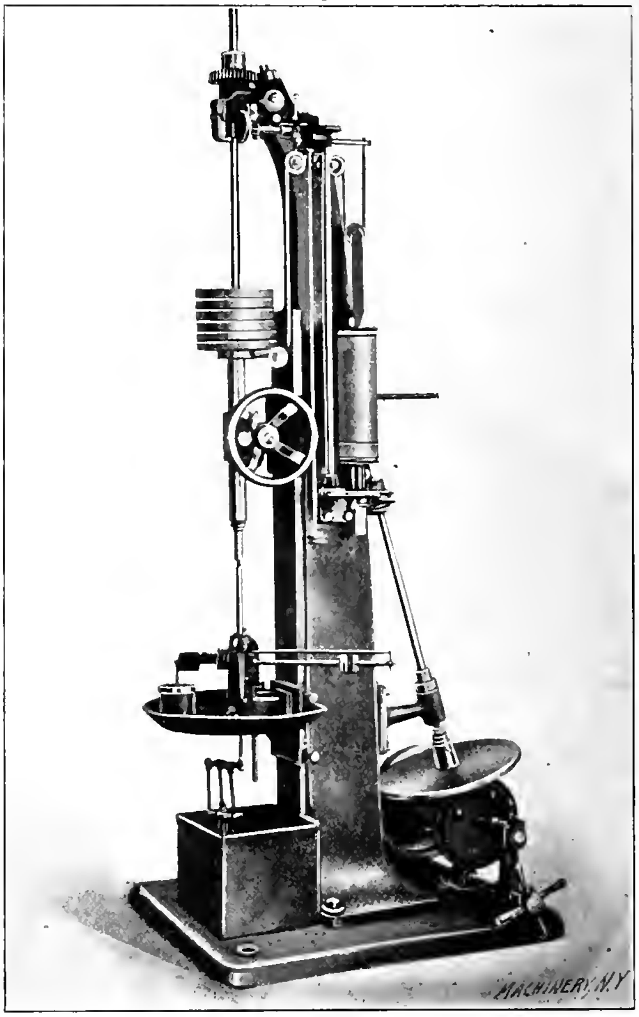


Fig. 7. Tool Steel Testing Machine

A series of experiments was made with a view to ascertaining the effect of varying degrees of rake and slope on the efficiency and durability of file teeth, the term slope being used to indicate the angle at which the up-cut lies across the face of the file. Only two slopes were experimented with —a slope of 90 degrees, corresponding to the cut of a file intended for brass, and a slope of 70 degrees, such as is commonly found in files intended for general work.

Each of these slopes was tested in conjunction with three different degrees of rake, *viz.*, a negative rake of 15 degrees, as commonly found in file teeth; a zero rake, the front face of the tooth standing at right angles to the surface of the work, a condition occasionally approached in file teeth; and a positive or forward rake of 15 degrees, a condition which is never found in file teeth, though experience with other cutting tools points to this as the correct form for cutting most metals. The same tool was used throughout, so as to eliminate any variations due to difference of temper or quality in the steel. Each test was made with a freshly sharpened edge, and was continued until cutting ceased. The pressure of the tool on the work was in all cases 25 pounds, the cutting speed 30 feet per minute, and the clearance angle of the tool 20 degrees in all except two of the tests.

The results of these tests showed that an extraordinary difference in the output of the work can be obtained in the same tool by a relatively slight variation in its cutting angles. Contrary to what might be expected, these variations have much greater effect on the output than on the rate of cutting. It was also noticed in these, as in all other tests made with the machine, that mere keenness of edge had very little effect on the efficiency. All the curves obtained were approximately straight lines, and cutting ceased abruptly with very little previous loss of efficiency.

Conclusions of Tests Relating to Shape of File Teeth

In relation to commercial file-making, the most important conclusion of the tests appears to be that the least desirable results of all were obtained with the tool which most closely resembled the commercial file tooth. The best results of all were obtained with a form of tooth which can probably be reproduced without great difficulty, but which appears never to have been adopted. This tooth would have a positive front rake of 15 degrees, and a clearance of 5 degrees. It was previously shown that the clearance angle is a most important factor in determining the total output and that the tool with no rake and only 5 degrees clearance will do only a very small amount of work, but it appears that a tool with the same clearance angle and with positive front rake will do an exceptionally large amount of work with great efficiency, and it is probable that by slightly increasing the clearance angle the output will be still further increased without undue weakening of the cutting edge.

Some caution will, of course, be necessary in applying the results just described to the art of file-making. These tests were made with what was practically a single isolated file tooth with a straight instead of a rounded cutting edge. The file is a series of round-nosed tools, lying very close together, and it may be found that a file with a positive rake will have a tendency to choke up with filings to such an extent as to neutralize its greater efficiency. The progress must be made by systematic experiments, confirmed at every step by the file-testing machine.

The results first described have a bearing on other cutting tools besides files. Of all the tool forms experimented with, among those that gave the smallest output of work was one having no front rake. This, however, is the usual form of tooth for milling cutters. There seems to be no reason for making milling cutters without front rake, except the well-known propensity of human beings to follow in their forefathers' footsteps. Milling cutters with front rake have been made and tried, and have given good results, and yet it is impossible to buy such cutters without having them made to order.

The Testing of Tool Steel

We now pass to the consideration of that function of the tool steel testing machine from which it derives its name and which may prove to be of greater practical importance than any other—the testing of the quality of tool steel. The slope of the curves produced on the diagram in the testing machine indicate the rate at which the test tube is being cut away by the tool point, and it is evident that this rate is governed by several factors: the speed and quality of the test tube, the shape and position of the tool, and the force with which it is pressed against the tube. Any alteration in any one of these factors will affect the rate of cutting and the slope of the curve, which therefore serves as an absolute check on the uniformity of the mechanical conditions. The remaining factor in the test is the quality of the steel, and a moment's consideration will show that this does not affect the rate of cutting at all. So long as a number of tools are equally sharp, they will all cut at the same rate under the same conditions, no matter what steel they are made of; but the tool which is made of the best steel will remain sharp longest.

The results of experiments on carbon steel and high-speed steel are shown in Figs. 8 and 9. At slow speed (30 feet per minute) the carbon steel lasted four times as long as the high-speed steel. At a somewhat higher speed (40 feet per minute), the high-speed steel tool lasted twice as long as the carbon steel. These tests were repeated, but the same results were obtained. Up to a certain limit all tools with increased speed not only did more work per unit of time, but lasted a greater number of revolutions. Another interesting experiment was carried out with a blunt tool. It was tested until it ceased cutting at 40 feet per minute; when the speed was increased to 85 feet per minute the same tool immediately began cutting faster, that is, removing more metal per revolution than when it was quite sharp and working at a lower speed. This indicates that there is a definite state of bluntness corresponding to each speed. These are a few of the many curious facts that have been brought into prominence by the tool steel testing machine. They may or may not have an important bearing on the art of cutting metals, but it is necessary to bear them in mind.

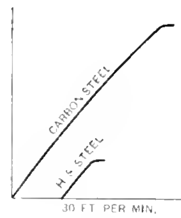


Fig. 8 Comparison of Durability of Carbon and High-Speed Steels at Low Cutting Speed

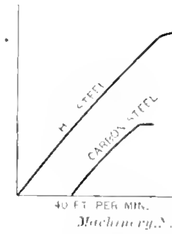


Fig 9. Comparison of Durability of Same Steels at Increased Cutting Speed

The conclusions also throw an interesting light on the relative value of ordinary carbon and high-speed steels for various tools. For files, for instance, having a low cutting speed, it is likely that special alloy steels are of but little value. While it may not be assumed that all alloy steels are inferior to carbon steel for file making, it is evidently unsafe to assume that because a certain steel has given good results, say, for twist drills, it would be suitable for cutting tools used under totally different conditions. For instance, reamers are generally used for a slight scraping cut at a low speed, precisely under conditions for which high-speed steel seems to be least suited, and for such tools the high quality steel appears to be unwarranted. It may be too soon to dogmatize, but there seems to be reason for caution in the application of high-speed steel to the manufacture of such tools as reamers and milling cutters for light finishing work.

Another experiment showed that the maximum duty could be obtained from a carbon steel at the cutting speed of 50 feet, by a good high-speed steel at 85 feet, and from one of the new British high-speed steels at 140 feet per minute cutting mild steel. This latter result was unexpected, since no increase in the working speed was claimed by the makers of the new steel, but only an increase of durability at the speeds at which high-speed steel is ordinarily used. The tool steel testing machine can also be used for ascertaining the wear of metals, the efficiency of the various lubricants in cutting operations to preserve the edge of the tool, and for testing the hardness of metals.

The testing for hardness is accomplished by a drill loaded with a certain weight, and the rate at which it penetrates the material under investigation is used as a measure of hardness. This test is by no means new, but it has often been regarded with some distrust, because the sharpness of the drill is a variable factor in the result of the test as ordinarily applied. The production of considerable quantities of

test bars for the file and steel testing machines has called for some accurate method of judging hardness (using that rather vague term to denote resistance to the action of cutting tools), and the drill test has proved itself during nearly two years of continuous use the most sensitive and reliable test available.

The distributing influence of the varying sharpness of the drill is eliminated by adopting a definite rate of penetration on a standard reference bar. Suppose the rate of penetration of half an inch per 1,000 revolutions to be adopted, the load on the drill is adjusted until this rate of penetration is obtained on the standard bar. Tests on the materials under investigation are then made, and any variation in the rate of penetration, beyond certain predetermined limits, leads to the rejection of the material. Periodically a return is made to the standard bar, and any loss of penetration due to blunting of the drill is corrected by increasing the load. In practice a considerable number of tests can be made on ordinary materials without perceptible blunting of the drill. The sensitiveness of the test depends entirely on the rate of penetration adopted. A drill so lightly loaded as to be on the point of slipping gives a hardness test which is probably more sensitive than any other. In this connection it is interesting to note that drills of high-speed steel have proved quite unsuitable for the drill test, as they lose their sharpness much more rapidly than drills of carbon steel, under the extremely light cuts that are essential for a sensitive test.

The results put forward in the foregoing have been confirmed by repeated experiments, and are believed to be reliable as far as they go, but important facts may be undiscovered and those phenomena which have come into view may be only parts of larger phenomena which cannot be seen in their true perspective until they have been investigated from every side, and under widely varied conditions of experiment.

* * *

SIZES OF PIPE MAINS FOR HOT WATER HEATING*†

CHARLES L. HUBBARD‡

In the accompanying Supplement three sets of curves are given for determining the sizes of pipe mains for hot water heating. Two of the diagrams are for gravity circulation where the water is moved under a low head, the motion being due solely to the difference in temperature between the supply and return. The third diagram is made up for the usual range of velocity and head employed in forced hot water circulation actuated by means of a pump. In all cases the capacities are for pipe lengths of one hundred feet.

Volume of Water to be Moved

The volume of water to be passed through the supply main in a heating system may be found by the following equation:

$$G = \frac{E \times H}{8.3 \times (T - T_1)}$$

in which G = gallons per hour,

E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1,000 for hot blast heating),

H = square feet of heating surface,

T = initial temperature of water (commonly taken as 180 degrees),

T_1 = final temperature of water (commonly taken as 160 degrees).

Example.—A heating system has 5,000 square feet of direct heating surface, and 1,000 of indirect; how many gallons of water (G_1) must pass through the main per minute, assuming a drop in temperature of 20 degrees?

$$G_1 = \frac{(170 \times 5{,}000) + (400 \times 1{,}000)}{8.3 \times 20 \times 60} = 125 \text{ gallons.}$$

* For additional information relating to heating and ventilation, see the following articles previously published in MACHINERY: Calculations of Fans and Heaters, June, 1908, engineering edition; The Heating and Ventilation of Machine Shops, September, 1907, engineering edition; and also the articles referred to in connection with the one last mentioned. See also MACHINERY'S Reference Series No. 39: Fans, Ventilation and Heating.

† With Data Sheet Supplement.

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Head to Produce Flow

The head to produce flow may be found by the equation

$$H = D \times h \times 0.000365,$$

in which

H = head in feet, producing flow,

D = difference in temperature between supply and return,

h = height or elevation of the heating surface above the boiler.

Example.—A certain quantity of heating surface is located at an elevation of 50 feet above the boiler; what is the available head for producing flow through the supply riser if the drop in temperature between the supply and return is 30 degrees?

$$H = 30 \times 50 \times 0.000365 = 0.55 \text{ feet.}$$

When the radiation is all on the same floor, the elevation h may be taken as the vertical distance between the center of the radiators and the center of the boiler. If it is equally distributed on several floors it may be taken as though it were all located upon the central floor.

If unevenly distributed, the *average elevation* may be found by the equation

$$h = \frac{A \times h_a + B \times h_b + C \times h_c}{A + B + C}$$

in which A, B, and C are the square feet of radiation upon the several floors, and h_a, h_b, and h_c the corresponding elevations of the radiators located upon these floors.

In computing the length of mains, provision must be made for the frictional resistance due to bends in the pipe. In practice it is customary to consider an elbow equivalent to increasing the length of the pipe 60 diameters, and a return bend equivalent to 120 diameters.

The size of main required to supply a heating system or group of heaters depends upon the square feet of radiation, the elevation above the boiler, the drop in temperature of the water in passing through the radiators, and the length of run. Taking the examples previously given, and assuming the length of the mains to be 200 feet, what size of pipe will be required?

Gallons per minute 125; available head to produce flow 0.55 foot. As the run of pipe is 200 feet long, the head per hundred feet is $\frac{0.55}{2} = 0.27$ foot. From diagram II in the Supplement we find that a flow of 125 gallons under a head of 0.27 foot calls for a pipe between 5 and 6 inches in diameter, in which case the larger size would probably be used.

Forced Circulation

In case of forced circulation the mains should be of such size that the total head required to overcome the friction will not exceed 50 feet, the usual range being from 30 to 50 feet. The velocity of flow is usually made from 5 feet per second in the smaller sizes (2 to 3 inches) to 10 feet per second in the larger sizes (6 to 8 inches).

The table in the Supplement gives the capacity of different sizes of pipe for varying velocities of flow through them.

* * *

In spite of their conservatism and proverbial "slowness," our British friends have achieved remarkable results in the running of fast trains, and on the Great Western R. R. results are obtained which are not equalled by any regular American service. Between London and Exeter, a distance of 174 miles, three expresses run daily without a stop, in exactly three hours, or at an average speed of 58 miles an hour. A fourth train on the same route makes the same run at an average speed of 56.3 miles per hour. It is not unusual for the total load back of the tender of these trains to be 400 tons.

* * *

The new radium institute of Great Britain has placed an order for a trifle over one-quarter of an ounce of radium-bromide, the price for which is not less than $150,000, or at the rate of $570,000 per ounce, or over $9,000,000 per pound. Some conception of the enormous labor involved in the extraction of this mineral is afforded by considering the price of a pound given as the wages of 15,000 men working one year of 300 working days at $2.00 per day.

THE COMMERCIAL AIRSHIP—A CRITICISM

FORREST E. CARDULLO*

In an article entitled "The Commercial Airship," in the August issue of MACHINERY, Mr. McCready reviews briefly the disadvantages of the heavier-than-air machines, and of the gas-inflated airships, stating that both are impractical for commercial work. As a substitute for them, Mr. McCready proposes a type of airship consisting in principle of a metallic reservoir of large volume from which air can be exhausted, lightening it by the weight of the air so exhausted. Obviously, if this contrivance is to be successful, the weight of the metal envelope must be less than that of the displaced air, and since the reservoir is to be exhausted of air, it must be strong enough to resist the external air pressure, which is 14.7 pounds per square inch or 2,117 pounds per square foot.

Now it follows that the material to use in the construction of this airship is that which has the greatest strength for a given weight. This material will be one of the alloy steels having high elastic limit and tensile strength. Aluminum is lighter, but is also weaker in much greater proportion. Many alloys of low specific gravity present advantages in certain types of construction, but pound for pound, they are not as strong as the alloy steels. Such alloy steels weigh about 480 pounds per cubic foot.

The form of reservoir which contains the largest volume within a given bounding area is the sphere. Consequently for a given volume and thickness of wall, a sphere will make the lightest reservoir. Also, since the compressive stress is the same in every cross section of the wall cut by a radial plane, the sphere will have the thinnest wall of any shape of the same diameter. It is apparent, then, that no lighter construction could be made than a perfect sphere without bracing. If the sphere is perfect, and the external pressure uniform, bracing is theoretically unnecessary, and no possible system of bracing can be devised which would make a sphere stronger for the same weight, than its theoretical strength, calculated on the assumption that it is perfect in form, homogeneous in material, and subjected to a uniform pressure. Hence if a spherical reservoir cannot be made light enough and strong enough to perform the desired service, no other form of reservoir will be possible.

Volume of 1 pound of air at 62 degrees F. and 14.7 pounds pressure per square inch = 13.141 cubic feet.

Volume of a sphere = $0.5236\, d^3$.

Area of a sphere = $3.1416\, d^2$.

Area of its great circle = $0.7854\, d^2$.

Circumference of its great circle = πd.

Diameter of a sphere having a displacement of 1 pound of air at 62 degrees F. at sea level = 2.93 feet, which is found as follows:

$$13.141 = 0.5236\, d^3$$

$$d = \sqrt[3]{\frac{13.141}{0.5236}} = 2.93.$$

Its area will then be

$$3.1416 \times 2.93^2 = 26.97 \text{ square feet.}$$

Assuming that the steel weighs 480 pounds per cubic foot, and further that the shell will weigh exactly one pound, we find for the thickness of the shell

$$\frac{1}{26.97 \times 480} = 0.0000772 \text{ foot.}$$

or $0.0000772 \times 12 = 0.000926$ inch, or the thickness of our shell will be a trifle less than one-thousandth part of an inch.

The area of the great circle of this sphere will be

$$0.7854 \times 2.93^2 = 6.74 \text{ square feet.}$$

and the pressure upon it, at 14.7 pounds per square inch, is

$$6.74 \times 14.7 \times 144 = 14,270 \text{ pounds.}$$

The circumference of the great circle is

$$3.1416 \times 2.93 = 9.205 \text{ feet or } 110.5 \text{ inches.}$$

It therefore follows that the cross section of the shell on the great circle is $110.5 \times 0.000926 = 0.1023$ square inch.

The compressive stress produced in this cross section by the pressure of the air is therefore

$$\frac{14,270}{0.1023} = 140,000 \text{ pounds per square inch.}$$

Now it is obvious that we have hardly any substance sufficiently strong to construct such a sphere, and certainly there is no substance sufficiently strong to construct a sphere able to float in air and in addition lift 55 per cent of its own weight, when interior bracing is added to prevent collapse.

Mr. McCready states in his article that the vacuum system becomes proportionately more practicable and efficient as the size of the airship is increased. Let us see if this is true.

$$\text{Stress} = \frac{\text{pressure on great circle}}{\text{cross section at great circle}} = \frac{0.7854\, d^2 \times 14.7 \times 144}{3.1416\, d\, t} = \frac{529\, d}{t}.$$

$$\text{Weight of 1 cubic foot of air} = \frac{1}{13.141} \text{ pound.}$$

$$\text{Volume of } \frac{1}{13.141} \text{ pound of steel} = \frac{1}{13.141 \times 480} = 0.0001585$$

cubic foot.

Cubic feet of steel in shell = $0.0001585 \times 0.5236\, d^3$.

Area of shell = $3.1416\, d^2$.

$$\text{Thickness of shell} = t = \frac{0.0001585 \times 0.5236\, d^3}{3.1416\, d^2} = 0.000026\, d.$$

$$\text{or the stress} = \frac{529\, d}{0.000026\, d} = 20,300,000 \text{ pounds per square foot,}$$

and is independent of the diameter.

One point alone in regard to the construction advocated in the article referred to will serve to show its futility. The figures for a proposed vacuum airship are given as 150 feet diameter by 750 feet long. The weight of the cylinder, fittings and machinery is given at 270 tons. *If all of this 270 tons were utilized as a 700-foot steel column, keeping the ends of the cylinder apart against atmospheric pressure, the stress in the column would be 163,000 pounds per square inch.*

The truth of the above assertion may be demonstrated as follows: The area of a circle 150 feet in diameter is 17,671 square feet. On each square foot there will be a pressure of 2,117 pounds, or a total compressive stress, tending to force the ends together, of 37,400,000 pounds. Assuming the column to weigh 270 tons, or 540,000 pounds, its volume will be 1,125 cubic feet, and if it is 700 feet long, allowing for the conical ends, its cross section will be 1.6 square foot or 230 square inches. Now the stress in the column = $\frac{37,400,000}{230}$ = 163,000 pounds per square inch.

This stress looks rather excessive in a column 700 feet long. The following figures in regard to the stress in the walls, normal to an axial plane are, however, even more illuminating.

The strongest and lightest construction that we know of in the case of a cylinder subjected to external pressure, is that used in the Morrison corrugated furnace. The reason it is so strong is that the cylinder wall furnishes its own bracing. Let us suppose that the airship is built on this principle, and that the whole 270 tons is put into self-bracing wall. Then, the weight of cylinder wall per foot of length will be $\frac{540,000}{700} = 771$ pounds. This 771 pounds of metal will form a band around the cylinder $150\,\pi = 471$ feet long, and its volume, if of steel, will be $\frac{771}{480} = 1.6$ cubic foot. Its cross-section will then be $\frac{1.6 \times 144}{471} = 0.5$ square inch.

The total stress in this band will be one-half the pressure of the air upon 150 square feet (*i. e.*, the area of the projection of a section of the cylinder one foot long upon the axial plane) which is $\frac{150 \times 14.7 \times 144}{2}$ or 159,000 pounds. The stress per square inch is then $\frac{159,000}{0.5}$ or 318,000 pounds.

We are forced to the conclusion that no ingenuity of construction will make such an airship able to support even its own weight, unless we construct it of some unknown material having a strength many times greater weight for weight than that of the strongest steel.

* Address: New Hampshire State College, Durham, N. H.

BUSY MAN'S METHOD OF KEEPING A NOTE-BOOK*

JOHN S. MYERS†

Ideas unapplied to a useful purpose are worthless. A man's mind may be as full of ideas as a dog's fur of fleas and yet the man derive no more benefit from those ideas than the dog does from the fleas. Now the more busy the individual, the greater the number of ideas which crowd around the court of judgment crying for deliverance, and the greater the number of other people's ideas that are recognized as good; yet, at the same time, from the very nature of the case, the less time the individual has to devote to the useful

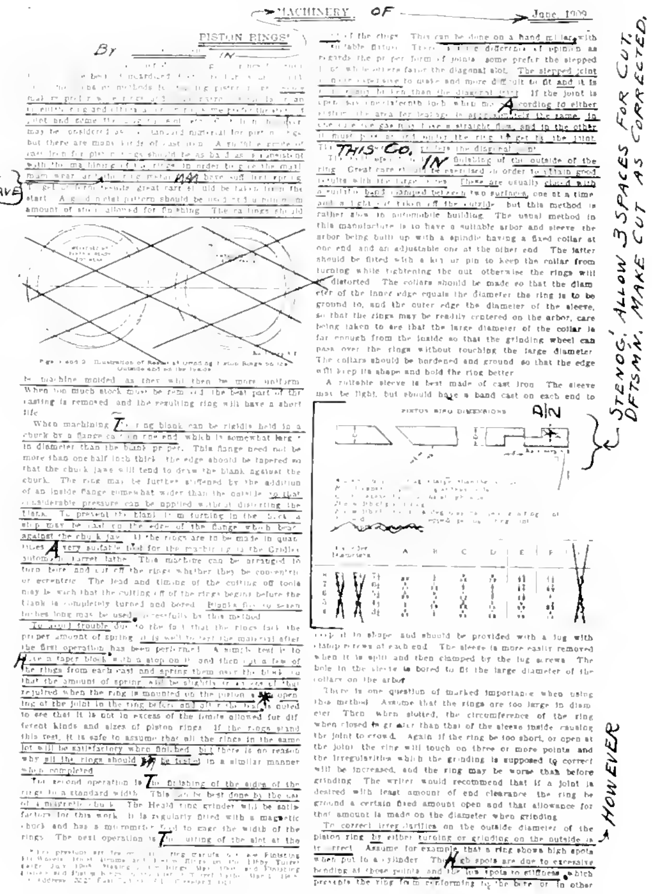


Fig. 1. Reproduction of Portion of Article, in June, 1909, Machinery, showing Underscored Matter to be copied by the Stenographer

application of those ideas. Nevertheless, if you have an idea to develop do not take it to a man of leisure, for he will not have time to consider it, but take it to the busiest man you know and you will find he can and will take time to pronounce judgment thereon.

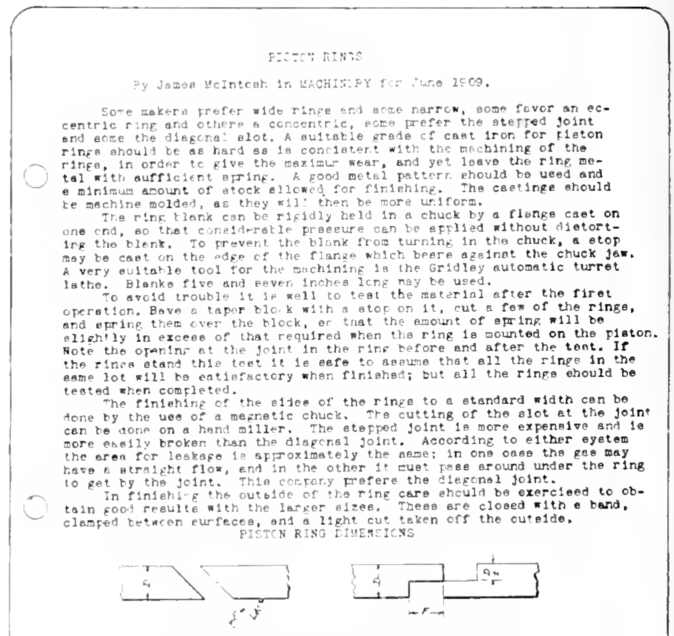
Now, in the matter of note-books, the chief draftsman of a concern should be the man best fitted for the compilation of all matter of a mechanical or constructive nature, but, at the same time, he is the one man whose mind is already burdened with excessive detail; how, then, is he to do anything in this line? The answer obviously lies in the proper direction of efficient help.

The writer once worked for a large concern that employed a librarian; the librarian had charge of the vaults, storage and recording of all drawings, correspondence, trade literature, etc. It was the duty of the assistant librarian to conscientiously peruse all the trade magazines, catalogues, etc., in search of salient or pertinent information, and all such was clipped, pasted to cards, referred to the proper officer of the company and afterwards carefully filed. The magazines were all subscribed for in duplicate so that there was always an unmutilated copy on file to refer to for the complete text of an article any clipping was made from.

But most concerns would not care to go into the matter so extensively, and even those who could and would might find, as the writer did, many mountains in the way of best results. I therefore take pleasure in presenting to the readers of MACHINERY an inexpensive scheme for the busy man to compile a note-book in neat form with the minimum expenditure of his time and nervous energy.

The scheme as outlined is for the *very busy man;* for those who have more time to devote to it I would suggest that they simply do more of the work themselves and leave less to their help.

1. Direct that all magazines, catalogues, etc., be left on your desk as received.
2. Glance through each as received and mark or note any article of promise which you think may contain matter of especial interest to your line of work.
3. After so marking, throw the magazine or article in a box or drawer especially devoted to the purpose.
4. If the concern is very large have several of these boxes or drawers labeled *Mechanical, Structural, Electrical,* or any other classification that may suit your commercial conditions.
5. Instruct your squad bosses or specialists in various lines to dispose of the material in the following manner:
7. Squad foreman will at stated or convenient intervals go over all matter in his box or folder and carefully read all marked articles, and if he finds matter worthy of noting he will underscore the salient or pertinent matter with such corrections, notes, etc., as will enable a stenographer to transcribe same in a condensed form.
8. The stenographer will typewrite the underscored matter on standard loose leaf note-book paper, using a black ribbon and a sheet of carbon paper *reversed,* so that blue prints may be made.
9. The squad foreman will read over such transcribed matter and make any necessary corrections.



PISTON RINGS

By James McIntosh in MACHINERY for June 1909.

Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and yet leave the ring metal with sufficient spring. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should be machine molded, as they will then be more uniform.

The ring blank can be rigidly held in a chuck by a flange cast on one end, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck, a stop may be cast on the edge of the flange which bears against the chuck jaw. A very suitable tool for the machining is the Gridley automatic turret lathe. Blanks five and seven inches long may be used.

To avoid trouble it is well to test the material after the first operation. Save a taper block with a stop on it, cut a few of the rings, and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. Note the opening at the joint in the ring before and after the test. If the rings stand this test it is safe to assume that all the rings in the same lot will be satisfactory when finished; but all the rings should be tested when completed.

The finishing of the sides of the rings to a standard width can be done by the use of a magnetic chuck. The cutting of the slot at the joint can be done on a hand miller. The stepped joint is more expensive and is more easily broken than the diagonal joint. According to either system the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. This company prefers the diagonal joint.

In finishing the outside of the ring care should be exercised to obtain good results with the larger sizes. These are closed with a band, clamped between surfaces, and a light cut taken off the outside.

PISTON RING DIMENSIONS

A = amount piston ring is larger than the cylinder
B = thickness of piston ring at heavy side
C = thickness of piston ring at light side
D = width of piston ring
E = width of cutter for 45 deg. diagonal opening in ring joint
F = width of cutter for stepped opening in ring joint

Cylinder Diameters		A	B	C	D	E	F
8	7-1/4	7/32	1/4	9/64	9/16	15/32	11/16
7	6-1/4	3/16	7/32	1/8	1/2	13/32	19/32
6	5-1/4	5/32	3/16	7/64	3/8	11/32	1/2
5	4-1/4	1/8	5/32	3/32	5/16	9/32	13/32
4	3-1/4	3/32	1/8	5/64	7/32	7/32	5/16

To correct irregularities by turning or grinding on the outside is, however, incorrect. High spots are due to excessive bending at those points, and low spots to stiffness. If we reverse the method and grind on the inside the irregularities will be corrected, for these stiff portions will become weaker and tend to bend more and the stresses in the ring will be equalized.

The table gives piston ring dimensions based on experience. The width D may be increased in wearing surface, but tabulated dimensions give satisfactory results. The inside of the ring should always be machined. The practice of annealing ring blanks does not seem desirable, as stresses due to cooling are remote with a ring blank of uniform thickness.

Fig. 2. Reproduction of Note-book Page, showing the Form in which Condensed Matter appears. Typewritten on Thin Paper with Carbon reversed on Back, thus making Copy that will blue-print well

10. The boy in charge of the note-books will see that blueprints of this matter are inserted in the several note-books kept in the office for general reference, and that special marked copies be delivered to foreman, etc., in charge of work upon which the articles especially bear.

To make the method perfectly clear I have selected at random an article in the June issue of MACHINERY, underlined it as would be done before passing to the stenographer. A reproduction of this underlined and noted article is shown in Fig. 1. In Fig. 2 is shown a reproduction (reduced) of the notes as transcribed by the stenographer.

* For articles previously published in MACHINERY on this subject, see "Envelope System for Filing Data," June, 1906, and "Binder for Preserving Articles of Special Interest," March, 1909.

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SIMPLE AND AUTOMATIC STOP-PINS FOR PRESS WORK

H. A. S. HOWARTH*

The stop pin occupies a position of much importance among the accessories of the blanking die. Upon its design and adjustment depend both the quality and the quantity of the output of the press. Hence it is fitting that some attention be given to the consideration of it. By proper selection from the types to be described it is possible to secure a large output of blanks without recourse to more expensive apparatus. The several forms of stop-pins enumerated in the following list will be described in order, their proper uses being noted together with their merits and faults: The plain fixed stop-pin; the bridge stop-pin; the simple latch; the spring toe latch; the side swing latch; the positive heel and toe latch; the gang starting device.

These devices are capable of giving under the proper conditions, the maximum output of blanks. With the exception of the first, they can be used with either hand feed or automatic roll feed.

The ideal output of one blank for every turn the press can make in a day is never realized, with single dies. The delays

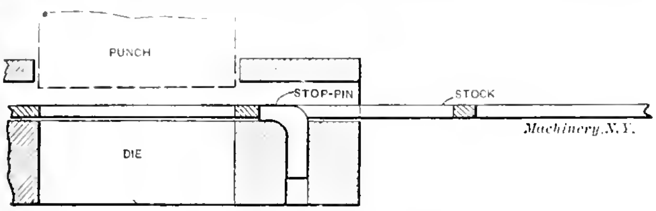

Fig. 1. A Plain Fixed Stop-pin

which arise from so many sources have to be studied carefully and eliminated so far as they contribute to unnecessary expense. In addition to improper design and poor adjustment of the stop-pin, other causes of small output are: Lack of skill; inconvenient arrangement of the new stock, the blanks and the scrap; inefficient methods of oiling the stock; and poorly made or poorly designed dies. A skillful operator, if given a little freedom, will usually arrange the stock distribution quite well, but the design and adjustment of the dies and the stop-pin usually devolves upon the toolmaker.

Plain Fixed Stop-pin

The plain fixed stop-pin, which is the simplest form, is indicated in Fig. 1. With it the operators become so expert that they are able for several minutes at a time to utilize every stroke of a press making 150 revolutions per minute. This stop is best suited to the use of strip stock in simple dies, because a miss will then cause no serious delay. The time between finishing one strip and starting the next affords the necessary rest for the operator. The concentration required is very intense—especially for the novice. When but a few blanks are made from a die at one time, and when changes of dies are frequent, this simple stop-pin is the most economical. Then too, it would not be feasible to use this stop-pin for coiled stock and expect the operator to finish the coil without

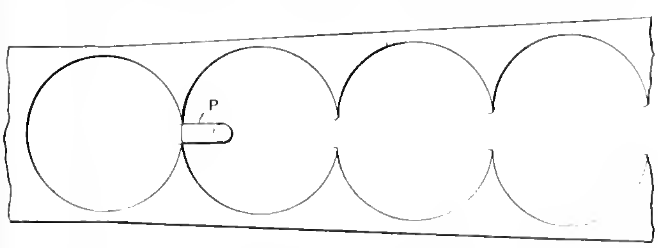

Fig. 2. Fixed Stop set close up to the Die so that there is no Stock between the Blanks

a rest or a miss. There is, however, one method of using this stop which permits of a maximum output: That is to allow no metal between the blanks. Then the stop-pin will extend clear up to the die and be high enough so that the stock cannot jump it. Each blank will then part the scrap at the stop-pin and allow the stock to be pulled along to its next position. This arrangement is shown in Fig. 2, with the stock parting at the pin *P*. This method is widely used on simple work where the edge of the blank does not have to be perfectly uniform. Where the die has least to cut it will wear away most on account of the thin pieces of stock that crowd down between the punch and the die. Small drawn cups are made in this way. The blank is cut by the first punch and held by it while a second punch, within the first, draws the blank through another die and forms the cup. This

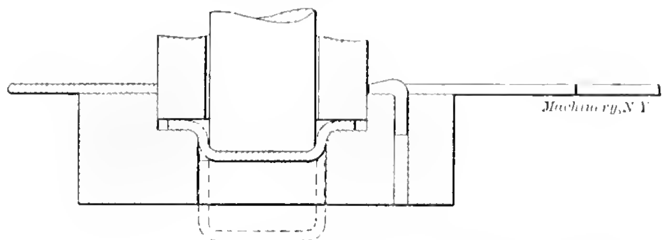

Fig. 3. Example of Work to which the Stop shown in Fig. 2 is adapted

is shown in Fig. 3. The stock feeds to the right and each cup, as formed, pushes the one ahead of it through the die as indicated by the dotted lines.

Bridge Stop-pin

The bridge stop-pin, shown in Fig. 4, is perhaps the most efficient and easiest to operate of all. It is also the simplest in design. The stop-pin *P* projects downward from a bridge *B* that extends over the stock which is being fed to the left. Provision is made for the blank (or scrap, as the case may be) to fall out under the bridge. Its use is limited, however, to that class of work which cuts the stock clear across and uses its edges as part of the finished blank. As here shown, the scrap is being punched through the die and the blank when cut falls down the inclined surface shown. When the

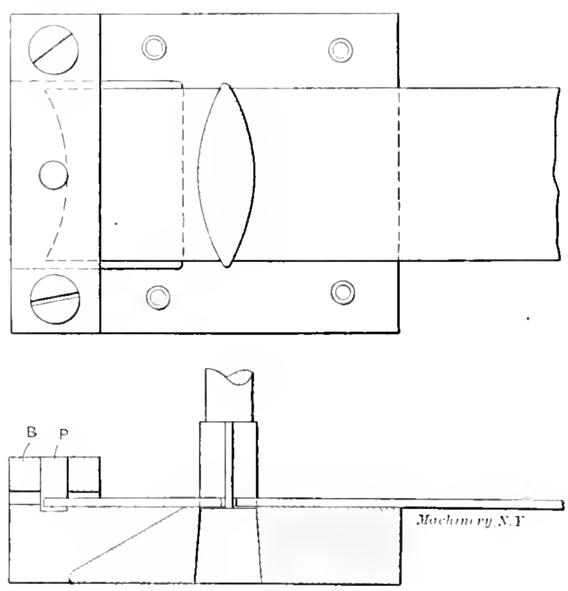

Fig. 4. The Bridge Stop-pin

blanks are simpler and have straight ends the die may be so arranged that each stroke finishes two blanks, one being punched through the die and the other falling outside down the incline. Little skill is required of the operator; he simply has to be sure to push the stock up to the stop-pin each stroke.

The Simple Latch

The simple latch is shown in Fig. 5. It is suited for dies that have pilot-pins. The latch is lifted by the down stroke of the punch and is lowered again as the punch rises. Hence it is evident that, if used with dies without pilot pins, the punch must reach the stock and hold it before the latch lifts. When its lifting is thus delayed it will lower before the punch withdraws from the stock and will fall in the same place it lifted from. The stock will then not be fed along. But if a pilot-pin is used, it may be set so as to enter the guide hole just before the latch lifts. The latch may be set to lift before the punch reaches the stock. It will then fall after the punch withdraws from the stock, and sufficient time may be allowed for the operator to feed the stock along. This device is best

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suited for use with automatic feed rollers because the timing of the operations would be more uniform; whereas if the operator does not pull the stock with uniform speed the latch is apt to drop too soon or too late. Another manner of operating this simple latch is to give it its motion by means of a

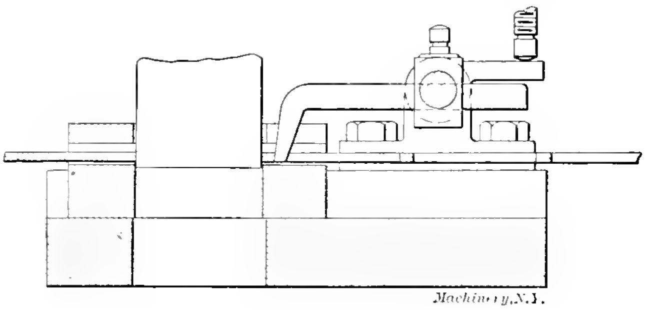


Fig. 5. The Simple Latch Form of Stop

cam or eccentric on the press shaft. When thus driven its motion can be very carefully timed, irrespective of pilot-pins. This style is also best suited for automatic roll feed. New presses are often provided with this attachment.

The Spring Toe Latch

The spring toe latch involves but little change from the simple latch. Fig. 6 shows it clearly with an enlarged detail of the spring toe. This latch may be used very successfully with hand feed and there is little danger of the stock getting

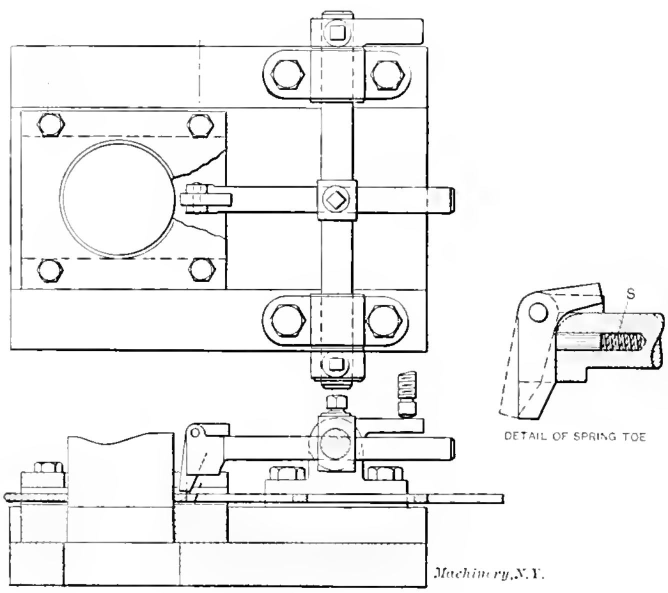


Fig. 6. The Spring Toe Latch Stop

by it too fast. Its operation is as follows: As the punch lowers and starts to cut the blank, an adjustable screw on the ram or punch plate lifts the latch. Its spring toe snaps forward and when the latch lowers, it rests on the scrap left between two blanks; hence it cannot fall back into its former place. When the operator pulls the stock along the latch toe drops into the next hole and brings the stock to a stop at the proper point, compressing the light spring *S* as it does so. This design is simple, rigid and effective. The spring toe here shown is preferable to the design which follows because it is light and requires but little tension on the stock to bring it to a stop.

The Side Swing Latch

The side swing latch is shown in Fig. 7 and it is but a modification of the latch shown in Fig. 6. When the punch descends, an adjustable screw hits lever *L* and lifts the latch. The whole rod *R* then springs forward till collar *C* stops against *B*. When the latch lowers it rests on the stock as did the spring toe latch. As the stock is pulled along the latch drops into the next hole and acts as a stop again. In this style the tension on the stock must be greater than with the spring toe latch because the whole rod *R* has to be pulled along against the spring *Q* until collar *D* stops against *E*. If this design were modified, however, so the side bearings would be used only for allowing the latch to swing, the toe could be constructed like the spring toe latch and would then be quite as effective as this type, though not so rigid.

Positive Heel and Toe Latch

While the two previous automatic stop-pins rely on gravity or a spring to bring them back in position, the heel and toe latch is positively operated. It is shown in Fig. 8, with the stripper removed. Its distinctive feature, which recommends it for use on a large variety of work, is that it is impossible for the stock to slip by it faster than one blank per stroke of the press. This is a very important matter when combina-

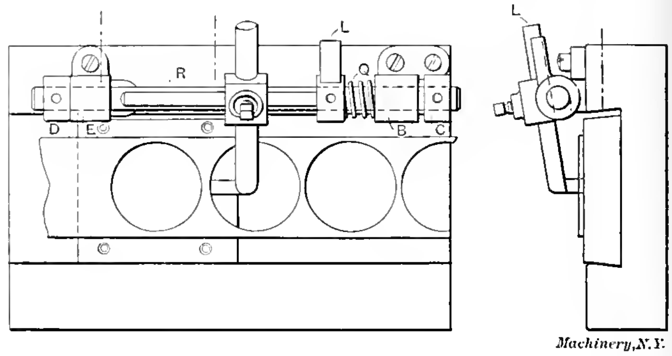


Fig. 7. The Side Swing Latch Stop

tion or gang dies are being used, because the pilot-pins so widely used require the guide holes to be punched just ahead of them. If the stock slips too far, the guide holes pass beyond the pilot-pins, and when the punch descends, the pilots punch their own holes, throw down a heavy burr and cause a delay—if nothing more serious.

Fig. 9 shows the catch in position to stop the movement of the stock at its point *A*. The stock is feeding to the right. The conical-pointed pin *B* is pushed by the spring *S* so that

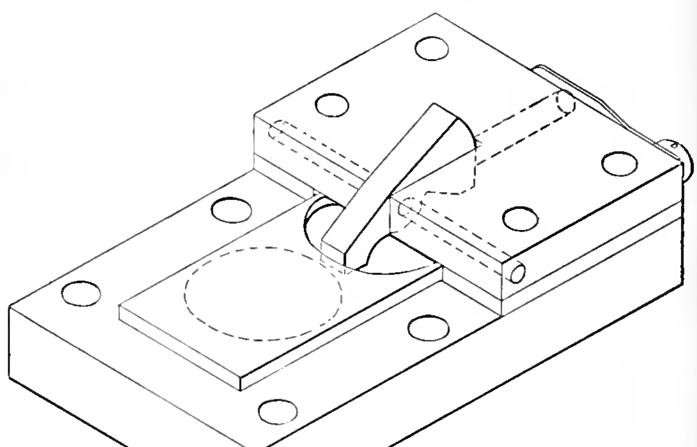


Fig. 8

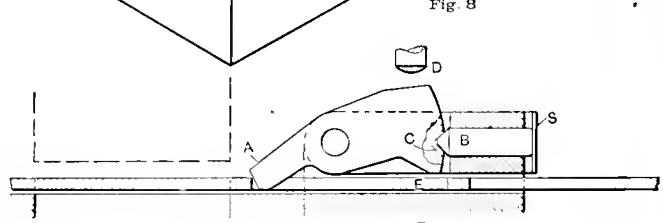


Fig. 9

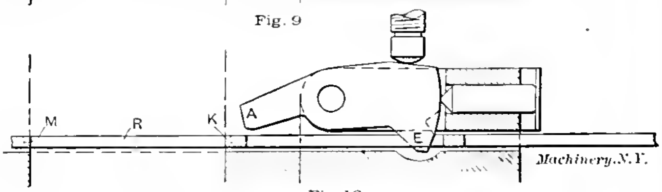


Fig 10

Figs. 8, 9 and 10. Positive Heel and Toe Latch which prevents the Stock from moving more than One Blank per Stroke of the Press

it engages a conical depression *C* in the end of the catch. By this means the toe of the catch is pressed against the die. As the punch descends to cut the next blank an adjustable screw on the punch plate presses on the top of the catch at *D* and causes the heel to lower and the pin *B* to disengage the

notch C. The position of the catch is now shown by Fig. 10. Its heel E has been lowered into the hole left by the previous blank. It is held in this position by the pressure of the point of B. While this is sufficient to hold the catch in its new position, it offers but little resistance to its return to its original position. The stock may now be moved along. The metal K, left between two successive blanks, engages the heel E of the latch and lifts it easily. This causes the notch C to engage with the pin B and the catch snaps back into its first position. The toe A falls into the new opening R, and M comes to a stop against it. Since the metal K, between two successive blanks, cannot pass the heel of the latch without raising it, and since the heel E cannot rise without lowering the toe A far enough to catch the stock, it is evident that the action is positive.* Hence the stock cannot jump ahead faster than one blank at a time. In constructing a stop of this kind care must be taken to allow under the heel E, Fig. 9, but little more height than the thickness of the stock. The length of the catch from toe to heel should be less than the opening left by one blank; then there will be no difficulty in starting the new ends of strips or coils. If necessary, however, the catch may be made so as to measure a little less than two or more openings in the stock. In such a case the catch would have to be tripped by hand until the first piece of stock K, between two blanks, had passed under the heel E. This would cause delays which would amount to considerable in the case of strip stock.

This style of stop-pin has been used successfully with gang dies cutting blanks from brass 1/32 inch thick, and cold rolled steel 1/64 inch thick. In the case of the steel blanks,

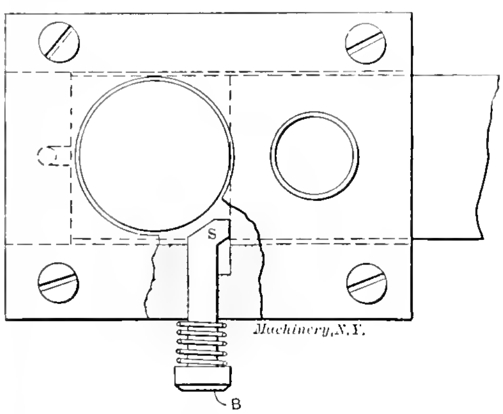


Fig. 11. Starting Device for a Gang Die

reels were used and the scrap was wound on a reel as it came from the die. By keeping the proper tension on the scrap, the stock was pulled through the die and kept against the stop-pin. Four thousand blanks per hour were made by this means. In view of the thin stock used and the fact that the dies were of the combination type, this was considered first rate. The stop-pin had to be set accurately because the thin stock prevented the pilot-pins from shifting it much in aligning it. Other precautions taken on account of the thin stock were to make the toe broad and to fit the stripper close to the front edge of the toe.

The Gang Starting Device

The devices so far described serve to stop the stock when it has passed the blanking punch. But there are many cases where two or more operations are performed on a piece before it reaches the blanking die and the usual stop-pin. The operator usually gages the proper positions by watching the end of the stock through openings in the stripper, but it is better to have temporary stop-pins that can be used for that purpose. Fig. 11 shows a starting device for a gang die with two punches. When starting a strip the button B should be pressed. This brings into action the temporary stop S, which locates the stock properly for the first operation. It is then released and springs back out of the way. The stock is then advanced to the regular stop-pin. As many of these side stops may be used as are necessary. Not only do they save annoyance and time, but they add to the life of the dies by preventing the partial cuts due to the stock entering too far at the start.

TWO FEED-STOPS OF WIDE UTILITY

C. W. D. AND W. B.

The authors make no claim of originality for the simple feed-stops here illustrated, nor is it desired to convey the impression that these stops are new or novel in their construction; experienced toolmakers will recognize them at once as "old acquaintances." There are certain points concerning

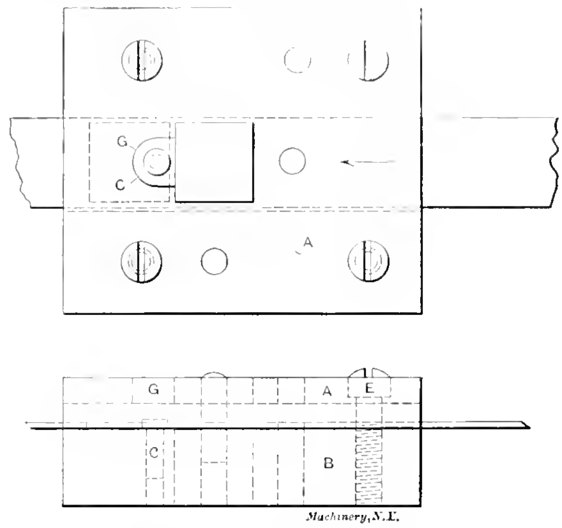


Fig. 1. Improved Form of Fixed Stop-pin

them, however, an explanation of which will be of benefit to those who are not experienced in punch and die work.

Fig. 1 shows a fixed stop-pin C, which is the most common of all feed-stops. It is the particular form of this simple stop to which we wish to call attention. The common way to make a fixed stop-pin is to bend over a piece of steel rod and drive it into the die. This appears simple enough, but we can say from experience that it is not so simple as it looks. As much as two feet of steel is sometimes used up in an attempt to make a bent stop-pin about one and one-quarter inch long. The difficulties and disadvantages connected with making a bent stop-pin are as follows: First, the difficulty of bending the pin at right angles without breaking it or bending the part to be driven into the die; second, after the pin has been made and hardened it is apt to break in driving it home to its place in the die because of its uneven shape; third, in driving the pin into the die it is apt to swing around out of its proper position making it necessary to knock it

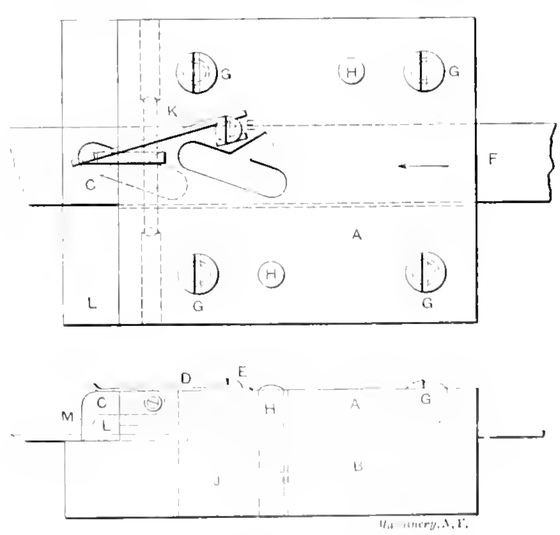


Fig. 2. Latch Stop-pin of Simple Design

around again and thus increasing the chances of breaking it. Every time the die is ground, this difficulty is experienced and the result is, frequent breakage and consequent loss of time in waiting for new stops. All these difficulties are overcome by making the style of pin shown in Fig. 1. This is simply a shoulder pin turned to a nice snug fit in the die. The shoulder, which acts as the stop for the stock, may be made

larger or smaller in diameter according to the width of scrap desired between blanks. This stop is quickly and easily made, is easily taken out and put back again after grinding the die, and it will last as long as the die itself. It is a good idea to cut a hole through the stripper *A* directly over the stop-pin as shown at *G* so that the operator can see the pin when the press is in operation.

The stop shown in Fig. 2 is excellent because of its simplicity, and also because of the great variety of work to which it may be applied. This stop is of the latch variety, but it differs from most stops of this type, in that it requires no mechanism to lift it. It is not operated by the action of the press nor by the punch, as is generally the case with latches. Its construction is simple. A hole is drilled through the stripper *A* to receive the pin *K* which passes through a hole in the stop *C*. The stop swings upon this pin. A light flat spring *D* is fastened to the top of the stripper so that the end of the spring rests on top of the stop. In securing this spring to the stripper, it is only necessary to place one end under the head of the screw *E* with a piece of the same material under the opposite side of the screw as shown in the plan view. By this method the spring can be quickly and easily attached or removed, and a straight piece of spring material can be used. The stripper, of course, should have dowel pins in it to insure its coming back in the same position every time the die is ground. The dowels and screws are shown at *H* and *G*, respectively. The stripper should also

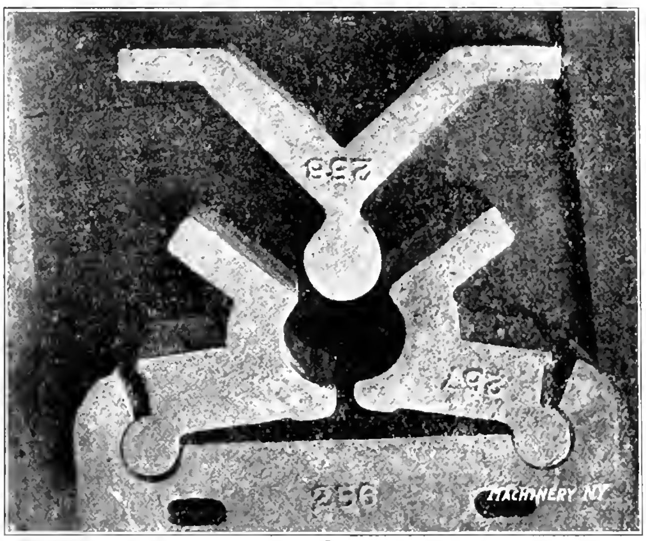


Fig. 1. Former for Making the Bracket shown in Fig. 3

be cut off at the stop end as shown at *L* so that the stop will be outside of the stripper and in full view of the operator. The action of this stop is as follows: The stock *F* is fed to the left, and as the punched strip passes the stop, the point of the stop *M* drops or rather springs into the hole made by the blanking punch. The operator then pulls the strip back against the straight outer edge of the stop, and holds it there until the next blank is punched. This process is repeated at each stroke of the press, the scrap between the blanks being pushed past the stop each time and then pulled back against it. The inner bevelled edge of the point *M* causes the stop to lift as the scrap between the blanks is pushed against it, while the outer edge, which is at right angles with the die, prevents the stop from lifting when the edge of the scrap is pulled back against it.

By this simple stop the operator can feed the stock at will without waiting for the operation of a mechanically-lifted stop, to say nothing of the time that is saved by not having to adjust an automatic stop. An operator, known to the authors, can make about 40,000 blanks per day with dies fitted with this form of stop on a press making about 100 strokes per minute. These stops are used only on hand-fed work.

* * *

Aluminum coins are to be circulated in France. The mint is ready to issue five and ten centime pieces of this metal. They will, of course, be much lighter than the ordinary coins, and have the advantage that they will not oxidize.

COMPOUND BENDING FORMS FOR THE BULLDOZER

ETHAN VIALL*

A short time ago, while visiting the shops of the Danville Car Co., at Danville, Illinois, the superintendent, Mr. H. C. Teipel, showed me several interesting bending forms which the shop foreman, Mr. A. S. Hesse, had made for use on their bulldozers. The forms shown in Fig. 1 are especially inter-

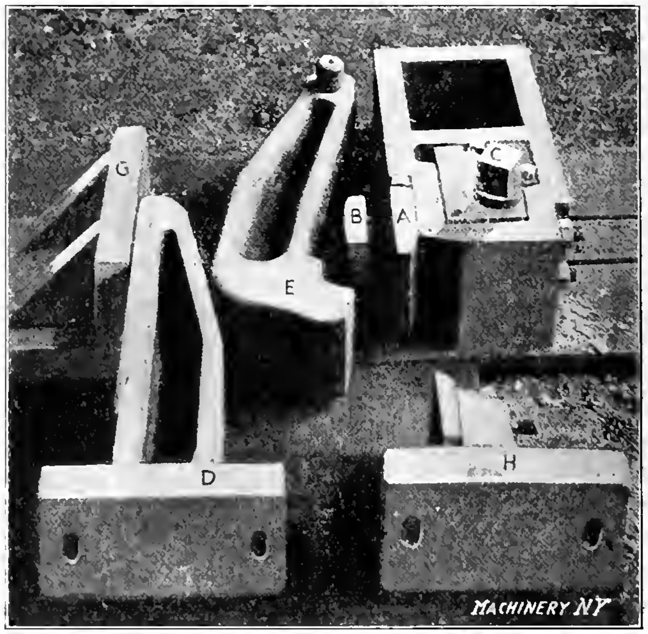
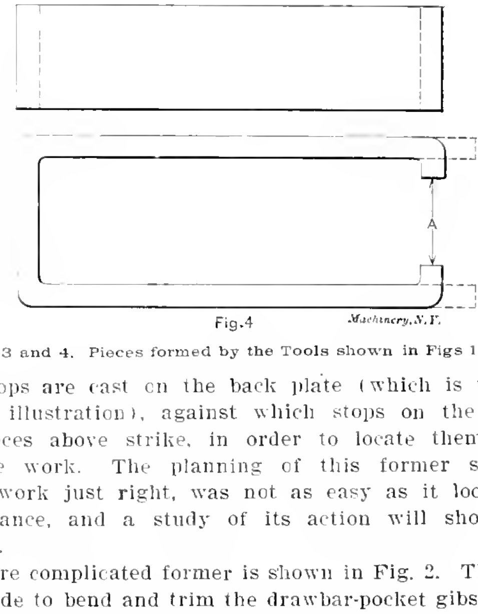


Fig. 2. Combined Former and Shear for Bending and Trimming the Gibs A, Fig. 4

esting from the fact that they were so cast that no machining was necessary in order to assemble them ready for use. Possibly a little filing was needed, or a small lump or two had to be knocked off with a hammer and chisel, but that was all. This device is intended to form the bracket, shown in Fig. 3, but a number of other brackets or hangers, can be made with formers constructed on the same principle. It will be noted



Figs. 3 and 4. Pieces formed by the Tools shown in Figs 1, 2 and 6

that stops are cast on the back plate (which is the lowest in the illustration), against which stops on the wings of the pieces above strike, in order to locate them properly for the work. The planning of this former so that it would work just right, was not as easy as it looks at the first glance, and a study of its action will show several reasons.

A more complicated former is shown in Fig. 2. This former was made to bend and trim the drawbar-pocket gibs *A*, Fig. 4. In using this former the bar is placed between part *A* and

* Associate Editor of MACHINERY.

the clamp-jaw *B*, which is tightened by turning the eccentric *C*. The gib is now bent by the part *D*, which is fastened to the bulldozer ram, shoving over the gib-former *E*. During the bending of the gib, the part *D* is steadied and guided by the part *G*, which is bolted solidly to the bed of the bulldozer. The end of the gib is trimmed off by the shear-blade on part *H*, which slides past the outer edge of the blade on part *A*.

The adjustable male and female parts of the radius bender, shown in Fig. 5, are used to bend iron parts that would otherwise require about twenty different forms.

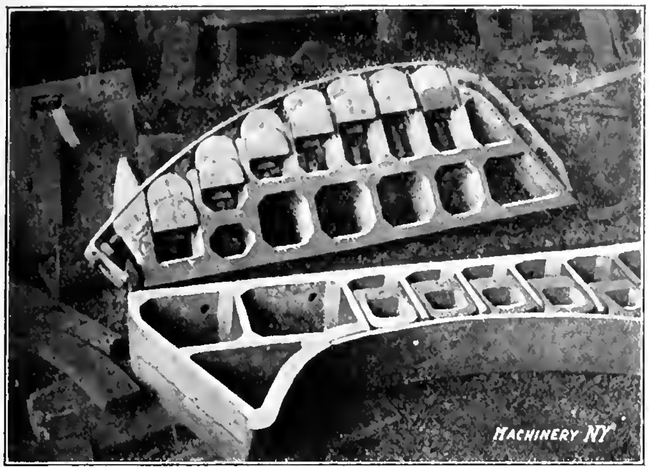


Fig. 5. Adjustable Bending Form

The draft-gear yoke-bender shown in Fig. 6, was made in the Ft. Wayne shops of the Pennsylvania Railroad and is only slightly different from those used elsewhere for the same purpose. The wings *A*, *A*, and the parts *B*, *B*, used to push them around during the stroke of the bulldozer ram, are all pretty well cored out to lighten them. The iron to be bent, is clamped between the form *C* and the sliding part *D* which is operated by the lever *E* turning an eccentric located in the block *D*. The yoke shown in Fig. 4, having straight ends as indicated by the dotted lines, is the product of this tool.

* * *

SPECIAL CENTERS FOR TAIL-STOCK

WALTER GRIBBEN*

The tubular shaft of tool steel, shown in section in Fig. 1, was so long in proportion to the diameter of the hole that it could not very well be turned on a standard bench-lathe arbor, and rather than make a special arbor of extra length, the tail-stock fixture shown in longitudinal and cross section in Fig. 2 was made to do this job. It has since proved remarkably useful on many other jobs, and is now considered a standard appliance in my bench-lathe outfit.

The body *A* is made of rectangular steel, with a 3/16-inch hole bored and reamed its entire length. The taper shank is turned true with the central hole, and fits the tail-stock spindle the same as an ordinary center. The binder *B*, and screw *C*, with the lever handle *D*, will hold any piece of 3/16-inch round stock, or any special piece with a 3/16-inch round stem, so that it will be in line with the live spindle.

For the job shown in Fig. 1, the plug *E*, Fig. 2, was made, the shank *F* being an easy fit in *A*, while the part *E* is 1/4 inch in diameter at its outer end, and slightly tapering, so that it is about 0.001 inch larger on the inner end. The part *E* was hardened, tempered, and polished smooth, while the part *F* was left soft. This plug answered as a dead center for the end of the tubular shaft to run on while turning the outside. As a driver for the other end, a piece of rod larger than the hole in Fig. 1 was held in the live spindle and turned to a tight wringing fit in this hole. This left the outside of the work entirely free to operate on, including the turning of both ends at one chucking, which insured all the parts being true with one another. The slight taper on *E* provided for any fine gradation between a running fit and a tight fit to be obtained on the tail-center end, by adjusting the tail-spindle back or forward.

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In work of this character, no attempt is made to preserve the driving plug for subsequent jobs, as it does not need to be hardened, nor does it need to be polished. It is a comparatively easy matter to turn one up each time it is needed, and it is then sure to run true. They are generally made on the end of a stock rod, and after the job is completed, the driving rod is put back in stock. This, of course, is from the jobbing point of view, and not from a manufacturing standpoint.

The hardened steel plugs, similar to *E*, are made for each job as it occurs, and are preserved for future use. Fig. 4

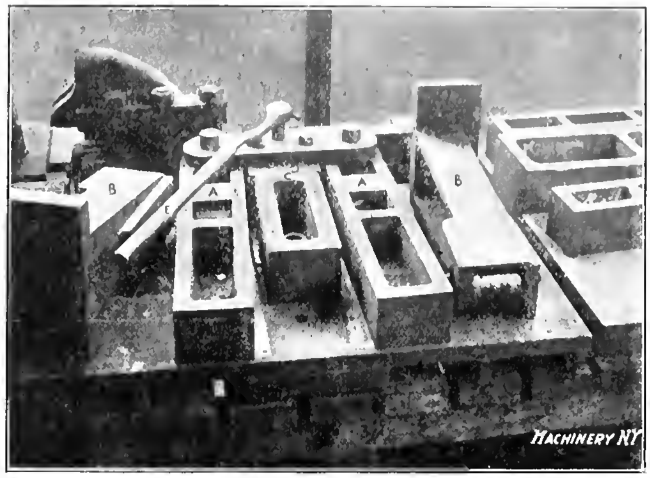
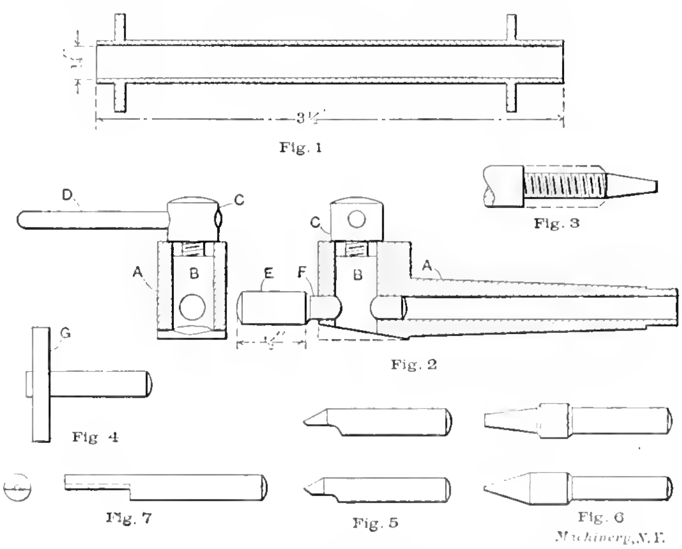


Fig. 6. Draft-gear Yoke Former

shows a sheet brass disk *G*, soft soldered onto a short piece of 3/16-inch wire, the edge of *G* being turned true after soldering on. This makes a convenient kind of center on which to run the end of a long piece of drawn brass tubing while truing the end, or cutting a thread on the outside.

Another use to which the tail-center, Fig. 2, is put is to hold short, stubby, flat drills for starting a true hole in chucked work. If the hole is in thin work, it may be drilled clear through with one of these flat drills, but if a hole has to be drilled in some distance, it may be started with one of the flat drills and finished with a twist drill.



Figs. 1 to 6. Special Tail-center for the Bench Lathe, and Auxiliary Attachments

In the outfit of plugs to go with Fig. 2 there are two male centers cut partly away to different amounts, as shown in Fig. 5, a female center with a much smaller hole than in the regular female center, and a 60 degree countersink for centering shafts. Some of the plugs are special in their nature, as shown in Fig. 6, and are hardly worth keeping. These were made for turning shafts that were to run on pointed screws of a special angle, and as only one shaft of each kind was to be turned, the plugs were not even hardened, but were left soft and kept well lubricated when in use. The stock from which one of the screws was to be made was chucked and its point turned to the specified angle, as in Fig. 3. A small dog was then clamped on the part shown

dotted. This made a live center on which to turn the shaft, one of the plugs shown in Fig. 6 being used as a dead center. After the shaft was completed, the pointed screw was turned down for the shank, threaded and cut off, thus performing a double duty, as live center first, and as a finished screw for the completed machine afterwards.

Having to make a tap 0.040 inch diameter and 100 threads per inch, a piece of 3/16-inch brass rod was drilled lengthwise about $\frac{1}{2}$ inch deep with a 0.040 drill, after which the outer end of the rod was cut partly away, as shown in Fig. 7, leaving about two-thirds of the original diameter of the hole in the brass. When this was clamped in the tail-center, Fig. 2, it made a very good steady rest, or back rest, for the slender wire to run in while doing the threading. The threaded part of the tap was only $\frac{3}{8}$ inch long. Of course, a hardened steel plug would have answered much better, but the job was in a hurry, and the brass plug was more quickly made, and was plenty good enough.

The part shown dotted in Fig. 2, is cut away to clear the turning tool when finishing the end of a tube or a solid shaft with a straight hole in the end. The central hole in Fig. 2 goes all the way through, but it does not need to. It was made that way because it was easier to get all the parts true, the hole being made first. Since making this fixture, it has occurred to me that it would have been an excellent device to use on a lathe that I worked on many years ago, which was somewhat out of alignment. In that case the central hole would be bored in place after the taper shank was fitted to the tail spindle, taking the precaution, of course, to mark the fixture and the tail spindle, so that the fixture would always be placed, when in use, with the same side up as when it was bored.

* * *

MACHINE SHOP PRACTICE*

LAYING OUT WORK—2

Before laying out a machine part it is first well to consider its particular requirements in order to obtain a definite idea of the relation that the various surfaces must bear to one another when the part is finished and assembled; and, as the method of procedure is governed somewhat by the way in which the part will subsequently be machined, it is also advisable to first determine the most practicable method of machining, before beginning to lay out the work. As an illustration of the kind of work which the machinist is often called upon to line out, we have selected the engine cross-

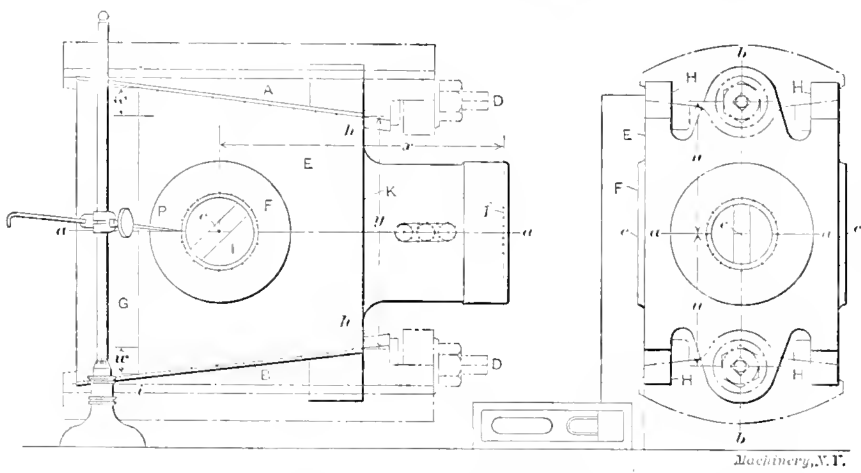


Fig. 1. Laying Out a Cross-head

head shown in Fig. 1, which is a type widely used. The shaded portion represents the main casting, and the dot-and-dash lines the shoes, or gibs as they are sometimes called, which are adjusted along the inclined surfaces *A* and *B* when there is too much play between the guides and the cross-head. In this particular case the principal requirements are that the axes of the piston-rod hole and the wrist-pin hole be at right angles; that the axis of the wrist-pin hole also be at right angles with the vertical center line *b-b*; that the inclined surfaces *A* and *B* have the same inclination to the center line *a-a* and be equi-distant from it; and that the guiding surfaces *H* be parallel with the axis of the piston-rod hole. Keeping these requirements in mind, we shall proceed to locate lines on the casting indicating the finished surfaces. After inserting centering pieces in the cored wrist-pin hole on each side and in the piston-rod hole as shown, locate the points *c* and *e* central with the outside of the bosses. A coat of whiting and alcohol, or chalk, should next be applied to those surfaces upon which lines are to be drawn. The casting is now ready to be set in an upright position on the surface plate, as shown in the illustration. The blocks which would be required to support it in such a position have not been shown, in order to avoid a confusion of lines.

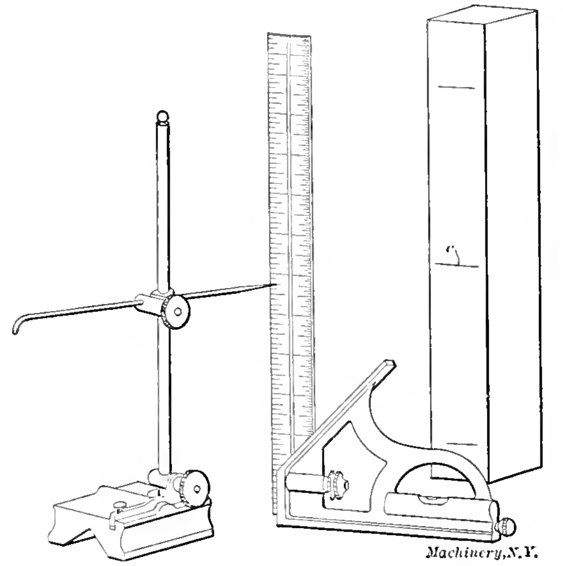


Fig 2. Setting the Surface Gage to the Dimension u, Fig. 1, by the Combination Square

The rough sides of the casting are set at right angles to the surface plate by the use of a square, as shown in the end view. The center *c* and the two centers *e* (see end view) are now set in the same horizontal plane by the use of the surface gage *G*. This is done by inserting the pointer *P* of the gage in one of the centers and then moving the gage to the other centers to see if they coincide with the first. It may be necessary in order to set these three centers in the same horizontal plane to move the two centers *e* toward each other slightly. It is better that each center be moved in order that the finished hole will be as nearly concentric with the outside of the bosses as possible. When the casting is thus set, the surface gage is used to draw the center line *a-a* on each side and across the end of the cross-head. This is done by holding the scriber against the casting while the base of the gage is moved along the surface of the plate; obviously a line drawn in this way will be parallel with this surface. Ascertain from the drawing in which direction the wrist-pin is to enter the cross-head in order to find out from which side the hole for this pin will be bored, and then, with point *e* as a center, scribe a circle equal in diameter to the small end of the wrist-pin hole. This circle will be used to set the casting by when boring the hole in the lathe or boring mill. Another circle, the diameter of the small end of the piston rod hole, should be scribed with point *c* as a center. With a pair of trammels, a line *f* should be located a distance *x*, as given on the drawing, from the center *c*. We shall assume that the dimension *y* is given, and that the taper of the inclined surfaces *A* and *B* is in inches per foot. Then to lay out lines for these tapering surfaces, locate points *h* and *h* equi-distant from the center line *a-a* and a distance *y* apart. With a square draw a line *i-i* 12 inches from the face *K*. With the surface gage transfer the points *h* to the line *i-i*, as shown, and then locate centers above and below these points a distance *w* equal to the taper per foot. Lines which are then drawn through these centers and the points *h* will have the

* With Shop Operation Sheet Supplement.

taper required. If the casting is not large enough to permit line *i-l* being drawn 12 inches from the face *K*, of course the same result would be obtained if this distance were a fractional part of a foot, providing the distance *w* were laid off to the same fractional part of the taper per foot. When locating the centers of the bolts *D* distances *u* above and below the center line *a-a*, the pointer of the surface gage should first be set to coincide with center *c*. The pointer may then be placed against scale of a combination square, and the scale moved vertically until the pointer coincides with one of the divisions, as shown in Fig. 2. If the dimension *u* then be added to the inches and parts of an inch indicated on the scale opposite the pointer, the sum thus obtained will be the division on the scale to which the pointer should be set when scribing the horizontal center lines for the bolts *D*. For example, if the gage pointer showed that the center line *a-a* was the same height as the 5¾-inch division on the scale, and if the dimension *y* on the drawing was 5¼ inches, the gage pointer would, when scribing the center line for the upper bolt, be set to 5¾ + 5¼ = 11 inches. The center for the lower bolt would, of course, be obtained by subtracting 5¼ from 5¾. In this way the scale of the combination square can often be used for accurately setting the gage pointer to vertical distances between points not in the same plane. A parallel block placed in a vertical position may also be used for this purpose. A center line *c*, coincident with the center in the work, would first be scribed and then arcs central with this line and the required distance apart would be struck with a pair of dividers or trammels.

One method of machining this cross-head would be to first bore and ream the wrist-pin hole concentric with the circle drawn for it, and at right angles with the rough surface *E*; the boss for this pin should also be faced. This finished boss can then be clamped against an angle plate (preferably on a vertical boring mill) when setting the casting for boring the piston rod hole. In this way the axes of the holes for the piston rod and wrist-pin will be at right angles, and if the center line *a-a* on the casting is set square with the table or face-plate, the axis of the two holes will also be in the same plane. By bolting the finished face *F* against an angle plate on the planer, the planes in which the finished surfaces *A* and *B* lie, will also be parallel to the wrist-pin axis, and the finished sides *H* for the shoe fittings will be parallel to the axis of the hole for the piston rod.

* * *

IMPROVEMENT VS. HUMANITY

An American and German were traveling by rail in Germany through one of the forests for which the country is noted. The wooded expanse on either hand showed the care of the trained forester. The trees were free from dead branches, and on the ground there was little or no debris. The roads were laid out with mathematical exactness; the sides were free from weeds and the gutters carefully graded and clear of obstructions. In short, the whole appearance of this great forest was that of a well-kept park, although miles and miles in extent. The German waxed enthusiastic and was constantly calling the attention of the American to the various features that attracted his admiration. He could not say enough for the beauty of the scene, for the well-kept appearance of the trees, the fine roads and the evidences of a mastery of nature and a carefully planned conservation of a valuable resource.

The American at last grew somewhat impatient and said: "You see one phase of this scene only, and that is the woods and the roads, while I am more concerned about another phase, which is the human side. Behold those men and women peasants broken down with toil before their time, stumbling along in wooden shoes, without hope, without courage and destitute of ambition! That is the other side of the scene not so fine. To me this scene is very depressing, for I see in it nothing for humanity. Of what good are all these roads, the well-kept forest, these water courses, when the men and women whose unremitting labor is required to do this work, have no joy in the prospect? Human happiness is worth more than all the improved roads and forests together, for without it all else is worthless."

GERMAN BENDING AND STRAIGHTENING MACHINE

A machine for bending cold iron and steel of round, square, T, I, channel and other sections is shown in Figs. 1 and 2. This machine which is built by Brüder Boye, Neue Friedrichstrasse 59, Berlin, Germany, is designed for bending and straightening small quantities of work of a special nature, which would not warrant the employment of special machines with expensive tools, such as bulldozers. The need of such a machine has long been felt by bridge and crane building establishments, shipyards, railway shops, machine

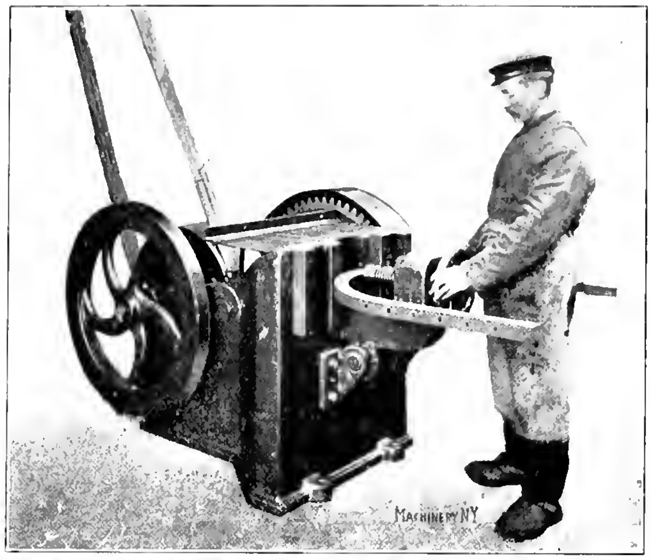


Fig. 1. The Power-driven Bending and Straightening Machine forming an Angle-iron

shops, etc. Although tools performing this work are in use, they are generally hand-operated and the results have been more or less unsatisfactory, both in regard to the output and the quality of the work produced.

As may be seen in the line engraving Fig. 2, the machine consists of a strong frame in the center of which is a massive steel ram *A*. This ram is connected at one end by an eccentric, which actuates it, and it is supported at the other by a roller *D*. In the end of the ram there is an adjustable spindle *C* which comes directly into contact with the work. By varying the position of this spindle, the piece being bent will

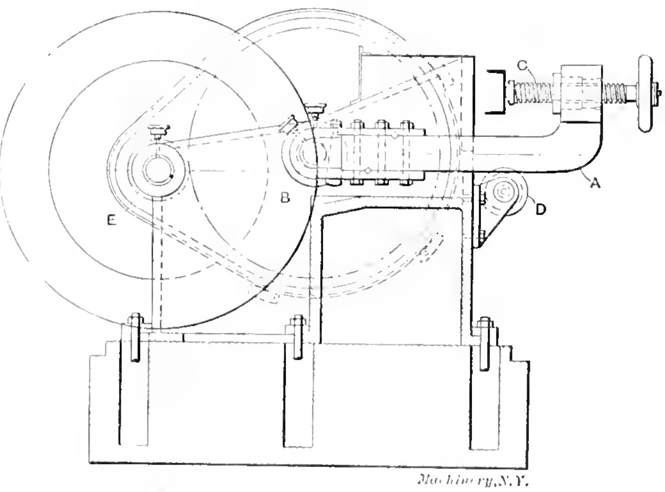


Fig. 2. Vertical Section through the Bending and Straightening Machine

be subjected to a greater or less pressure and the radius of the bend will be varied accordingly. The shaft upon which eccentric *B* is mounted is connected to the driving shaft *E* by reduction gearing. The speed of the driving shaft is 110 revolutions per minute, and the resulting speed of the ram is 25 strokes per minute. While the stroke of the ram, which is approximately 1 inch, is not changeable, the distance between its working end, that is the end of *C*, and the frame can be changed, as before stated, by simply moving *C* in or out by the hand-wheel shown, thus subjecting the work to a greater or less amount of pressure on each individual stroke. Obviously, this machine can be used either to bend

straight bars to any desired form or to straighten crooked bars. These bars may be round, square or any desired shape and the iron can be bent at any point by turning the work to the desired position. The various pieces in Fig. 3 show what uniform results can be obtained with this simple machine. Pieces having the same section throughout can easily and quickly be bent to approximately a true circle, providing the spindle C is not adjusted after a bend is started and the work is fed practically the same amount for each stroke. It is said that this machine bends the various

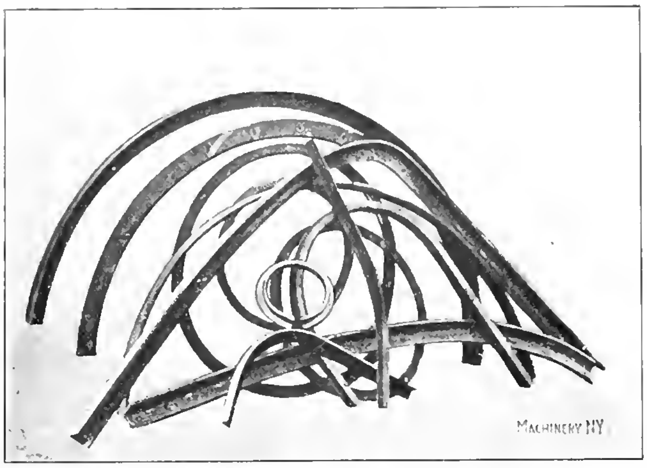


Fig. 3. Some of the Work done by the German Bending Machine

sections without any appreciable amount of buckling, which, considering the simplicity of its construction, is quite remarkable. When bending long pieces, the ends are supported by tables or horses which are arranged on both sides of the plunger or ram. Angle iron 2 by 2 inches in size can be bent to a minimum radius of 8 inches, while 4 by 4-inch angle iron can be formed to any radius greater than 2 feet 6 inches. The smallest radius to which an 8 by 3-inch channel can be bent is 4 feet 9 inches. The radius to which any material can be bent is, of course, dependent on its stiffness. About 3 horse-power is needed to drive this machine, and its weight, when ready for shipment, is approximately 2 tons.

* * *

THE LARGEST CRANE IN THE WORLD

The accompanying illustration shows what is stated to be the largest crane in the world and is the crane that was referred to in a short item in the August issue of MACHINERY,

Crane Capable of Lifting 240 Tons at a 95-foot Radius

engineering edition. As there stated, the crane will lift 160 tons at a 95-foot radius, and when tested it lifted a load of 240 tons. The illustration shows the crane while being tested ready to lift the load mentioned. The crane is erected at Devonport Dockyard in England. Its total height is 166 feet, its length over all 230 feet, and its weight 950 tons. It was built by Messrs. Cowans, Sheldon & Co., of Carlisle, and was designed by Mr. J. W. Branston.

THAT NEW APPRENTICE BOY

A. B. SAW

Terry, the new apprentice, came into the pattern-shop about three months ago, bringing his dinner wrapped up in his apron and towel and looking for all the world like a raw recruit from the Emerald Isle; but after he had been there three or four days, he was one of the most welcomed boys that ever got his trademarks in the shop.

He was, as one of the journeymen expressed it, "always keeping us in good spirits by doing funny stunts and asking innocent questions about his work."

The second day that he was in the shop, the boss came to him, where he was sorting screws, and said: "Terry, you can have that bench up there by the band saw for a while, it's kind of old but it will hold you for a time." "All right, sor," says he. So hurriedly finishing his work, he went up to the bench and started to tidy up a bit, feeling as big as life to think that he had a bench all his own.

When he had it fixed up nice and clean, he noticed with dismay that the top of his bench was full of small holes and knife cuts, while the tops of the adjoining benches were smooth and shiny. However, this down-cast mood soon gave way to one of delight because he had an "idea" that would remedy the unsightly appearance of his bench. "Why not fill up those holes with beeswax?"

For two hours he dug and worked at the old bench filling the holes with beeswax. This made the men jolly him a

"Begorra, I'll give it a good draft"

good deal, and they dubbed him "Beesy," a name he went by for the rest of his apprentice days.

Not long after this little incident, he was given a flange to make, twelve inches outside diameter, six inches inside diameter, and about two inches thick. He turned it up in the lathe and, as he thought, "made a pretty foine job." He took it up to the boss, who, after measuring it up, tried a small square to the edges. "There's no draft on it, Terry, give it a little draft and it will be all right."

Terry went back to his bench with a perplexed look on his face, until the meaning of the word "draft" dawned on him. "Begorra, I'll give it a good draft," said he, and at that he put the flange upon the window ledge and opened the window about three or four inches, letting the cool breezes from the water blow on his pattern.

About half an hour afterwards he came over to my bench and said, "Do youse think there's enough draft on me pattern, Mr. Saw? It's been there thirthy minutes."

Well, I explained to him, with a straight face, what the meaning of "draft" was, when applied to a pattern; but I must confess that after he had gone I had to give way to my suppressed mirth, and when the story was repeated to some of the others, they joined in with me.

* * *

The minute a man begins to consider himself indispensable he ceases to be.—*The Silent Partner.*

CASTING NEW FACES ON WORN VALVE SEATS

The accompanying view shows the operation of casting a new face on an old valve seat of a locomotive cylinder, as it is performed at the Firenze (Florence) repair shops of the Italian State Railways. The illustration shows the cylinder with the mold clamped to it ready for the pouring of the metal from the adjoining cupolas. Briefly described, the process consists of removing the worn or damaged part that is to be renewed, and fixing in its place the mold of the new part. Before running the metal, the cylinder is highly heated and then the pouring is performed in such manner that the metal runs freely over that surface of the cylinder which is to be fused and welded, and then passes out through a hole such as is shown in the side of the mold in the photograph. After running from 200 to 500 pounds of metal, the old metal softens and melts; the escape hole is then plugged and the mold filled up to the top of the runner head.

Unless a cylinder has been rebored so many times as to approach its final limits for thickness, this process is found to be cheaper than casting new cylinders and then machining them. The new gas "welding" processes would not be so economical in Italy considering the thickness to be melted for a weld joint; this too is the experience in French railway shops where autogenous welding (*soudure*) has been practiced for some time with considerable success up to a certain thickness, past which ordinary methods become cheaper.

Casting a New Valve Face on an Old Cylinder—Italian State Railway Shops at Florence

C. R. K.

A VARIABLE LINEAL SPEED DRIVE

Fig. 1 shows a general view of a slide *A* which moves back and forth in a straight line with a variable speed by means of a common rack *B* securely mounted on the slide, and a spiral spur gear *C* keyed on the shaft *D* running at a constant speed. From the drawing it can easily be understood that this spiral gear can only make a part of a turn or possibly a little over a turn before reversal, in order to move the slide in the desired direction. The reversing of the shaft *D*, on which the spiral is fastened, is done by a jaw clutch body *E* sliding on a feather on shaft *F*, and engaging automatically with either one of the two pulleys *G* and *H*. These pulleys, located one on each side of the clutch body *E*, run continuously in opposite directions, thus changing the direction of the rotation of shaft *F*. On this shaft there is a worm fastened which meshes with a worm-wheel fastened to the spiral gear *C*. The rack is mounted on the slide at a certain angle depending upon the required variation in speed, which is in direct proportion to any line *m*—*m'* or *n*—*n'* drawn from the pitch line of the rack perpendicular to the center line *I*—*J*. It would not be advisable to mount the rack on the slide at a steeper angle than 30 degrees. If the angle be more than this a greater resistance to the movement of the slide will occur.

The diagram, Fig. 2, shows how to construct the spiral gear when the pitch and the angle to which the rack is set are given.

The center line of the spiral gear is located as near as possible to the lower end of the rack, just enough space being left to get a good size hub around shaft *D*. In this way the smallest possible spiral gear required for the movement will be obtained, providing that the movement of the slide is not too great, in which case the size of the spiral gear may have to be increased in order to get the right number of teeth. First, space off one-half of the pitch *a*, *b*, *c*, *d*, *e*, etc., on the proper length of rack and then project lines to the center line *I*—*J* from each one of these divisions. With *A* as a center and *aa'*, *bb'*, *cc'*, *dd'*, *ee'*, *ff'*, *gg'* as radii, strike small arcs as shown at *b"*, *c"*, etc. Space off half of the pitch on these arcs, going from one to another to get the intersecting points for the pitch lines of the spiral gear. By rights the pitch should be measured on the spiral, but for a small pitch the difference is so slight that it need not be taken into consideration. When all the intersecting points are found, find the centers *B*, *C*, and *D* needed for forming the spiral. Lines drawn from these centers through the intersecting points *b"*, *c"*, etc., will give the center lines for the teeth and spaces in the spiral gear.

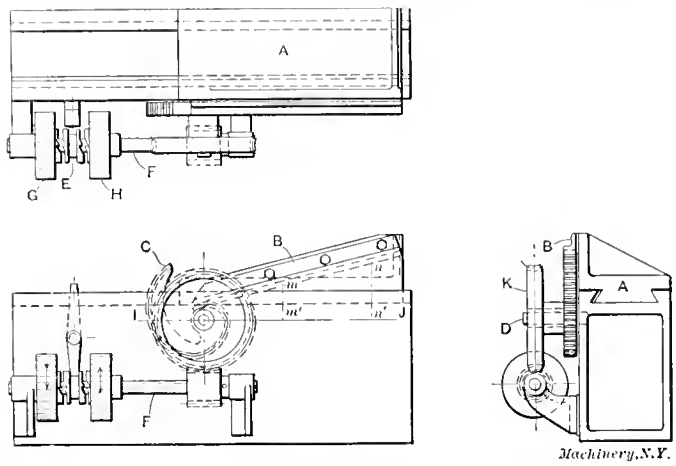


Fig. 1. Mechanism with a Spiral Spur Gear for Imparting a Variable Lineal Speed to a Slide

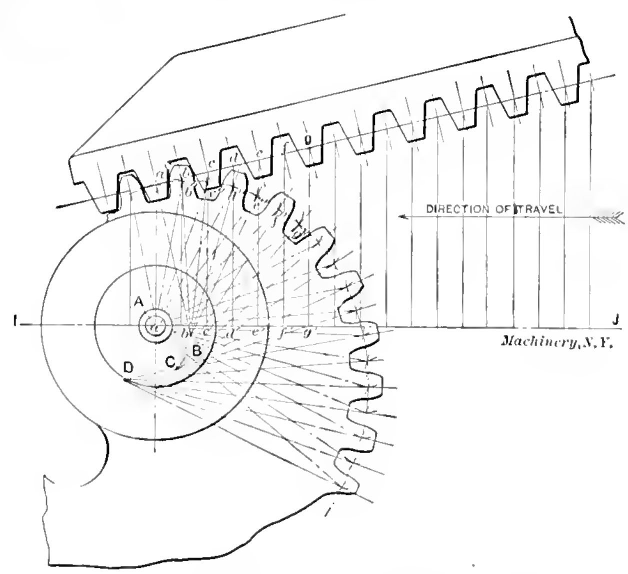


Fig. 2. Method of laying out the Spiral Spur Gear

For cutting the spiral gear, a templet was made having the correct shape of the teeth according to the various radii in the spiral. This templet was fastened on the blank and the spiral was cut in the regular way, only that it could not be cut with one cutter as the shape of the tooth changes with the spiral. [The paradoxical name of spiral spur gear given the gear illustrated in connection with this article.

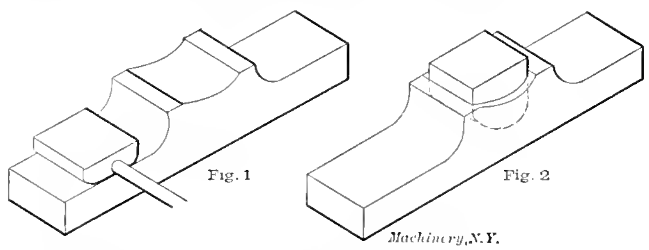
illustrates the folly of naming what is really a helical gear a spiral gear, as the gear here shown is truly spiral in form. —Editor.] Edward Person.

Brooklyn, N. Y.

FORGING DRIVING BOXES

Forged driving-boxes are preferred to steel castings by many European railway works. On account of their great height there are some difficulties in the way of forging them direct in the press. The accompanying sketches show how this work has been simplified at the Epernay shops of the French Eastern railways.

The billet for the driving-box forging is first rough-dressed as shown in Fig. 1, and then, with the aid of a die, the hollow is shaped in the crown as at Fig. 2. The third operation is to channel the sides as shown in Fig. 3, and then swage the middle portion on the block, or matrix, as in Fig. 4. The forging is then passed to the press in which it is given a truer form by a die and matrix. The sixth operation is to close up the sides or cheeks of the box by straightening out the curved ends according to the manner shown in Fig. 5, and the seventh and final operation is to square up the forging on the form or die as in Fig. 6.

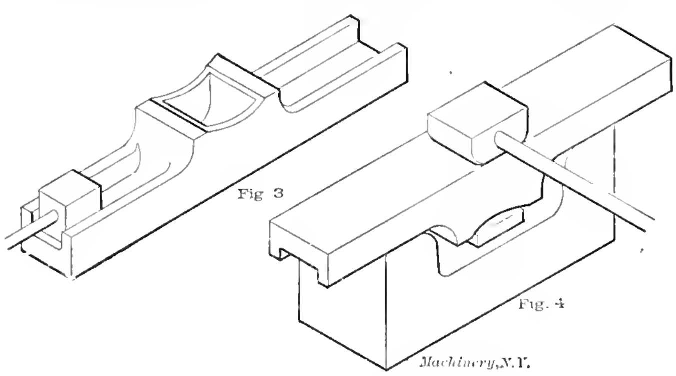


Figs. 1 and 2. Rough Dressing and Shaping the Crown of the Box

The weight of the billet being 264 pounds, the forging thus far completed will weigh 172 pounds, and, after machining, the finished driving box will weigh 105 pounds. For heavier finished boxes the weight of the billet and forging are correspondingly heavier. C. R. K.

BLIND ACCEPTANCE OF AUTHORITIES

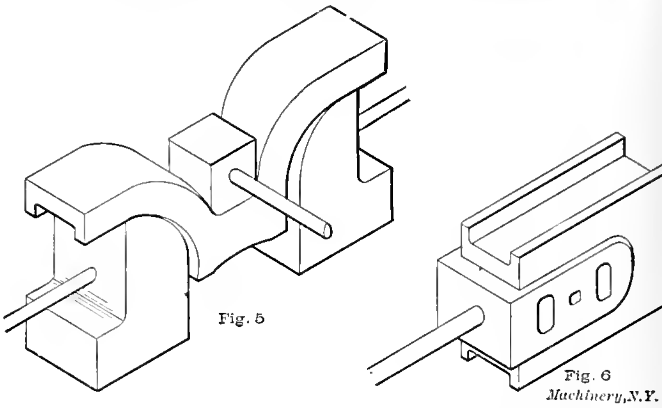
In the June number of Machinery, in an editorial, some space is devoted to what is perhaps the greatest fault of the young college-bred engineer—that of adhering blindly to rules laid down by the authorities. No text-book, or college professor, however, can overcome the handicap of a poor memory or lack of good common sense; neither should such authorities be credited with mistakes resulting from such inability, nor should ridicule emanating from it reflect on them.



Figs. 3 and 4. Channeling the Sides and Swaging the Middle

Incidents concerning the deeds of college engineers are plentiful, and two old, familiar ones may bear repeating. One young man while employed in a drafting-room was given the task of making the necessary drawings for a certain mechanism. When completed he turned the "drawing" over to the chief along with twelve closely written sheets which he said were directions for the drawing. The other engineer in writing of a new locomotive stated that it weighed 160,000 pounds, though the actual weight was slightly in excess of this, for the boiler carried 200 pounds of steam!

Just how some students manage to graduate is hard to conceive. Quite recently a graduate of the engineering school of a large university was unable to tell what part of a dynamo was the commutator. It is impossible to believe that any part of a college training is responsible for such glaring ignorance and errors. Happily for him, the college engineer may sometimes link arms with the practical man and share the "knocking" that his co-workers are only too ready to administer. Witness the following: The mechanical superintendent of a certain factory, a man of 35 years experience in various positions from apprentice to machine shop owner, was telling with a show of pride how he had forestalled a move to put 12 presses on the fourth floor of one of their buildings. The machines were hydraulic presses weighing 1,500 pounds and capable of exerting 35 tons on any article placed between the platen and bed. "Why," said he, "those floor beams are only 2 × 12, set 2 inches into the brick, and with all 12 presses working there would be 400 tons on that floor; I'd resign my position before risking lives that way."



Figs. 5 and 6. Closing in the Sides and Squaring the Forging

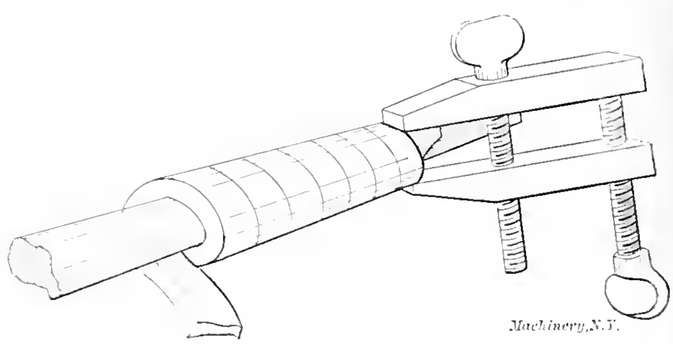
Let us have all the training obtainable; that, tempered with good common sense and coupled with broad, practical experience will give us the engineer par excellence.

Middletown, N. Y. Donald A. Hampson.

A CHEAP BUILT-UP LAP

A great deal of machine work would be considerably improved by having the holes which require accuracy, lapped smooth and true, but the equipment of the average machine shop does not include laps of all sizes, and if a few are carried the chances are all in favor of their being of the wrong size for the work in hand.

It does not take very long to make a lead lap of the ordinary kind, but molds must be provided for casting them, and, as the variety of work to be lapped is infinite, it is practically impossible to have a complete set of molds. Casting laps upon a tapered arbor, as is customary, also requires that the holes in the mold must fit the arbor to be used, at the place where the lap is desired on the arbor, and as that place may vary or



Forming a Lap by winding Narrow Strips of Sheet Lead around a Taper Arbor

one may wish two separate laps on one arbor for lapping journals some distance apart, variations of hole size must be compensated for by the use of clay or some similar expedient. Another fault of the cast lead lap is its tendency to run dry and bind in the hole, unless carefully scored to provide oil channels over most of its surface. It also must be split if of any considerable size as compared to the arbor, or it will require too much of a blow on the arbor to expand it, if this be possible at all.

To reduce the work required to make a lap, and provide material which can always be worked up into a lap on short notice without casting and without the use of molds, keep a piece of sheet lead about 3/16 or 1/4 inch thick, or even thicker, on hand. Use the same taper arbor as for the cast lap, and place it between the centers in the lathe. Cut a strip from the sheet lead about ½ inch wide with the tin shears and fasten it to the arbor a little nearer to the small end than you wish the end of the lap to be, with a clamp or lathe dog, as shown in the illustration. Now wind the lead strip as tightly as possible upon the arbor in the same way that a helical spring would be wound, tapping the lead with a hammer to produce an impression of the spline, if a splined arbor is used. If one layer of the lead does not give a lap large enough to turn to the desired size, another layer can be wound over the first in the same direction, but beginning at the opposite end. This operation may be repeated until the desired diameter is obtained, after which it is often well to fuse the ends together with a soldering iron if the lap is very large. The whole can now be driven firmly onto the arbor and turned true and round in the lathe. The helical grooves left between the various convolutions of the strip serve admirably as channels for the proper distribution of the oil and emery, and this construction will be found more elastic and easily expanded than the conventional cast lap.

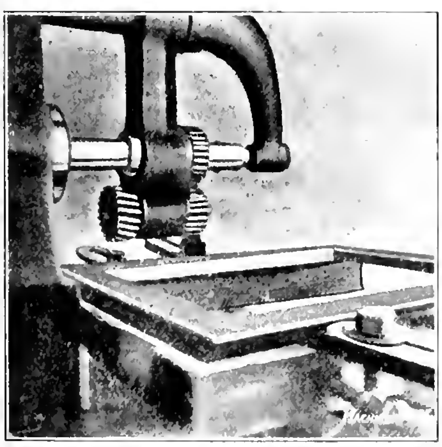
Needless to say, the lap must be run so that friction with the piece to be lapped will tend to wind the lead strip more tightly around the arbor; this proves quite an advantage rather than a disadvantage as it makes it possible to use an unsplined arbor without the constant danger of the lap slipping on it. On laps having but a single layer of lead it will be found desirable to reduce the diameter for an inch or so at the small end to prevent friction with the piece to be lapped, which would tend to unwind it. On laps of two or more layers this will not be necessary. HERBERT L. THOMPSON.

Elgin, Ill.

CORNERING TOOL FOR THE MILLING MACHINE

During periods of industrial depression a struggle for existing business is very naturally induced, which results in prices trimmed so close that there is little or no profit in handling the work. Business of this class, however, serves to keep together for future increase a force of men trained in some particular line of work, and for such purpose is self-justifying.

In an ambitious attempt to transfer some of this competition type of work into profitable business the "square cornering" tool, shown in the engraving, was evolved. We had a large number of flat castings 3/4 inch thick, with a rectangular opening 12 x 15 inches, the sides of which had to be machined straight and square with each other. As the speed of the cutters limited the time consumed in milling the sides, any reduction in manufacturing cost had to be made by cutting the time between, or rather after, these cuts had been taken. Therefore it was desirable to remove the sections left in the corners by the straddle mills as quickly as possible. The device by which this was done was simply an auxiliary arbor suspended below the regular arbor and driven by spur gearing. The castings were clamped on parallels, as in slotter work, and passed across the cutter by the elevating screw. This was a lighter task than would at first appear, for the weight of the knee formed a hold-back that permitted the work to be fed *into* the cutter, which, in turn, materially assisted in lifting the weight by its upward movement. This device turned out ten complete castings, or forty corners, in one hour, using a carbon steel cutter. DONALD A. HAMPSON.

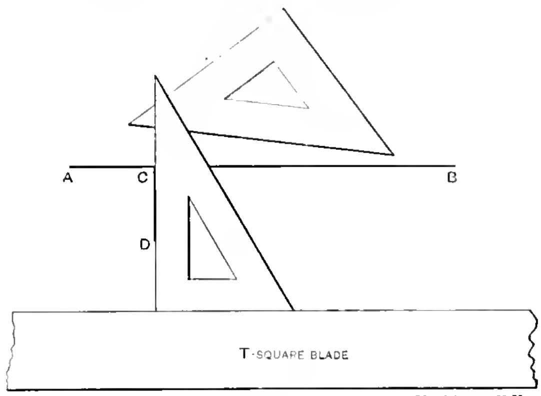


Cornering Tool attached to the Milling Machine and Example of its Work

Middletown, N. Y.

TO AVOID BLOTTING FRESH INK LINES

It sometimes becomes necessary for the draftsman to draw short vertical lines before the horizontal ink lines are dry, and it is impossible to lay the triangle on them without causing a blot. The lines can often be drawn by laying one triangle over the other, to lift it off the paper, as shown in the sketch, where the line $A—B$ is supposed to be a freshly inked line, and it is desired to draw the line $C—D$ without waiting for $A—B$ to dry. One triangle can be laid on the board just above $A—B$ with one edge approximately parallel to it. Then the upper end of another triangle can be laid over the first, its lower edge being guided by the T-square blade in the usual way. This lifts it clear of the line $A—B$, and $C—D$ can be drawn just about as well as though the triangle were flat on the paper. WALTER GRIBBEN.

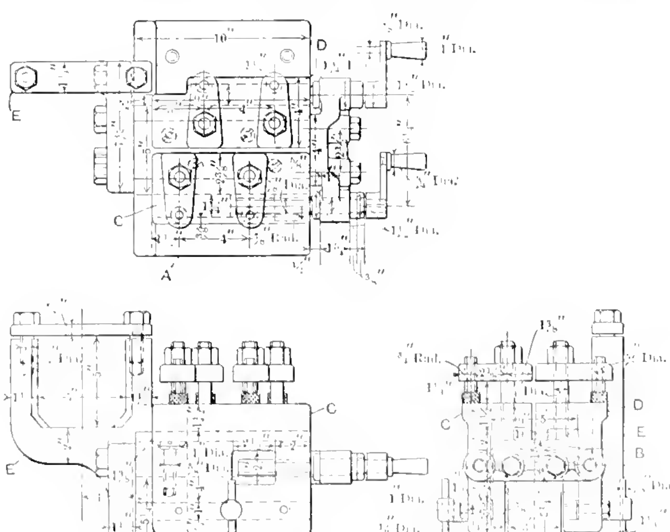


Method of using Triangles to avoid Blotting Fresh Ink Lines

Brooklyn, N. Y.

A SHAFT TURNING ATTACHMENT

We recently had to supply a three-tool rest for shaft turning which had to fit onto a lathe which was used for practically any job that came along, and as shafting seemed to come along pretty often, it was thought advisable to provide some means whereby this kind of work could be more economically dealt with. It was desired that the attachment be so designed that little time would be required in changing from shaft turning to ordinary work and *vice versa*. The device consists of a base A, which in operation is securely clamped to the cross-slide of the lathe; a slide B on which tool-holders C and D work, and a stay E which carries either metal or hard wood steadies for supporting the work. The slide B is made separate from the main casting



Shaft Turning Attachment for the Lathe

A so that the bearing surfaces may be more easily machined and scraped to fit. It will be seen that the tools come quite close together and yet plenty of room is left for the handles which work the screws for adjusting each tool.

In operation the ordinary tool rest of the lathe is moved to the back of the carriage and the two-tool rest mounted on the front. The back rest carries the roughing tool which is, of course, clamped with the cutting edge downward. The left-hand tool-holder of the attachment carries the first finishing tool, while the right-hand one carries the finishing tool proper. All three tools are under perfect control from the operator's working position in front of the lathe (the back tool is, of course, adjusted by the regular cross feed screw) and when the lathe is needed for work other than shaft turning, five minutes, at the most, is all that is required to dismount the shafting attachment.

I might say, in conclusion, that with this arrangement a feed of 1/32 inch per revolution of spindle leaves a fairly good finish which only needs polishing to meet ordinary requirements. A good stream of lubricant is required on the tools, particularly if high speed tools are used. RACQUET.

SWINGING INK-BOTTLE HOLDER FOR DRAWING TABLE

Experienced draftsmen know the risk in keeping the ink bottle on the drawing board, especially if it be a sloping board. Even when the bottle is fastened in a heavy base to avoid tipping over, it may slide off the board, or ink may be dropped on the surrounding board or paper when filling the pen, and anyway it is in the way and takes up space on the board. To avoid these difficulties, I designed and had applied to several drawing-tables the device shown in Fig. 1, which has been found very satisfactory and convenient. The line illustrations, Figs. 2 and 3, show the construction with certain improvements over the original design shown in the half-tone.

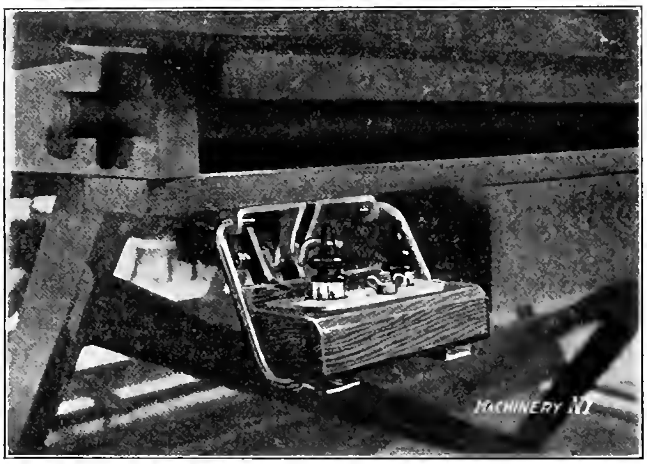


Fig. 1. Holder for Two Ink Bottles, which is easily swung out of the Way

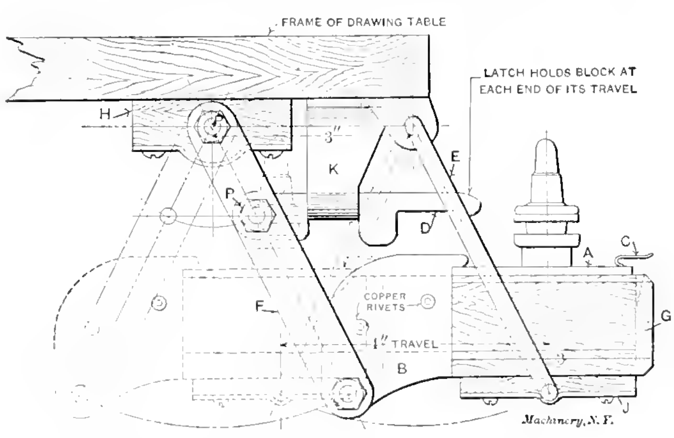


Fig. 2. Side Elevation of the Holder, showing the Inner and Outer Positions

The device illustrated may seem to have a great many parts, as compared, for instance, with a drawer, which is the first thing one would think of for the purpose; but a drawer on this folding drawing table would have been in the way, and a slide of ample length would have required more depth than was here available. This holder is located next to the left side of the draftsman, and in the half-tone it is shown pulled out, affording ready access to either of the two ink bottles which are locked fast in it, and requiring one hand only for removing the filling quill. The bottles may be quickly removed for changing or renewing, by unscrewing the one thumb-nut and removing the brass retaining-plate *A* (Fig. 2), the back edge of which slips into the recess in the wooden strip at the back. In the improved design this wooden strip is done away with, as is evident in the line drawing, ears being formed on the plates *B*, instead; also the thumb-nut and screw have been superseded by a spring clip, *C*, making it still easier to remove the bottles.

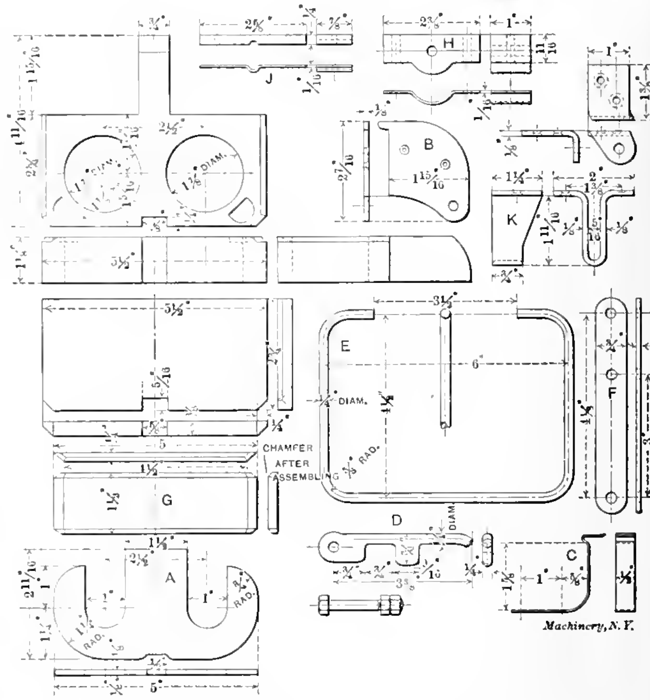


Fig. 3. Details of the Swinging Holder

After inking the pen, lifting the latch *D* with the tip of the finger enables the holder to be instantly pushed back out of the way; at the back end of the stroke the latch drops into place again and the swinging holder is retained there, entirely underneath the table and out of the way. The construction should be clear from the drawings, the marks or symbols used being the same in Figs. 2 and 3. The wooden parts of the holder are glued together, other fastening being afforded by the wood screws and the rivets indicated in the assembly drawing, Fig. 2. The portion of the drawing table to which the holder was attached is permanently horizontal, the drawing board, of variable slope, being pivoted above. Attachment was made by 8 wood screws; of course, if desired it could be all attached to a separate block, permitting, in the event of shipment, removal without disassembling.

Berkeley, Cal. H. J. KENNEDY.

HOSE COUPLING AND CLAMP

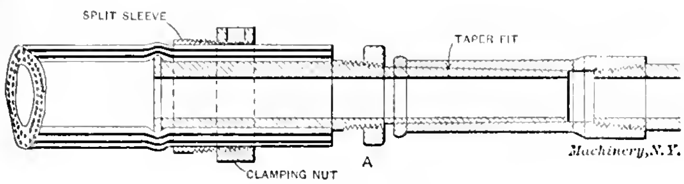
There are a great many different styles of hose couplings on the market, but still there seems to be room for improvement. No matter how careful the operators of pneumatic tools are, there is always a certain amount of time lost because couplings slip out of their hose or because the quick-adjusting types become disconnected. This trouble may be caused by poor construction and partly by rough handling.

The accompanying engraving shows a quick-adjusting hose coupling and also a hose clamp, that are giving satisfaction.

This coupling has a taper of 1/32 of an inch in 3 inches, which is very gradual, and when the parts are connected with a quick jar the taper "bites" so that they seldom come apart. When the coupling is to be disconnected, the parts are twisted by placing a wrench on the nut *A* provided for

that purpose. This takes time, but it is well spent as most couplings that can be taken apart by hand are generally leaky or very liable to come apart with the pressure on, and possibly cause an accident.

The hose clamp shown, is made of brass tubing. It has a 16-pitch taper thread cut on it and is split with a hack-saw in about six places. A knurled nut is also provided which is drilled for a round spanner, for tightening. As the nut is screwed on the taper thread, the tube takes a firm grip on the hose, which, in turn, is compressed against the inside connection or coupling.



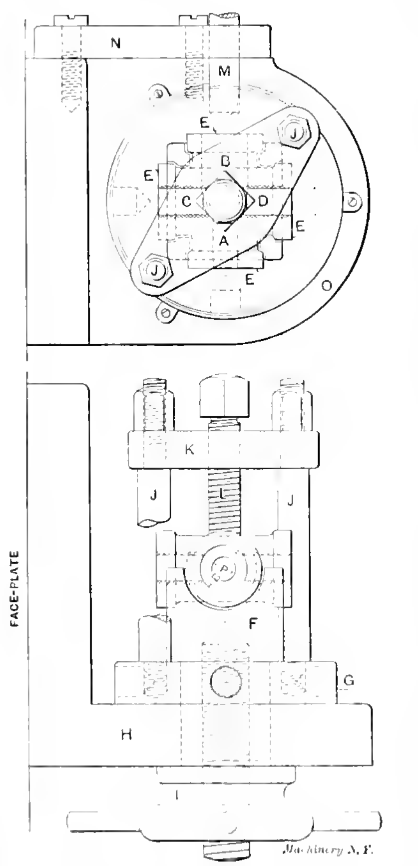
Simple Form of Hose Coupling for the Air Hose

This clamp has no extending parts such as screws, bolts or lugs which are usually found in hose clamps, to catch, as the operator pulls or drags the hose along the floor or ground. The hose couplings on one end are either made to screw on a nipple or be clamped in a hose. It will be found quite profitable in a large works to have patterns made and then cast the parts of brass as the occasion demands, rather than to buy and experiment with couplings of various kinds.

R. S. F.

TURRET LATHE FIXTURE WITH INDEXING ATTACHMENT

In the accompanying engraving is shown a fixture for facing, drilling and tapping the knuckle in a universal joint. This fixture, when in use, is mounted on the face-plate of a turret lathe, and with it the several operations are done very rapidly and at one setting of the work. These knuckles must be interchangeable, as they are used for repairs. They are made of malleable iron, and it is necessary to face the four sides *E*, drill holes 3/8 and 9/16 inch in diameter at *A* and *B*, respectively, and drill and tap the holes *C* and *D*. The castings are located in the fixture in the correct position by the holder *F*, the top surface of which is made to conform to the four flanges, there being clearance for the body of the casting. The holder *F* is made a press fit in the steel ring *G*, and the protruding end is made a sliding fit in the angle-iron *H*. Tapped into *F* is a stud on which the clamping-wheel *I* is mounted. Two tie-rods *J* are screwed into the plate *G*, and at the ends of these rods there is a strap *K* through which passes the clamping screw *L*. In the ring *G* four holes are drilled to receive the index pin *M* which is mounted in the arm *N*. This pin is held in place by a spring not shown. In the illustration the fixture is shown with the work in place, machined and ready to be taken out, which is done by simply releasing the clamping screw *L*. The changes are made for the different holes by releasing the clamp-nut *I* and withdrawing the index pin, after which the work can be turned to the desired position, the index pin locating the chuck while it is being clamped by the nut *I*. To prevent any dirt or chips from working into the index holes, a band of brass *O*, having a hole for the index pin, is placed around the ring *G* and fastened to the angle-iron. This fixture can be used for more than one class of work, as the holder *F* can be removed and replaced with one of a different shape and size.



Fixture for Universal Joint Knuckles

C. A.

OBTAINING DIAMETERS WITH A BEVEL AND SCALE

That diameters may be obtained by the use of an ordinary bevel and scale, is perhaps not as well known as the advantage of this method merits. Of course, these tools are only used when it is impossible to caliper the piece, as would be the case were it necessary to determine the radius of the cylindrical surface shown in Fig. 1. In order to obtain a diameter with the above tools, the bevel must be set to a certain angle previously determined, which corresponds to the graduations on the scale; then the diameter can be read directly from the scale. For example, if the bevel is set to an included angle of 125½ degrees, as illustrated in Fig. 2, and the distance x from the surface to the apex of the angle is measured with a scale, as shown in Fig. 1, the diameter may be readily determined, for it will contain as many inches as there are sixteenths of an inch in the distance x. Thus, if x equals ¼ inch, which is equivalent to four sixteenths, the diameter would equal 4 inches. When the bevel is set to 140½ degrees, each 1/32 inch represents an inch of diameter; 142¾ degrees, each 1/10 inch; 106¼ degrees, each ⅛ inch; 83⅝ degrees, each ¼ inch; 60 degrees, each ½ inch.

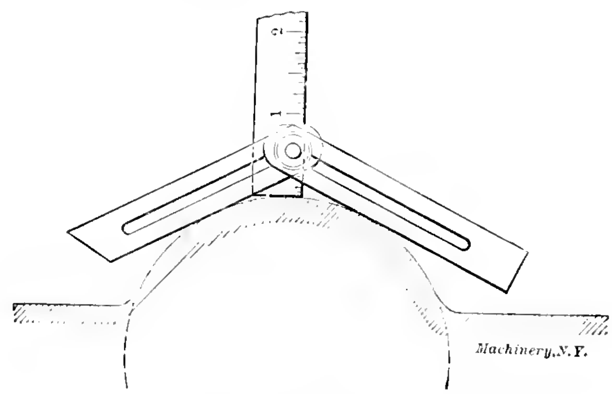


Fig. 1. Method of applying Bevel and Scale to Work which cannot be Calipered

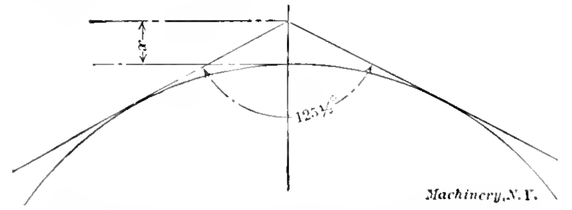


Fig. 2. When the Bevel is set to the Angle shown, each 1-16 inch in the Dimension x is equivalent to 1 inch of Diameter

It will be noticed that the less the angle the greater the distance representing inches becomes, and consequently the smaller the range of diameters which can be obtained. Thus, if the angle is set at 60 degrees, each half inch on the scale will represent an inch of diameter, and accurate fractional diameters can be obtained; but with this angle a large diameter could not be measured, and it would be necessary to use the bevel set at a greater angle.

A carpenter's square can also be used to obtain the same results, but a little calculation is necessary to get the diameter. After measuring the distance x with a scale, as explained, it must be multiplied by 4.83 in each case where an included angle of 90 degrees is used. Thus, if the distance measured 4 13/16 inches, the decimal equivalent to 13/16 should first be found, and the number 4.812 multiplied by the constant 4.83. The result would be 23.242 inches, which represents the diameter. As before stated, this method is

intended to be applied to inaccessible diameters, but it can often be used to advantage for measuring pulleys, etc., which are too large to permit the use of calipers.

C. E. J.

LARGE COMPACT DRAWING-BOARD

At the present time many shops are figuring on propositions which require large layouts, and the ordinary drawing-boards are far too small; yet conditions do not warrant the purchase of a large outfit or perhaps there is no room avail-

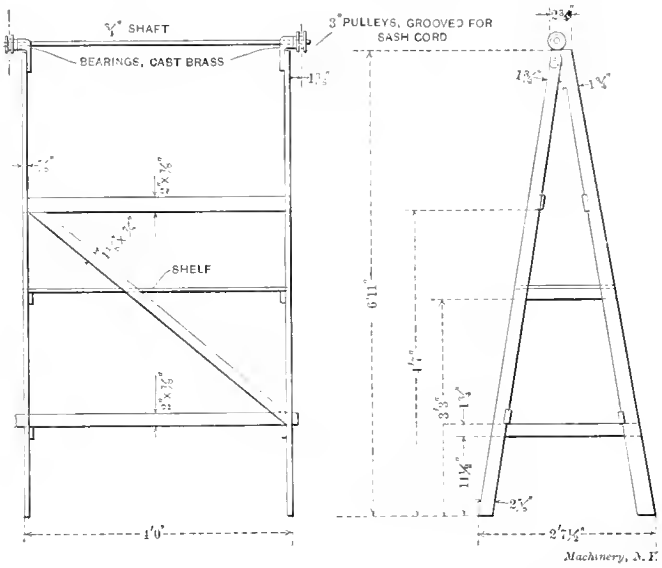


Fig. 1. Elevations of the Drawing-board Frame or Easel

able, and to meet the conditions requiring large capacity and minimum floor space, the board here shown has been built. It proved so useful that a second one was asked for and both are now in constant use. The frame, or easel, as artists would term it, is shown in Fig. 1. Only general dimensions are given, for such details as placing screws and making joints can be decided by the workman. The shaft, pulleys, and bearings, shown at the top, carry the counterweights needed to balance the drawing-board. Fig. 2 shows the general dimensions of the board and straight-edge. The board is built of 7/8-inch stock in the usual manner, with a brace at each end and one in the middle. The end braces also act as

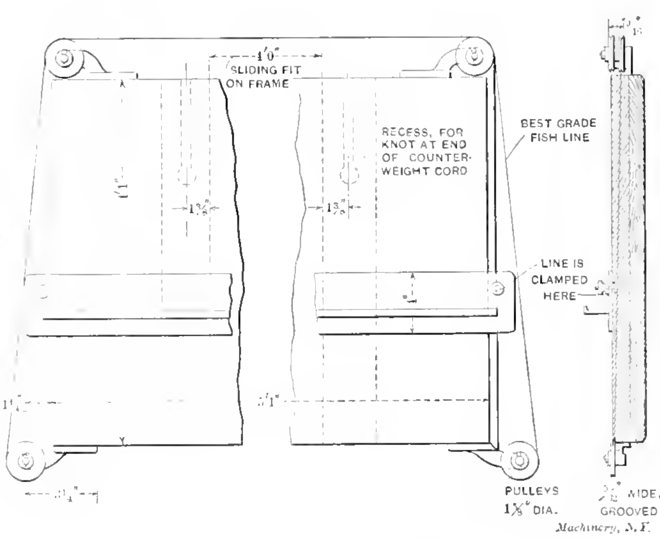


Fig. 2. Detail of the Drawing-board and Straight-edge

guides, their centers coming in line with the center line of the pulleys on the shaft shown in Fig. 1. A 25-pound window-weight at each end serves as a counter-balance for the board which is thus easily raised or lowered.

The straight-edge requires care in making, as both the upper and lower edges should be parallel. The projecting shelf is intended primarily as a brace but it is also very handy for holding tools. By means of the line and small pulleys, shown in Figs. 2 and 3, the straight-edge is moved and kept in a parallel position at every point, the line being clamped at each end of the straight-edge by a brass screw and nut. The straight-edge is counterbalanced by a weight of cold-rolled steel hung from a cord attached just above the brass clamping nut.

The material used was as follows: 25 feet of pine, 15 feet of white wood, 2 pounds of brass used in the small pulleys and bearings, 53 pounds of cast iron in the drawing-board counter-weights and large pulleys, 4 pounds of cold-rolled steel 1 inch in diameter for the straight-edge counter-weights, 7 pounds of cold-rolled steel 3/4 inch in diameter for the shaft at the top of the frame, 25 feet of window cord, 35 feet of best quality fish line, and 3 dozen wood screws.

The time required to build this board depends, of course, on the skill of the workman. About 25 hours seems to be a good average time, a large part of which is spent in gluing the board. Foreign engineers say that this type of board is very generally used in Europe, and while at first sight a designer will usually disapprove of a vertical board, a few hours trial will prove its merits.

RALPH W. DAVIS.

Rochester, N. Y.

TOOL-ROOM CHECK SYSTEMS

I have read with considerable interest the articles dealing with checking systems for tool-rooms which appeared in the numbers of March, May and July. The various systems which were mentioned each has its merits and its defects as will any system, for keeping account of tools or supplies of any kind, which depends upon human care and intelligence for its operation. The efficiency of the system will also vary directly with the quality of the care and intelligence employed.

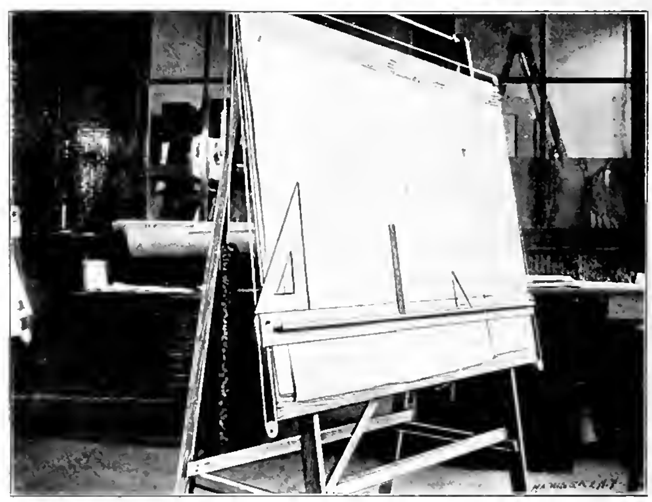


Fig. 3. Compact Drawing Board having Independent Vertical Adjustments for Board and Straight-edge

It is not my intention to put forth a better method of checking tools taken from the tool-rooms, but merely to call attention to another method which has recently come to my notice and is in operation and giving satisfaction in a large railroad shop in the East. This system consists of giving the checks to the tools instead of to the men, and it is operated as follows: A board large enough to accommodate the names of all the men who are to be served with tools, is placed in the tool-room in a location convenient to the man in charge of the distribution of the tools. Opposite each name is a hook upon which the checks are hung. The tools are numbered and the checks are also numbered to correspond. When, for example, John Jones calls for a 1-inch reamer which is number 27, the reamer is taken from its case and the check number 27, which is on a hook at the side of the case, is hung on the hook opposite John Jones' name on the board. Upon the return of the reamer the operation is reversed. The shop in which this system is in use, adopted it to overcome the trouble that was being experienced by the men losing checks and to put the prosperous check-borrow sharks out of business.

I am of the opinion that the system could be improved by supplying each man with a certain number of checks, keeping them upon a hook opposite his name on the board and exchanging one of these checks with the tool check when a tool

was taken out. This would be practically a debit and credit system of checking. Another road which uses the system of giving the checks to the men, provides for their loss by placing a value of 25 cents upon each check and deducting this amount from the man's wages for each check that is lost.

Chicago, Ill. G. E. RYDER.

The following system for keeping a record of the tools which the workmen use and which are regularly kept in the tool-room, will be found to give entire satisfaction, both to the workmen and management. It consists of two boards, each with a number of hooks equal to the number of workmen to be served. The hooks are numbered in consecutive order. On one board which is the *in* board, a number of tool checks are hung on each hook; in this case ten. The other board is the *out* board. The system operates as follows:

Every workman, when employed, receives an identification number corresponding to his number on the time recorder. Every tool kept in the tool-room is identified by a small pasteboard check, which is kept with the respective tool. Now if a workman desires a tool he presents his identification number at the receiving window. The tool-keeper hands out the tool, transfers the tool check corresponding to the number of the workman from the *in* board to the *out* board, and on the same hook hangs the check identifying the tool. It is very obvious that, through this simple system the tool-keeper is always able to tell what tools are out, and who is using them. By keeping the tool checks in the tool-room none are lost, or carried away. When a man quits, or is discharged, he must present a receipt from the tool-keeper to the timekeeper, showing that his account with the former department is in order, before he can receive his pay. This system is very easy to install and requires but little effort to operate.

Peoria, Ill. JOHN M. KUPEL.

SIMPLE FIXTURES FOR MAKING WORMS AND WORM GEARS

In Figs. 1 and 2, at *A* and *B*, respectively, are shown a single thread brass worm and a worm gear which were made in the fixtures also shown in these illustrations. As the requirements did not demand great accuracy, the worms were turned in a screw machine and the threads cut on a hand milling machine, while the gears were punched out of flat stock and then hobbed.

The thread milling fixture (Fig. 1) has a plain block of machine steel through which a hole is bored which will just admit the worms. A part of the top of the block is removed, so that the periphery of the worm is exposed, as shown. The end view shows that the worm is held true from all sides by the walls of this block. The mandrel *E* is fitted so that it

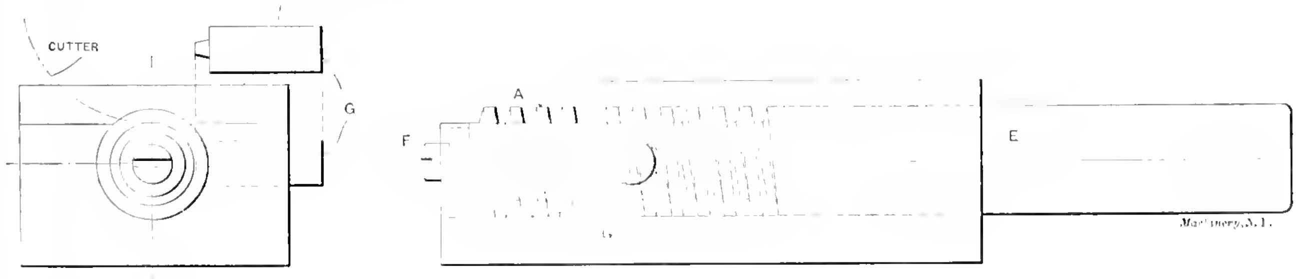


Fig. 1. Fixture for Milling Small Worms

turns snugly in the hole already mentioned. In one end of the mandrel a hole is tapped to receive the screw *F*, which holds the worm firmly against the end of the mandrel. On the mandrel a thread is cut, as shown, with the same pitch as that required for the worm. Instead of the nut ordinarily used on such fixtures, a plain key *G* is used. One end of this key is filed to fit into the thread on the mandrel, the sides of the tongue being left flat. It is hardened and driven into position in the block. In the illustration the pin is seen to extend from the block. This exposed end can be gripped in a vise if necessary to adjust the tongue properly into the thread on the mandrel.

An ordinary lathe dog is used to turn the mandrel in the block and feed the worm against the cutter. If, when the cutter comes into contact with the work, the worm tends to turn, such tendency is checked by the screw in the end of the mandrel, which tightens.

The cutter is ground to the standard 29-degree angle for the job. As the milling machine with which this fixture is used, has a hand lever to move the table, it is easy to bring the work up to the cutter. The table is held against a stop while the thread is being milled.

Before hobbing, the gears are gashed on the milling machine already mentioned, in lots on a special mandrel. The hob-

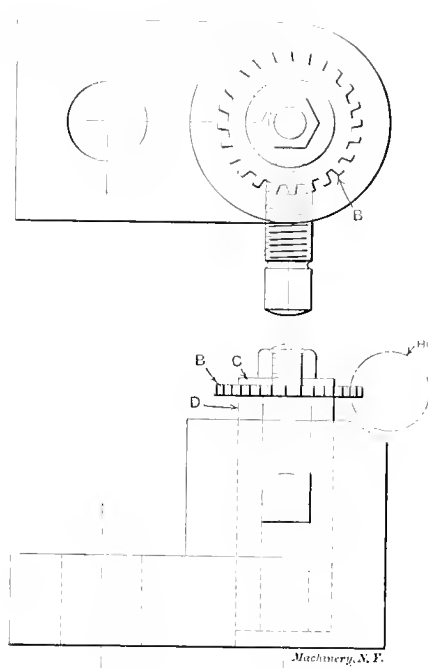


Fig. 2. Fixture for Hobbing Small Worm Wheels in the Lathe

bing fixture is shown in Fig. 2. The body is of cast iron and is made of a discarded punch holder. Into this body is fitted a post, *D*. This post has a vertical adjustment, and it is held by the set-screw shown. On the top of the post there is a shoulder on which the gear is placed for hobbing. The washer *C* is held tight against a second shoulder by the nut shown. Just enough clearance is allowed to permit the gear to turn when it is driven by the hob. The hob is used on the centers of a small lathe and is driven by an ordinary lathe dog. The hobbing fixture is mounted on the cross-slide from which the tool-post has been removed.

It was found necessary to aid the hob by turning the gear with the thumb when beginning the cut, but after the gear had made one turn, the hob finished the work without further assistance. The gear was advanced toward the cutter by turning the cross-slide feed-screw. HERBERT C. BARNES.

Brooklyn, N. Y.

* * *

A side light on methods of computing charges for job work that may be useful is the practice followed by a country printer: For composition he charges two times the labor cost; for press work two times the labor cost plus 25 per cent; for illustrations, paper, etc., the charge is the cost plus 10 per cent; and all other work involving labor is charged two times the cost and 10 per cent.

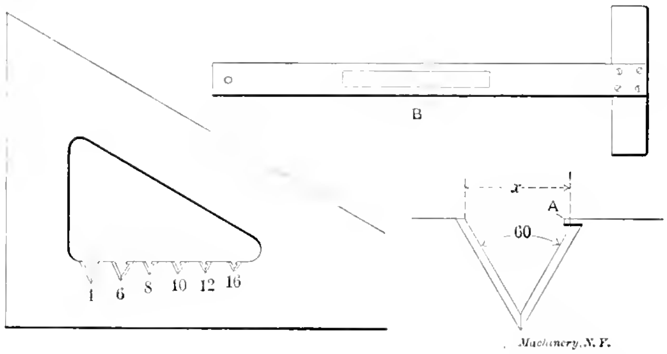
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

DRAWING OF V-THREADS

I found the drawing of V-threads to be very trying until I thought of the following scheme which makes this work much easier. The idea is as follows: File a number of 60-degree notches in the inner edge of the triangle, as shown in the illustration, for different thread pitches. Make the top width x equal to 1 divided by the number of threads per inch, and leave a small point A to stop the pencil. To use the triangle,

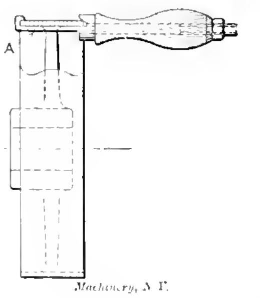


place the pencil against the left side of the notch and run it down that side and up the other to the stop; then move the triangle to the right until the pencil is again against the left side. By repeating this operation as many times as is required, a uniform thread can be rapidly drawn. Another suggestion for draftsmen is to have a 12-inch scale fastened to the T-square as shown at B. This is also a time-saver, as the scale is in a position where it is always ready for use.

Plainfield, N. J. JOSEPH WEANER.

REMOVABLE PULLEY HANDLE

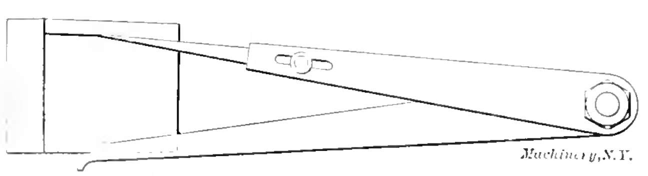
When a new machine is being built it is often necessary to revolve the feed or other pulleys by hand in order to observe the working of the machine. The removable handle shown in the engraving is extremely useful, as it may be attached to the rim of the pulley which is to be turned, thereby making the operation easy. The hook-bolt A passes under or over the pulley rim and through the handle, and is secured by a nut, as shown. The bolt is made long enough to suit various widths of rims and the ferrule is notched to grip different thicknesses. For pulleys with flanges another type of handle may be used in which a hoop-iron strap passes around the rim of the pulley, the handle being attached to the hoop iron.



BRUM.

NEW STYLE OF HERMAPHRODITE CALIPERS

The illustration shows a pair of hermaphrodite calipers, which seems to me to be an improvement, at least for a large class of work, over the style generally used. As will be seen the notch in the end of the caliper leg makes it much

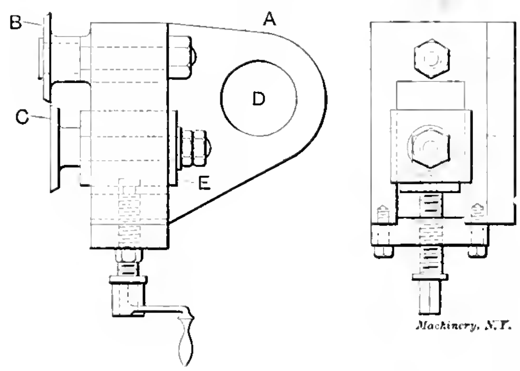


easier to scribe a line parallel with a finished edge, since the point of contact which this leg makes with the finished surface as the calipers are drawn along, is kept the same. The curved extension will also be found useful in laying out work.

Dayton, Ohio. J. L. MARSHALL.

TOOL FOR TRIMMING THIN TUBING

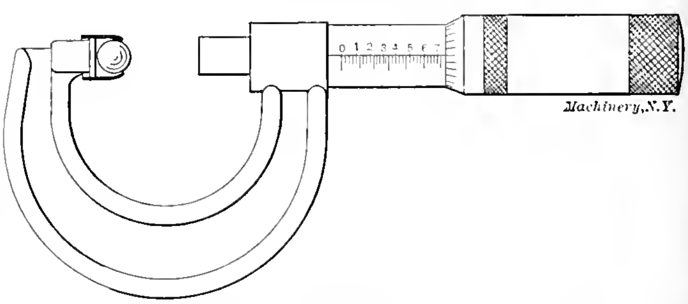
We had a number of large, drawn steel shells of about 26 gage, that had to have the ends trimmed. The metal was too thin to permit the use of a single cutting tool in the lathe, so a tool similar to the one illustrated herewith was made. It consists of a cast iron frame A, and two cylindrical cutters



B and C. The hole D through the casting A fits the tool-post of the lathe, and the fixture is clamped by passing a piece of steel through the tool-post and tightening it against the casting. Cutter B is free to revolve on a fixed stud, while cutter C is carried in a sliding box E, thus permitting it to be fed in toward B by the handle shown. When trimming the end of a tube the tool is set so that the cutter B just touches the inner side of the shell. Cutter C is then fed against the outside, and the tool makes a clean smooth cut. W. ALTON.

A MICROMETER ATTACHMENT

The engraving shows an ordinary micrometer with an attachment for measuring the thickness of metal shells or other irregular pieces of metal. A piece of brass tubing is reamed out to make a sliding fit on the anvil of the micrometer.

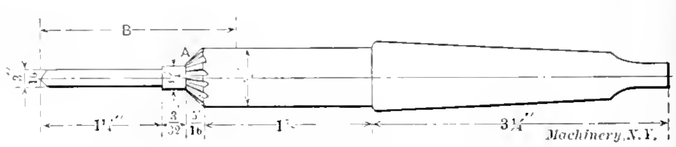


This tubing holds loosely a 1/4-inch bicycle ball, which extends beyond the end of the tube, the latter being bent over to prevent the ball from falling out. The reading, of course, will be taken from the 0.250 inch graduation as zero. Bicycle balls of this size are true to 0.0001 of an inch.

Candiac, Canada S. A. McDONALD.

HARDENING A SMALL DRILL AND COUNTER-SINK

The combination drill, counterbore, and counter-sink shown in the illustration had, of course, to be hardened. This was rather a ticklish job as the drill is so much smaller than the counter-sink, that hardening it in the usual way would mean that the drill would be at a white heat before the large part would be cherry red. To overcome this difficulty, I obtained



a fair-sized raw potato and pressed it onto the drill up to the part marked A. The tool was then placed in a slow fire and the 5/8-inch part heated, the water in the potato keeping the small part cool. When the counter-sink was heated sufficiently, the potato was removed, thus allowing the heat to run from the large part to the drill. When all was an even cherry red, the tool was cooled and the hardening was accomplished without any difficulty. JOSEPH WEANER.

Plainfield, N. J.

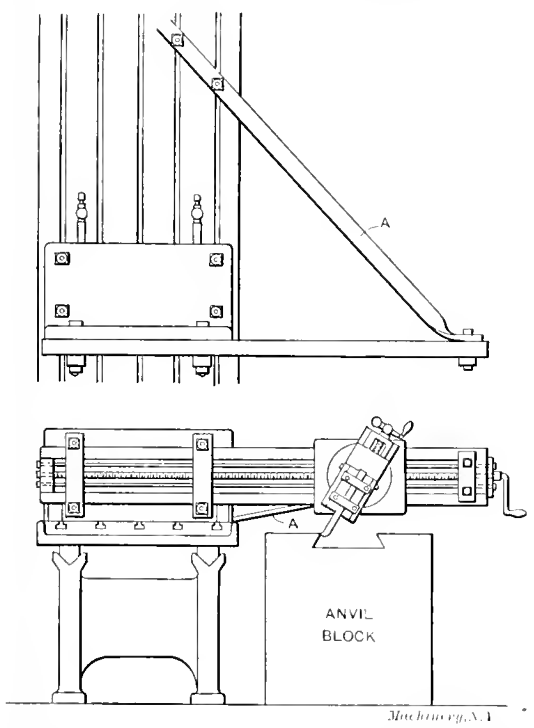
TO OBTAIN THE LENGTH OF STOCK FOR BANDS

A machinist was trying to shrink a band around the hub of a cracked pulley. He first measured the diameter of the hub and multiplied it by 3.1416 to get the circumference. The blacksmith was then told to cut off a piece of 1/4-inch steel stock equal to the length of the circumference of the hub. When the band was formed to the diameter of the hub, the ends were 3/4 inch apart; that is to say, they did not come together by that amount. The machinist could not understand how he had made the mistake. By the use of the following rule, trouble of this kind will be avoided: Multiply the diameter of the hub by 3.1416 and to the product add 3 times the thickness of the metal used for the band. JOSEPH WEANER.

Plainfield, N. J.

PLANING WORK THAT IS TOO LARGE FOR THE PLANER

The accompanying line engraving shows how a steam-hammer anvil-block that was too large to go on the planer, was machined. The block was first leveled up on the floor beside the planer, so that the top of the casting was a little below the top of the planer platen. For safety the casting was clamped to the floor, although its weight was such that there was no great danger of its moving under the thrust of the cut. The cross-rail with the attached head was then removed and clamped securely to a heavy angle-plate, which was bolted to the platen. A substantial diagonal brace A was then fastened to the cross-rail and platen as shown. The tool was fed, of course, by hand, and the dove-tail for the dies was planed by the use of the adjustable head in the usual manner. The job was satisfactory in every way and caused considerable comment in the shop. FREDERICK SEABURY.



Chicago, Ill.

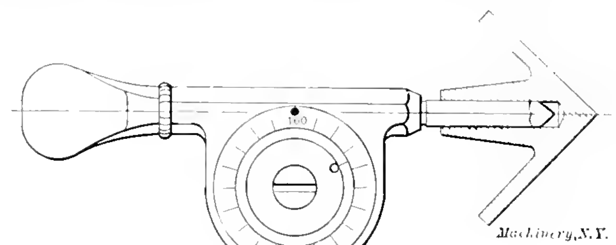
SUBSTITUTE FOR METAL WHEN MAKING ACCURATE LAY-OUTS

When making accurate lay-outs on metals, such as brass or zinc, to avoid troublesome and time-consuming calculations, I find the following objections: The needles of the drawing instruments become dull; the lines cannot be erased, and they are not very plain, especially if the metal is not coated or prepared in some manner; and the metal cannot be fastened or worked upon as easily as paper. To overcome these objections I have used as a substitute for metal what is known as filler board. This is a kind of heavy paper which looks somewhat like leather and has a mottled surface. It is often used for covers on cheap memorandum books, and is about 1/32 of an inch thick. Before lines are drawn on the surface of this board, the gloss should be removed with an eraser. The board has a good, firm body, and therefore a fine center can be made in it from which several circles can be drawn without appreciably enlarging or injuring it. Like other materials in the paper line, filler board will change slightly on account of variations in the temperature and atmosphere, and for this reason the measurements should be marked on the drawing as soon as it is made to avoid any possibility of slight errors due to changes. Where extreme accuracy is required and the nature of the lay-out is such that measurements cannot be marked to advantage, metal is advisable, especially if the drawing is to be kept for a considerable length of time as a record or for reference. H. R. ASH.

Chicago, Ill.

SPEED INDICATOR ATTACHMENT FOR SCREW MACHINE

It was necessary to determine the spindle speeds of a large number of screw machines which were operating on a wide variety of work, ranging from 1/4 to 1 3/4 inch in diameter, and it was desired to get the speeds more accurate than would be possible by simple measuring pulleys and calculating the speeds from the speed of the line-shaft. The following method

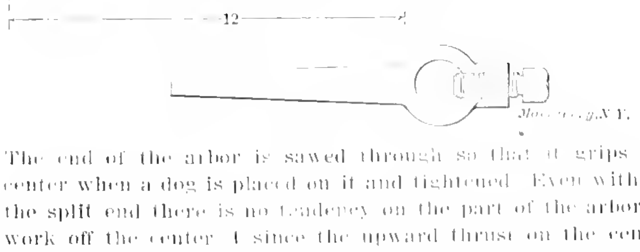


was tried with satisfactory results. An ordinary speed indicator was fitted with a brass conical tip 2 inches in diameter, as shown in the illustration. This tip was made a tight fit on the indicator spindle and was turned out to reduce the weight. To keep the indicator from slipping, three grooves 1/16-inch deep were cut radially in the conical surface and pieces of rubber peened in. In order to secure satisfactory results the indicator should be used when the feed tube is nearly empty, or just after the stock has fed into the tube; then the tip of the indicator will center in the tube and the correct spindle speed is easily taken. In this way accurate results are obtained, because there is no error due to slip of belt or variation in size of pulleys. By watching a group of machines and taking the speeds as the stock runs out, the time consumed is not as great as with the usual method of measuring pulleys and figuring from the line-shaft speed.

Indianapolis, Ind. C. C. MYERS.

ARBOR FOR SHELL REAMER

The engraving shows an arbor for a shell reamer, which is so designed that it will not creep off of the tail center and crowd into the work, as is the case when the arbor is held directly against a cone center. This arbor has a hole drilled in the end about 1 1/4 inch deep in which is fitted a special tail center A, having a straight portion about 1 inch long.



The end of the arbor is sawed through so that it grips the center when a dog is placed on it and tightened. Even without the split end there is no tendency on the part of the arbor to work off the center A since the upward thrust on the center (equal to the downward thrust on tail of the dog) has no horizontal component. There is also a special straight tailed dog to go with the arbor, but this is not really necessary. The diameters of the holes in ends of all arbors are made the same. Since adopting this form I have had no difficulty with bent arbors, broken centers, broken shell reamers and inaccurate holes. W. A. KNIGHT.

Columbus, O.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

DESIGN OF MACHINE LEGS

C. E. F.—Is the design of machine legs based on empirical rules or theoretical assumptions? I have given the matter considerable thought and have been unable to arrive at any definite conclusion from a study of existing designs.

A.—It is generally conceded that design of machine legs which shall have a pleasing appearance and fulfill their purpose is one of the most difficult parts of machine design. There are no empirical rules of general application or theory of design that provides for grace of outline as well as proper support. The function of the legs should be that of supporting the machine and transmitting its vibrations to the foundation, especially in the case of machine tools. The tendency of modern design is to eliminate the legs entirely and carry the frame to the floor or foundation. This form avoids the troublesome feature of proper leg design and increases the solidity and rigidity of the frame by deepening it and more closely associating it with the foundation.

ANNEALING AIR-HARDENING STEEL

F. T. M.—I would like a reliable method of annealing air-hardening steel so that I can drill holes about 3/32 inch diameter 2½ inches deep, and tap same to a depth of about ½ inch. The brands of steel that I have tried are refractory, and it has been found impossible to anneal them so that the drills will stand up. I have tried a certain brand of high-speed steel drill but the results are about the same as with regular drills.

A.—We are unable to suggest any but the well-known method of annealing air-hardening steel by using air-tight receptacles in which the steel is packed with lime, sand, ashes or other neutral material; and heating the box and contents to a full red heat for a number of hours, depending on the size of the box and stock, and allowing the whole to cool down slowly. The question is referred to the readers for answers and suggestions. Many, no doubt, will highly appreciate a description of a method of annealing air-hardening and high-speed steel that is superior to the common method in use.

CUTTING SPEEDS

F. W.—Please state the proper cutting speeds for both carbon and high-speed steel tools, cutting tool steel, machine steel, cast iron and brass, in different machines.

A.—The proper cutting speed depends on several factors besides the kind of material to be cut and the kind of steel used for the cutting tool. The depth of the cut, the feed, and whether roughing or finishing, also influence the cutting speed. For general purposes the table above, however, referring to regular carbon tool steels, will be found to give figures representing good average practice. For high-speed steel tools these speeds may be at least doubled. The Cleveland Twist Drill Co. recommends for high-speed steel drills a cutting speed of 50 to 70 feet per minute for machine steel; 60 to 80 feet per minute for cast iron; and 100 to 140 feet per minute for brass, when starting the drill. When a few holes have been drilled at these speeds, still higher speeds may be employed, as the drill point is then heated and high-speed steel tools have a higher cutting capacity when heated than when cold. At the W. G. Armstrong, Whitworth & Co. works of Manchester, Eng., a cutting speed as high as 160 feet per minute for turning machine steel and 150 feet per minute for milling machine steel with high-speed steel tools and cutters, has been employed successfully.

TABLE OF CUTTING SPEEDS IN FEET PER MINUTE

Carbon Steel Tools

Machine	Material			
	Tool Steel, Annealed	Wrought Iron and Mch. Steel	Cast Iron	Brass
Lathe, planer and shaper...	18 to 25	30 to 40	40 to 50	80 to 125
Milling machine..........	25 to 35	35 to 45	40 to 60	80 to 120
Drill press..............	20	30	35	60

A PROBLEM INVOLVING MOMENTS OF FORCES

B. R. E.—A window cleaner sets an eight-foot ladder weighing twenty pounds against a plate glass window with the foot of the ladder two feet from the plane of the window glass, and climbs to a height of three-fourths of the ladder's height. If he weighs 150 pounds, what is the horizontal pressure against the glass window when he stands erect without touching the glass?

A.—In the accompanying illustration, AB represents the ladder, the length of which is 8 feet; BC is the plate glass window; the lower end A of the ladder is placed 2 feet from the plane of the window. Four forces act on the ladder, *viz.:* the reaction P at the upper end, at right angles to the window plane; the weight W of the window cleaner, acting vertically downward at a point three-fourths of the ladder's height from the ground; the weight W_1 of the ladder, concentrated at its center and acting vertically downward; and the reaction R at the foot of the ladder acting vertically upward.

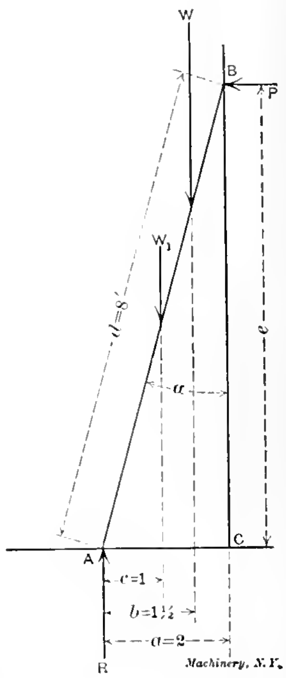


Diagram showing Forces Acting on Ladder

In order to arrive at a universal formula, let the various dimensions be represented by a, b, c and d, as shown in the illustration. To find P, find the moments of the forces relative to point A. The moment of force R relative to this point $= 0$. Hence, the moments of W and W_1 must balance or equal the moment of P. Therefore:

$$Wb + W_1c = Pe.$$

But $e = a \cot \alpha$; consequently

$$Wb + W_1c = Pa \cot \alpha,$$

or

$$P = \frac{Wb + W_1c}{a \cot \alpha} = \frac{Wb + W_1c}{a} \tan \alpha.$$

If we now insert the given values for the various quantities, we have:

$$P = \frac{150 \times 1\frac{1}{2} + 20 \times 1}{2} \tan \alpha = 122.5 \tan \alpha.$$

As $\sin \alpha = \frac{2}{8} = 0.25$, $\alpha = 14° 29'$. Tan α, then, is 0.25831, and

$$P = 122.5 \times 0.25831 = 31.64 \text{ pounds}.$$

This is the pressure due to the combined weight of the window cleaner and ladder, tending to break the glass.

* * *

It frequently happens that a babbitt-metal is required intermediate between the well-known genuine mixture and the cheapest grade in which nothing but lead and antimony is used. As the market price of tin is always high, genuine babbitt is often too expensive for many consumers to employ. The following mixture, given in the *Brass World*, will serve in instances where an intermediate grade is desired:

Lead	50 pounds
Tin	35 pounds
Antimony	15 pounds

This mixture has the advantage of containing no copper, and, therefore, is easily made in an iron kettle. It is not only intermediate in quality but in price as well. It is better than the lead and antimony mixtures, and is only slightly inferior to genuine babbitt. Many large machine builders now use it with good results where genuine babbitt was formerly employed.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

LE BLOND HEAVY-DUTY ENGINE LATHE

The accompanying illustrations show a general view and details of a 20-inch heavy-duty engine lathe recently placed on the market by the R. K. LeBlond Machine Tool Co., 4609 Eastern Ave., Cincinnati, Ohio. This is one size of a line of lathes of the same type, including 16-inch, 20-inch, 24-inch and 30-inch lathes. The principle on which these machines have been designed has been to furnish a tool capable of taking a given cut and removing a given number of cubic inches of metal per minute. The 20-inch lathe shown in Fig 1, for example, is capable of taking a cut ¼ inch deep with a feed of 1/6 inch at a cutting speed of 65 feet per minute, in 50-point carbon steel. This is equal to removing 32 cubic inches of metal per minute. While the new ideas incorporated in the design of this new line of lathes do not involve radical departures from the company's previous designs, an effort has been made to increase the productive capacity of the machine in all respects. At the same time, the manufacturers have aimed to produce a machine without complicated detail arrangements, so that it would be easily operated, and remain rigid even under heavy stress.

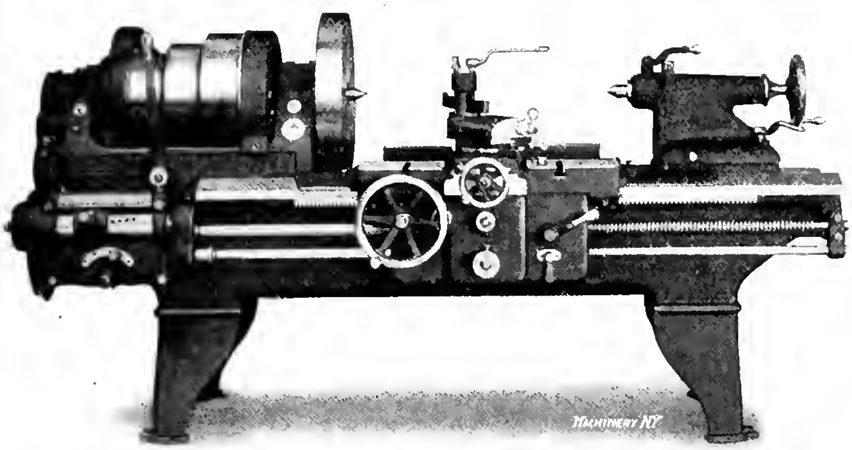


Fig. 1. R. K. Le Blond Machine Tool Co.'s 20-inch Heavy-duty Engine Lathe

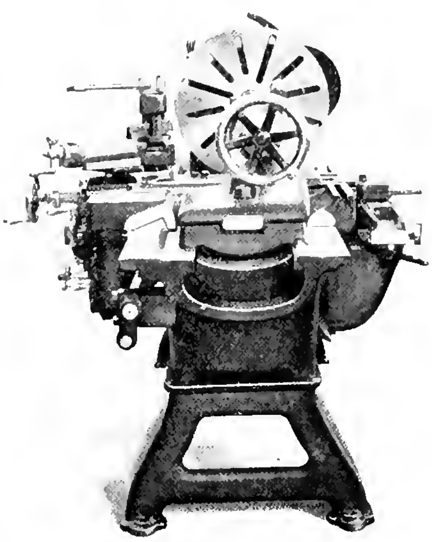


Fig. 2. End View of Lathe

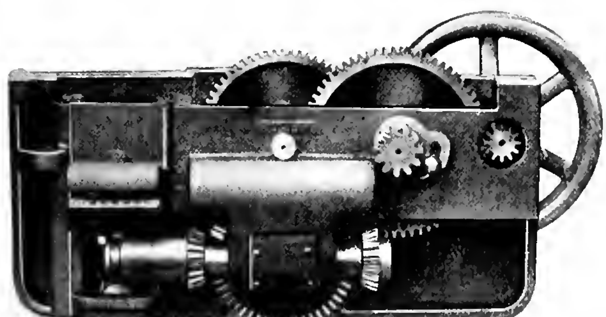


Fig. 3. View of Apron, showing Construction

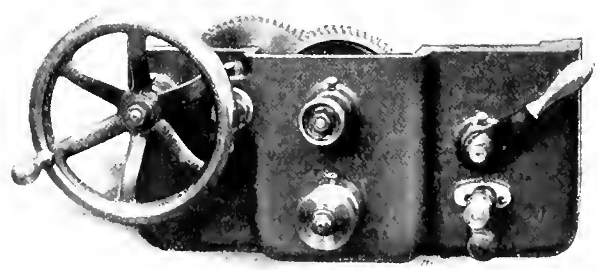


Fig. 4. Front View of Apron

The Head-stock and Tail-stock

The head-stock is of the LeBlond improved drop braced pattern and is securely fastened to the bed with bolts of large size. The three-step cone pulley in conjunction with the double friction back-gears and a two-speed countershaft, provide, in all, eighteen changes of spindle speeds, covering a range carefully selected for the purpose of the machine. The spindle is hollow and made of high carbon hammered steel, and is hardened and ground at the front and rear journals. These latter are carried in cast iron boxes scraped to a good bearing fit. This type of bearing the builders consider preferable, because it does not require intricate oiling devices with continual attention on the part of the operator; yet the lubrication is well taken care of. The bearing standards are cored out to form large oil chambers which are filled from the front of the lathe; from these the oil is fed to the bearings by means of felt pads. This construction eliminates all possibility of grit and dirt entering the bearings, and reduces the attention required to filling the oil receptacle once a week.

The tail-stock is of massive design with a bearing of ample length on the bed. The tail-spindle barrel is designed in such manner as to give the maximum length of bearing combined with long travel. Screws are provided for setting over the tail-stock for taper work, the base being graduated so that this setting can be easily accomplished.

The Bed

In the end view of the lathe, Fig. 2, the form of bed, which is a new departure, is clearly indicated. The tail-stock slides on a V of the usual proportions on the rear way, and on a flat surface in the front. The carriage travels on a flat surface in the back, as shown, and is held down in the back by a flat gib. The front of the carriage slides on a guide of different shape from that usually found in engine lathes. This guide, as shown, is V-shaped, but is machined at an angle of 15 degrees on the front side, and 70 degrees on the back, making the total included angle 95 degrees. The force exerted downward on the carriage of an engine lathe is many times greater than the upward pressure, and in designing the lathe bed this fact has been given due consideration, the wearing surfaces, therefore, having been proportioned accordingly, as shown.

The bed, in addition to having an unusually deep section, is reinforced and braced by a transverse rib of an I-beam section directly under the front bearing; this rib extends up to the extreme top of the bed. In addition to this, the metal around the holding-down bolts for the head has been reinforced to about three times the thickness usually found at this place.

The Carriage and Apron

The carriage is held in alignment on a scraped surface on the front of the bed by taper gibs at both end bearings. This

construction, together with the 70-degree angle on the back of the V overcomes any tendency of the carriage to climb the ways when the lathe is engaged on heavy work. The gibs are tongued in position in the carriage, and in combination with the special construction of the V, they automatically compensate for the wear; this makes it unnecessary to give any attention to the adjustment of the gibs. Wipers are provided, fitted with felt pads, which in addition to wiping off chips and grit from the sliding surfaces also provide for automatic oiling of the ways.

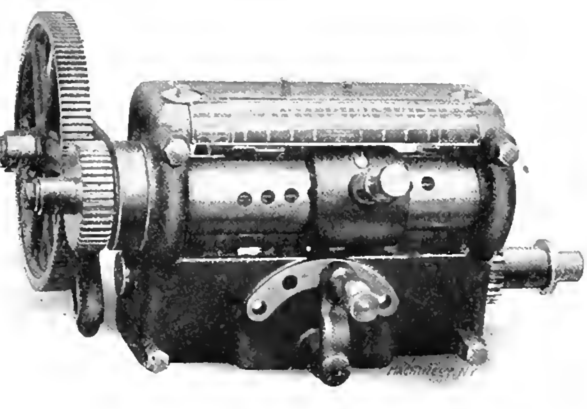


Fig. 5. Gear Box, complete, ready to be Applied to Machine

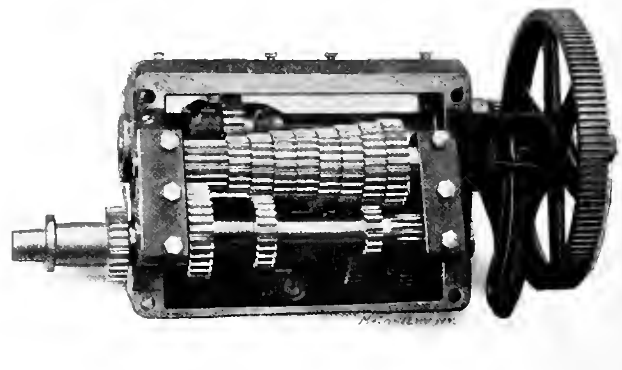


Fig. 6. Arrangement of Gearing in Gear Box

The line engraving, Fig. 7, shows a cross-section through the bed, carriage, apron and taper attachment. This engraving indicates clearly the proportions of the shears, and shows also the relative position of the lathe spindle to the bed. The spindle, as will be noted, is set back a certain distance (in this size of lathe two inches) from the center of the shears, which construction not only provides for an increased swing over the carriage, but at the same time permits the machine to be used at full swing without the tool overhanging the bed, a construction which adds greatly to the rigidity of the machine when turning work of large diameters.

Figs. 3 and 4 show a front and rear view of the apron. From these illustrations it will be seen that the apron is constructed of a one-piece box section casting, with all gears and studs supported at both ends. The apron has a wide bearing on the carriage, is held in position by four bolts, and is fitted to the carriage by means of a tongue. The single box section form of the apron, it is stated by the manufacturers, does away with the necessity of an auxiliary support at the lower end of the apron, and overcomes the difficulty of uneven wear between the lower slides and the V on the top of the bed.

The longitudinal and cross feeds are operated by a single friction which, in addition to being of large diameter, is so placed in regard to the gearing that it has but a light duty to perform. The feeds are engaged by an inward or outward movement of the knob of the lever shown on the front of the apron in Fig. 4. This lever has a central position, which disconnects all gearing when the lathe is used for screw cutting. The apron is further provided with a device which makes it impossible to engage the feed rod and lead-screw at the same time.

Change Gear Box

The quick change gear box supplied with these lathes is shown in Figs. 5 and 6, the former showing the gear box ready to be assembled to the lathe, while the latter shows the gearing, the front cover having been removed. The entire mechanism is completely self-contained. Nine changes of speed for the lead-screw are obtained by means of the cone of gears shown and the tumbler. The tumbler gear, as will be seen, is supported on a cylindrical bearing, and is securely locked in position by the plunger in the change handle. This construction is the same as has been used on the LeBlond lathes for some time. The nine changes mentioned above are quadrupled by the addition of a sliding gear transmission, which is illustrated in Fig. 6. The gears of this sliding transmission are operated by the lower lever shown in Fig. 5. This construction permits of the use of a speed or index plate which reads directly, and from which the operator can see at a glance the position of the levers required for any desired speed. The changes can be made while the lathe is running under the heaviest cut. The gears in the gear box as well as all other feed gears are made from drop-forged steel blanks. The feed rod is driven by the same mechanism by means of gears connecting it with the lead-screw, the range of feed being from 8 to 120 per inch. The changes for the lead-screw provided by the gear box are thirty-six in number, ranging from 2 to 30 threads per inch.

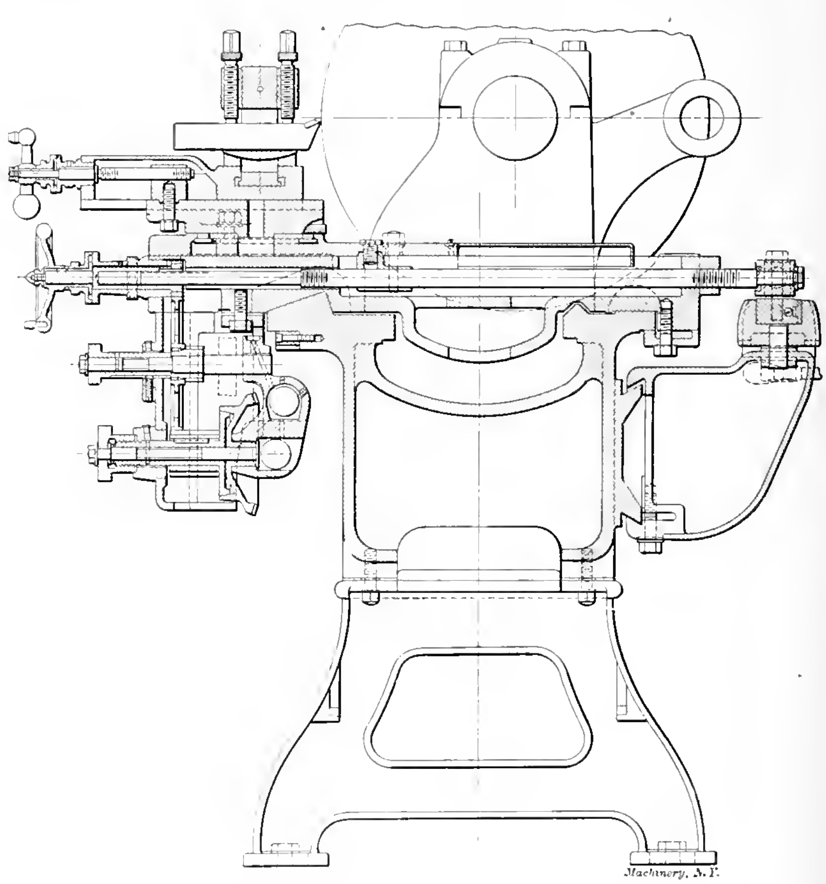


Fig. 7. Cross-section through Bed, Carriage and Apron of Le Blond Lathe

The feed box is connected to the spindle by means of gears, the intermediate one of which is mounted on a quadrant, which permits the use of compound gearing at this point if required for cutting special or metric threads with a standard English pitch lead-screw. A metric pitch lead-screw can also be supplied, in which case the gearing arrangement permits of cutting English pitch threads with this screw, by using compound gearing in the same manner.

UNIVERSAL HORIZONTAL BORING MACHINE

A universal horizontal boring machine has recently been placed on the market by the Universal Boring Machine Co., of Hudson, Mass. This machine has been built with a special view to accuracy and permanence of alignment, and is known as the No. 2½ universal horizontal boring machine with extra long bed; this latter feature facilitates the machining of large castings. The machine is especially adapted to jig work and similar operations where it is necessary to do very accurate boring, milling and drilling, the machine itself being used for obtaining the various distances between the centers of the holes.

A general view of the machine is shown in Fig. 1. As will be seen from this illustration, the machine is of the constant

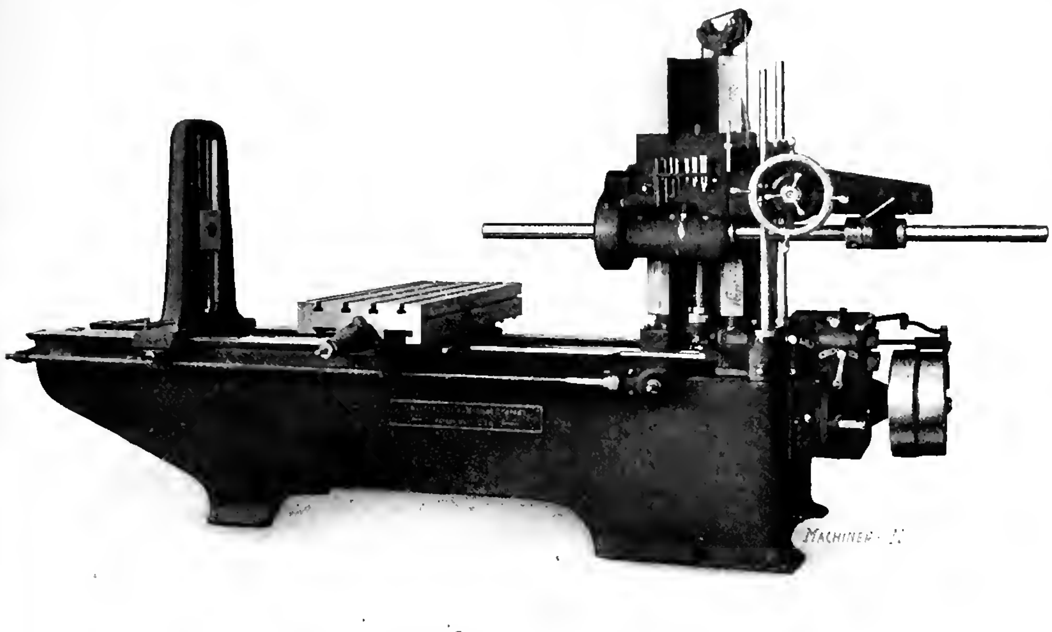


Fig. 1. Univereal Boring Machine Co.'s Horizontal Boring Machine

belt speed gear-driven type. The bed of the machine is of a deep box construction, and is heavily ribbed on the inside to insure rigidity, which is one of the most essential features in machines of this type when accurate results are required. A heavy bed also gives a solid foundation to all the different parts mounted on it, keeping them in accurate relation to each other in all positions, and eliminating the necessity of building a foundation under the machine. Due to the fact that a foundation is not necessary, the location of the machine is not confined to the ground floor. The bed rests on three

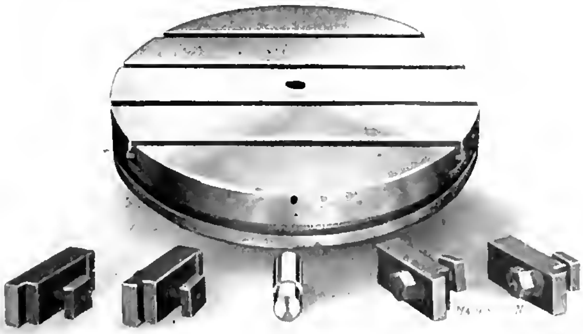


Fig. 2. Rotary Table used on the Horizontal Boring Machine

points, making it very easy to level up on uneven floors; at the same time undue strain on the bed, due to imperfect support, is eliminated.

Head and Driving Mechanism

One of the prominent features of the machine is embodied in the placing of the head at the right-hand end of the machine. This arrangement permits the spindle to run in the same direction when milling as when boring and drilling. The hand-wheel for the rapid adjustment of the spindle is placed on the head conveniently in relation to the spindle where the cutter is mounted, thus allowing the operator to see the milling cutter and to make adjustments at the same time. In the line engraving, Fig. 4, is shown a cross-section of the head and the feed and speed gear box. It will be noted that the machine is provided with a power vertical feed to the head, employed when milling, which for many classes of work is a very valuable feature. Aside from the regular vertical milling feed, the head has a power feed raising and lowering device. A hand feed for fine adjustment of the head by a micrometer dial graduated to thousandths of an inch is also furnished. The head is counter-balanced by a weight attached to a wire rope, as shown, and it is moved by a large screw of coarse pitch. Suitable arrangement has been made to oil the sliding surfaces in order to minimize the wear.

The gear box, the arrangement of which is shown in Fig. 4, is strong and compact and contains both the feed and speed change gears, which are all made of steel and run in a bath of oil to provide quiet running and long wear. Eight speed changes are secured in the gear box, and these are doubled by the back gearing in the head. There are nine feed changes in either direction for the head, one lever reversing or stopping all the feeds.

The spindle is driven at a point near to the work, and thus torsional stresses are practically eliminated. This manner of driving the spindle is of special advantage when using large milling cutters, because the chatter usually present when taking heavy milling cuts on machines where the application of the drive is some distance from the cutter, is eliminated. The driving gear has a long hub in which the spindle is inserted and held by two sliding keys. The spindle itself runs in self-oiling bearings, these bearings having an individual oil compartment containing enough oil for about twenty months running. The bronze bearings, which are fitted into the bearing proper, have a groove cut the entire length, and in this groove is laid a wick having its ends submerged in the oil compartment below. The bearing proper is also split and provided with clamp screws for taking up the wear.

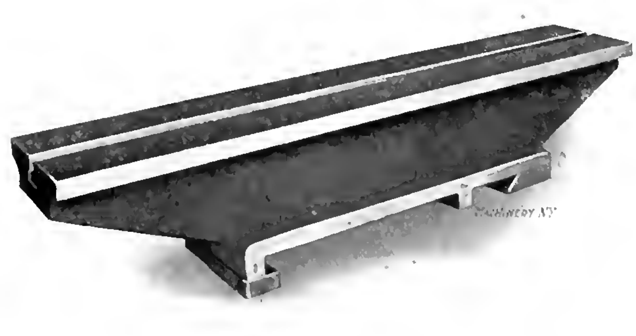


Fig. 3. Auxiliary Table used for Work which would Overhang the Regular Table

Fig. 4 also shows a cross-section of the tight and loose pulleys on the driving shaft. It will be noted that the loose pulley is slightly smaller in diameter than the tight pulley, so there is practically no tension on the belt when it is on the loose pulley, consequently there is but slight wear. The loose pulley is made in one piece and has an oil reservoir cored out around the bearing. This reservoir is filled with cotton waste and oil, and a wick is laid in a groove cut in the bearing, the ends of the wick extending downward into the oil reservoir below.

Table and Table Feed Motions

The platen or table of the machine is made especially heavy in order to avoid springing when clamping the work upon it. It is provided with power feed in either direction, and with automatic stops. The screw which imparts motion to the platen, carries a dial graduated to thousandths of an inch. The gears which drive the feed-screw are encased and run in oil. The top of the table is provided with four milled T-slots running the entire length.

The feed motion of the machine is taken from the driving shaft which runs at a higher speed than the main spindle. This arrangement, shown in Fig. 4, makes it possible to obtain nine feeds without increasing the ratio of the gearing, thus avoiding excessive stresses on the feed gears and bearings. The fine feeds are obtained by reduction gearing. Besides the table shown in place in Fig. 1, the machine is provided with a rotary table, shown in Fig. 2. This table is 24 inches in diameter and is graduated on the outside periphery to one-half degrees. The feed in both directions to the table, together with the rotary table arrangement, permit of finishing at one setting many classes of work, which would otherwise require re-setting and finishing in other machines. Holes, for instance, may be bored and drilled and surfaces milled at various angles without re-setting, thereby saving considerable time and expense in handling. In Fig. 3 is shown an auxiliary table which is used for work which would overhang the regular table. This auxiliary table has a T-slot milled its entire length as shown, and is a very essential feature in the rapid and accurate machining of large castings.

Miscellaneous Features

The outer support bearing for the boring-bars, shown in position on the bed in Fig. 1, is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing in the support is accomplished by means of a screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two bearings for the bar move simultaneously. Provision has also been made for re-aligning the bearings in case of wear. The outer support bearing is moved longitudinally on the bed of the machine by a hand-crank. It can easily be removed from the machine, if required, by removing the bracket at the end of the bed and pulling off the supporting post, and it can be replaced in exact alignment without difficulty.

The machine is provided with extension boring-bars, and bushings to fit in the outer support bearing, and with one roughing and finishing cutter for each boring-bar. The extension boring-bars are provided with No. 4 Morse taper shanks, fitting the socket in the spindle. The spindle is provided with a slot for driving the extension boring-bars by means of two keys in addition to the usual driving tang. Two face milling cutters are also furnished with the machine, if required, one being 2 inches and the other 10 inches in diameter. The hub of the driving gear forms a face-plate to which the 10-inch face milling cutter, provided with holes for clamping screws, may be fastened. This arrangement makes the most rigid connection possible between the drive and the cutter. The smaller face milling cutter is attached to an arbor fitting the taper hole in the end of the spindle. The 10-inch cutter is provided with a center hole large enough to permit a spindle, when carrying the 2-inch cutter, to pass through it, so that either of these two cutters may be used without the necessity of removing the other.

The machine will take pieces 94 inches long between the face-plate and the outer support of the boring-bars. The greatest distance from the top of the platen to the center of the spindle is $22\frac{3}{4}$ inches. The table or platen is 20 inches wide by 42 inches long and has a cross-feed of 34 inches.

Messrs. Hill, Clarke & Co., Inc., 14 So. Canal St., Chicago, Ill., are the selling agents for this machine, and it may be seen in operation in their demonstration shops.

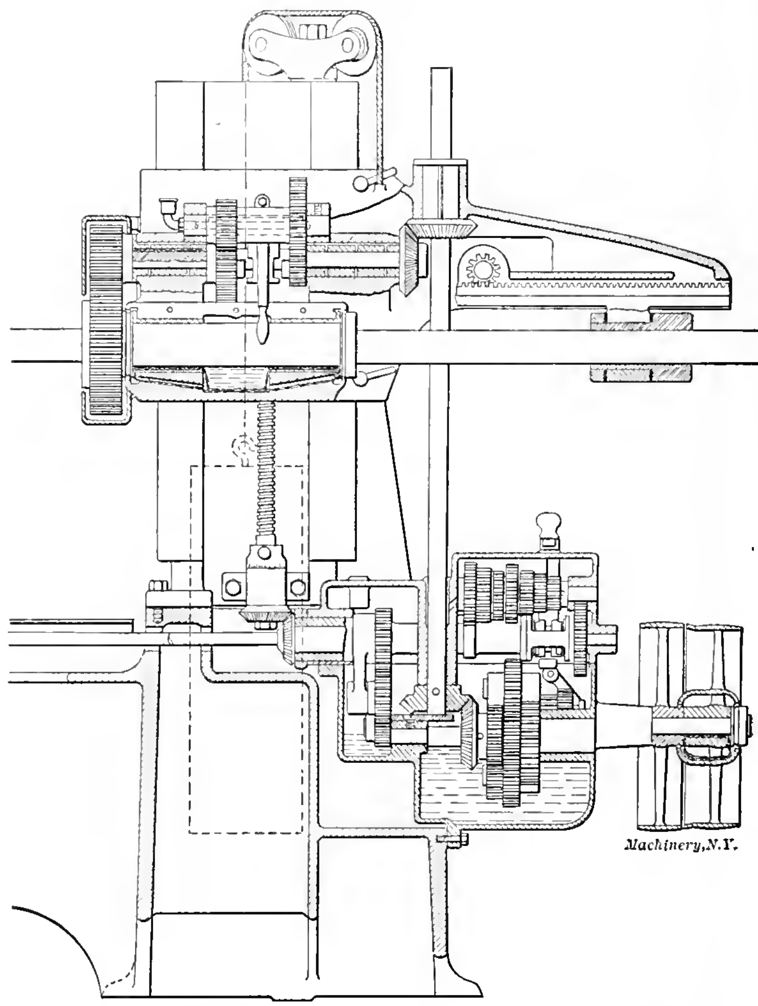


Fig. 4. Section through Head and Gear Box of Universal Boring Machine

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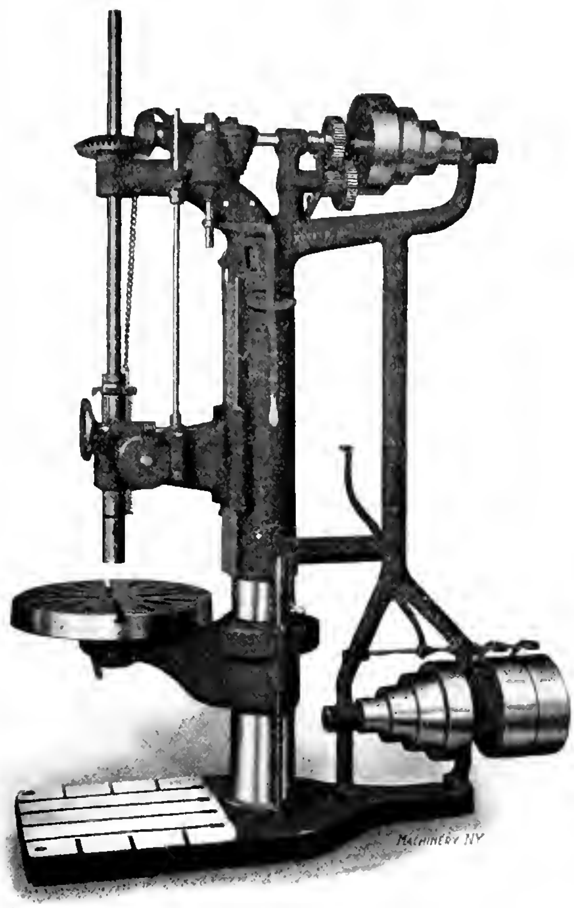
HOEFER DRILL PRESS WITH POSITIVE GEARED FEED

The accompanying illustration shows an improved drill press recently brought out by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill. The most important feature in this new machine is the positive power feed and the method of changing the feed. An improvement has also been introduced in the mechanism used for raising and lowering the table arm.

As will be seen from the illustration, the drill spindle is fed downward by means of a series of gears enclosed inside of a gear box at the top of the machine, which transmit motion from the main driving shaft through a worm and worm-gear to a pinion engaging a rack on the drill press spindle sleeve. Described in detail, the motion is transmitted as follows: The horizontal driving shaft at the top of the machine carries a worm which engages with a worm-wheel keyed to a short vertical shaft. To this shaft are also keyed five gears of different sizes each engaging with a corresponding gear on a second vertical shaft. The gears in the second set run loosely on the shaft on which they are mounted, except that any one can be engaged with the shaft by means of a key sliding in a spline in the shaft and the gears. By shifting this sliding key up and down, any one of the gears in the second set can be engaged to transmit motion from the first vertical shaft to the vertical feed spindle. The motion between the second vertical shaft and the feed spindle is transmitted by means of a gear keyed permanently to the lower part of the second vertical shaft, driving a gear on the feed spindle, the latter, of course, being splined so that, while its driving gear is keyed to it, it can yet slide freely. The feed spindle carries at its lower end a worm engaging with a worm-gear keyed permanently to the short horizontal shaft

which carries the pinion engaging with the rack on the spindle sleeve.

By shifting the sliding key up or down to engage with the different gears in the gear box, as already mentioned, the amount of feed per revolution of the main spindle can be adjusted as desired, five feeds of 0.006, 0.015, 0.023, 0.032 and 0.041 inch per revolution, respectively, being obtainable. The feed can be changed while drilling, by merely moving the lever operating the sliding key. The lower end of the key is attached to a collar on the second vertical shaft, previously mentioned, and the horizontal arms of the bell crank lever engages with this collar. The handle of the vertical arm of the lever is within easy reach of the operator, as shown in the



Hoefer Improved Drill Press with Positive Geared Feed

engraving, and by shifting it to various notches on the projecting boss on the side of the column of the machine, the feed is easily adjusted to any predetermined amount. The design prevents the key from engaging with two gears at once, as this would obviously cause damage to the mechanism. For this reason, a hardened tool steel ring is placed in a recess on one side of each gear, and as the key slides past this ring, it is forced back into the keyway in the shaft and out of engagement with both the gear that is being disengaged and the gear that is to be engaged. Continued movement of the sliding key will bring it into engagement with the next gear. In order to obviate any unnecessary loss of time, three keyways are provided in each gear so that the engagement is practically instantaneous.

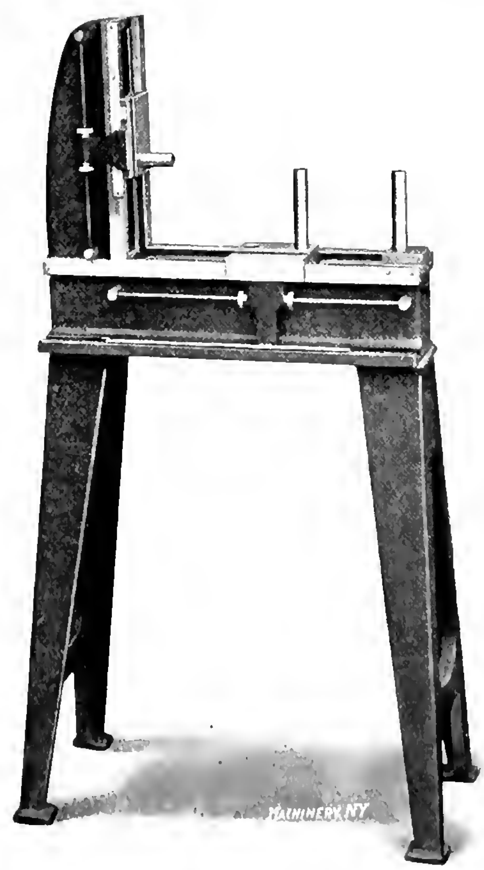
Returning to the feed mechanism on the sliding head of the machine, it should be noted that the drill or tool used can be fed by three methods, viz.: by a hand lever, by the hand worm feed, or by the power feed just described. The hand worm feed is thrown into engagement with the worm-wheel by an eccentric, while the power feed is thrown into engagement by a cam, the cam lever and eccentric being so interlocked that the engagement of both worms with the worm-wheel at one time is impossible. When passing into or out of engagement, the vertical power feed spindle swings through a small arc, but is in true alignment when in the driving position so that there is perfect mesh between the small gear by which it is driven and the driving gear on the second change gear shaft. A stop is provided by means of which the feed can be thrown out of mesh automatically at any desired point.

The improved feature for raising or lowering the table arm consists of a screw passing through a nut so arranged that it bears equally against both sides of a circular slot in the table bracket. When manufactured each machine bores the hole in its own table arm and the circular table is turned to fit the socket in the arm exactly, so that an accurate and rigid bearing is provided and, at the same time, perfect alignment of the spindle and table is assured.

The horizontal driving shaft at the top is fitted with back gears having a ratio of 4 to 1, the back gears being thrown into and out of engagement by an eccentric, as usual. The machine can be either belt or motor driven, but in either case, the driving speed can be changed, in addition to the speed change by the back gears, by means of a pair of four-step cone pulleys. The brace support at the outer end of the pulley shaft gives additional rigidity to the machine. The greatest distance from the spindle head to the base is 56 inches, and the greatest distance from the top of the table to the spindle head, 45 inches. The distance between the column and the center of the spindle is 16¼ inches. The vertical feed of the spindle is 16 inches, and the vertical motion of the spindle head 27 inches. The diameter of the spindle is 2 1/16 inches.

GEAR TESTING MACHINE

The accompanying illustration shows a gear testing machine built by the Cincinnati-Bickford Tool Co., Cincinnati, O. This machine was originally designed for the company's own use without any intention of placing it on the market; but as many of the company's customers intimated that such



Gear Testing Machine built by the Cincinnati-Bickford Tool Co

a machine would undoubtedly meet with favor if made on a commercial basis, it has finally been decided to manufacture it for the trade. The machine is intended for testing the running of both spur and bevel gears. The gears are mounted on the removable studs shown, which are held in adjustable slides, moving freely. Provision is made for clamping these slides at any point. Each slide is capable of a fine adjustment by means of a screw and knurled nuts, the screws being seen in the illustration, one running horizontally and one vertically on the side of the machine. A vernier scale is also provided, reading to thousandths of an inch, so that

the correct center distances between the gears when mounted on the studs can be determined. The shortest distance from center to center of the two studs for testing spur gears is 2 inches and the greatest is 19½ inches. This permits of testing a pair of gears where the sum of the pitch diameters of the gears is 4 inches as a minimum and 39 inches as a maximum. The two studs for bevel gears permit of testing miter gears from the smallest made up to 18 inches in diameter, and of a combination of bevel gears where one is 4 inches and one 32 inches in pitch diameter. Each machine is furnished with two studs one inch in diameter, and 4 inches long above the slide. Extra studs can be furnished if required.

The slightest imperfections in the gear teeth are readily detected by this testing device and the cause can be analyzed with comparative ease. By remedying the defects, it is possible to produce gears that have a perfect bearing on the surfaces in contact, and that will run smoothly and noiselessly when in service. The net weight of the machine is 325 pounds and the floor space required, 16 by 34 inches.

QUEEN CITY DOUBLE-ACTING PRESS

A new double-acting press has recently been placed on the market by the Queen City Punch & Shear Co., 208 Lawrence St., Cincinnati, O. The machine has been designed for forming and pressing operations of various kinds in sheet metal, and is of especial value where a large quantity of duplicate work is to be done. The main feature of the machine is the oscillating table, presenting a feature whereby the operator is safeguarded from personal injury. Patents have been applied for, for such features as are new departures in this design. The general construction and operation of the machine will be more easily understood by referring to the accompanying two half-tone engravings, Figs. 1 and 2, one of which shows the front view and the other the rear view of the machine.

Two operators are required for the machine, to feed and remove the work, one standing in front of the machine and the other in the rear. In the illustration, Fig. 1, the plunger or ram is shown down and the front die projects out in the front of the machine. This is the proper position of the die when the work is removed, and the die remains in this position sufficiently long without motion so that the operator in the front can remove the finished work and replace it with a blank, meanwhile being entirely out of the range of the plunger and without any danger of injury. The plunger then raises up and the die moves in under the ram for pressing or forming the blank just inserted. While this is being done the rear die projects outward in front of the operator in the rear, see Fig. 2, who then removes the finished work from this die and replaces it with a blank. It is evident that there is no occasion for the operators to place their hands or fingers under the press plunger, and the danger thereby avoided is of equal importance to employe and employer, for while the former, of course, is the one who suffers most directly through the bodily injury in case of accident, it is also a very important feature to the manufacturer, who is continually liable for damages sustained to operators when working with machines where the operation presents a constant danger to the workman.

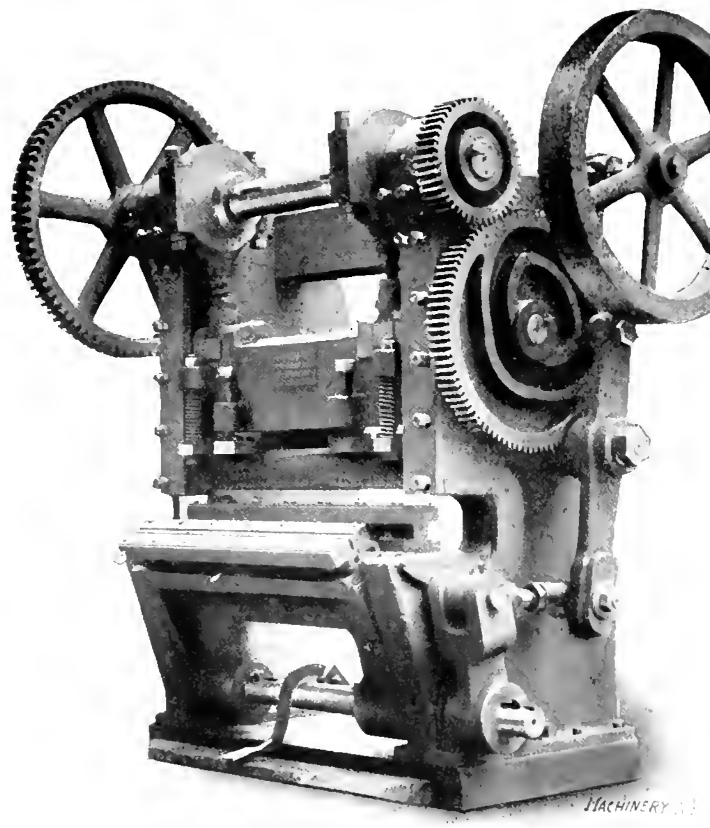


Fig. 1. Front View of the Queen City Double-acting Press

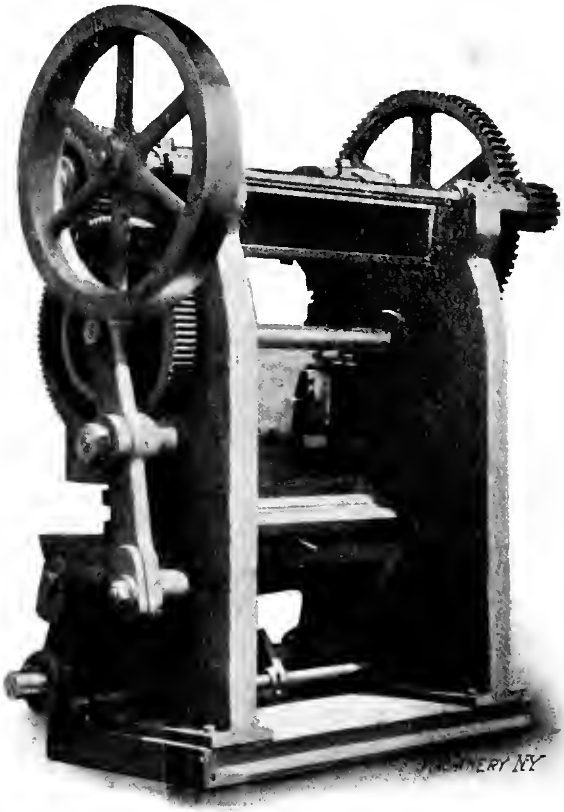


Fig. 2. Rear View of Double-acting Press

The machine runs continually, the movements being divided in two equal periods of time, as follows: One-half of the revolution of the cam-shaft is devoted to pressing the work in the die, removing it when finished and replacing it with a new blank; the other half of the stroke allows the filled die to enter the pressing ram; this is repeated for each of the two tables or dies, thereby making it possible to press a piece of work for every revolution of the cam shaft. There is no necessity of stopping the machine except in a case of emergency, but the machine is provided with an automatic safety clutch by which either of the operators can stop the machine at will. The speed of the machine can be regulated and is governed by the character of the work to be done and by the rapidity with which the operators can handle the finished work and the blanks.

The machines of this type are equipped with machine-cut gears and can be either belt or motor driven, as required. The machine illustrated in Figs. 1 and 2 is 36 inches between the housings and weighs 7,300 pounds. It can be built in any size required and adapted to any class of forming or pressing. The novel features introduced in the design of this machine should make it a valuable tool in the sheet metal trades, both on account of its productive capacity and the safety of operation.

COLBURN 30-INCH VERTICAL BORING MILL

A new 30-inch vertical boring mill embodying a number of interesting improvements has recently been brought out by the Colburn Machine Tool Co. of Franklin, Pa. The most prominent feature of the new design is embodied in the main

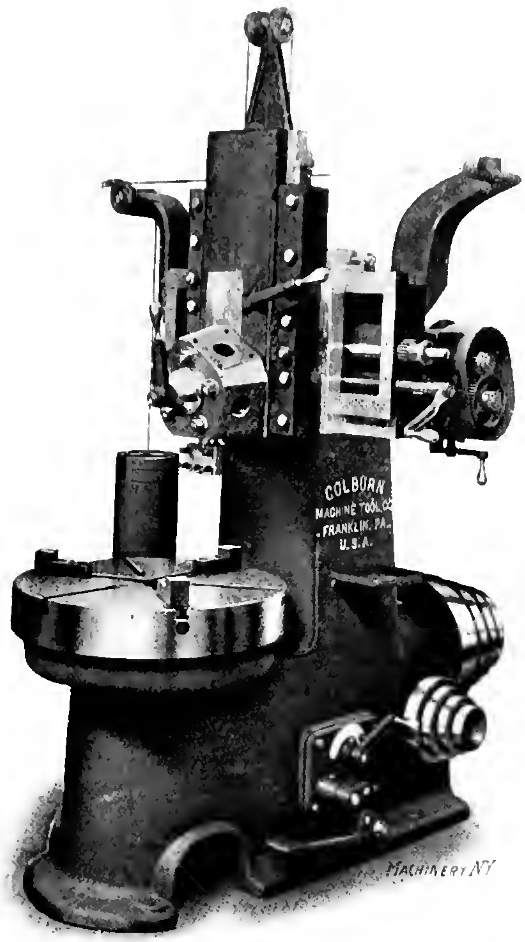


Fig. 1. Thirty-inch Vertical Boring Mill, built by the Colburn Machine Tool Co.

drive or head-stock, which is enclosed in a separate box or frame, and which can be quickly detached from the main frame of the machine and removed if required. This construction makes the assembling of the machine very convenient, and enables the proper fitting of the various parts to be done with greater accuracy. This feature is also of advantage in case of repairs, as all the parts are easily accessible and can be handled without difficulty. Another feature of special interest in the machine is the addition of a foot brake for quickly stopping the machine with the table in any desired position; this feature is not generally found on small boring mills. A general view of the machine is shown in Fig. 1, and in Fig. 2 is shown a view of the head-stock detached from the machine. In Figs. 3 and 4 are shown sectional views which give a clear idea of the construction of the machine.

As will be seen from Fig. 1, the turret is five-sided. It is set on an angle of 8 degrees with a vertical line which gives sufficient clearance for large tools when swung over the slide. The turret slide can be swiveled to any angle up to 30 degrees to either side of the vertical center line. A graduated scale with a pointer is provided which makes it convenient to measure the depth of the cut taken. The boring mill is

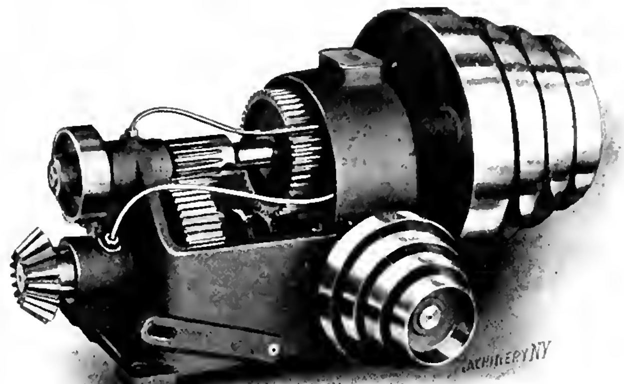


Fig. 2. Driving Head of Colburn Boring Mill

provided with a plain table having three or four chuck jaws, as required. The main spindle has sixteen speed changes, and provision is made for eight feeds vertically, and the same number horizontally. The machine is furnished with a two-speed counter-shaft.

Construction of Driving Mechanism

In Fig. 3 is shown a cross-section of the head of the machine, the table, the lower part of the frame and the driving mechanism. The motion from the cone pulley *E* to the table is transmitted through shaft *F* to which are keyed a gear *G* and a pinion *H*, which in turn drive the gears *K* and *L*. These latter two gears revolve loosely on the shaft *M*. A clutch operated by the handle on the outside of the frame directly above the foot treadle, as shown in Fig. 1, is provided with teeth on the face on both ends, and can engage with the clutch teeth on the sides of either gear *K* or *L*. By this arrangement two speeds are provided for, and by means of the four-step cone pulley eight speeds are obtained. The two-speed counter-shaft increases this to sixteen speeds.

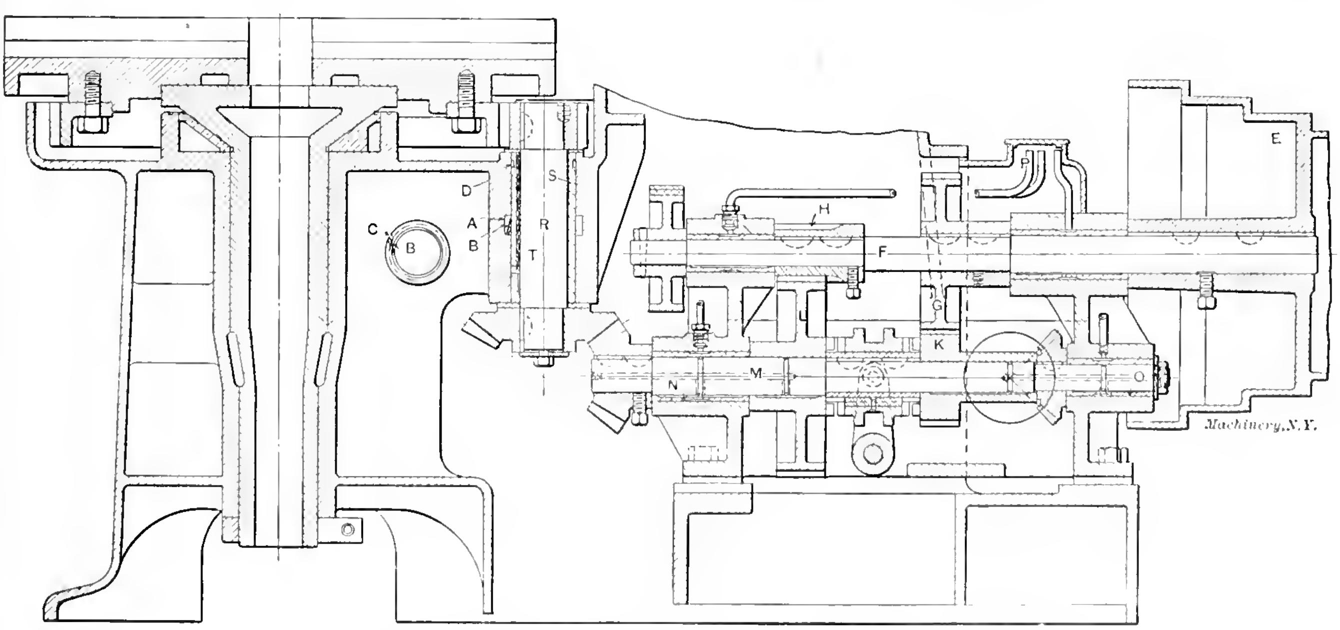


Fig. 3. Section through Driving Mechanism of Colburn Vertical Boring Mill

From shaft M the motion is transmitted in the usual manner by bevel and spur gearing to the table.

Method of Lubrication

Special attention should be called to the manner in which all running bearings are lubricated. The two gears K and L

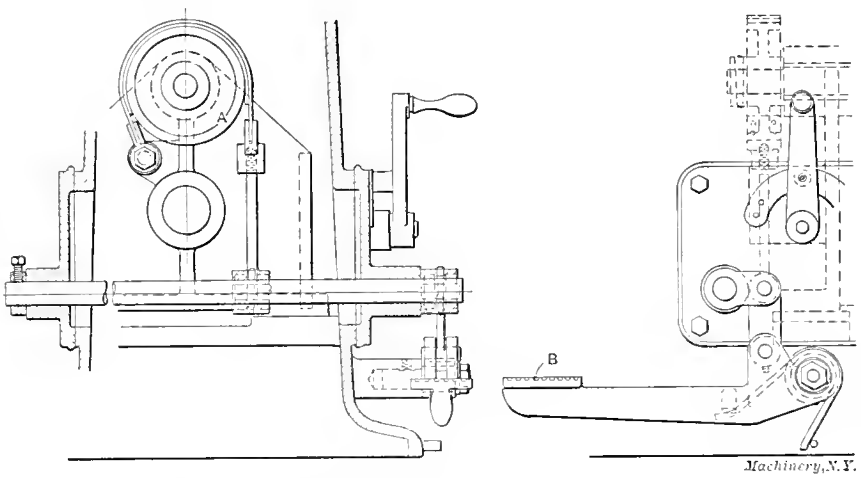
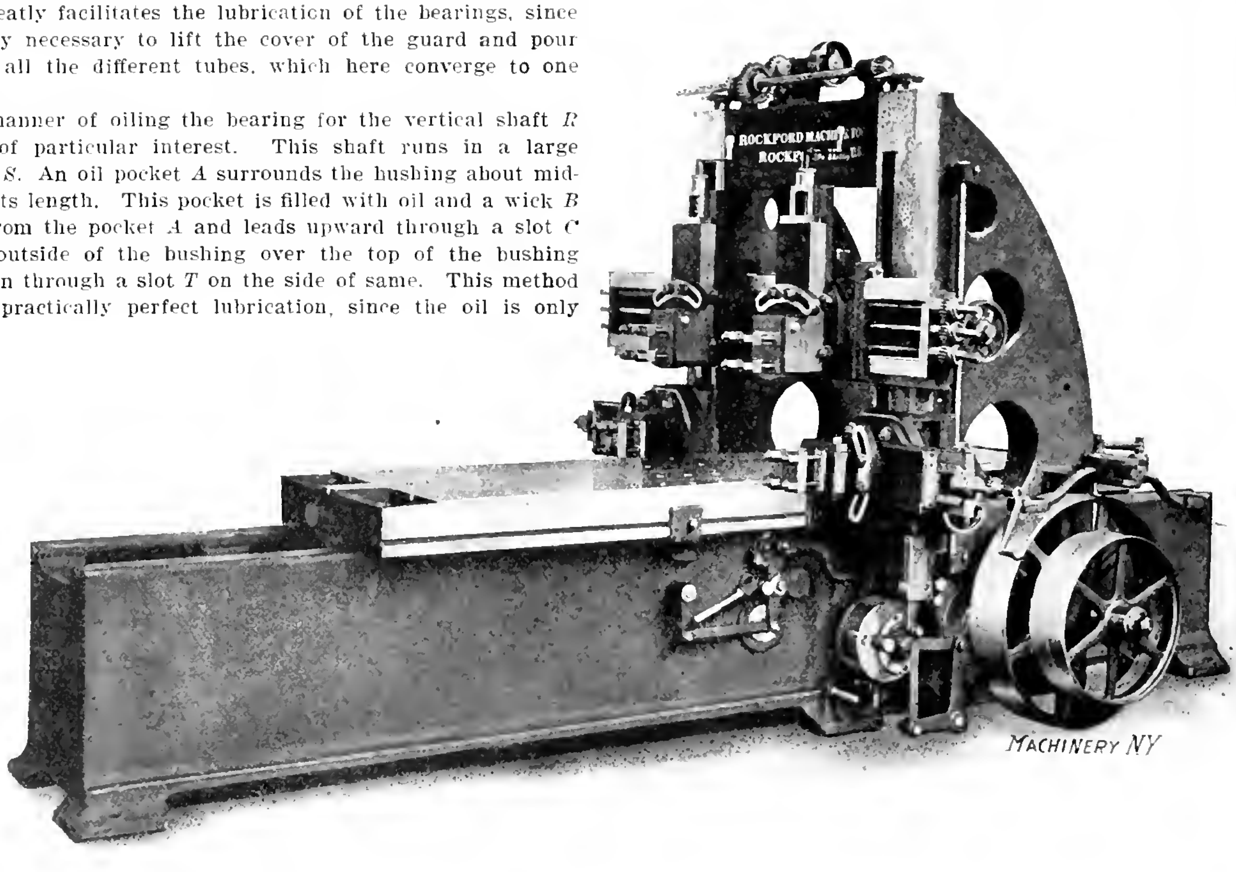


Fig. 4. Foot Brake Mechanism for Stopping the Table at any Point

which run freely on shaft M are oiled through holes drilled through the center of the shaft M, as shown, the oil being carried to the gears from the bearings N and O. Brass tubes which all end at the common location P, under a cover provided at the top of the gear guard enclosing the head-stock gears, lead to every bearing in the head-stock. These tubes are indicated in Fig. 3 and some of them are visible in the half-tone illustration of the head-stock Fig. 2. This arrangement greatly facilitates the lubrication of the bearings, since it is only necessary to lift the cover of the guard and pour oil into all the different tubes, which here converge to one point.

The manner of oiling the bearing for the vertical shaft R is also of particular interest. This shaft runs in a large bushing S. An oil pocket A surrounds the bushing about midway of its length. This pocket is filled with oil and a wick B starts from the pocket A and leads upward through a slot C on the outside of the bushing over the top of the bushing and down through a slot T on the side of same. This method insures practically perfect lubrication, since the oil is only



Rockford 32-inch x 32-inch x 8-foot Heavy Duty Planer

fed through the wick in the required quantities and in an amount determined by the amount used, on the same principle as that of an oil lamp. As long as there is any oil left in the reservoir, the wick will feed it to the bearing. Should the supply in the reservoir run out, there will always be a sufficient amount in the wick to insure the bearing running reasonably well lubricated for a long time without causing any difficulties. Oil is supplied to the reservoir A from the outside by means of the pipe shown directly in front of the tool-pan in Fig. 1. This pipe leads to annular groove D cut in the bushing S, whence it flows downward to the reservoir A. Thus, in fact, two supplies of oil are maintained, one at D and one at A, making it practically impossible for the bearing to ever become dry.

Brake Mechanism

The line engraving Fig. 4 shows the brake mechanism. The band-wheel A, which is also shown in Fig. 2 directly above the bevel gear at the left-hand end of the head-stock, is used in connection with the foot brake B for stopping the machine at any desired point. The details of the mechanism are simple in their construction, and the working of the brake can be studied without difficulty from the illustration. The leverages of the foot treadle arm are of such a ratio that considerable power is exerted at the hand-wheel by even a comparatively light pressure on the treadle at B.

The new features embodied in this boring mill make it a very convenient tool, and its distinctive points will undoubtedly be appreciated by mechanics.

ROCKFORD HEAVY DUTY PLANER

The accompanying illustration shows a planer manufactured by the Rockford Machine Tool Co., of Rockford, Ill., and is known as the 32-inch by 32-inch by 8-foot heavy duty planer. This company has been for some time manufacturing planers in smaller sizes, in addition to its line of shapers, and have recently developed a full line of planers, the feature of the design of which is, in the first place, rigidity and power, while at the same time efforts have been made to maintain the smooth running qualities and the ease of operation required of modern machine tools.

As seen in the illustration, the planer is equipped with four heads of which two are placed on the cross-rail and one on each side of the machine on the housing. All the heads are provided with horizontal, vertical and angular feeds. The down feed for the heads on the cross-rail is 12 inches.

The gearing of the main drive is located inside of the planer bed between the bearings. These latter are provided with long straight bushings fitted into holes bored directly into the bed casting. The belt shifting device is of a very simple construction and reverses the table smoothly. Ample means are provided for lubrication.

The feed friction is of the combination releasing type and will carry the heaviest feeds without slipping or running warm. The feeds are changed by moving the knob shown in the illustration on the front of the friction device, a pointer indicating the feed obtained at different settings of the lever.

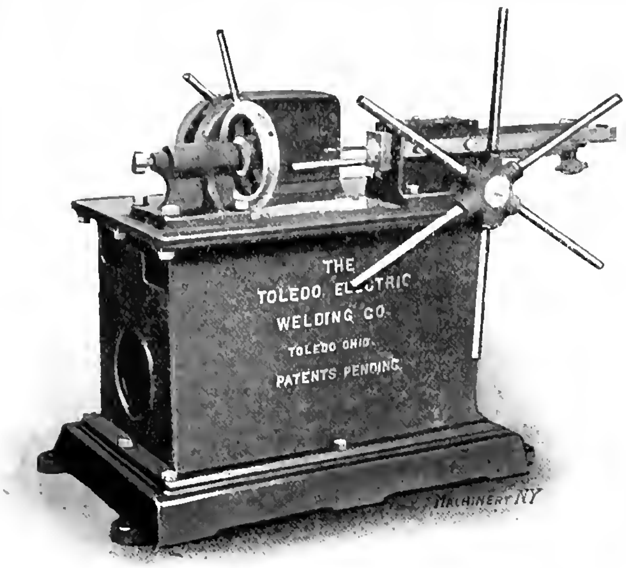


Fig. 1. Machine for Electrically Welding Small Drills to their Shanks

By means of this device the feed can be changed for the finishing cut after having rough planed a piece of work, and the lever can be instantly returned to the position for the roughing feed for the next casting. Besides the time thus gained, an additional advantage is obtained in that the operator knows exactly what feed he is using, and can get the feed he wants without making several adjustments.

All running bearings are provided with means for adjustment for wear and taper gibs are used in the slides throughout the machine so that any wear may easily be taken up in these parts. Bevel gears, pinions and feed racks are made from open-hearth bar steel. The machines are built on the interchangeable plan, and side heads can be furnished at any time to fit the machines, if not originally so equipped.

TOLEDO ELECTRIC WELDING MACHINES

The Toledo Electric Welding Co., Toledo, O., has brought out a line of electric welding machines for various purposes, three of which are shown in the accompanying illustrations. The machine shown in Fig. 1 is intended for welding small drills to their shanks, one of the drills being shown in place in the machine. The head on the left-hand end is provided with a chuck for holding the drill. Sockets are provided for different sizes of drills, and the varying lengths are taken care of by means of the adjusting bolt with a knurled head, shown at the left-hand end of the head. By this arrangement every drill projects the same distance from the clamping jaws. The shanks of the drills are held in the chuck shown at the right-hand end of the machine. The two heads are brought together by turning the spider on the right-hand head; the pieces, when brought together, are in practically perfect alignment.

The automatic switch shown at the back of the machine is adjustable and can be set to open the circuit at any predetermined point. This enables the operator to set the machine so as to make the welds with a great degree of accuracy. After the weld is made, the drill is automatically thrown out, and the chucking jaws are in a position ready to receive another drill. The operation of this machine is simple and no expert operator is required.

Fig. 2 shows a larger machine designed for welding tubing, such as automobile steering rods, etc., or solid bars up to and including $1\frac{1}{8}$-inch round iron or steel. The stock is clamped between the copper jaws by means of the hand wheels shown at the top of the machine. The right-hand head slides back and forth in ways on top of the machine bed, and is actuated by the spider shown at the right-hand end of the machine. The current is turned off and on by means of a foot switch shown on the floor at the side of the machine.

The clamping dies project far enough above the top of the table to permit bars or tubes of any length to be conveniently handled and welded without in any way interfering with

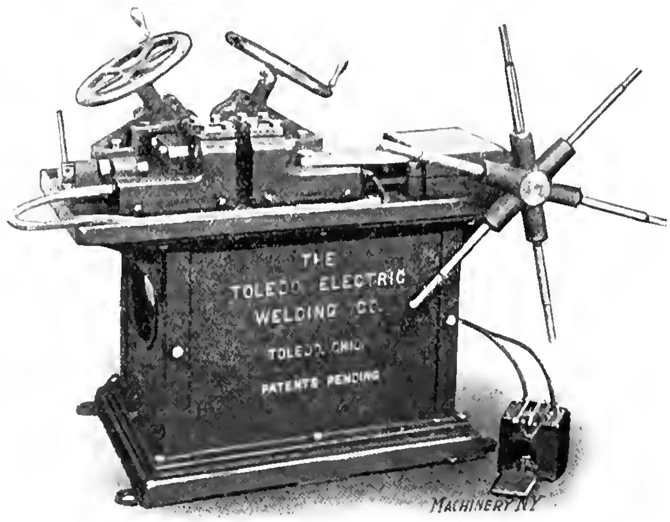


Fig. 2. Machine for Welding Tubing and Solid Stock of Large Sizes

the working mechanism. The line of thrust is in the center of the work-holding jaws, thus insuring alignment of the parts when welded. The copper jaws are water cooled in all of these machines.

Fig. 3 shows a universal welding machine which welds solid iron or steel up to and including $\frac{3}{4}$-inch diameter. The

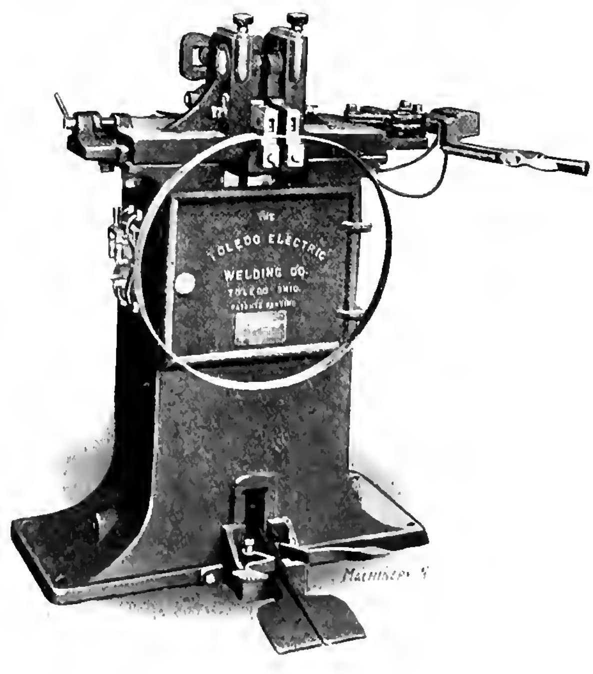


Fig. 3. Universal Welding Machine for Steel up to $\frac{3}{4}$-inch Diameter

clamping jaws are here actuated by foot treadles, and the current is turned on or off by means of a switch mounted on the lever handle shown at the right-hand end of the machine.

These welding machines are, of course, adapted to work done in quantities and are not intended for the average repair man, who has only a few pieces to weld per day. When work is done in quantities, however, the cost per weld is very small. The accompanying table gives a general idea of the time required for making a weld and the cost per

1,000 welds if the current cost is, say, 4 cents per kilo-watt hour. If the cost of current is more or less than this, the total cost will, of course, be accordingly greater or less. Figs. 4 and 5 show some examples of work which has been electrically welded on the machines shown. These illustrations also give an idea of the variety of work that can be done on these machines. On some pieces part of the metal at the weld has been cut away to the center in order to show the internal structure of the metal at the place where the weld is made.

The underlying principle of the electric welding machine is simple and is based on the fact that a poor conductor of electricity offers so much resistance to the flow of the current that heat is produced, the degree of heat depending on the amount of current and the resistance of the conductor. The process of electric welding is especially applicable to butt welding of metals having practically the same cross-section at the weld. The temperature produced by the current can be maintained at any point desired for any length of time, and any degree of heat may be obtained up to the melting point of the metal. The heat can be increased and decreased at the will of the operator by means of turning on or cutting off the current by the switch on the machine.

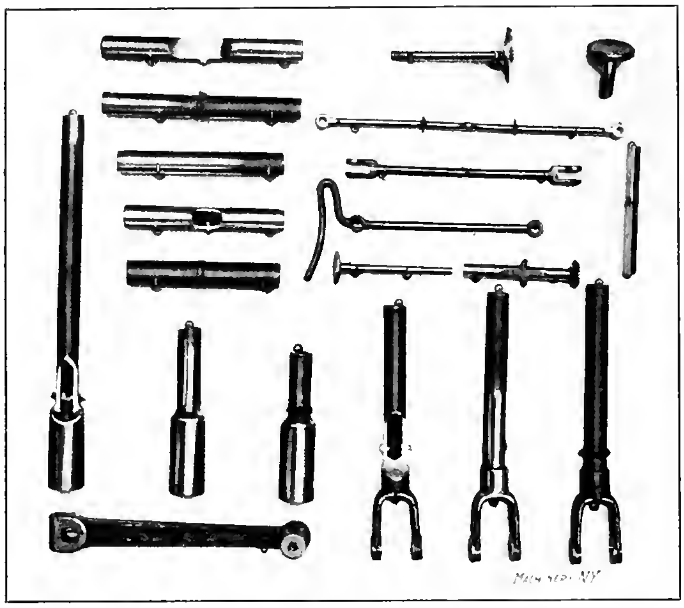


Fig. 4. Examples of Work Welded Electrically

An advantage of the electric welding process is that there is none of the disagreeable glare or blinding effect which takes place either in the arc welding process or the oxy-acetylene process of welding. No goggles or smoked glasses are, therefore, needed. No flux is required in making an ordinary weld.

For electric welding an alternating current is necessary. The current as supplied from a dynamo in the plant or from a central power station is transformed so that it has a pressure of from 4 to 5 volts, there being then absolutely no danger for the operator. The copper clamping jaws of the electric welding machine are similar to a pair of movable vise jaws, and form the terminals of the secondary current of a special transformer located in the welding machine.

TIME REQUIRED FOR MAKING WELD, AND COST OF 1000 WELDS

Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour	Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour
$\frac{1}{4}$	3	$0.28	$\frac{5}{8}$	10	$1.32
$\frac{3}{8}$	5	0.52	$\frac{3}{4}$	12	2.00
$\frac{1}{2}$	7	0.88	1	20	6.00

When two pieces of iron are to be welded they are clamped between the vise jaws, the ends of the metal to be worked touching each other. The current is then turned on and when the metal reaches a white heat and is in a partially molten state, the ends of the metal are forced together by means of a lever, thus producing a perfect weld. A projection or fin is raised where the ends come together, but this may be ground off or removed by any other suitable means. A weld properly made in this manner is practically as strong at the welded point as at any other place.

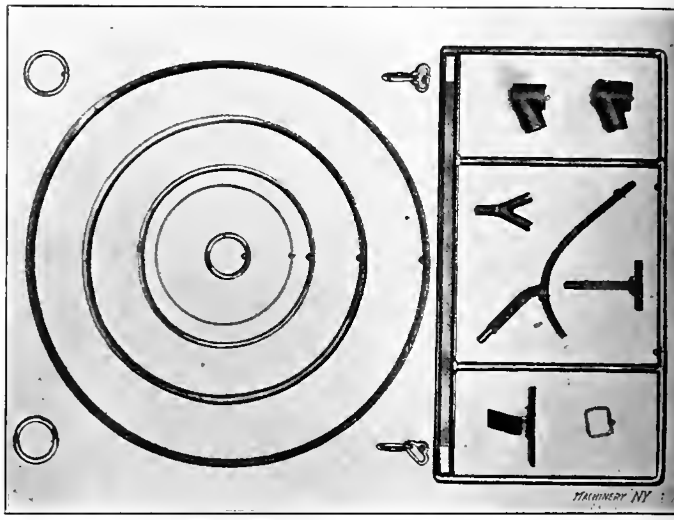


Fig. 5. Other Examples of Electric Welding

NEW MODEL "STAR" LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has re-designed its line of 9- and 11-inch "Star" lathes. The accompanying illustration, Fig. 2, shows the lathe having 11-inch swing with a 5-foot bed, known as the No. 30H Star lathe. The following description of the improvements in this lathe also applies to the 9-inch size.

The bed of the machine is mounted on an oil pan as shown. In the head, guards have been provided for the back-gears, and the main spindle, which is made of 60 to 65 point carbon steel, revolves in large ring oiling bearings. The spindle nose is threaded only part of the way, and the remainder is ground cylindrical so as to insure accurate fit for chucks and face-plates. The tail-stock has been made heavier to insure greater strength, and has a longer bearing on the bed; it is provided with side adjustment and an oil-well. The carriage has been made stronger and is provided with T-slots for fastening the tool-posts. The cross-feed screw and the ways have been carefully protected from chips and dirt by a guard reaching the full length of the slide. The cross-feed screw is provided with a micrometer collar graduated to read in thousandths of an inch, and secured by a friction spring. Even when the machine is not originally provided with a taper attachment, the carriage is so designed that a taper attachment can be applied to the lathe at any time. The plain and compound rest easily interchange, and a binding device has been introduced which facilitates quick changes and rigidly binds the rest to the cross-slide. Graduations up to 180 degrees are provided for setting the compound rest.

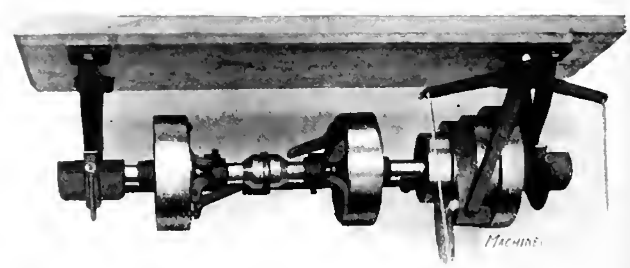


Fig. 1. Counter-shaft for the "Star" Lathe

The automatic cross and longitudinal feeds are actuated by a friction clutch and driven from the head spindle through gearing and the splined lead-screw, as usual. The range for thread cutting is very wide, it being possible to cut all standard threads from 3 to 72 per inch, including 11½ and 27. The lathe is also furnished for cutting metric threads, either by using proper translating gears with the regular lead-

screw or by using a lead-screw having threads cut with metric pitch.

The change gears have rounded edges so as to avoid injuring the hands when handled. The change gear yoke has an improved intermediate stud which is adjustable from the outer end. All the adjusting screws are provided with uniform size heads, fitting the same wrench as is used for the tool-post screw. Patented split spring washers hold the change gears in place, making convenient and rapid changing of the gears possible.

A full line of regular attachments may be used with this machine including taper attachment, draw-in chucks and collets, automatic draw-in chuck and rod feed, milling and gear cutting attachments, automatic turret on the bed, carriage turret, double tool block, and stop for the carriage. These attachments can be furnished and applied to the machine at any time without special fitting.

Fig. 1 illustrates a new counter-shaft furnished with the machine which is provided with improved friction clutch pulleys with large friction surfaces. In this counter-shaft the wear on the friction parts when the pulley is running idle, has been eliminated, and the usual counter-shaft troubles are, therefore, renduced to a minimum. The belt-shifter for the cone pulley shown in place on the counter-shaft operates quickly and will be found very convenient especially with high ceilings. The hangers are provided with large ring-oiling shaft bearings and are adjustable for alignment. The advantages of these features will undoubtedly be appreciated by the lathe operator.

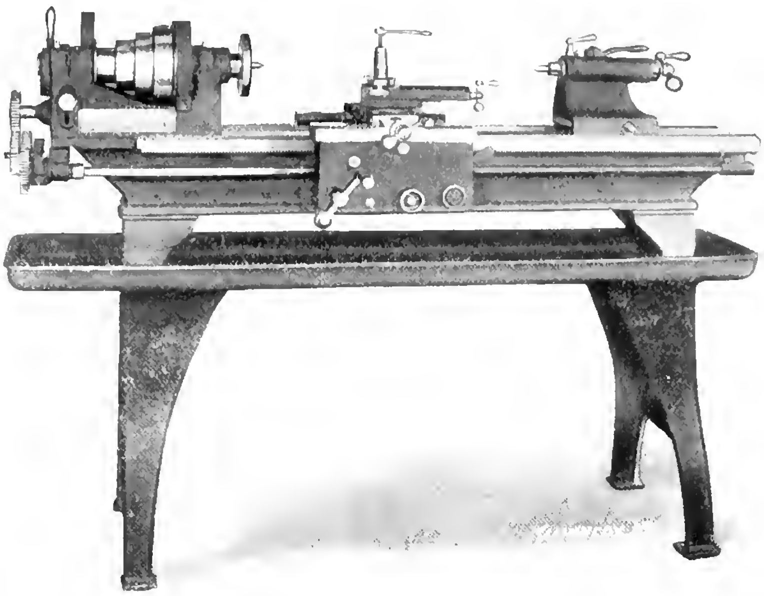
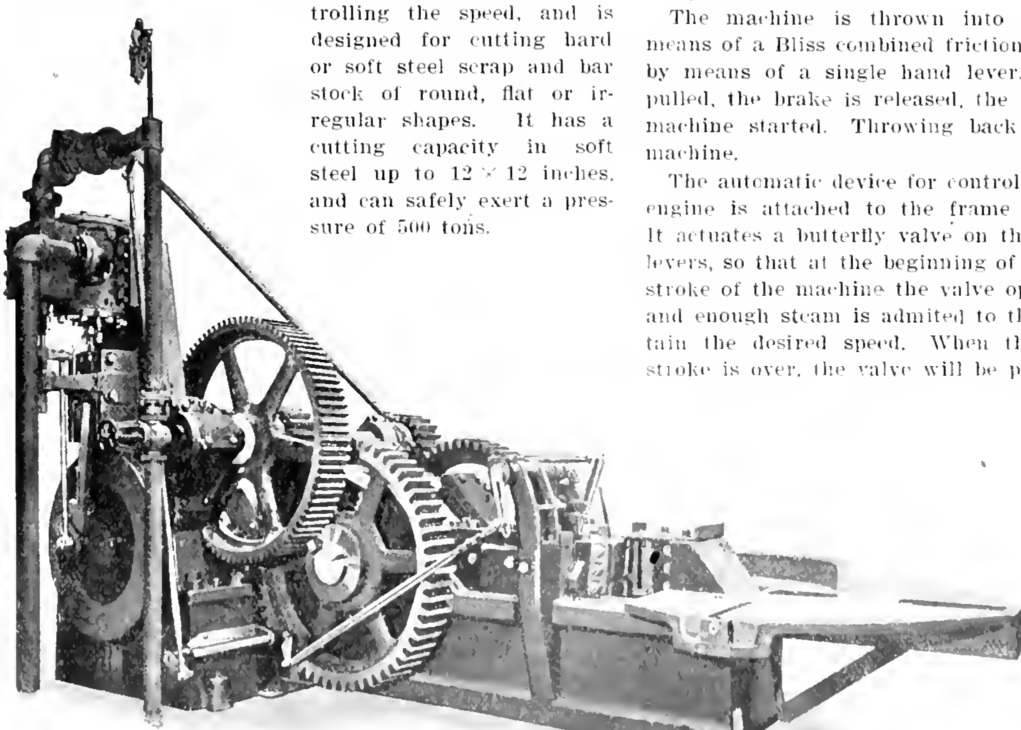


Fig. 2. New Model 11-inch "Star" Lathe, built by the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

BLISS HORIZONTAL SHEARING MACHINE

The accompanying illustration shows a special horizontal shearing machine built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The machine is driven by an independent steam engine, provided with an automatic device for controlling the speed, and is designed for cutting hard or soft steel scrap and bar stock of round, flat or irregular shapes. It has a cutting capacity in soft steel up to 12 × 12 inches, and can safely exert a pressure of 500 tons.



Bliss Heavy Horizontal Shearing Machine

The slide carrying the cutting knife is designed rather long for the purpose of providing proper guidance. The socket and pin for the pitman end are near the middle of the slide; in this way the downward pressure of the pitman is utilized for minimizing any lifting tendency due to the shear of the knives. The slide is held in position and guided by beveled gibs, firmly bolted both horizontally and vertically. These gibs are designed with a view of making provision for taking up the wear. The stroke of the slide is 4½ inches, which allows the moving knife to safely clear the bar or piece when it is fed in to be cut. The pitman is of cast iron, and the frame, slide and gearing are steel castings. The crank-shaft is made of 50-point carbon open-hearth steel and is 10 inches in diameter in the bearings; the eccentric portion, which serves as a crank, is 14½ inches in diameter. The shaft is driven from both ends, there being a main driving gear on each side of the press. This arrangement tends to reduce the stresses, and makes possible a more rigid and compact machine.

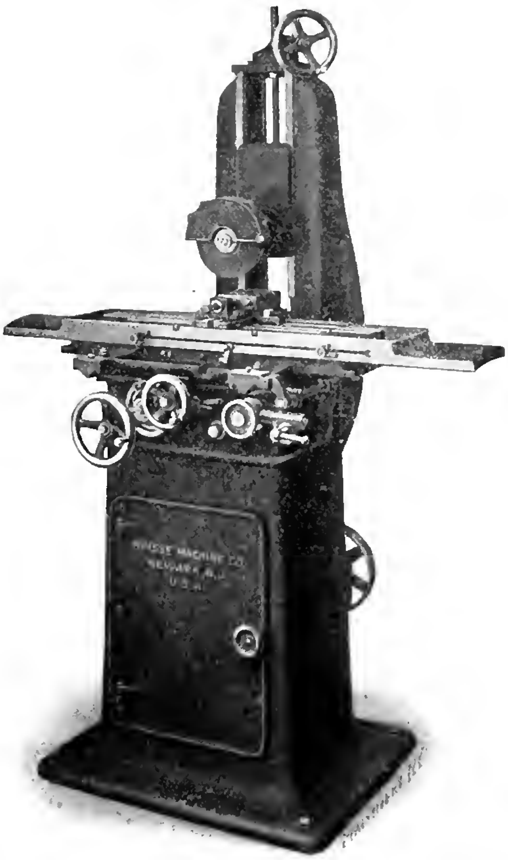
The machine is thrown into operation and stopped by means of a Bliss combined friction clutch and brake operated by means of a single hand lever. When the hand lever is pulled, the brake is released, the friction thrown in, and the machine started. Throwing back the hand lever stops the machine.

The automatic device for controlling the speed of the steam engine is attached to the frame and slide of the machine. It actuates a butterfly valve on the engine through rods and levers, so that at the beginning of the working portion of the stroke of the machine the valve opens wider than previously, and enough steam is admited to the engine cylinder to maintain the desired speed. When the working portion of the stroke is over, the valve will be partly closed, thereby reducing the amount of steam admitted to the engine, and thus preventing excessive speed. This device takes the place of the usual engine governor.

The cylinder of the steam engine is 12 inches in diameter and the stroke is 14 inches, the speed of the engine being from 200 to 250 revolutions per minute. All the gearing is machine cut, and it has a ratio of 17 to 1, which gives a speed of from 12 to 15 strokes per minute to the slide of the machine. With a steam pressure of 80 pounds, the engine will deliver from 70 to 90 H. P. at the speeds mentioned above. The total weight of the machine, including the engine, is approximately 65,000 pounds.

BINSSE SURFACE GRINDING MACHINE

An improved design of surface grinding machine, as shown in the accompanying illustration, has been brought out by the Binsse Machine Co., Newark, N. J. The most important improvements of the design are the added rigidity and the provisions for taking up wear and preserving the alignment—



Surface Grinding Machine built by the Binsse Machine Co., Newark, N. J.

the most important points in securing long life in grinding machinery. The working parts and the feed mechanism have also been efficiently protected from dirt and chips by ample covers and guards, and the arrangement of hand-wheels and levers has been taken care of in such a manner that the greatest possible ease in the manipulation of the machine is assured.

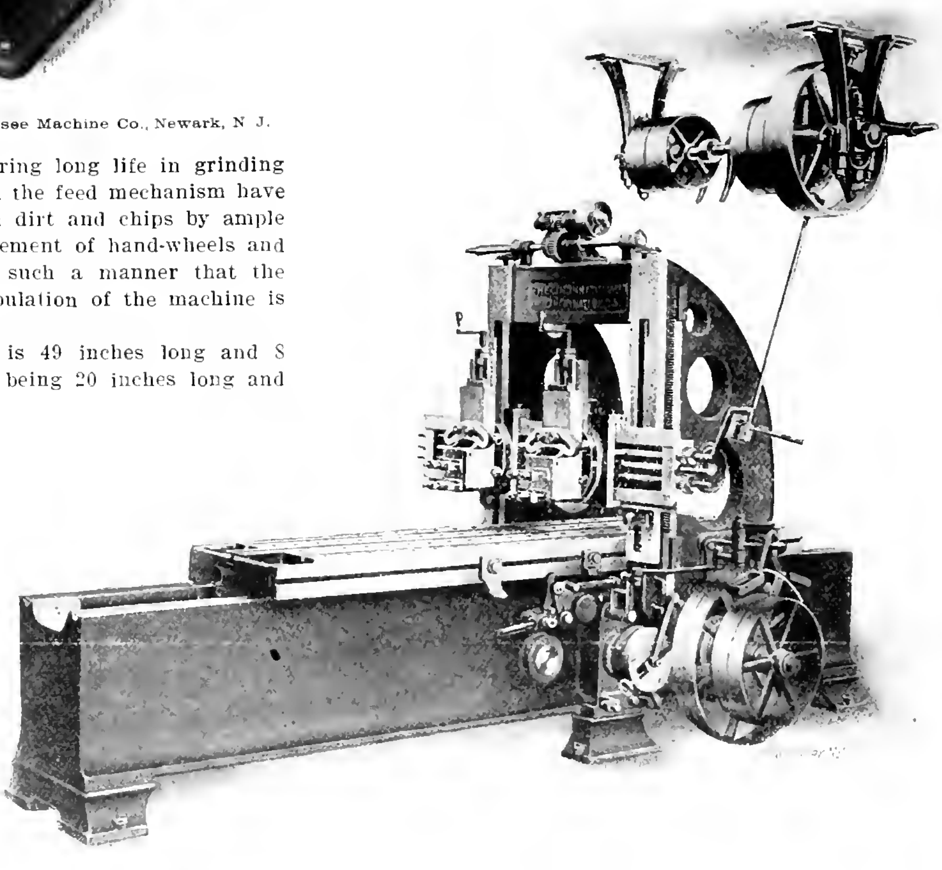
The work-table of the machine is 49 inches long and 8 inches wide, the working surfaces being 20 inches long and 6 inches wide with three slots ½ inch in width. The largest piece of work which can be ground on the machine, using a 7-inch diameter wheel, is 20 inches long, 6 inches wide and 10 inches high. The table is provided with automatic motion in the longitudinal direction, and an automatic cross feed. The length of the stroke is regulated by dogs in the usual manner. The reversing lever can be turned down so it will clear the dogs, thus enabling the table to run past the reversing position, if required, without changing the adjustment. A hand-operated movement for the table is also provided which enables the operator to move the table by hand without changing the automatic feed. The automatic cross-feed movement of the table may be worked in either direction, and it can be stopped automatically when the cut has passed over the work.

The spindle is made of tool steel and is hardened, ground and lapped, and runs in bronze boxes provided with adjustment for taking up all lost motion. The end of the spindle is tapered to receive the wheel flanges. The vertical movement of the spindle is controlled by a hand-wheel at the top of the machine, as shown, which is provided with a graduated dial reading to one-half thousandths of an inch. The shortest distance from the spindle center to the table is 3½ inches and the maximum distance 13½ inches. The maximum size wheel that can be used is 7-inch diameter by ½-inch face.

The machine is equipped with a 7-inch emery wheel, ½-inch face, 1¼-inch hole, with one pair of wheel flanges; a complete separate counter-shaft with tight and loose pulleys, 8 inches in diameter for a 3-inch belt; wrenches and spanners; and flanged vise with hardened jaws, 4⅛ inches long, 1 1/16 inch deep, opening to 2 inches. The counter-shaft should run at a speed of 360 revolutions per minute. The net weight of the machine is 1,500 pounds, and the floor space 6 feet by 3 feet.

CINCINNATI TWO-SPEED PLANER DRIVE

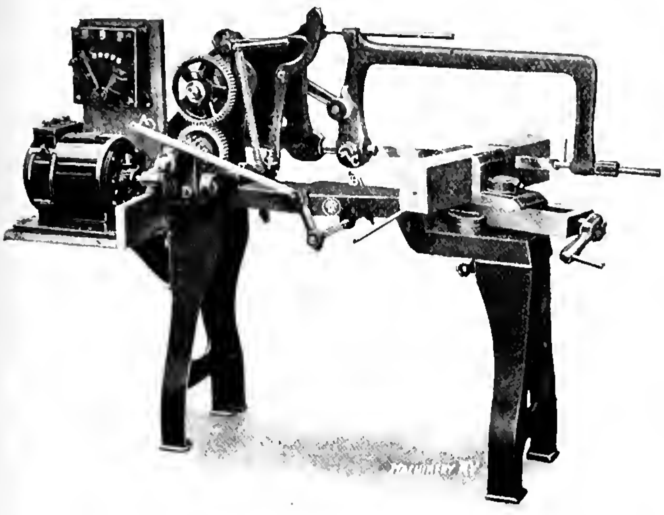
The accompanying illustration shows a planer provided with a two-speed drive brought out by the Cincinnati Planer Co., Cincinnati, O. By means of this drive two cutting speeds for the table are obtainable with a constant return speed. Either of the two cutting speeds can be obtained instantly, and change from the one speed to the other can be made while the machine is running. The speed change is accomplished by the arrangement of the pulleys in the counter-shaft, the drive consisting of two sets of pulleys, one pulley in each set being keyed to the shaft and the other pulley running loose. By operating the lever shown at the side of the housing, either speed required is obtained, the high speed by moving the belt to the right and the low speed by moving the belt to the left. The return belt remains in one position, giving a constant return speed to the table, as mentioned. The simplicity of construction and ease with which the device can be manipulated, makes it very useful for the planer drive; and it can be applied advantageously to all planers from 22 inches to 36 inches, inclusive.



Cincinnati Planer Co.'s Two-speed Planer Drive with Constant Return Speed

ROBERTSON MOTOR-DRIVEN HACK-SAW

The accompanying illustration shows a motor-driven hack-saw built by the Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. The machine shown is known as the No. 3 saw, but all the sizes of the company's saws may be motor-driven by using the same attachment as applied to the present machine. The motor is mounted on a bracket secured to the rear leg of the frame of the machine and provision is made on the same bracket for mounting the rheostat or starting box. The machine is provided with an automatic stop arrangement working through the levers *A* and *B* and actuated by the pin *C*. Lever *A*, shown disconnected in the engraving, connects the switch handle with the cutting mechanism, and when the cut is completed, pin *C* will trip lever *B*, thereby throwing the switch and stopping the machine by cutting off the current.



Robertson Motor-driven Hack-saw

The machine is driven from the motor through a worm and worm-gear, the worm being placed on the motor shaft inside of the housing *D* and the worm-gear on a shaft on which a spur gear is also mounted from which in turn the power is delivered to the reciprocating saw mechanism. The worm and worm-wheel run in oil.

The machine can be conveniently mounted on a platform or truck and taken to any place inside or outside of the shops, where beams, bars or other steel parts have to be cut. It thus serves the purpose of a portable machine, and the only thing necessary is that electric power be available, so that the machine can be easily connected by wiring at any place where it is to be used.

STARRETT'S MACHINISTS' AND TOOL-MAKERS' TOOLS

A number of new machinists' and tool-makers' tools have been recently brought out by the L. S. Starrett Co., Athol, Mass. Fig. 1 shows a taper gage in which the thin leaves

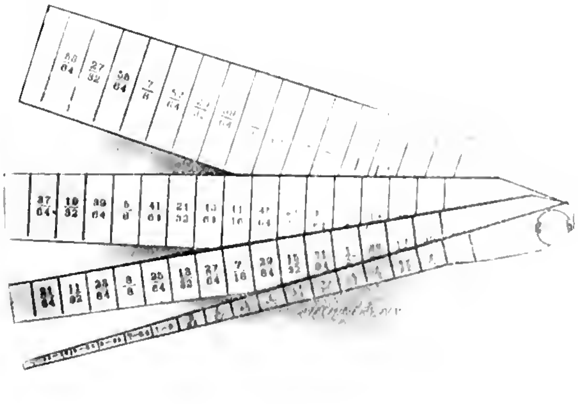


Fig. 1. Starrett Taper Gage

are tapering, the widths varying by 1/64 inch for every quarter inch of the length of the gages. The gages are graduated by lines ¼ inch apart, and on each gage is stamped the width at each division, the graduations reading by 64ths from 1/16 up to 1 1/16. The gage is designed for brass and steel tube manufacturers, for inside measurements, and is also convenient for tool-makers and machinists when measuring the width of slots and the size of holes, as well as for setting calipers to size within its capacity.

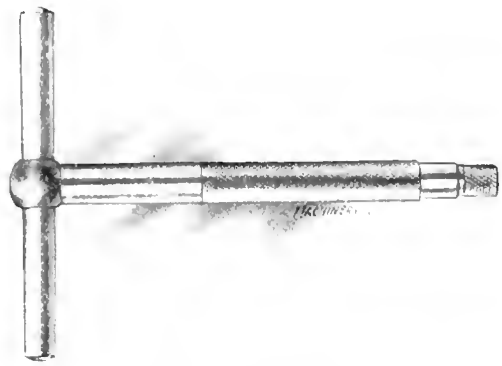


Fig. 2. Telescoping Gage used in conjunction with Outside Micrometer for Inside Measurements

Fig. 2 shows a telescoping inside gage by means of which the exact size of holes or slots can be measured by outside micrometers, so that various classes of fits, varying in thousandths of an inch or less, can be made and measured without resorting to inside micrometers. The instrument is used in the following manner: The telescoping head is compressed and the plunger locked by a slight turn of the knurled screw in the end of the handle. The head is then inserted inside of the hole to be measured, the lock is released, and the plunger allowed to expand to fit the hole. Then the plunger is again locked by a slight turn of the screw. The instrument is withdrawn and is calipered over the ends of the head with a micrometer, thus obtaining the exact size of the hole. The ends of the telescoping head are hardened and are made to a radius equal to that of the smallest hole the instrument will enter. The gages are made in five sizes, the total range of the complete set being made to enter holes from ½ inch to 6 inches.

In Fig. 3 are shown a number of tool-makers' buttons with screws and washers for jig work. The buttons are hardened

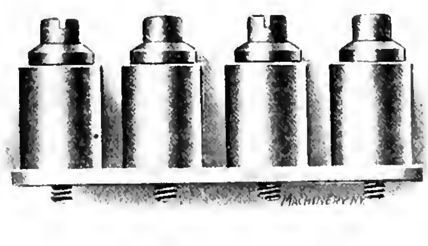


Fig. 3. Tool-makers' Buttons with Screw and Washers for Jig Work

and ground to exact standard size, the diameter being 0.400 and the length ½ inch. The use of these buttons in jig making is well-known to tool-makers, and constitutes one of the most accurate methods for laying out holes with accurate center distances in jigs. These buttons are furnished in sets of four screwed into a small plate, which makes a convenient holder for them when not in use.

MAYMONT SELF-OILING LOOSE PULLEY

The accompanying half-tone illustrations, Figs. 1 and 2, and the line engraving Fig. 3, show a new design of loose pulley brought out by the McMaster-Carr Supply Co., 176 Lake St., Chicago, Ill., and known as the Maymont self-oiling loose pulley.

As shown by the illustrations, the pulley is made in halves and bolted together, and provided with an oiling collar between the two halves. Fig. 1 shows the outside of the enlarged hub which encloses an oil reservoir. This reservoir is plainly shown in Fig. 2, where the two halves of the pulley are shown before final assembling. The two halves are bolted together with a thin oil-proof gasket between, to prevent leakage of oil. The oil distributing collar is fixed to the shaft by two set-screws, and therefore also serves the purpose of shaft collar, so that no outside collar is needed.

Fig. 3 shows the construction of the pulley. A is the collar with its two set-screws. All the rest of the pulley is free to rotate on the shaft. The collar has two curved wings or lips B, extending outward so that they nearly touch the inside walls of the oil reservoir. Close inside of these wings

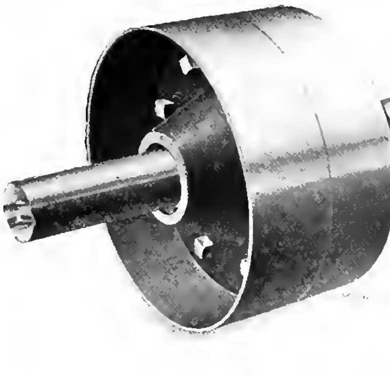


Fig. 1. The Maymont Self-oiling Loose Pulley

are inclined drilled holes C passing through the body of the collar and leading to the shaft at each side. Cored into the hubs at the outer ends are recesses D and E, the former closed and the latter open, as shown. These recesses are connected with the central reservoir by four drilled channels F. As the pulley rotates, these holes at their reservoir ends pass close to the wings of the fixed collar.

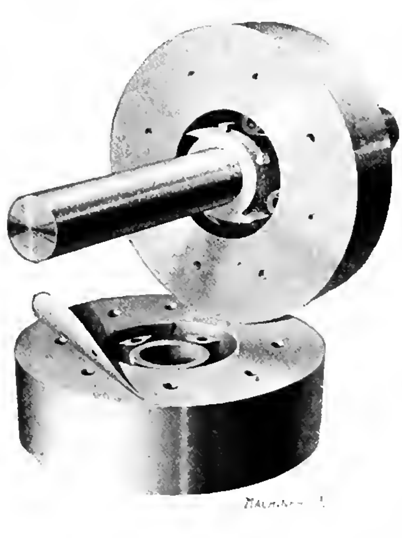


Fig. 2. View of Pulley in Halves, showing Oil Reservoir and Collar

The operation of this device is as follows: As the pulley rotates, the oil in the reservoir is carried up by the wings B of the collar, and forced into the holes C leading to the shaft, where the oil passes directly onto the surface between the hub halves and the shaft. Working along either way of the shaft, the oil reaches the end recesses D and E, where the centrifugal force carries it outward to the ports F and through them back into the reservoir. As the oil returns through the channels F, the wings B collect it and again force it into the holes C; thus continuous circulation of oil is automatically maintained.

The joint between the two halves of the pulley is made tight by a thin oil-proof gasket as shown in Fig. 2. The centrifugal force prevents oil from leaking out along the shaft when the pulley is in motion, and when it stops the

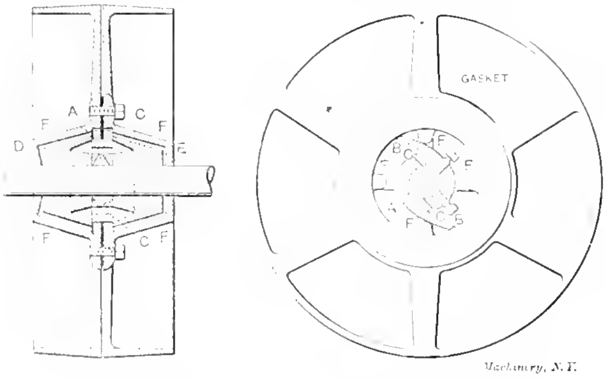


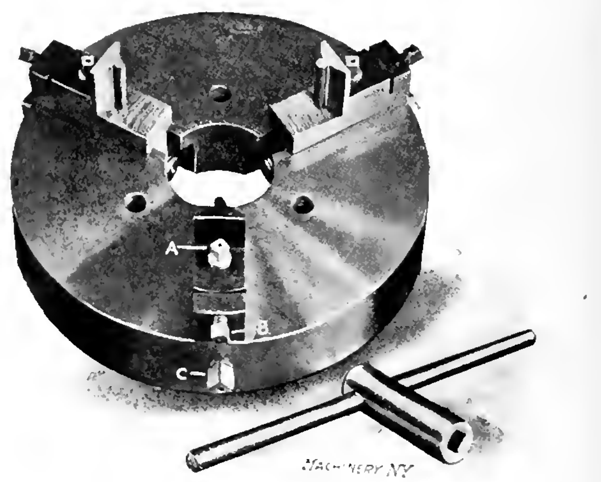
Fig. 3. Section of Self-oiling Pulley, showing Construction

oil in the channels F above the shaft will drain to the recesses D and E, and from there down around the shaft to the bottom of the reservoir. The oil is fed in with the pulley in motion by feeding it in at the open end E of the pulley. As there is practically no loss of oil, an addition of a small amount of oil once a month usually maintains the supply.

With slight alterations the construction can be changed to suit vertical and inclined shafts. The pulley is made regularly in sizes from 6 to 30 inches diameter, and with width of face to suit conditions. Special sizes of pulleys are made to order.

SKINNER CHUCK FOR HOLDING AUTOMOBILE GEARS

The accompanying illustration shows one size of a line of special three-jaw universal chucks designed especially for holding automobile gears on the pitch line, and made by the Skinner Chuck Co., 94 No. Stanley St., New Britain, Conn. This line of chucks is especially adapted for use on grinding machines when grinding the holes of hardened gears true with their pitch circle. The chuck shown in the illustration is known as the 12-inch size and is set for a 6-pitch gear with a number of teeth which can be evenly divided by 3. Within



Skinner 12-inch Chuck for Holding Gears true with the Pitch Circle

its range it will hold the gear true at the pitch line at three points. When the number of teeth in the gears is not evenly divisible by 3, it is necessary to loosen the binding screws A on two jaws, leaving the third jaw stationary. The gear is then placed in the chuck, and the jaws are adjusted by means of the pinion screws C, each jaw being thus permitted to find its own place. The binding screws are then tightened enough to hold the top of the jaws in this position. The gear is removed and each jaw is set an equal distance from the center by means of the independent adjusting screws B, a test indicator being used for this purpose. Then the binding screws are firmly tightened and the chuck is ready for operation. Gears of any pitch can be held in these chucks by using interchangeable top jaws with rounded ends of suitable size for the required pitch.

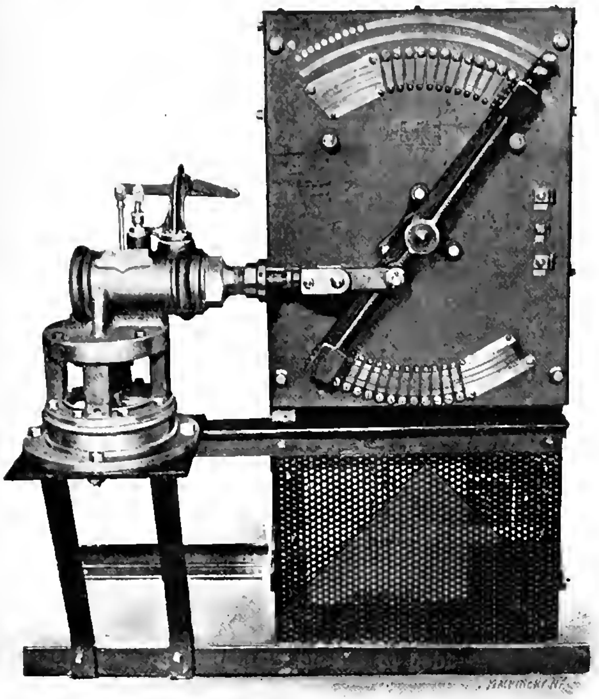
CUTLER-HAMMER PRESSURE-CONTROLLED SPEED REGULATOR

The accompanying illustration shows an interesting speed regulator built by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and intended for use in connection with electric motors operating the blower of a mechanical stoker, a boiler feed pump, a gas pressure blower, etc. It automatically regulates the speed of the motor to maintain the operating pressure practically constant.

The controlling equipment for use in connection with a direct current motor consists of a standard hand-operated starting rheostat (provided with no-voltage release) and a special speed regulator designed to vary the speed of the motor in accordance with the variations of pressure of the boiler system served by the stoker. The speed regulating part of the equipment may be designed to reduce the speed of the motor below its normal rated speed by inserting resistance in the armature circuit, or to raise the motor speed above normal by field weakening, or by a combination of these two methods.

A direct current blower regulator designed for armature and shunt field regulation is shown in the accompanying en-

graving. Another regulator is also designed for armature regulation only. The regulator consists of a slate panel mounted on the front of an angle iron cage, the panel carrying the contact segments over which a double-ended lever moves. The cage contains the necessary regulating resistance. The lever is actuated by the piston of a hydraulic cylinder, the admission and exhaust port valves of which are in turn controlled by the movement of a pressure regulator diaphragm, one side of which is subjected to the boiler



Cutler-Hammer Pressure-controlled Speed Regulator arranged for Armature and Shunt Field Regulation

pressure. The normal boiler pressure on the under side of the diaphragm is balanced by a weighted lever bearing on the top of the diaphragm in such a manner that the lever will rise or fall as the boiler pressure rises above or falls below the normal pressure for which the lever is counter-balanced. This up and down movement of the lever operates a pilot valve controlling the admission of water to the hydraulic cylinder, and due to the variations in pressure, the piston of the cylinder is moved back and forth, and in turn actuates the double-ended lever, the ends of which move over the contact segments on the slate.

The operation of cutting the resistance in and out of the circuit is not a continuous operation but proceeds step by step with pauses between each movement of the contact lever. This is accomplished by the bell crank connection shown above the cylinder. The lower end of this bell crank is connected to the piston rod of the cylinder and the upper end to the floating lever. Any upward movement of the weight lever results in an upward movement of the floating lever, admitting water to the right-hand end of the cylinder and forcing the piston to move inwardly (to the left), while any downward movement of the weight admits water at the left-hand end of the cylinder and forces the piston rod out (to the right). As soon as the piston begins to move, however, it exerts through the bell crank connection a pressure on the floating lever exactly contrary to the movement produced by the weight lever; that is, if under the influence of increasing steam pressure the weight lever moves up, the pilot valve stem and floating lever will also move up, and the piston rod of the cylinder will start to move to the left. This movement of the piston, however, is presently checked by the operation of the bell crank attached to it which pulls down on the floating lever, depresses the pilot valve stem, and shuts off the water pressure, stopping the movement of the piston and the lever on the slate actuated by it. Thus the lever proceeds step by step with a pause after each movement, resulting in a gradual cutting out of resistance and increase in motor speed.

The cylinder has been assumed to be hydraulically operated in the description above, but if water pressure is not available the same results are accomplished by connecting the inlet of the cylinder to a compressed air tank; the pressure, however, whether air or water, should not be less than 25 pounds per square inch. The system, as described, applies to direct current motors, but a regulator can also be furnished for alternating current motors, the operation being similar to the one described.

MULTIPLE TOOL-HOLDER FOR THE LATHE

A multiple tool-holder which was invented by Mr. F. J. Brewer and placed on the market by the Multiple Tool-Holder Co., 3197 West 48th St., Cleveland, O., is shown in the accompanying illustrations. As shown in Fig. 2, this tool-holder can be used for holding four tools at a time, and it is, in fact, a small temporary turret which can be applied to any engine lathe. Provision is made for indexing the upper part of the holder to different positions, so that the tool is particularly useful when a number of similar pieces are to be made and but few operations are necessary. This holder can also be used with equal advantage for chucking work, boring and turning. It is provided with a T-shaped bottom piece which fits in the slot where the usual tool-post is attached to the cross-slide of the lathe. This bottom piece, *B*, Fig. 1, is held in place by two set-screws *C* so that it will not shift when the top part of the holder is loosened for the purpose of indexing it. Indexing pins *D* for accurately locating the upper or turret part of the holder, are provided. These pins, which operate in threaded bushings screwed into the bottom piece, are pressed against the plate *E* by springs *F*, so that when the turret is turned it is easy to determine when the pins are in alignment with the holes in plate *E*. This plate has eight holes, and it is screwed and doweled to the bottom of the tool-holder proper. All indexing parts are made of hardened tool steel and the holder proper is a steel casting. The tools are adjusted vertically by the ordinary shoe or wedge, one of which is shown in Fig. 2. Each tool is held in place by two set-screws, and it can be clamped in either of two positions at right angles to each other. When the holder and the tools are properly adjusted, it is securely locked in position by turning the center clamping nut *A*. One-half a revolution of this nut releases the holder so that it may be indexed. When this nut is released the turret part of the holder is lifted by

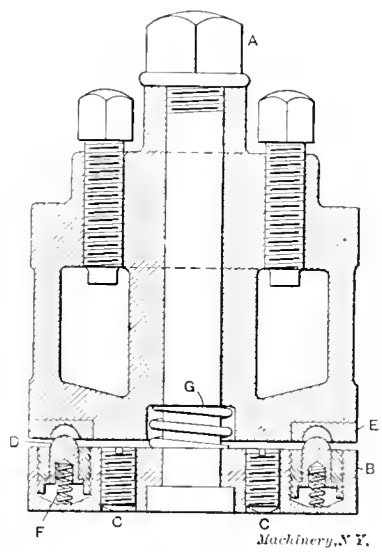


Fig. 1. Sectional View of the Brewer Multiple Tool-holder

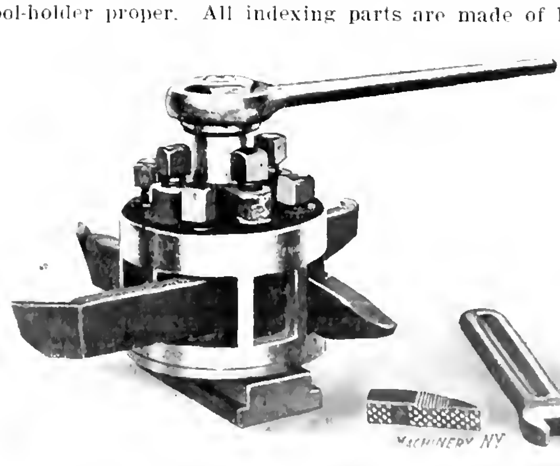


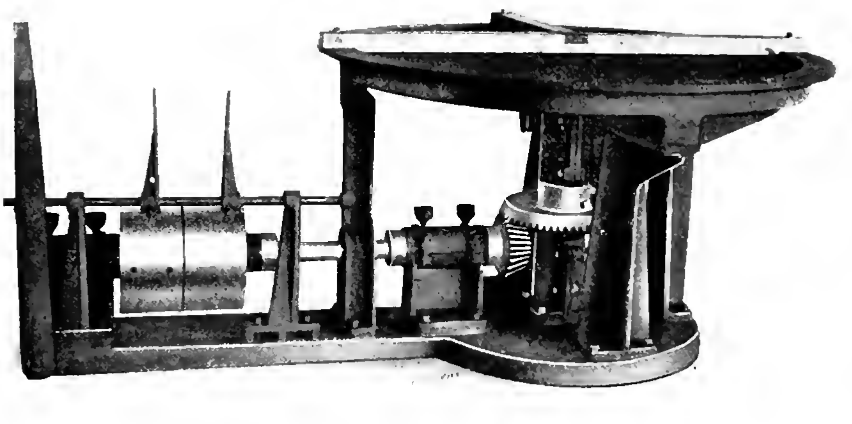
Fig. 2. Brewer Multiple Tool-holder for the Engine Lathe

a central spring *G*. As this tool-holder practically transforms an engine lathe temporarily into a turret lathe for work where only a few operations are required, it will undoubtedly prove a useful tool in any machine shop, particularly as it can be very quickly attached and detached, and in no way interferes with the usefulness of the lathe for ordinary straight turning work.

BESLY HORIZONTAL DISK GRINDER

The accompanying illustration shows a new 48-inch horizontal disk grinder brought out by the Charles H. Besly Co., 15 So. Clinton St., Chicago, Ill. This machine is designed for grinding large surfaces such as fire doors, door jams of furnaces, stove doors, and large gear case covers for automobiles.

The method by which the machine is driven is clearly shown in the illustration. The belt used for driving is 8 inches wide and runs on a 12-inch diameter pulley from which the power is transmitted to the grinding wheel spindle by means of a 2-inch horizontal shaft and bevel gearing. The gears have planed teeth, and all gears and pulleys are keyed and held in place by set-screws directly on the keys. The vertical spindle, to which the large bevel gear is attached, is 3 inches in diameter at the bearings and 6 inches in diameter at the wheel collar, and is provided with a pilot 2 inches in diameter for holding and centering the disk wheel. The thrust is taken by two hardened tool steel blocks, one of which is secured to the lower end of the spindle and rotates



Besly No. 19. Forty-eight inch Horizontal Disk Grinder

with it, while the other is secured to the bed plate. Proper attention has been given to the lubrication of this thrust bearing.

The spindle and driving-shaft bearings are 9 inches long and are of the split type, babbitted and reamed. The disk wheel is 48 inches in diameter and provided with ribs radiating from the hub to the outer rim. The thickness at the hub is $2\frac{1}{2}$ inches, between the ribs $\frac{3}{4}$ inch, and at the rim $1\frac{1}{2}$ inch. A guard ring is provided around the disk wheel, projecting $\frac{3}{4}$ inch above the face of the wheel. This prevents the work from flying off the disk wheel while being ground. The top surface of the guard ring is machined true with the face of the disk wheel, so that bars, jigs, etc., for holding the work to be ground can be secured to it. The speed of the disk wheel is 400 revolutions per minute, and the bevel gearing being in the ratio of 1 to 2, the driving shaft should run at 800 revolutions per minute. The machine can be driven either direct from the line-shaft or from a counter-shaft as required. The operating space for the machine is 8 by 10 feet, and the height over all 32 inches. The net weight of the machine complete is 2,400 pounds.

MOTOR-DRIVEN SENSITIVE DRILL

In the June, 1908, issue of MACHINERY, a sensitive drill built by the Rockford Machine & Shuttle Co., of Rockford, Ill., was described. An improvement on this machine was illustrated in the department of New Machinery and Tools in the March, 1909, issue of MACHINERY. The improvement related particularly to the drive, the general arrangement of the machine being unchanged. The company has now brought out a motor-driven machine of the same general design as the one described in the previous issues. The driving cone, however, is eliminated, and a bracket is provided instead on the lower part of the column on which is placed the motor and starting box. The bracket for the motor is mounted on a slide which is vertically moved by means of an adjusting screw so that the tension on the driving belt can be varied. This movement permits an adjustment of 3 inches, which is sufficient to take care of the stretch of the belt for a long time without requiring that the belt itself be shortened. In all other details the machine is the same as that which has previously been described in MACHINERY.

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NEW MACHINERY AND TOOLS NOTES

ANGLE BENDER: Estep & Dolan, Sandwich, Ill. This machine has a capacity for bending round or square stock cold, up to $1\frac{1}{4}$ inch in size, to a right angle, and it can be used for bending flat stock up to 4 by $\frac{1}{2}$ inch.

IMPROVED BALL BEARING UNIVERSAL JOINT: B. Frank Teal, Glenside, Pa. In this device the journal friction on the trunnions has been largely eliminated by using a ball bearing trunnion with automatic lubrication. The bearings are dust-proof. The weight and dimensions are no greater than of the ordinary type of universal joints.

HEIGHT GAGE: Louis Mastrangal, 35 Spring St., West Hoboken, N. J. This instrument is designed to provide means whereby the distance between a stationary surface and a given point outside of it may be accurately determined. It consists of a base carrying an upright, which in turn carries the gage mechanism proper.

"HIGHPOWER" TWISTED DRILL: Pratt & Whitney Co., Hartford, Conn. This is a flat twisted drill with a twisted taper shank and is practically the same as the Hackett twisted drill shown in the October, 1908, issue of MACHINERY. Another convolution has been added to the shank, however, to increase the holding power in the socket.

LINE OF POPPET DROP HAMMERS: Miner & Peck Mfg. Co., New Haven, Conn. These hammers are adapted particularly for silverware, jewelry and similar light stamping work, and are used as plain drops, controlled by the foot or hand, and operated by the maker's lifting pulley, or automatic lifter. The four-poppet drop is made in five sizes of 50, 100, 150, 200 and 300 pounds, respectively, and the six-poppet in five sizes of 300, 350, 500, 600 and 800, respectively.

GASOLINE HEATING TORCH: Volcano Torch & Mfg. Co., Erie, Pa. This torch is intended for making or releasing shrinking fits of various descriptions, extracting broken taps and drills, brazing, straightening shafts and similar work between lathe centers, annealing, hardening and tempering tools, and for repair work in general. Pieces three inches in diameter can be heated to a red heat in from ten to fifteen minutes. The torch can also be used for illuminating by changing the burner plug.

UNIVERSAL PLATE, BAR AND ANGLE SHEAR: Covington Machine Co., Covington, Va. This machine is adapted both for boiler-makers and structural shops. The location of the angle shears permits right or left angles of even or uneven legs to be cut to any angle up to 45 degrees. The clutch mechanism is positive and stops the knives at the highest point of the stroke. A table and gages are provided for the double angle shear for cutting different angles. Bars may be cut in either the angle or plate shear.

GEAR TOOTH GRINDER: G. W. Baker Machine Co., Wilmington, Del. This machine is intended for grinding the teeth of cast spur and bevel gears, as well as of racks. The grinding head carries a wheel of a shape to suit the gear tooth to be ground. The machine is adapted for spur gears up to 36 inches in diameter, and an attachment is furnished for holding bevel gears at any required angle while being ground. The work is indexed by use of a tooth rest engaging with one tooth in the gear while another tooth is being ground.

HOB GRINDING ATTACHMENT: Brown & Sharpe Mfg. Co., Providence, R. I. This attachment, used on the company's No. 13 universal and tool grinding machine, is intended for accurate sharpening of spirally fluted hobs by grinding the faces of the teeth. The mechanism for revolving the hob resembles in design that of the spiral head used on universal milling machines. Hobs with from two to twenty grooves can be ground, index plates being furnished for indexing within these limits.

SCREW DRIVER: Lynn Tool Forging Co., 260 Maple St., Lynn, Mass. This tool consists of a very substantial handle and is provided with blades specially forged and inserted by a locking arrangement so that the screw driver cannot work

loose from the handle, and the annoyance usually met with on this score is eliminated. Three blades of different lengths and widths are provided with each handle. The blades are forged from square stock so that a wrench can be used on the screw driver if necessary.

Sand Blast Nozzle: Walter Macleod & Co., Cincinnati, O. This nozzle largely overcomes the expense and annoyance in connection with the use of sand blast, due to rapid wear of the nozzles. By a special construction a film of air is interposed between the sand and the nozzle, which in an effective manner prevents undue wear. The device works by suction, and the sand reservoir may be placed at any convenient point, as the nozzle will elevate the sand to a point up to 50 feet above the sand tank.

Universal Shear: C. C. Wais Machine Co., Cincinnati, O. This machine is designed particularly for boiler makers and structural iron workers for cutting plates, bars and angles of even and uneven lengths of legs. The changes required and the loss of time incident to cutting angles or plates on an ordinary punching and shearing machine are eliminated. The machine is built in five sizes, the largest adapted for angles 6 x 6 x 1 and 7 x 7 x 3/4 inch, and to cut plates 7/8 inch thick. The smallest will take angles 3 x 3 x 1/2 and 4 x 4 x 3/8 inch, and will cut 1/4-inch plates.

Blue-print Washing Machine: Williams, Brown & Earle, Philadelphia, Pa. This machine is intended to accompany the makers' blue-printing machine mentioned in the August issue of Machinery. The machine is attached to a water pipe and takes care of the blue-prints as they come from the printing machine, washing them and passing them over a gas drying arrangement; the prints can then be delivered at the rear either separately or in a continuous roll. In connection with the electric blue-printing machine referred to, four feet of prints can be printed, washed and dried per minute.

Double Crank Press: E. W. Bliss & Co., 5 Adams St., Brooklyn, N. Y. This machine is designed for accurate cutting and punching operations extending over the entire width of large sheets which are fed through the machine from front to back. The safe working capacity of the machine is from 100 tons for operations requiring great rigidity, up to 140 tons for less particular work. The machine can be provided with an automatic feed for sheets from 6 to 10 feet wide and up to 40 inches long. It is driven by a direct connected 10 H. P. motor and makes 18 strokes per minute.

Hydraulic Beam Shear: Watson-Stillman Co., 192 Fulton St., New York City. This machine is designed for cutting I-beams, channels, flat bars, angle irons and other structural shapes, and may be used for cutting round sections in emergencies by removing the regular cutting mechanism. It can also be readily converted into a powerful hydraulic press for general work. The machine is made in two sizes to take beams and sections having the longest dimensions 15 and 24 inches, respectively. It is hydraulically operated. The weight of the smaller size shear is 12,000 pounds, and that of the larger, 16,500 pounds.

Automatic Two-jaw Chuck: Cleveland Chuck Co., 514 Garfield Bldg., Cleveland, O. This chuck is intended as a substitute for the old style box chuck. It is mechanically operated, but its action is similar to that of a pneumatic chuck, while the expense of installing and maintaining an air supply system is eliminated. The gripping action is accomplished by a rocking movement of the jaws, effected by the spreading of the rear ends by the axial movement of a conical collar. One pair of jaws is required for every 1/16 inch difference in diameter of the work, but the device is so designed that the change for different sizes is very quickly made.

Drill Press with Universal Table: Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. This machine, known as the tilting table drill press, is provided with a table which can be swung to any position in the vertical plane. It is operated by worm and worm gear, and graduations up to 90 degrees are provided so that the table can be set accurately to a given angle. After the table has been swung into an angular position it can be turned on its center bearing so as to bring the work to any position under the drill. It can be tilted over to either side of the knee, and clamping bolts are provided to secure it firmly in any position.

Machine for Testing Hardness of Metals: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This machine is designed for use in every-day shop practice for testing the hardness of locomotive tires and other material entering into locomotive construction. The test is made by means of the Brinell method, using a ball which is subjected to a standard pressure for different materials. A dial is provided where the amount of penetration of the ball in the material tested may be read off directly without calculations. To make a test with this machine requires less than a minute, including the time necessary for inserting and removing the test specimen.

Transmission Devices: Carl M. Wheaton, 9 Callender St., Providence, R. I. The devices brought out include a self-oiling bearing in which the oiling device consists of a number of cork balls contained in tubes and held in contact with the shaft by their buoyancy or inclination to float on the oil; a method of hanging shafting in rooms with high ceilings, consisting of brackets holding a pipe which in turn supports the hangers; a clutch pulley where centrifugal action is made use of for throwing out a counter-weight holding the friction surfaces out of contact except when forced into position by the clutch lever; and a loose pulley with special oiling arrangement.

Hydraulic Coping Machine: Watson-Stillman Co., 192 Fulton St., New York City. This machine, designed for trimming structural shapes, small pieces of plate metal, bar iron, etc., is especially intended for use in steel mills, shipbuilding plants, and structural iron, boiler and locomotive shops. It is operated by hydraulic pressure and consists essentially of a heavy steel beam or lever actuated from the rear, and having the forward end fitted with shearing knives. The construction offers a large number of cutting combinations, the change from any one of which can be made in less than a minute's time. The machine is operated by a foot lever. The total weight of the machine is 4,700 pounds.

Testing Machine of 1,200,000 Pounds Capacity: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This testing machine has been designed for the new testing labaratory of the Rensselaer Polytechnic Institute of Troy, N. Y. The method of weighing the load is a departure from all previous methods. The pressure in the main cylinder is transmitted to a diaphragm, which is exactly 1/25 of the area of the main press cylinder. The pressure on the diaphragm is communicated to a lever system terminating in a standard dial vernier screw beam. As the transmission of pressure through the diaphragm is frictionless, the amount of pressure is thus weighed with great accuracy.

Double Seamer for Cans: Charles Leffler & Co., 49 Clymer St., Brooklyn, N. Y. This machine, known as the No. 21 double head automatic square double seamer, will simultaneously double seam the top and bottom to the body of square and irregular cans, such as cocoa cans, powder cans, etc. The machine is entirely automatic and can be operated by one man. All that is required of the operator is to put the cans on and off of the machine and press the treadle. Despite the complicated movements required, the machine works as easily as single end machines, and runs at the same speed. It will take work up to 8 inches wide and 12 inches high. It is possible to double seam more than 10,000 can ends, of certain shapes, per day.

Steam Turbine: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This steam turbine is the outcome of several years of experimenting; as far as possible the weaknesses of other turbines have been avoided, and structural strength is one of the main features of the design. The steam is expanded completely in the nozzles, so that there is no difference in pressure between the buckets in the wheel and the reversing chamber, and consequently no loss from leakage. This makes it possible to run with a very large clearance without the primary losses in efficiency common in most turbines and caused by steam friction and leakage. The turbine is made in types for operating both condensing and non-condensing, and also to run on exhaust steam from reciprocating engines.

Speed Reducer: Foote Bros. Gear & Machine Co., 44 No. Carpenter St., Chicago, Ill. This device is designed for driving machinery running at relatively low speeds from a source of power running at a high speed. The speed reducer known as style D is particularly adapted for high reduction ratios, and will give any reduction of speed up to 60 to 1. These reducers can be furnished in seven sizes, in capacities from 1 to 50 H. P. The reduction of speed is obtained through spur gears, but the design provides for elimination of the usual objections to a spur gear speed reducer in that sufficient central support of the shaft between the high and low speeds is provided. There are no rotating parts in the interior that can get out of balance and cause vibration.

Flame Welding Outfit: Schaap Flame Utilities Corporation, 344 Cumberland St., Brooklyn, N. Y. This apparatus is designed for the purpose of fusion welding cast iron, aluminum and other metals by the heat generated by combustion of the illuminating gas. The special novelty of the device is the torch. A mixture of gas and air under high pressure is sent through the tip in the center of the torch, thus generating the heat for melting the metal to be welded. A mixture of gas and air under low pressure is forced through openings of the torch which surround the central nozzle and this mixture protects the central jet from the outside atmosphere; for this purpose the torch is composed of five tubes, one inside of the other, with a space between each for the low-pressure gas to pass through.

Drilling and Milling Machine: W. B. Knight Machinery Co., 2019-2025 Lucas Ave., St. Louis, Mo. This machine, known as the No. 2 Knight drilling and milling machine, is designed with the object in view of furnishing a machine on which a great variety of both drill press and vertical milling machine work can be done. It is built along the same lines as the original Knight machine, but is intended for much heavier duty. The machine is particularly advantageous to use upon work which requires drilling, boring and milling op-

erations which ought to be done at a single setting of the work. In this way greater accuracy is obtainable, and a considerable saving in time is effected. The table of the machine can be tilted, and is mounted so as to permit of rapid adjustment. This permits some of the operations required to be performed at an angle with some of the other operations.

IMPROVED PIPE MACHINE: Bignall & Keeler Mfg. Co., Edwardsville, Ill. This machine is designed for cutting off and threading pipe from 2½ to 8 inches inclusive, and has been constructed with a view of eliminating rocking gears and clutches. The speeds are obtained through a gear box and a compound sliding gear on one of the shafts, a speed plate attached to the box showing how to obtain the speeds for the various sizes of pipe. A single driving pulley is used, and the belt speed, consequently, is constant. The die-head is of the "low-down" type, placing the handles and die lever within easy reach of the operator, and is equipped with a special adjusting mechanism, making it very simple to operate. The chucks are of the independent type, each having three jaws, and the jaw slides are graduated and easily set to any required size of pipe. On the rear chuck, the slides are provided with flange grippers in addition to the regular pipe grippers, so as to hold flanged work. The pipe grippers are of hardened steel, are dove-tailed into the ends of the slides, and can be removed and sharpened.

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HEAVY TRAINS ON THE VIRGINIAN RAILWAY

The Virginian Railway, built by the late H. H. Rogers, is probably the most carefully engineered railway in the United States, if not in the world. It was planned with the idea of making a locomotive utilize its maximum hauling capacity from the coal fields in the Alleghanies to Tidewater. It was recently announced that 80 cars of 100,000 pounds capacity each had been hauled from Alleghany summit to Tidewater, the total weight of the cars being 4,310 long tons. This record was soon beaten by a train of ninety cars loaded with 100,000 pounds, drawn by a single Mikado type locomotive. The total weight of the train approximated 7,000 tons. The maximum adverse grade is about 0.2 per cent, compensated. The grades are such that the empty cars can be hauled back to the mines by a single locomotive in trains equivalent in length to the loaded trains. That is, a locomotive that is able to handle ninety cars to Tidewater is able to haul the empty cars back to the mines.

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PERSONAL

Herbert L. Beeler has been appointed advertising manager of the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio.

C. W. Wrenshall, superintendent of the Western Steel Car & Foundry Co., has been made general superintendent of the Pressed Steel Car Co., Pittsburg, Pa.

H. E. Longwell has been appointed consulting engineer with particular jurisdiction over the publicity department of the Westinghouse Machine Co., East Pittsburg, Pa.

W. A. Bole has been appointed assistant manager of the works of the Westinghouse Machine Co., East Pittsburg, Pa., with particular jurisdiction over the Trafford Works.

Otto J. Rantz, formerly in charge of the shop work at the Haverford College, Haverford, Pa., has been appointed superintendent of the Stephens Industrial School, Lancaster, Pa.

John Scott, a contributor to MACHINERY, recently was promoted to the position of factory inspector of the Tomson Co., Lowell, Mass.

H. L. Mills, president of the American Specialty Co., Chicago, has just returned from an extensive business trip through the East.

Hiram Pruim, for nearly ten years in the employ of the William Hahn Co., Chicago, makers of flexible shafts, has been made superintendent.

J. E. Stark, formerly with the Courier Koeth Mfg. Co., has accepted a position as superintendent of the Western Wire Goods Co., of Buffalo, N. Y.

R. L. D. Mackie, formerly with the Morgan Construction Co., Worcester, Mass., is now manager of the high pressure and pipeage department of the W. J. Scholl Co., Youngstown, Ohio.

W. S. Heger, of the Allis-Chalmers Co., who was formerly assistant to the president, has been placed in charge of the company's interests in southern California, with headquarters at Los Angeles.

Harold O. Rugg, a graduate of Dartmouth College, and now in the employ of the Missouri Pacific Railway, has been appointed instructor in civil engineering in the James Millikin University at Decatur, Ill.

S. H. Reck, of the Rockford Drilling & Machine Co., Rockford, Ill., sailed from New York August 26 on the *La Lorraine* for a two months trip in Europe. Mr. Reck expects to visit the various machine tool agencies in England and on the continent.

F. C. Armstead, supervising engineer of the stoker department of the Westinghouse Machine Co., who, for a number of years, has been located at East Pittsburg, Pa., has moved his headquarters to the Westinghouse Works, Attica, N. Y., where the stokers are manufactured.

Charles M. Robertson, formerly superintendent of the Colburn Machine Tool Co., Franklin, Pa., will henceforth be associated as special representative and expert with the E. L. Essley Machinery Co., 62 West Washington St., Chicago, selling agent for the Colburn Machine Tool Co. Mr. Robertson has a large and varied experience in the manufacturing and selling of vertical boring mills.

W. R. Chapin, who has been for five years connected with the Cleveland Twist Drill Co., Cleveland, Ohio, has engaged with E. C. Atkins & Co., saw manufacturer, Indianapolis, Ind. While with the Cleveland Twist Drill Co. Mr. Chapin was in charge of the chemical laboratory, heat treatment and experimental departments, and will have a similar position with E. C. Atkins & Co.

Charles T. Hawley, of Gardner, Mass., has been appointed assistant examiner in the patent office at Washington, and has, therefore, resigned from an important position with the Simplex Time Recorder Co., of Gardner, Mass. Mr. Hawley has been active as an inventor, and was formerly connected with the experimental department of the Draper Machine Co. of Hopedale, Mass. He graduated in 1898 from the Worcester Polytechnic Institute.

E. H. Fish, well known to the readers of MACHINERY as a frequent contributor to its columns, has been elected director of the new Worcester Independent Industrial School. For nine years Mr. Fish was associated with his father, Henry C. Fish, in the machine tool manufacturing business in Worcester, producing a line of engine lathes. Later he went to the Worcester Polytechnic Institute—from which he graduated in 1892—as instructor. He has been instructor in various subjects, and his experience in this work make him particularly fitted to take charge of a trade school designed primarily for the education of mechanics.

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OBITUARIES

T. H. Sears, builder of machinery, Holyoke, Mass., died July 30, aged fifty-eight years.

Fred W. Ridlan, treasurer of the Superior Grate Co., of Springfield, Mass., died July 27 at the age of thirty.

Levi M. Brown, who for more than thirty years was superintendent of the Gilbert & Barker Mfg. Co., Springfield, Mass., died July 15 at the age of seventy-three.

John Moore, superintendent of the machine shops of the Carnegie Steel Co., at Bellaire, Ohio, died by accident at Wheeling, W. Va., July 26.

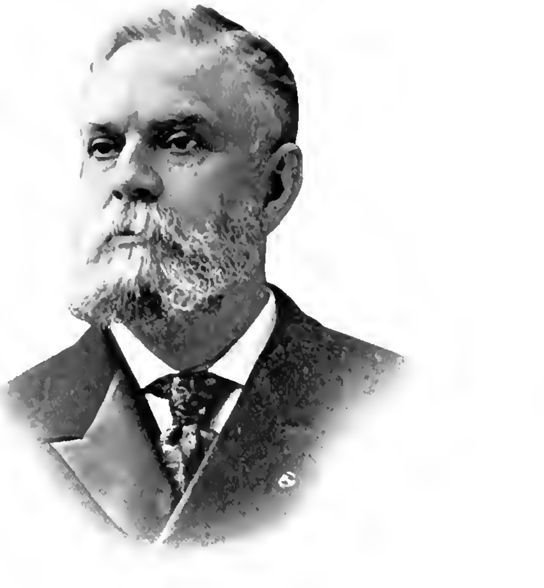
Henry Mitchell, well-known as an engraver of seals, medals and coats of arms, died at his home in Chelsea, Mass., August 1, in his seventy-fourth year. He entered the service of the United States Government as official engraver in 1868, and engraved the medals for the Centennial Exposition, 1876, before he was thirty years old.

John Morse Ordway died at his home in Saugus, Mass., July 5, at an age of eighty-six years. He was a graduate of Dartmouth College in the class of 1844, and was, up to three years ago, professor at Tulane University, New Orleans. He has also been a member of the faculty of the Massachusetts Institute of Technology.

David H. Gildersleeve, mechanical engineer, died at his mother's home, 104 Montague St., Brooklyn, July 30, aged forty-one. For five years Mr. Gildersleeve was sales manager for the C. W. Hunt Co. Early in 1909 he became vice-president of the Waters, Gildersleeve, Colver Co., in the shipbuilding and marine machinery business. He is survived by a widow and two children.

Leffert Lefferts Buck, a well-known civil engineer, who was associated with Roebling in the building of the Brooklyn bridge, and who was engineer of the Williamsburg bridge across the East River, New York, died at Hastings, N. Y., July 17. Mr. Buck also designed two steel arch bridges across the Niagara river, and had direction of many other engineering works of note both in this country and South America.

Roderick Perry Curtis, president of the Curtis & Curtis Co., Bridgeport, Conn., died at Southport, Conn., August 9, aged fifty-nine, as a result of injuries received in an automobile collision at Westerly, R. I., a few weeks previous. Mr. Curtis was born in New York, from where his family moved to Southport, Conn., in 1868. In 1882 he founded, with William D. Forbes, the firm of Forbes & Curtis, for the manufacture of the Forbes patent die stock. In 1887 the Forbes interests were taken over by Mr. Lewis B. Curtis and the firm of Curtis & Curtis formed to continue the business. In 1900 the firm was incorporated under the name of the Curtis & Curtis Co. Mr. Curtis was also director of several other manufacturing corporations.



Albert A. Pope

Albert A. Pope, pioneer bicycle manufacturer of the United States, died at his summer home in Cohasset, Mass., August 10. He was born in Boston in 1843, and at the age of nineteen he joined the volunteer force of the Union army, and was made lieutenant-colonel in 1865. In 1876, at the Centennial exposition in Philadelphia, he first saw a bicycle. Early in 1877 he organized the Pope Mfg. Co., and as soon as the company was organized he went to Europe to study the development of the bicycle and its possible manufacture in America. In 1878 he placed an order for the manufacture of bicycles with the Weed Sewing Machine Co., which concern he finally bought out, merging it with the Pope Mfg. Co. The business grew rapidly until, after twenty years, it comprised five large factories. In 1896 Col. Pope formed the Columbia Electric Vehicle Co., of Hartford, Conn. In 1899 the Pope Mfg. Co. was absorbed by the American Bicycle Co., but in 1903 the Pope Mfg. Co. was re-organized, and the factories became largely devoted to the building of automobiles. A lull in the motor car business proved unfortunate for the company, and after a period of financial readjustment, the company was again reorganized and incorporated last December under the laws of Connecticut. Col. Pope was prominent in many other industrial undertakings, and was also a director of several banks and other corporations.

Frank L. Bliss, president of the Ajax Iron Works, Corry, Pa., died in Corry, August 3. Mr. Bliss was active in the management of the company since its organization.

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COMING EVENTS

September 14-16. Fourteenth annual convention of the International Association of Municipal Electricians, Atlantic City, N. J. Frank T. Foster, secretary, Corning, N. Y.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one-hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

September 27-October 1.—Autumn meeting of the Iron and Steel Institute, London. G. C. Lloyd, secretary, 28 Victoria St., London, S. W.

October 3-9.—St. Louis Centennial Week, St. Louis, Mo. Balloon, airship and aeroplane races will be arranged under the auspices of the Aero Club of St. Louis.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12-13. Convention of National Machine Tool Builders' Association, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY'S seventh annual outing.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

NEW BOOKS AND PAMPHLETS

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS, Park Row Building, New York. Journal containing the constitution and list of members.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York. Pocket list of the 3,680 members, including the life members. The list appears in a new form, better adapted to the side pocket than the former shape, it being $4\frac{1}{4} \times 6\frac{1}{2}$ inches, or "standard" pocket-book size.

DICTIONARY OF CHEMICAL AND METALLURGICAL MATERIAL. 182 pages, $4\frac{1}{2} \times 7\frac{1}{2}$ inches. Published by the *Electro-Chemical and Metallurgical Industry*, 239 W. 39th St., New York City. Price $0.50.

This dictionary contains an alphabetically arranged list of chemical and metallurgical machinery appliances and material, manufactured and sold by advertisers in the *Electro-Chemical and Metallurgical Industry*. It is divided into three sections, the first or main section being a dictionary of industrial supplies, the second section giving a finding list of manufacturers of measuring instruments and laboratory supplies, while the third section is given up to a professional dictionary of metallurgical, analytical and engineering chemists, consulting engineers and patent lawyers.

WORKSHOP RECEIPTS FOR MANUFACTURERS AND SCIENTIFIC AMATEURS. VOLUME 1. 532 pages, $4\frac{3}{4} \times 7\frac{1}{4}$ inches. Published by Spon & Chamberlain, 123 Liberty St., New York. Price $1.50.

The older edition of "Workshop Receipts" has, during the past few years, grown into five bulky volumes, and the present edition therefore has been thoroughly revised and a great number of the receipts that seemed obsolete have been omitted. The remaining matter has then been carefully revised. The arrangement of the book is alphabetical, and the present volume treats of subjects from Acetylene Lighting to Drying. Outside of the alphabetical arrangement of subjects, a very complete index is given, which will be of considerable aid in finding certain subjects which have not been given a special heading in the main text.

ELEMENTARY PRINCIPLES OF INDUSTRIAL DRAWING. By George Jepson. 29 pages, 8 x 6 inches. 11 plates of illustrations. Published by the author, Roslindale, Boston, Mass.

The object of this book is to present the subject of industrial drawing by such a method that the student will master the fundamental principles without a great deal of preliminary study. Special efforts have been made to make the descriptive matter as short, simple and concise as possible, and to let the drawings largely explain the principles involved. The book should be of great value to beginners as well as to teachers of geometrical drawing, who desire to get a clear conception of the simplicity of the subject when viewed from the position of the practical user of mechanical drawing, rather than from the point of view of the mathematician or student of the theory.

A PRIMER OF THE CALCULUS. By E. Sherman Gould. 122 pages, $3\frac{3}{4} \times 6$ inches. 24 line engravings. Published by D. Van Nostrand Co., New York. Price $0.50.

This book, which is at present in its fourth edition, is No. 112 of the Van Nostrand Science Series. The work treates of calculus as far as the first differentials of algebraic functions of one independent variable, and their corresponding integrals. It is thus restricted to the first principles of the subject, but within its limits, however, it is reasonably complete and gives the beginner a clear idea of the far-reaching importance of calculus, even in its elementary steps. The book may well be recommended to students who want to acquire a general working knowledge of calculus and desire to become familiar with its fundamental principles.

STEAM POWER PLANT PIPING SYSTEMS. By William L. Morris. 490 pages, $6 \times 9\frac{1}{2}$ inches. 389 engravings. Published by the McGraw-Hill Book Co., New York. Price $5.

In this work the author has taken up the design, installation and operation of piping systems for power stations, giving a detailed and consecutive treatment of the entire subject. Only such parts of the power plant are dealt with as are directly related to the piping system. The design of boilers and engines has not been touched upon, as being outside the limits of the treatise, but their operation has been covered. All auxiliary apparatus in the pipe circuit between the boiler and engine and in the various piping systems for steam, oil, air, etc., are also described, and their general design discussed. The book embodies the personal experience of the author and is written from his own point of view. The main subjects of which the book treats are as follows: Piping diagrams and systems; condensers and heaters; live steam drips; blow-off and exhaust piping; air and oiling systems; oil and water purifying systems; details of piping arrangements for live steam, vacuum and atmospheric exhaust, boiler feed, fire pump suction, heater water supply and condensation, air and vacuum lines; city water piping; artesian water piping; fire service piping; hydraulic elevator piping; tile sewers and sundry minor piping details.

CATALOGUES AND CIRCULARS

TRENTON ENGINE CO., Trenton, N. J. Catalogue illustrating the Reeves compound and single cylinder steam engines.

PROTECTIVE VENTILATOR CO., 129-133 Fulton St., New York. Circular and leaflets advertising protective window ventilators.

AMERICAN BLOWER CO., Detroit, Mich. Card advertising the Detroit trap system for boiler feed, water lift and coil drainage.

FIRTH STERLING STEEL CO., E. S. JACKMAN & CO., agents, Chicago, Ill. Circular of Blue Chip high-speed steel.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue describing the construction of rock drills and drill mountings.

H. W. JOHNS-MANVILLE CO., 100 Williams St., New York. Folder describing safety blow-off sectional pipe covering, giving price list and directions for applying the covering to pipes.

SUCRO FILTER CO., 12 Broadway, New York. Catalogue of Sucro water coolers and filters, and filtration plants, showing a number of interesting devices for purification of drinking water.

AMERICAN TAP & DIE CO., Greenfield, Mass. Catalogue No. 3 of "Adamantine" screw plates, "Eagle" brand taps and dies, stocks and tap wrenches; also pipe tools, comprising stocks, taps and reamers.

ABBOTT BALL CO., 14 Hicks St., Hartford, Conn. Circular describing the use of the Abbott steel balls for finishing metal goods by the burnishing and tumbling process, using the Abbott tumbling barrel.

E. W. BLISS CO., 5 Adams St., Brooklyn, N. Y. Catalogue of Bliss steam turbines, describing the construction of the Bliss turbine and calling attention to the advantages of turbines over reciprocating engines.

FULLER & JOHNSON MFG. CO., Madison, Wis. Circular illustrating and describing the Fuller & Johnson diaphragm bilge pump outfits. A general description of the engine and pump is given, and the cost of operation is stated.

JNO. HY. ANDREW & CO., Ltd., Toledo Steel Works, Sheffield, England. Booklet giving information relating to the Toledo high-speed steel and instructions regarding its hardening, together with notes on the forging and tempering of the regular Toledo carbon tool steel.

KEUFFEL & ESSER CO., Hoboken, N. J. Leaflet calling attention to the fact that during the summer months quick-printing blue print paper should not be carried in stock more than one month, because the heat and moisture at this time of the year is detrimental to the paper.

GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4675, describing and illustrating a new single-phase induction motor of the repulsion induction type, designated as the type RI. Bulletin No. 4677, containing data relating to the Sprague-General Electric Type M system of control.

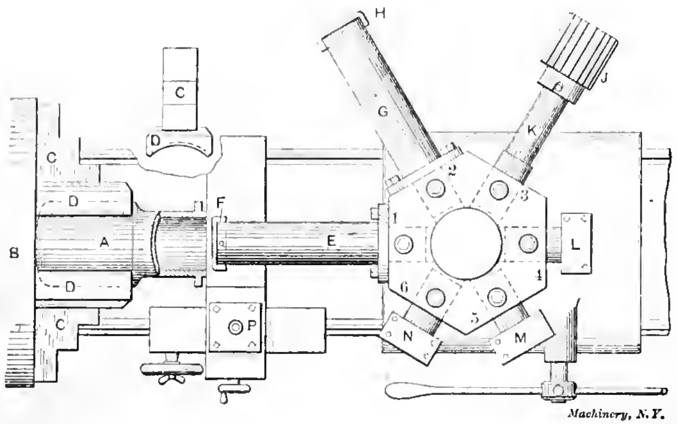
RUSSELL, BURDSALL & WARD BOLT & NUT CO., Port Chester, N. Y. Catalogue of bolts and nuts, comprising Philadelphia turned head eagle carriage bolts, turned bevel head carriage bolts, loom bolts, cold punched square and hexagon nuts, square head cap screws, machine screws, rivet heads, etc.

Supplement to MACHINERY, October, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Boring Cylinders"

SHOP OPERATION SHEET NO. 112.

Oscar E. Perrigo. MACHINERY, October, 1909



Machinery, N.Y.

Boring and Turning an Automobile Engine Cylinder Casting.

Note.—The turret lathe is supposed to be provided with a hexagonal turret, and a carriage supporting a rectangular revolving tool-post, with provision for four tools. The turret faces are also assumed to be bored for tool shanks, and drilled and tapped for bolting on large and heavy tools. The chuck *B* should be provided with strong and massive jaws for doing work of this kind.

1. To the soft chuck jaws *C* fit secondary jaws *D* having grooves formed in them for fitting the jaws *C*, as shown in the end view. Fasten these secondary jaws by small screws, and bore them out to fit the large diameter of the cylinder.
2. Provide the boring-bar *E*, with a shank fitting the hole in the turret, and a flange for bolting on to the turret face, and having its front end slotted and provided with the flat boring cutter *F* secured in place by a pin. The cutter should be of such length as to fully clean the rough bore of cylinder *A*, and should have its front corners somewhat rounded. Bolt this bar to turret face 1.
3. Provide for turret face 2 a boring-bar *G*, similar to that described in step 2, except that its cutter *H* is of proper length to bore 1/64 inch smaller than the finish diameter of the cylinder.
4. Provide for the turret face 3 a shell reamer *J*, of the exact diameter of the finished bore. The ends of the teeth should be somewhat rounded, and the reamer fitted loosely to the arbor *K*.

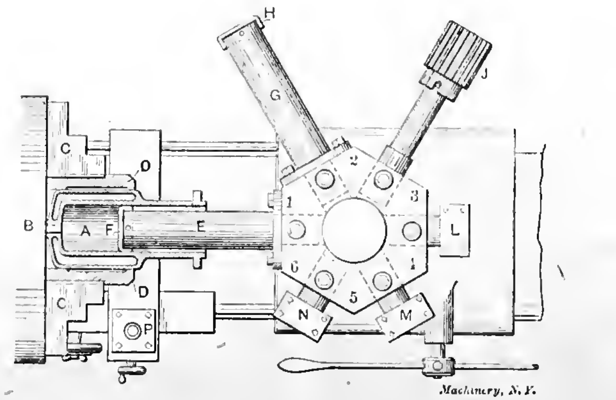
Note.—It is the practice in many shops, particularly where gasoline engines are manufactured, to finish the bore of the cylinders by grinding.

5. Provide and place in turret faces 4, 5 and 6, tool-holders *L*, *M* and *N*, suitable for holding square tools.

Note.—The tools for use in the holders *L*, *M*, *N*, and in the rectangular tool-post *P*, will be described in Operation Sheet No. 113, as they are necessarily brought into use in connection with the facing operations.

SHOP OPERATION SHEET NO. 113.

Oscar E. Perrigo. MACHINERY, October, 1909.



Machinery, N.Y.

Boring and Turning an Automobile Engine Cylinder Casting.

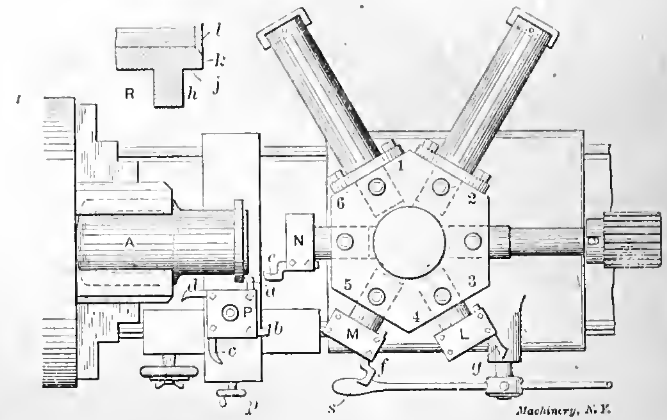
Note.—The cylinder *A* is shown in section, held in place by the secondary jaws *D*, which are attached to the regular jaws *C* of the chuck *B*, and with its large end resting against the face of the chuck. The turret is fitted with the tools necessary for the operations, which have been previously described.

1. Place the casting A within the jaws *D*, and screw up the chuck jaws lightly. Start the machine slowly, holding a piece of chalk against the outside of the rough casting at the outer end. If necessary, slightly change the position of the casting *A*, as indicated by the chalk marks, until the casting runs practically true. Screw up the jaws gradually and successively until the casting is fully secured; proper care should be taken to prevent crushing its thin walls. When the casting is clamped, it should be again tested and adjustment made if necessary.
2. Bring up the rough boring-bar *E*, and start the cut with its tool *F*, using a coarse feed. If the tool chatters, it will be necessary to reduce the feed. Stop the feed as soon as the rounded corners of the cutter have cleaned the bottom of the bore.
3. Withdraw the roughing tool-bar *E*, bring the sizing tool-bar *G* into operative position, and take a second cut, using the same care as to the feed, and stopping it when the bottom of the bore is reached.
4. Withdraw the sizing tool-bar *G*, turn the turret until the reamer *J* is in operative position, and proceed to ream the bore by forcing the reamer carefully, by hand, to the bottom of the bore.

Note.—While the roughing and sizing cutters are at work, chips may collect in the bore so as to make it necessary to withdraw the tool and clean them out. This will most likely occur if a small or distorted core was used in making the casting. If chips are allowed to clog the cutters, the surface of the bore may be "roughed up" by them.

SHOP OPERATION SHEET NO. 114.

Oscar E. Perrigo. MACHINERY, October, 1909



Machinery, N.Y.

Boring and Turning an Automobile Engine Cylinder Casting.

Note.—The casting *A*, which has been bored and reamed, remains in the chuck at the conclusion of those operations. The form of the mouth of the cylinder bore and the flange surrounding it is shown on an enlarged scale at *R*. The cross slide carriage is clamped to the bed throughout these operations.

1. Place a bent rough facing tool *a* in the tool-post *P*. Set it to face the front *h* of the flange to 1/32 inch of finish dimension and take the cut.
2. Place a bent finish facing tool *b* in the tool-post *P*. Set it to face the front *h* of the flange to the finish dimension and take the finishing cut.
3. Place a bent rough facing tool *c* in the tool-post *P*. Set it to rough face the end *k* of the cylinder to 1/32 inch of the finish dimension and take the cut.
4. Place a bent finish facing tool *d* in the tool-post *P*. Set it to finish face the end *k* to finish dimension and take the cut.
5. Place the offset rough turning tool *e*, in turret tool-holder *N*, and set it 1/16 inch over finish diameter at *j*. Bring the tool up and rough turn this portion down to the face *h*.
6. Place the offset finish turning tool *f* in the turret tool-holder *M*, and set it to finish diameter *j*. Bring the tool up and finish this diameter down to the face *h*, making a sharp corner.
7. Place the straight chamfering tool *g* in the turret tool-holder *L*, and set it to cut the chamfer *l* to the angle required. Bring up the tool and cut the chamfer, using the hand feed.

Note.—It is understood that the regular adjustable stops of the machine are to be used in limiting the travel of the tools; that the hand wheel *p* is used for operating the tool-post *P*, and the pilot *s* for operating the turret tools on short cuts, etc.

FORMULAS FOR CONE CLUTCHES

H.P. = horse-power transmitted,

N = revolutions of crank-shaft per minute,

r = mean radius of friction cone, in inches,

r_1 = large radius of friction cone, in inches,

r_2 = small radius of friction cone, in inches,

R_1 = outside radius of leather band, in inches,

R_2 = inside radius of leather band, in inches,

v = velocity of a point at distance r from the center, in feet per minute,

F = tangential force acting at radius r, in pounds,

P_n = total normal pressure between cone surfaces, in pounds,

P_s = spring pressure, in pounds,

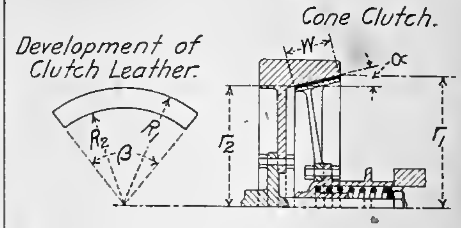
α = angle of clutch surface with axis of shaft = 7 to 13 degrees,

β = included angle of clutch leather, when developed, in degrees,

f = coefficient of friction = 0.20 to 0.25 for greasy leather on iron,

p = allowable pressure per square inch of leather band = 7 to 8 pounds,

W = width of clutch leather, in inches.



$$R_1 = \frac{r_1}{\sin\alpha}$$

$$R_2 = \frac{r_2}{\sin\alpha}$$

$$\beta = \sin\alpha \times 360$$

$$r = \frac{r_1 + r_2}{2}$$

$$v = \frac{2\pi r N}{12}$$

$$F = \frac{H.P. \times 33000}{v}$$

$$W = \frac{P_n}{2\pi r p}$$

$$H.P. = \frac{P_n f r N}{63025}$$

Engagement with some slip:

$$P_n = \frac{P_s}{\sin\alpha}$$

$$P_s = \frac{H.P. \times 63025 \sin\alpha}{f r N}$$

Engagement without slip:

$$P_n = \frac{P_s}{\sin\alpha + f\cos\alpha}$$

$$P_s = \frac{H.P. \times 63025 (\sin\alpha + f\cos\alpha)}{f r N}$$

Contributed by C. A. Schaefer

HORSE-POWER OF AUTOMOBILE ENGINES

Horse Power of Automobile Engines.
Based on the A.L.A.M. Standard Horse Power Formula, assuming a piston speed of 1000 feet per minute.

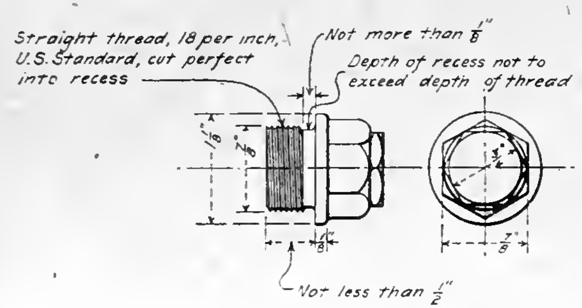
$$H.P. = \frac{(\text{Diam. of cyl.})^2 \times \text{No. of Cylinders}}{2.5}$$

Diameter of Cylinder		Horse Power			
Inches	Millimeters	1 Cylinder	2 Cylinders	4 Cylinders	6 Cylinders
2 1/2	64	2 1/2	5	10	15
2 5/8	68	2 3/4	5 1/2	11	16 1/2
2 3/4	70	3	6	12 1/10	18 1/5
2 7/8	73	3 5/16	6 5/8	13 1/4	19 7/8
3	76	3 3/5	7 1/5	14 2/5	21 3/5
3 1/8	79	3 15/16	7 13/16	15 5/8	23 7/16
3 1/4	83	4 1/4	8 1/2	16 9/10	25 2/5
3 3/8	85	4 9/16	9 1/8	18 1/4	27 2/5
3 1/2	89	4 9/10	9 4/5	19 3/5	29 2/5
3 5/8	92	5 1/4	10 1/2	20 1/4	31 3/5
3 3/4	95	5 5/8	11 1/4	22 1/2	33 3/4
3 7/8	99	6	12	24	36 1/16
4	102	6 2/5	12 4/5	25 3/5	38 2/5
4 1/8	105	6 13/16	13 5/8	27 1/4	40 9/10
4 1/4	108	7 1/4	14 1/2	28 9/10	43 4/5
4 3/8	111	7 5/8	15 5/16	30 5/8	45 15/16
4 1/2	114	8 1/10	16 1/5	32 2/5	48 3/5
4 5/8	118	8 9/16	17 1/8	34 1/4	51 3/5
4 3/4	121	9	18	36 1/10	54 1/10
4 7/8	124	9 1/2	19	38	57
5	127	10	20	40	60
5 1/8	130	10 1/2	21	42	63
5 1/4	133	11	22	44 1/10	66 1/5
5 3/8	137	11 9/16	23	46	69 1/10
5 1/2	140	12 1/10	24 1/5	48 2/5	72 3/5
5 5/8	143	12 5/8	25 5/16	50 5/8	75 15/16
5 3/4	146	13 1/4	26 1/2	53	79 1/2
5 7/8	149	13 13/16	27 5/8	55 1/4	82 9/10
6	152	14 2/5	28 4/5	57 3/5	86 2/5

A. L. A. M. Standard

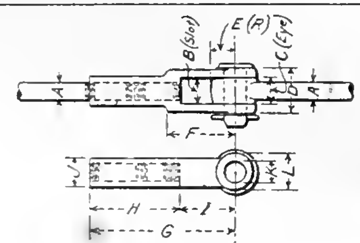
A. L. A. M. STANDARD SPARK PLUG AND YOKE AND ROD ENDS

A. L. A. M. Standard Spark Plug



Association of Licensed Automobile Manufacturers Standard Threads, Screws, Castle and Plain Nuts:—See MACHINERY'S Data Sheet No. 63, November 1906.

A L. A. M. Standard Adjustable Yoke and Eye Rod Ends

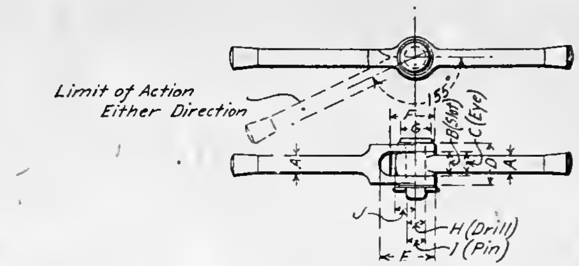


Rod A	Thread	Slot B	Eye C	D	E	F	G	H	I	J	K	L
1/4	1/4 x 28	7/16	0.432	3/4	3/8	1 1/4	2 3/8	1 3/8	1	1/2	5/16	11/16
5/16	5/16 x 24	1/2	0.495	7/8	7/16	1 3/8	2 3/4	1 5/8	1 1/8	9/16	13/32	3/4
3/8	3/8 x 24	19/32	0.588	1	1/2	1 1/2	3 1/8	1 7/8	1 1/4	21/32	15/32	7/8
7/16	7/16 x 20	21/32	0.651	1 1/8	17/32	1 11/16	3 5/8	2 1/4	1 3/8	3/4	9/16	15/16
1/2	1/2 x 20	3/4	0.770	1 1/4	5/8	1 7/8	4	2 1/2	1 1/2	13/16	5/8	1 1/16

A. L. A. M. Standard

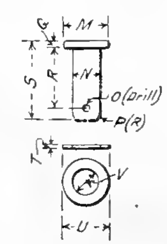
A. L. A. M. STANDARD YOKE AND ROD ENDS

A. L. A. M. Standard Solid Yoke and Eye Rod Ends



Rod A	Slot B	Eye C	D	E	F	G	Drill H	Pin I	J
1/4	7/16	0.432	3/4	1 1/32	25/32	1/2	5/16	0.310	3/8
5/16	1/2	0.495	7/8	1 7/32	15/16	5/8	13/32	0.403	7/16
3/8	19/32	0.588	1	1 3/8	1 1/16	3/4	15/32	0.465	1/2
7/16	21/32	0.651	1 1/8	1 9/16	1 5/32	7/8	9/16	0.559	17/32
1/2	3/4	0.745	1 1/4	1 11/16	1 5/16	15/16	5/8	0.621	5/8

A. L. A. M. Standard Pin and Washer Dimensions



Size Rod	1/4	5/16	3/8	7/16	1/2
M	1/2	5/8	3/4	7/8	15/16
N	0.310	0.403	0.465	0.559	0.621
O	5/64	5/64	7/64	9/64	11/64
P	5/16	13/32	15/32	9/16	5/8
Q	3/32	3/32	1/8	1/8	1/8
R	53/64	61/64	1 3/32	1 17/64	1 3/8
S	1 3/32	1 1/4	1 7/16	1 5/8	1 3/4
T	1/32	1/32	1/32	1/16	1/16
U	1/2	5/8	3/4	7/8	1
V	5/16	13/32	15/32	9/16	5/8

A. L. A. M. Standard

MACHINERY

October, 1909

THE DESIGN AND MANUFACTURE OF A HIGH-GRADE MOTOR CAR*

RALPH E. FLANDERS†

FOUR years ago, at the New York Automobile Show, the writer's attention was first attracted to the Stevens-Duryea machine, particularly from the standpoint of design. It exhibited a thoroughness and consistency in the proportions and arrangement of its mechanism, which was at that time much rarer in automobile construction than now. The good impression then produced has been deepened by a recent visit to the factory, where the management very courteously granted the freedom of the shop, and answered without a quiver or qualm all the questions that a prying editor could think to ask. Some of the results of this visit are here set forth.

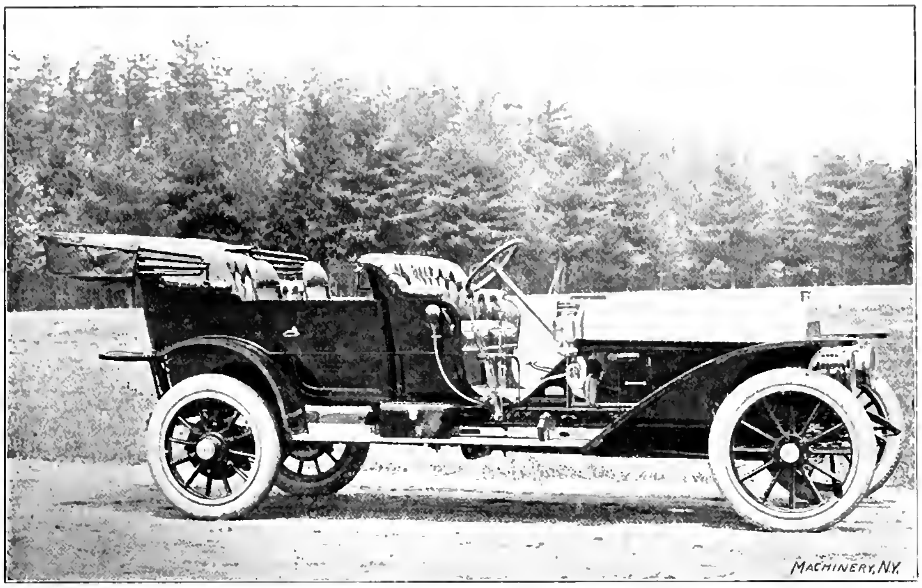


Fig. 1. Stevens-Duryea "Big Six" Motor Car, 1910 Model

The Factory and its Product

The shops of the Stevens-Duryea Co. are located at Chicopee Falls, near Springfield, Mass., in part occupying buildings originally used by the Spaulding bicycle factory. The business was founded by Mr. J. Frank Duryea and Mr. William H. Remington, who began experimenting with automobiles in 1892. Mr. Irving H. Page later became interested in the work, and his firm, the J. Stevens Arms and Tool Co., commenced making cars for the market in 1899. The business grew so rapidly that it was found wise in 1905 to organize a separate firm—the present Stevens-Duryea Co.

These shops are at present building a 40 H. P. six-cylinder machine, a "light six," 35 H. P., and a four-cylinder 24 H. P. car made in two lengths of base. Many of the engine and transmission parts of the 40 H. P. and the four-cylinder machines are identical, thus simplifying the manufacture to a marked extent.

Description of 40 H.P. Six-cylinder Machine

Without doubt there are many readers of MACHINERY who are quite familiar with the automobile as a machine. There are as many who are not, however, so if the knowing ones will skip the next four or five pages, they will come to an article relating to manufacturing methods, which will doubtless be of more value to them. The average reader, however, should be interested in an elementary description of this car, which, except for certain important details which will be mentioned, may be taken as typical of the design of high-grade cars in general.

In Fig. 1 is shown a side view of the "Model Y," 40 horse-power, six-cylinder machine, with 36-inch wheels and 112-inch wheel-base. An automobile may be divided into two parts—the body and the "chassis." The former is the product of the carriage-maker's art, the latter of the mechanic's and engineer's. The chassis of this machine is shown in Figs. 2 and 3, to which reference should now be made.

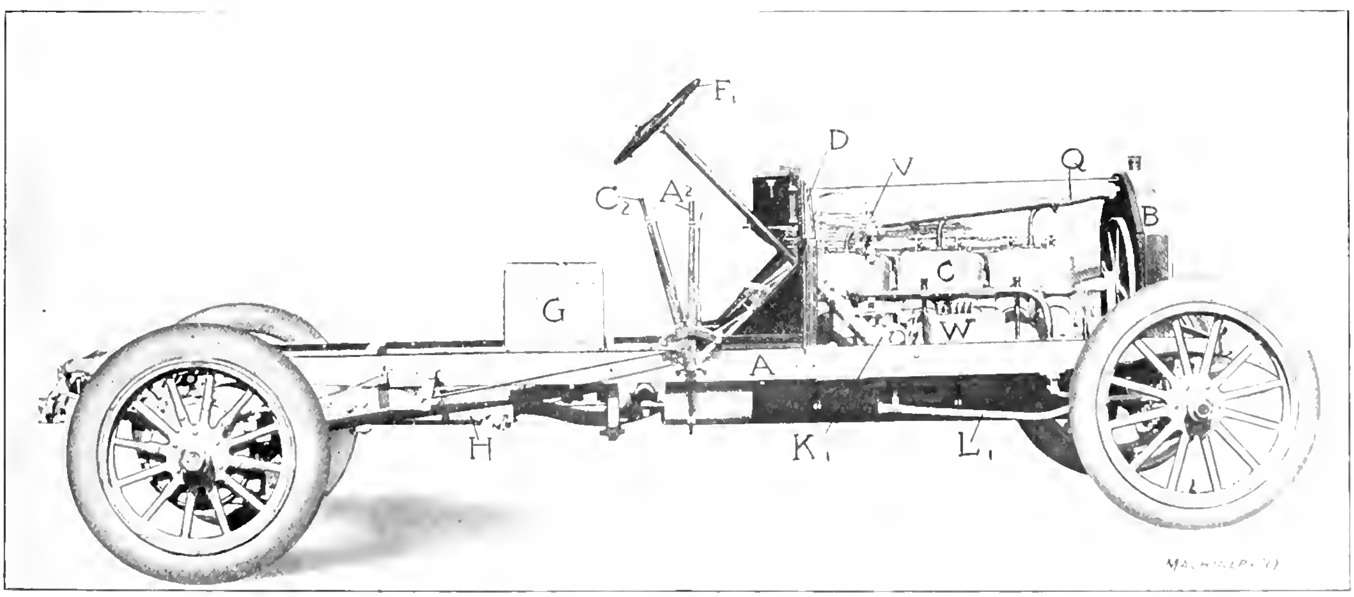


Fig. 2. Side View of Car with Body Removed, showing Chassis

The mechanism and body of the car are supported by a frame whose side members, of chrome nickel steel, are shown at *A*. These are connected by four cross pieces, and are supported on the front and rear axles by the spring connections shown. The cross pieces are also pressed from chrome nickel steel, and are hydraulically riveted to the side frames. A platform spring suspension is used at the rear, hung on connecting shackles designed to overcome the side roll met when round-

* For further information on this subject, see "Machines and Tools for Automobile Manufacture," June, 1909, and articles there referred to.
† Associate Editor of MACHINERY.

ing curves in large and fast cars. The springs are made from steel selected after careful tests of both American and imported materials. The cost of the brand selected was far in excess of the nearest competitor, but it gave an endurance under repeated shock and reversal of stress not met with in any other make.

On the chassis frame are mounted, first the radiator *B*, next the engine *C*, then the dash-board *D* with its steering and controlling mechanism, the clutch and speed change mechanisms at *E* and *F* respectively, the gasoline tank *G*, the muffler *H* for the exhaust, the propeller shaft *J* for transmitting the power to the rear axle, and the rear axle with its differential gearing at *K*.

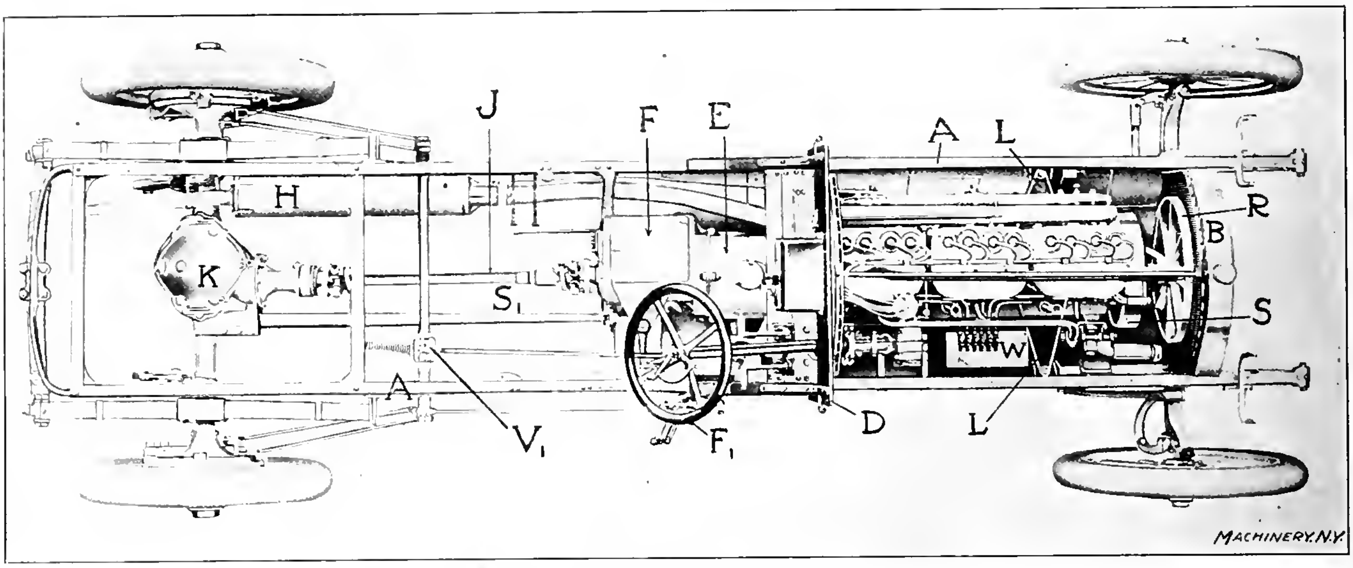


Fig. 3. Top View of Chassis, showing Arrangement of the Mechanism

The Unit Power Plant, with Three-point Support

The engine is shown more clearly in Figs. 4 and 5, which show the "unit power plant" form of construction, one of the important original features of the design. This peculiarity consists in mounting the engine, clutch, and transmission casings as a single rigid member, supported by a three-point bearing on the flexible frame. Supports *L* bear on the two side frames, while pivot *M* is riveted to one of the cross pieces. This allows the whole of the contained mechanism to run without distortion or bending, even on roads which rack the frame severely, and thus results in less friction and lighter structural parts, giving a high available horse-power per hundredweight of load. It also permits the power plant to be assembled as a whole and to be bolted in place without fitting. This construction, which is the distinctive point in the design of this motor, has been successfully followed by the builders for the last five years, and it is one of the things which serve to give an attractive mechanical appearance to the whole mechanism. Only one double set of universal joints is required, that connecting the propeller shaft with the transmission gearing at one end, and the differential gearing at the other.

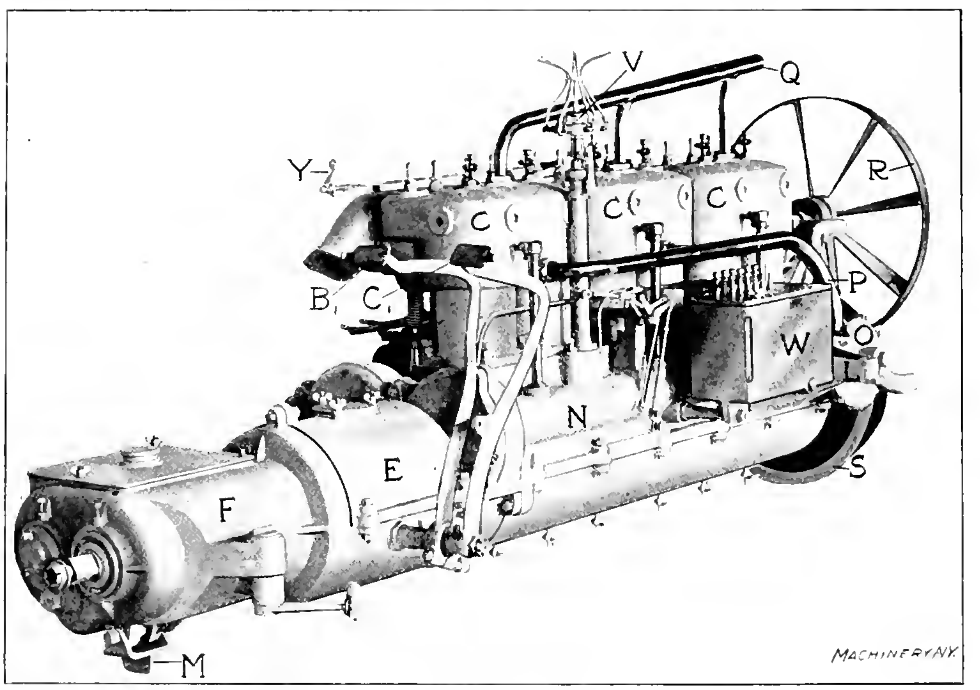


Fig. 4. The Unit Power Plant, comprising Engine, Transmission, etc.; View taken from the Timer and Lubricator Side

The cylinders are grouped in three two-cylinder castings *C*, bolted to the crank case *N*. As is common with internal combustion engines in ordinary practice, they are water jacketed, there being a continuous circulation from radiator *B* through centrifugal pump *O* and pipe *P* to the water jackets, thence back again through the return pipe *Q* to the top of radiator *B*. Here the heated water is cooled by passing through sheet metal channels, having a large radiating surface exposed to the draft of wind produced by the passage of the machine through the air. This draft is increased by an aluminum fan *R*, belted to the pulley on the outside of fly-wheel *S*. An automatic tightening arrangement assures a serviceable drive throughout the life of the belt.

It should be mentioned that the placing of the fly-wheel at the forward end of the crank-shaft, as here shown, is unusual, the common construction being to locate it between the crank-shaft and the clutch. It tends, for instance, to bring more of the weight onto the front wheels, off from the heavily loaded rear wheels of the machine, and permits the reducing of the clearance over the roadbed in the center of the chassis, where there is the greatest danger of striking on high water bars, railroad crossings, etc. It will be readily seen that more clearance is required at the center of the machine than at the axles, when crossing a hump in the road.

Lubrication, Ignition, etc.

Two shafts mounted in the crank casing, on either side, above and parallel to the crank-shaft, are driven from it by enclosed gearing. The one at the side shown in Fig. 5 is the cam-shaft and is provided with twelve sets of cams for operating the six inlet and six exhaust valves, whose stems and

closing springs are plainly shown in the engraving. The driving gear of this cam-shaft is also connected with a pinion on the armature shaft of the magneto, whose function will be described later. The shaft on that side of the machine shown in Fig. 4, is known as the lay-shaft. Its office is the driving of the timer V which controls the ignition, the driving of the forced lubrication mechanism at W, and of the water jacket circulation pump O.

gasoline, and a supply of fresh air to furnish the oxygen for the charge. The gasoline is received in a float chamber, where the level of the liquid is maintained by a suitable float and valve. An automatic valve provides for a constant proportion of oxygen and fuel at widely-varying speeds. The carburetor is provided with a throttle which controls the needle valve connection in the feed pipe, together with the butterfly valve in the suction to the cylinders, thus providing

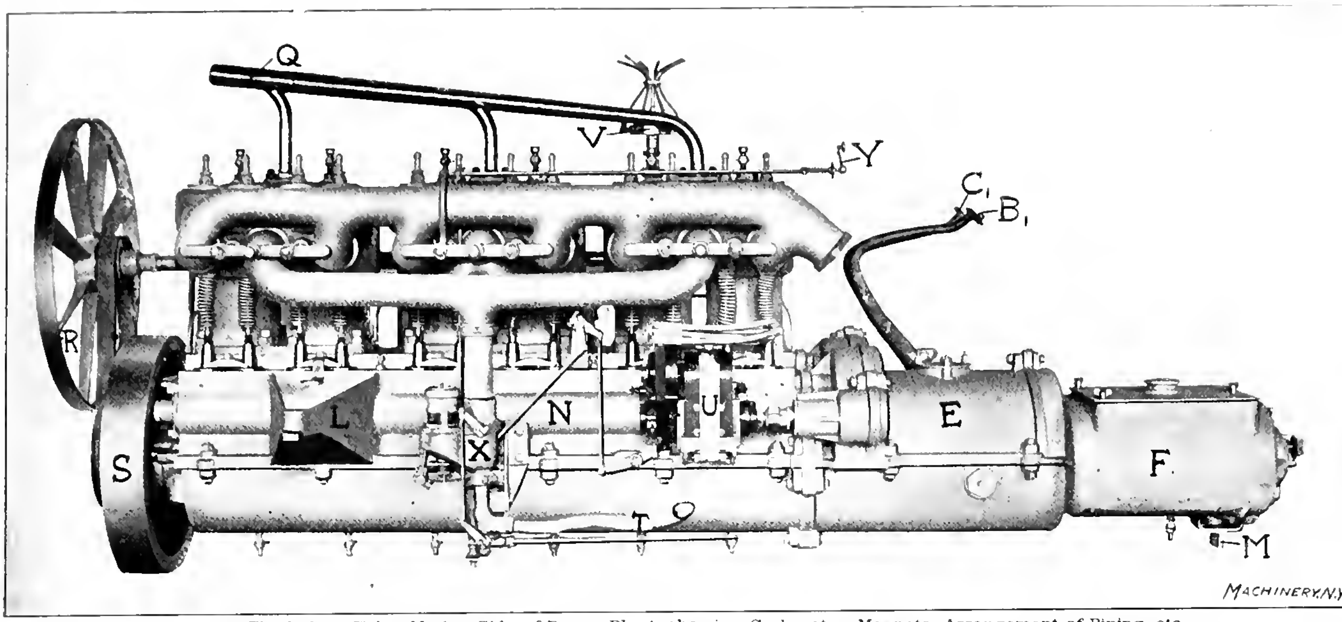


Fig. 5. The Left or Valve Motion Side of Power Plant, showing Carburetor, Magneto, Arrangement of Piping, etc.

The lubricator gives a forced oil supply with sight feed, and is always in operation when the engine is in motion. The six-throw crank-shaft is mounted in four bearings in the crank case, with two cranks between each pair of bearings. The boxes at these points are connected with the lubricator W. The lower half of the crank case forms a reservoir for

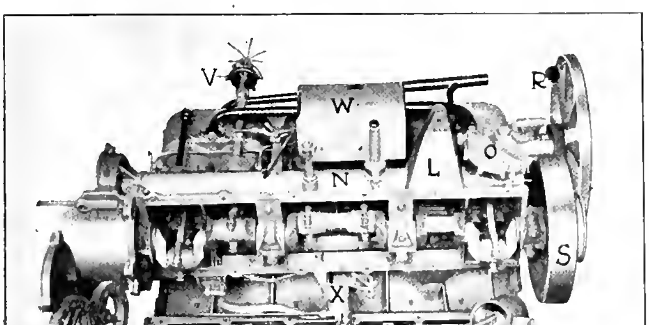


Fig. 6. View of Engine from Beneath, showing Removal of Piston, Cam, and Lay-shafts, etc., without Dismantling

the oil escaping from the main bearings. The connecting rod splashes into this and thus supplies the pistons, connecting-rod bearings, etc., with the necessary lubrication.

The ignition in each cylinder is effected by either of two systems, the one by storage or dry battery and induction coil, and the other by means of a magneto U connected by gearing with the crank-shaft. The battery and spark coil is used in starting, while the magneto is used for regular running. The spark coils and switches are located on the dash-board. A lever on the steering wheel, as will be described, is connected with the commutator or timer V, which distributes the current to the six cylinders, in such a way as to enable the operator to advance or retard the spark at will.

The Carburetor and Fuel Supply

An important and rather delicate piece of apparatus essential to the operation of the gasoline engine, is the carburetor, shown at X in Fig. 5. This receives a supply of gasoline through a feed pipe from the tank G (see Fig. 2), a supply of air through T heated by the exhaust gas for vaporizing the

the driver with means for varying the amount of charge furnished the machine; this controls the speed without shifting the gears in the transmission case. The automatic air valve is controlled from the seat by a handle Y on the dash-board, which permits the obtaining of a proper mixture for the starting. A button at the front of the radiator, where the machine is cranked for starting, also provides means for flooding the carburetor with fuel for a send-off. The throttle is controlled from a lever on the steering wheel concentric with the spark control lever or from an "accelerator pedal" on the foot-board.

The gasoline supply tank G is located under the front seat. It contains a partition near the bottom which saves about three gallons out of its twenty gallons' capacity, for use in emergency. By the manipulation of cut-off valves passing

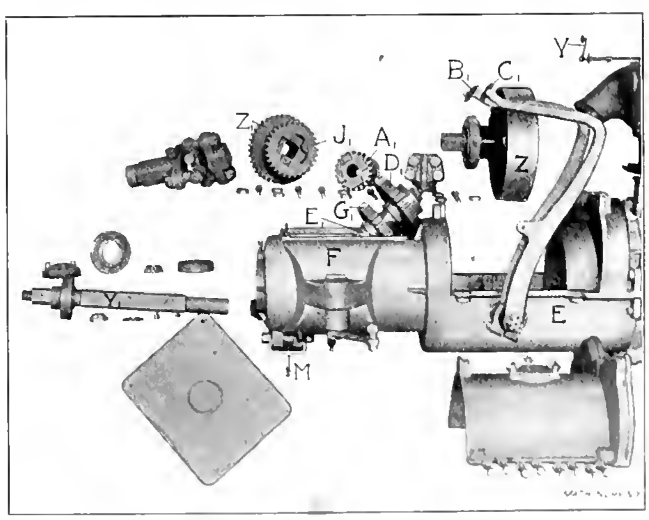


Fig. 7. Clutch and Transmission Gear Members Dismantled to show Construction

through the left side frame of the chassis, it is possible to use this reserve supply after the tank has been otherwise exhausted. This provision is a great comfort to the motorist at critical times.

The Clutch and the Transmission Gearing

In casing E is mounted the clutch Z (Fig. 7) connecting the engine with the transmission to the driving wheels. This is of the multiple disk type, with alternate disks keyed to the

driving and driven members. The driving disks have a wired asbestos facing which makes a superior friction surface, and gives a high resistance to heat as well. This construction obviates, and in fact makes impossible, the use of oil in the clutch. The friction surfaces are held in engagement by a spring, and are released by a pedal B_1, which projects through the foot board at the driver's side of the machine. The spring is so proportioned as to give a smooth, easy engagement, entirely out of the control of the driver, who thus finds it impossible to start the machine with a sudden shock. The second foot lever, C_1, is connected with the rear wheel brakes, as will be described. The driven member

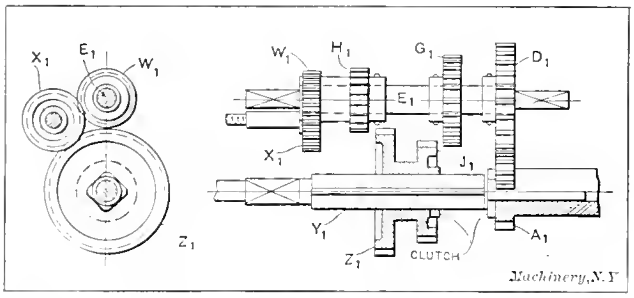


Fig. 8. Sketch showing Arrangement of Gears in Transmission Case

of the clutch is connected with the driving shaft in the transmission case or speed box F. Contained within it is a mechanism which, by the aid of the sliding gears, clutches, etc., permits of the obtaining of three forward and one reverse speed.

The operation of this gearing will be understood from the sketch shown in Fig. 8. Gear A_1 receives its movement from the clutch. It meshes with gear D_1 keyed to the secondary shaft E_1, which is thus in motion whenever the engine is running and the clutch is engaged. This shaft carries also gears G_1, H_1, and W_1, the latter of which drives, in turn, the idler X_1. Squared shaft Y_1 is directly connected by means of propeller shaft J (Fig. 3) and the universal joints with the rear axle. On Y_1 is mounted the double sliding gear Z_1. Clutch teeth are provided in the faces of the gears A_1 and J_1.

In the position shown in Fig. 8, the transmission is in the neutral position, so that the motion from the clutch is not transmitted to the axle. The right-hand end of shaft Y_1 lies loosely in the revolving gear A_1. When the sliding gear is thrown to the extreme right, the clutch faces of A_1 and J_1 are engaged, so that shaft Y_1 is driven directly, and at the highest speed, from the clutch. By shifting it a step to the left, J_1 is thrown into mesh with G_1, thus giving a lower rate of speed through the back gear shaft E_1. A still further movement to the left, past the neutral point shown in the engraving, brings Z_1 into engagement with H_1, giving the lowest forward speed. A final movement to the left engages Z_1 with idler X_1, thus reversing the drive.

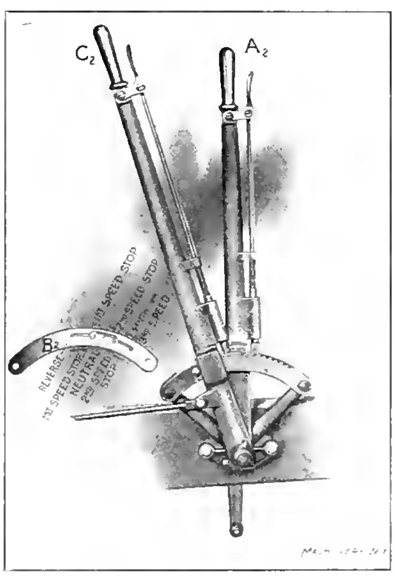


Fig. 9 The Speed Gear Control and Emergency Brake Levers

The shifting of gears Z_1 and J_1 is effected by a forked lever connected with lever A_2 (Fig. 9) at the side of the machine, which thus controls the speed changes. This lever is provided with a latch connected with a pin in the slot of the quadrant B_2, operating in a manner easily understood from the engraving. It will be seen that it is possible to move between the reverse and the lowest speed, or between the second and the high-speed, without touching the latch, and it is possible to make all the movements rapidly and precisely by the sense of touch without looking at the quadrant at all.

The Differential Drive

Propeller shaft J leads from the transmission case F to differential case K on the rear axle. The bevel gear M_1 (Fig. 11) is connected with the two rear wheels by a differential mechanism, whose function it is to give an equal tractive force to each of the two wheels, but at the same time to permit either of them to run ahead or lag behind the other as may be required in rounding curves, riding over obstructions, etc. The principle of this mechanical movement will be understood by referring to Fig. 10.

Referring first to the sketch at the left, N_1 is the pinion on the propeller shaft and M_1 is the driven bevel gear, concentric with the axle. This gear and shell O_2 to which it is bolted, revolve freely on the hubs of E_2 and F_2. Within the shell are mounted radial pivots on which revolve, loosely, bevel pinions D_2. These engage with bevel gears E_2 and F_2, connected respectively with the right- and left-hand axle shafts T_1. It will be seen that under ordinary conditions the rotating of gear M_1 carries gears E_2 and F_2 along with it, by the pull exerted on them by the bevel pinions D_2, which are stationary; thus the two rear wheels are driven at the same rate of speed. Suppose now that the right-hand wheel be held from turning, so that gear E_2 is stationary, then the rotating of bevel gear M_1 will roll pinion D_2 about on E_2 with

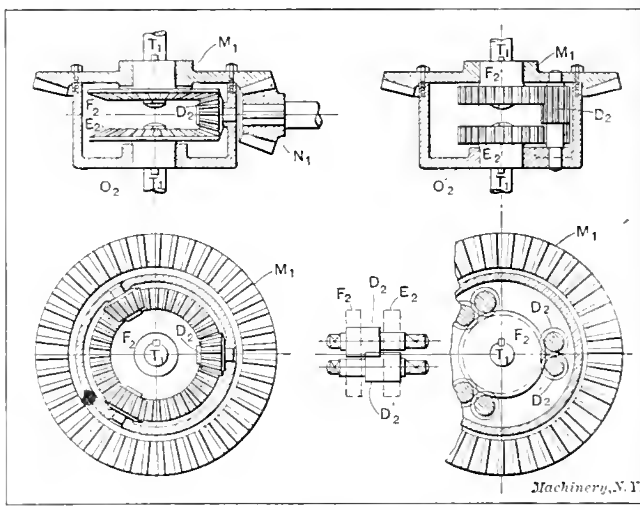


Fig. 10. Sketch showing Principle of the Bevel and Spur Gear Types of Differential Gearing

a compound action, which will give F_2 twice the rate of speed it had before. In the same way, F_2 can be held from revolving, in which case E_2 will have twice its normal speed, or either of them may be slowed down, in which case the other is speeded up correspondingly. The driving force on both wheels, however, is always the same.

An alternative form of this device is shown at the right of Fig. 10, in which each of the bevel gears D_2 is replaced by a pair of spur pinions D_2 and D'_2, meshing with each other and with spur gears E_2 and F_2 as shown. A little study will show that the action of this device is identical with that shown in the sketch at the left of the figure, the only change being the employment of spur gearing in place of bevel gearing. The differential used on the Stevens-Duryea machine is of the second or spur gearing type.

The Full Floating Type Rear Axle

The differential gearing is contained in the casing O_1, which forms the central member of the axle. Tubular extensions to either side carry the spring supports P_1 on which the weight of the car rests. The brake flanges Q_1 and the wheel bearings at R_1, all of which are solid with each other, are nonrotating. The rear axle, however, is permitted to rock in spring supports P_1. The torque rod or tube S_1, which is fast in case O_1, extends toward the center of the chassis, where it is hung in a spring suspension as seen in Fig. 3, permitting a limited vibration up or down, with a constant force urging it toward a central position. This construction furnishes the resistance against the climbing of pinion N_1 on bevel gear M_1. In case of sudden starting or stopping, a limited amount

of climbing either way is permitted, the torque rod being raised or lowered against the spring pressure to correspond. This greatly decreases the danger of gear breakage.

The construction thus described belongs to what is known as the full floating type axle. The wheels are mounted on ball bearings on stationary journals R_1. Shafts T_1 are provided with squared driving ends engaging sockets in the differential gearing in casing O_1 at one end, and similar sockets cut in driving dogs U_1 at the other end. These latter members have driving slots engaging dove-tails in the hubs of the wheels, to which the power is thus transmitted. The

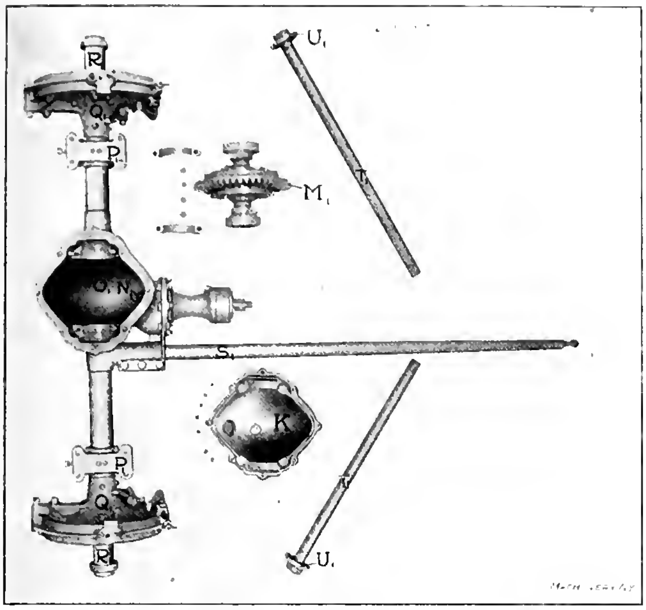


Fig. 11. The Full Floating Type Rear Axle, Differential Gearing, etc.

squared ends of shafts T_1 are rounded to permit a slight rocking movement in their sockets in the differential gearing and driving dogs U_1. This permits the springing of the rear axle under the load without cramping the driving mechanism.

To allow for the springing of this axle under the load, the two sections of tubing on either side, between members O_1 and Q_1, are held in bored seats which point downward at an angle of ½ degree from the horizontal on each side. Thus the rear axle wheels point in toward each other at the bottom on an angle of ½ degree from the vertical, giving a much better appearance than would be the case if they should by some mischance point the other way. It would take a load in excess of any which would ever be applied to spring the axle and bring the wheels into the vertical plane. It is stated that when the wheels are exactly vertical, they have the appearance of being sprung out at the bottom, into the position occasionally seen in a vehicle of the "one-horse-shay" type.

The Brakes

The brake mechanism of the automobile is of the utmost importance, as is realized by anyone who has had anything to do with these machines whether as driver, passenger or pedestrian. It is usual to provide two complete sets of braking mechanism, one for regular use and the other for emergency. That for regular use is controlled by the foot lever C_1 (see Fig. 4) which is connected with a reach rod leading to double cranks on a transverse rock-shaft at V_1 (Fig. 3). One section of this rock-shaft is connected with the brake at the right side of the machine, and the other at the left. An equalizing lever between the two insures an even pressure on each of these two brakes, even though one be much more worn than the other. The brake is of the band type, applied to the outside of a brake rim fast to the hub of the wheel. The emergency brake is operated by lever C_2 (Fig. 2). This, by means of a second rock-shaft concentric with V_1, controls internal expanding ring brakes in the hubs of the wheels.

The Control of the Machine

The steering gear will be best understood from Figs. 2, 3 and 12. The wheel F_1 is mounted on a tubular shaft which carries at its lower end a worm engaging the segment of a worm-wheel G_2 in casing K_1. To the hub of this segment is connected a bell crank H_2 which, through the operation of the steering rod L_1 (see Fig. 2) and suitable connecting cranks and links, turns the front wheels to the right or left as may be required. Spring cushions are provided at the ends of steering rod L_1 so that sudden shocks and twists of the wheels are not transmitted to the worm-gearing and the steering wheel, even when traveling at a high rate of speed. As most of our readers doubtless know, the center line of the pivots about which the wheels are swiveled meets the road at about the point where the tire touches it. This makes it possible to turn the wheels easily when standing still, and decreases the danger of accident while running, as well.

As previously stated, the throttle control and the timing of the spark are effected from levers placed at the hub of the steering wheel. Lever K_2 controls the throttle. This is mounted on a tube passing through the steering wheel tube and connected at its lower end by bevel gear segments with a bell crank L_2, which is, in turn, connected by suitable rods and levers with the carburetor. Inside of the throttle lever tube is still another fixed tube on which is mounted the segment M_2, which is thus held stationary. This is provided with notches for locating lever K_2, and lever J_2 as well, which latter controls the timing of the spark. This is mounted on a rod which passes through the center of the system of tubes and is connected by bevel segments with lever N_2 leading to the commutator or timer V.

It may be well to recapitulate as to the functions of the levers, etc., used in the control of the machine. At the front of the radiator is the crank by which the motor is turned, for starting. By the side of it is a button connected with the carburetor, for flooding the latter at starting to obtain a rich mixture on the first stroke. On the dashboard is mounted a lever Y, for setting the automatic air valve to supply the proper amount of oxygen for starting. Beside it is a switch for throwing the ignition spark from the battery to the magneto when the machine is changed from the starting to

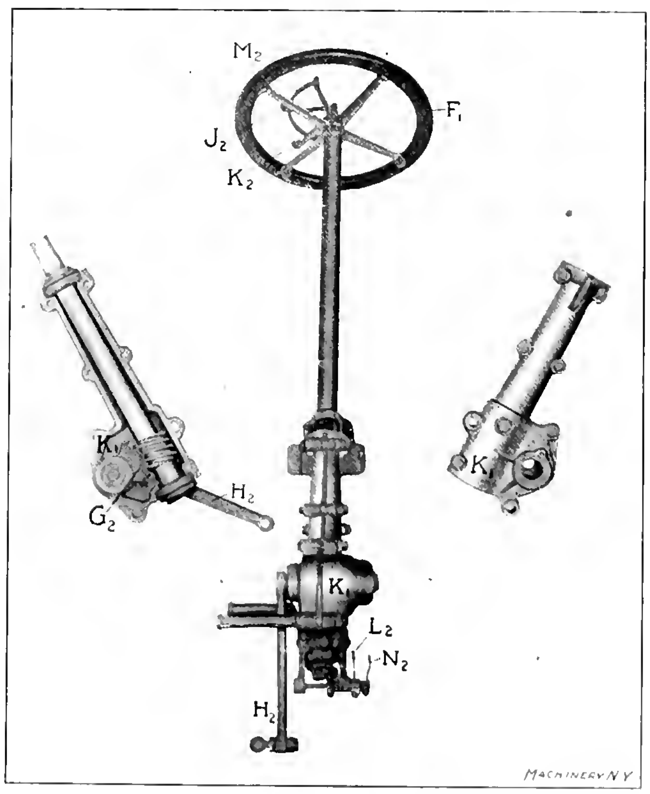


Fig 12. The Steering Post, with its Throttle and Sparking Connections

the running condition, and *vice versa*. On the dashboard are also mounted the spark coils. Through the foot board project the two pedals B_1 and C_1 controlling the clutch and the operating brake respectively, as described. Hand levers C_2 and A_2 control the emergency brake and the speed changes respectively.

Two small pedals are also provided on the foot board. One of these is connected with the throttle in such a way that this may be controlled by the foot instead of by the hand if required. It is called the accelerator. By its use, when the hand throttle lever has been set to a certain point, the valve may be opened clear out to the maximum, as desired, by the

foot, thus giving immediate control under varying conditions of traffic. The other pedal operates a valve which cuts out the muffler. This is occasionally done to make the exhaust audible, for finding out how the engines are working, and also for removing the back pressure, and thus giving every ounce of power possible on critical occasions. At times, too, it would seem to the disinterested bystander that the muffler is cut out from "cussedness" pure and simple.

These levers, pedals, etc., with the main and supplementary gasoline supply valves previously mentioned, give the driver complete control of a powerful, swift machine, if he has the knowledge, experience and nerve to use them properly.

General Considerations in Automobile Design

A glance at the illustrations will serve to show that the chassis of the modern high-power automobile is a rather complicated, highly-specialized, and carefully-designed piece of mechanism. It is within the memory of the child in kindergarten when this was not the case, and the writer has painful memories of his duties as consulting physician to one of the best of the machines in existence six years ago. At that time, the mechanism of the automobile did not have the homogeneous, appropriate structure that the successful machines of the present day possess. It had a gasoline engine, an epicyclic speed change mechanism, a jack-in-the-box differential gear, and chains leading to the rear wheels of a "horseless carriage." Over the mechanism thus described wandered a maze of levers, braces, pipes, wires, etc., supported at intervals at any part of the mechanism which happened to be in convenient reach. That, however, was before the automobile "found itself." The present development has been the result of the experience of many men with break-downs and failures, as well as of an enormous amount of theoretical work in the matter of testing of materials and analysis of conditions. These theoretical and practical results have been combined on the drawing board and the resulting machine has the appearance of having been *designed* rather than simply *built*.

The guiding principles in the design of the automobile relate to strength, power, lightness, durability, accessibility, and economy in operation. The matter of economy in construction and materials is about the last thing to be thought of, instead of the first, as with many other classes of machinery. The severe and often reckless usage received by one of these machines demands special treatment in the design and construction which should not ordinarily be necessary.

As an illustration of what has been said in this respect, attention may be called to the method of connecting the driving members of this machine from the engine through to the wheels. In no place throughout the length of the chassis are keys used for this work. Reliance is everywhere placed on square joints or dovetailed flanges. The crank-shaft is connected with the driving member of the clutch by a square taper socket. The driving member of the clutch is connected by a square socket with the driving shaft of the transmission gearing. The sliding gears of this mechanism are mounted on squared shafts, and the same squared drive is used for the universal joints, propeller shafts, pinion shafts, etc., through the intermediate pinions in the differential gearing at M_1 in Fig. 11, and through driving shafts T_1, to the driving dogs on the wheel hubs. These latter, as well as the side plates of the differential gearing, drive or are driven by the engagement of dovetailed teeth. The possibility of the shearing of keys, always present in machine parts subject to shock, is thus avoided. The makers believe themselves to be the only firm employing a complete drive of this kind.

In the matter of accessibility, a study of Figs. 6 and 7 will be found interesting. By removing the lower crank chamber casing and turning the crank-shaft to the proper position, the piston and piston rod may be removed without further trouble, and without removing cylinders or cylinder heads. The same is true of the cam- and lay-shafts. The covers provided for the clutch and transmission casings give evidence of care in providing easy means for inspection and removal of all parts likely to need attention. With a well-designed machine the man on his back under the motor car is a mere figment of the imagination.

Take it all in all, the present-day automobile is a machine of which the mechanic and engineer may well be proud.

MANUFACTURING METHODS IN THE STEVENS-DURYEA AUTOMOBILE WORKS

The subserviency of manufacturing considerations to considerations of strength, durability, accessibility, etc., mentioned in the preceding article, results in the design of parts which require special and interesting provisions for their economical production. Only a few of the operations particularly noticed in the Stevens-Duryea factory will be described here. They will serve, however, to give an idea of the general practice in such work, and will illustrate the ingenuity required for the solution of some of the problems.

Operations in the Machining of Cylinders

In Fig. 1 is shown a Beaman & Smith combined horizontal and vertical milling machine engaged in surfacing the base,

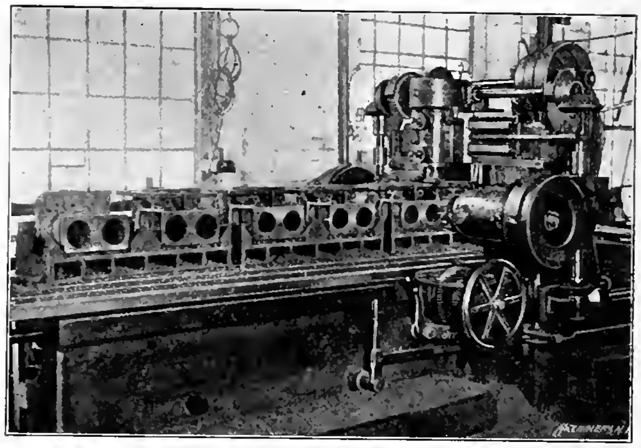


Fig. 1. Gang Milling Operation. Surfacing Cylinder Sides and Ends

exhaust and inlet flanges, and the spark plug bosses of a series of cylinder castings. The work is mounted in gangs according to the most approved methods. The picture is chiefly interesting in that it shows that the builders take advantage of wholesale manufacturing methods even in the building of a $4,000 machine. Of course, an extensive use of jigs and fixtures, besides reducing the cost of manufacture, results in a greater uniformity in the product and thus gives the advantage of an easy renewal of worn or damaged parts.

Fig. 2 shows a Beaman & Smith boring machine of a type we have illustrated and described in these columns. Fixtures mounted on the rotating table give provision for holding four double-cylinder castings. This table can be rotated and ad-

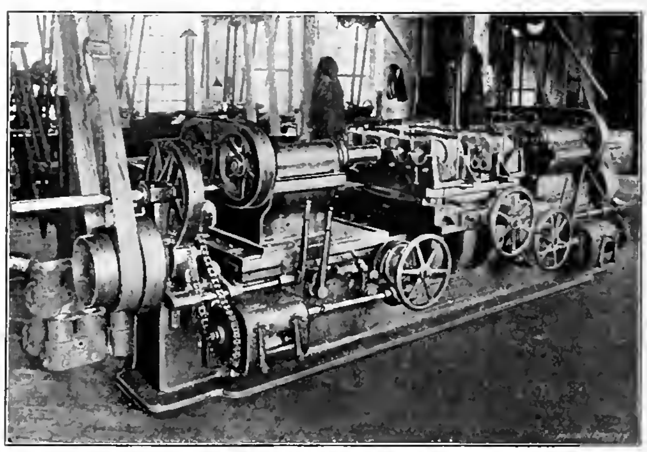


Fig. 2. Four-cylinder Boring Machine with Revolving Table

justed across the bed of the machine. On each side of the table, double boring heads may be fed in along the bed, one carrying roughing and the other finishing cutters, the feeds and speeds of the two heads being independent. A set of two castings being in place on the roughing end, the head is fed into them and one hole in each casting is roughed out. The work-table is then shifted, by means of the hand-wheel, against suitable stops and the other bore of each cylinder is roughed. The table is then indexed to bring these castings to the finishing side, where the same operation is repeated, the boring being here carried to size for grinding. This rotating of the table, in turn, brings a new set of the cylinders up to be rough-

bored. The process is continuous, the work being removed from the finishing side and new cylinders clamped in, while the rough boring is being completed.

For setting out the cutters in the boring bars, a construction is used which is similar to Fig. 16 of the Data Sheet of the May, 1909, issue of MACHINERY, except that a taper screw is used for forcing the blades out simultaneously. This is shown in Fig. 3 at the left. The cutters *B* bottom on this taper-headed screw *C*; filister head screws *D* serve to keep the blades forced down to their bearing on *C*, and so draw them firmly against the side of the slot. By this means two or more blades may be set out simultaneously for regrinding to exact size. A similar arrangement (see view at the right of Fig. 3) is used for cutters in the middle of long boring bars, except that the taper point of a screw tapped into the bar from the side, is used in place of the corresponding taper-headed screw in the first case.

The bore of these cylinders is finished in Heald internal grinding machines especially built for this work. These are

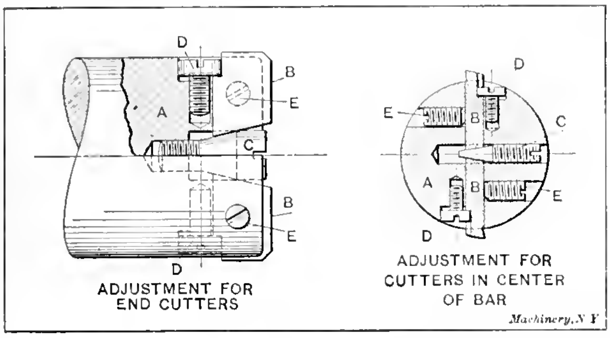


Fig. 3. Adjustment used for Boring-bar Blades

of the type in which the work remains stationary while the axis of the spindle is revolved about the center line of the bore and parallel with it, on such a diameter as to bring the outer periphery of the wheel in contact with the inner surface of the bore. The grinding spindle is fed out so as to rotate in a larger circle as the diameter of the bore is increased. An interesting feature shown in Fig. 4 is the provision of a flexible suction tube for drawing out the dust of the grinding through the inlet and exhaust ports, and also the provision made for water cooling. The water is not applied directly to the wheel, as in an ordinary external grinder, but is forced

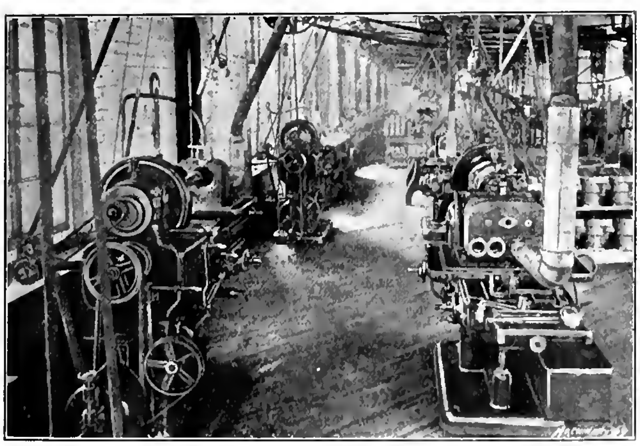


Fig. 4. Grinding the Cylinders. Note Connections for Exhausting the Dust and the Use of the Water Jacket for Cooling

instead through the regular water jacket of the cylinder casting. This reproduces, in a measure, the conditions met with in actual use, and so tends toward accurate work.

Machines and Fixtures for Grinding and Lapping

There are other operations of interest in the grinding department besides that of finishing the bore of the cylinders. Extensive use is made of the Pratt & Whitney face grinding machine for finishing flat surfaces; in fact, it has largely displaced the vertical milling machine for this work, on parts in which the surface to be finished is clear of projections or obstructions to the sweep of the wheel. The faces of the various castings, covers, inlet and exhaust pipes, etc., are finished on this machine. At the time of the writer's visit, most of these parts were still being made from castings on which 3/16 inch of stock had been left, in accordance with the usual practice of milling. The castings come true enough to shape, however, to permit this finish being reduced to 1/16 of an inch, or thereabout, thus materially reducing the time required.

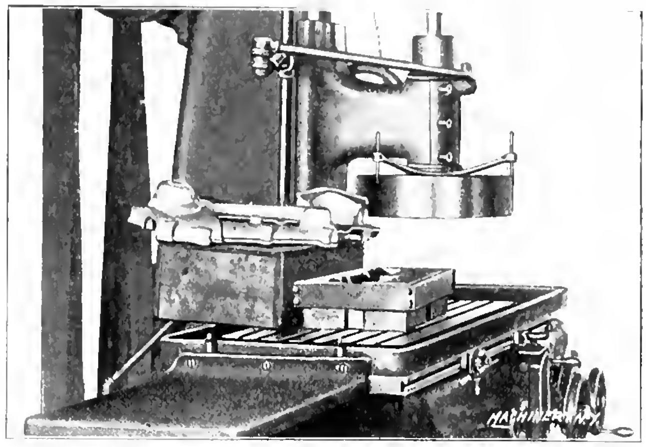


Fig. 5. The Acme of Simplicity in Fixture Making. Face Grinding the Steering Gear Casing

Even when removing 3/16 inch of stock the grinding machine has proved its superiority to the milling machine in the matters of cost, finish and accuracy. The foreman of the grinding department discovered that a little experimenting and investigating along the line of the grading of wheels made a tremendous difference in their durability and effectiveness in removing metal. For aluminum work a Vitrified

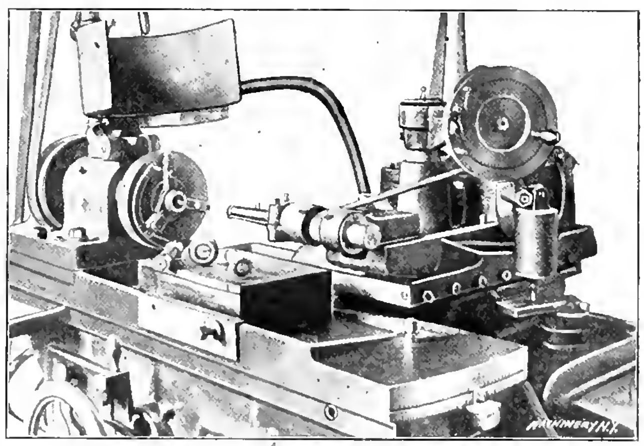


Fig. 6. Grinding the Bore of the Cams Concentric with the Cylindrical Surface

carborundum wheel of about No. 24 grain and grade H hardness is used, a soda compound being employed for cooling.

The cover side of the steering gear casing is one of the parts surfaced on the face grinder. A ridiculously simple fixture is used for holding it. This fixture, as may be seen in Fig. 5, is nothing more or less than a mass of lead melted and poured around a sample casting as a form. The work is set into the bed, thus prepared to receive it, and is supported on the table by its own weight, no fastening being necessary. The castings come uniformly enough so that they fit well in this device, except at certain points around the gates and sprues, where it is found necessary to relieve the form slightly to allow for these variations. It may be mentioned that the other or main member of the steering gear casing has a boss projecting above the finished surface of the joint, making it necessary to mill that surface. The joint is thus formed of one ground and one milled surface.

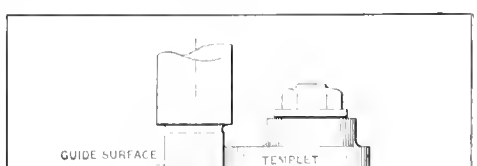


Fig. 7. The Simplest and Stiffest Arrangement for Cam Cutting

In Fig. 6 is shown the operation of grinding the holes in the cams. It is quite important that the cylindrical portion of the cam shall be exactly concentric with the cam-shaft to prevent shock or jar during the period when the valves are supposed to be closed. To make sure that this surface is concentric, the cam is located by it in the grinding fixture as shown. After the fixture has been mounted on the faceplate of the machine, the gripping surfaces of the two jaws at the right are ground out by the internal grinding attachment, to the radius of the cylindrical dwell of the cam. The cam is clamped against the surface thus prepared, by the lever, which forces a wedge across and down upon the cam, holding it firmly into the corner in both directions.

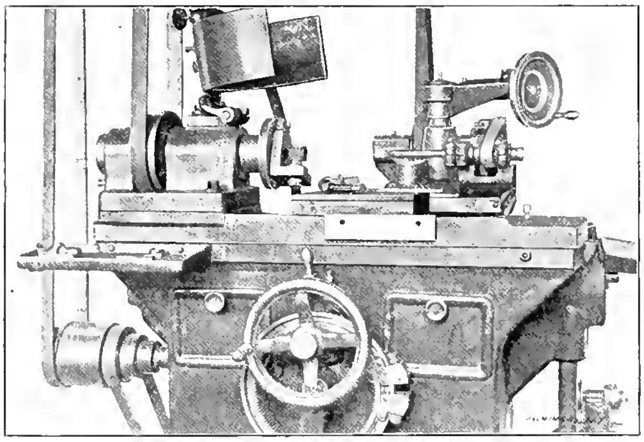


Fig. 8. Grinding the Holes in the Universal Joint Pivots

It will be seen that this car does not employ the integral cam-shaft. By giving careful attention to the locating of the cams on the shaft and by being careful to obtain a strong drive fit between them, the difficulties of loosening and dislocation, which the integral construction is expected to cure, have been avoided. It is thus permitted to cut the cams in a way which gives the best chance for producing accurate shapes and smooth finish. The obvious scheme shown in the sketch, Fig. 7, is followed, the operation being performed on a profile machine. The connection between the forming cam and the work is so close that the difficulties of springing and chattering, met with in the construction of the more elaborate machines required for integral cam-shaft, are avoided.

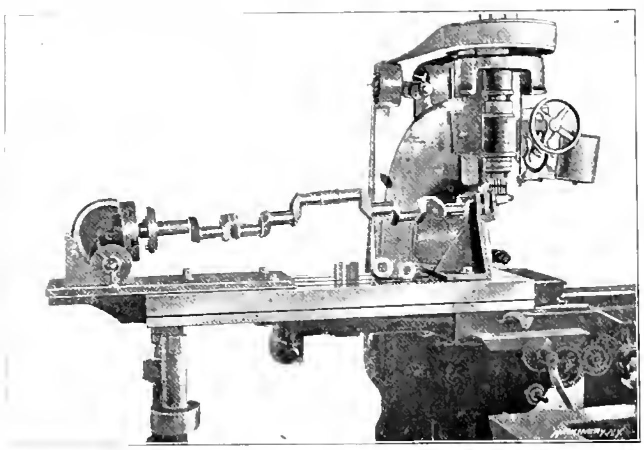


Fig. 9 A Vertical Milling Machine set up for Milling the Tapered Square Drive on the Crank-shaft

Another faceplate fixture for internal grinding is shown in Fig. 8, where it is employed for grinding the hole in the hardened nickel steel sockets used for the universal joints (see Fig. 7, previous article). The socket is held in the same way as when in use, by a nut screwed onto its threaded shank. It is also located in the same way, a pin in the fixture engaging a slot in the flange as shown. A limit of 0.0005 inch only is permitted in this operation, and an allowance of about 0.003 inch for the depth of the hole is the maximum, just enough being permitted for proper lubrication by the grease supply provided. This fixture is kept in place on the machine practically throughout the season. If at any time it is necessary to remove it, however, it can again be trued up by clamping a model socket in place, inserting a plug in the ground hole, and truing up the plug. These studs are held in the same way in the screw machine for roughing out the hole preparatory to grinding. The form of internal grinding spindle used should be noted. One of them is shown detached in Fig. 6, lying on the table of the machine. These spindles and their bearings are self-contained, interchangeable and adapted to work in holes of various sizes. The clutch drive provided rotates the spindle without side pressure on the bearings.

Machining the Members of the Squared Drive

As previously mentioned, the use of keys is tabooed in the drive of the Stevens-Duryea machine, their place being taken by square sockets throughout. A tapered square drive is used to connect the crank-shaft with the driving member of the clutch. The method of machining this is shown in Fig. 9. It has been found advisable to keep the milling machine set up for this work, continuously, owing to the difficulty of making a good taper square fit. When the machine has once been set it is kept so throughout the season. An ordinary dividing head is used, as shown, tipped up to the angle of the taper. To the face-plate of this dividing head is clamped the fly-wheel flange of the crank-shaft. The outer end of the crank-shaft is supported in a suitable steady-rest as shown. For shorter lengths of crank, filling pieces are employed, having flanges bolted to the face-plate at one end, and to the work at the other. The use of filling pieces permits machining of the full line of crank-shafts without disturbing the adjustments.

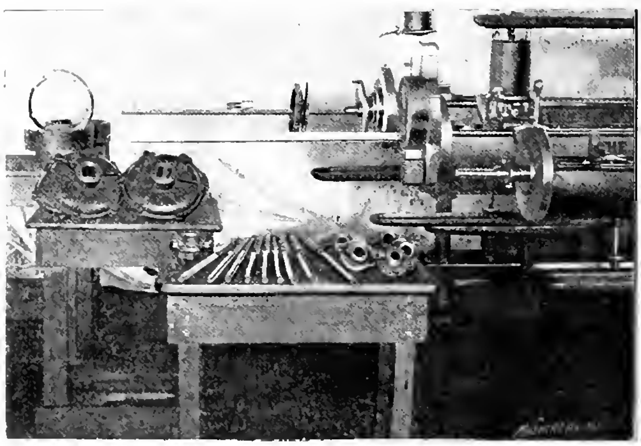


Fig 10. A Set of Interesting Broaching Operations

The automatic cross-feed is employed in feeding the work past the end mill in the vertical milling attachment. The table has to be so far overhung that an out-board support is provided as shown, which permits this cross-feed. This consists of a sliding guide, supported by two standards, reaching to the floor and provided with jack screw adjustments for careful leveling.

The squared holes of the drive are finished on a La Pointe broaching machine in the usual manner. The further machine shown in Fig. 10 is engaged in finishing taper square holes in the clutch driving flange, this being the member into which the taper squared end of the crank-shaft shown in Fig. 9 fits. The hole is first reamed out to a taper a little larger than the distance across the flat of the finished hole. The work is then mounted on a broaching machine on the fixture shown in place. As may be seen, the broach cuts one corner of the square hole, and one-half way up each of the two adjacent sides, into the relief formed by the taper hole. A dog is fastened to the hub of the work, and the latter is mounted

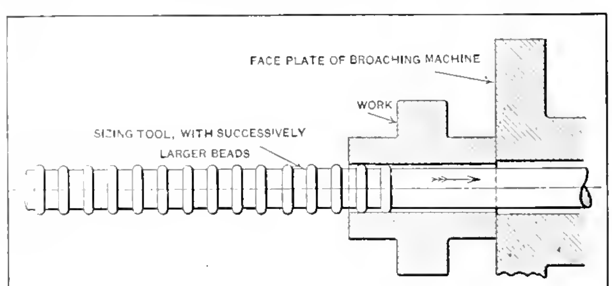


Fig. 11. Method of Sizing Phosphor-bronze in the Broaching Machine by Compression

on a taper plug fitting the hole, with the tail of the dog located by a pin in the face-plate of the fixture, the latter being mounted on the face-plate of the machine at an angle as shown, to agree with the angle of the corner of the tapered sides. This broaching operation was described in October, 1908, page 151.

One pass of the broach finishes one corner of the tapered hole. The broach is then returned to the starting position, the work is drawn off the taper plug, the dog indexed to the second pin on the face-plate, the work is put in position and the second corner broached. This operation is repeated until the four corners have been machined, and the square hole finished, the work being centered on the taper plug of the fixture throughout the whole operation. A taper square gage is shown lying on top of the broach in the engraving. This is used for testing the fit of the holes and the accuracy of the work, and a most accurate fit is made on this by no means easy operation. In the machine in the foreground, another operation is being done—that of broaching the driving slots in the driving clutch members for the multiple disks.

the sizing tool in the broaching machine, it will be found that the hole will be somewhat larger in the large diameter of the work than in the hubs. It has been found that this difference in size can be practically avoided by passing the sizing tool through the work three or four times. Few pieces of this kind are found, however. The operation is a rapid one as compared with reaming.

An Adaptable Lapping Machine

The machine shown in Fig. 12 was built mainly in the factory, use being made, however, of the adjustable columns of a Taylor & Fenn sensitive drill press. This special machine is intended for lapping out the square holes of the drive, but is provided also with a rotary movement in addition to the vertical movement thus necessary, so as to provide for cylindrical lapping as well. The driving pulley at the right gives the reciprocating motion, while the pulley at the left rotates the spindles through the medium of the regular geared speed drive. The sprocket wheels shown, driven from the right, are loose on the driving shaft, and carry eccentrics whose rods are extended to form racks engaging, through a

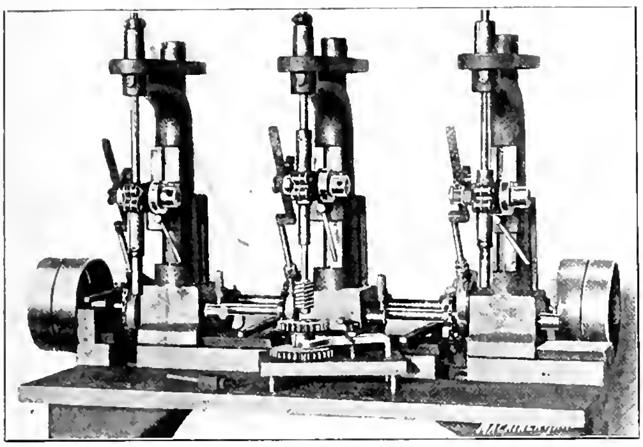


Fig. 12. Machine for Circular and Square Lapping Operations

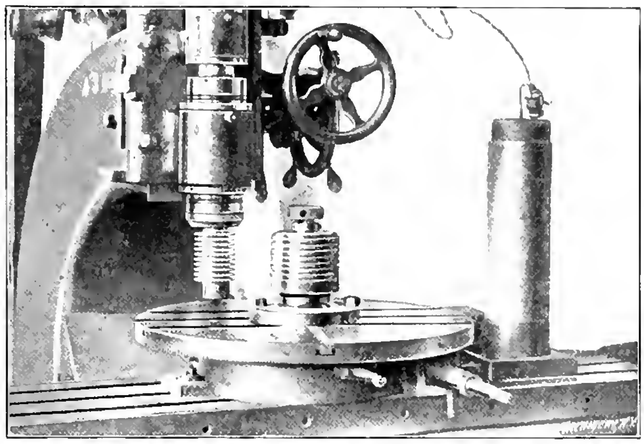


Fig. 13. Cutting out Piston Rings in the Vertical Milling Machine

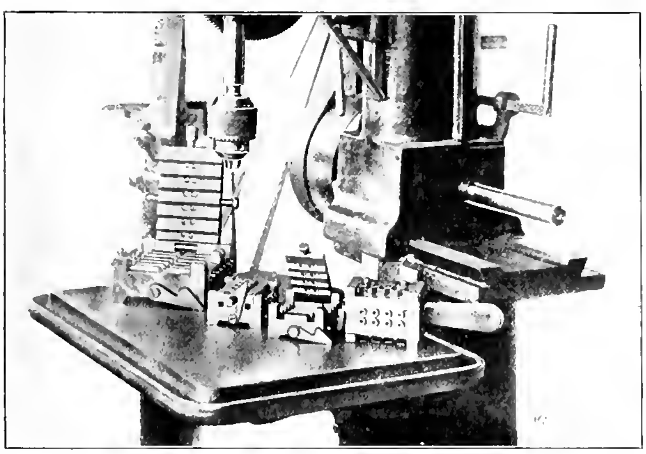


Fig 14. Interesting Drill Jigs for a Simple Operation

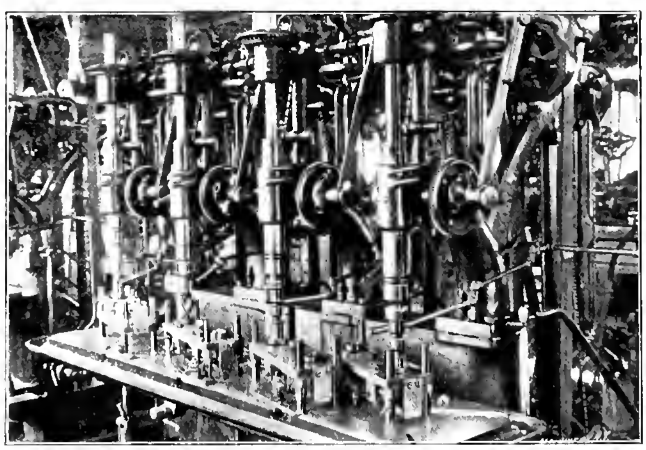


Fig. 15. Gang Drill used in Drilling and Reaming Connecting-rod Ends

Sizing Round Holes in the Broaching Machine

Another unusual operation for which the broaching machine is here used, is that of sizing holes in hard phosphor bronze bushings. This material, as any mechanic who has had any experience with it knows, is as hard on a finishing reamer as anything well can be. It is tough, elastic and slippery, and the less there is to ream the more difficult becomes the operation. Instead of reaming such holes, the tools shown in Fig. 11 are used in this shop. It will at once be seen that the operation is that of compressing the metal in the sides of the hole, until it has been enlarged to the finished size. The tool is drawn through the work. Each of the rounded rings or beads is a little larger than its predecessor, thus gradually compressing the metal the desired amount. The finished hole springs to a size smaller by some few thousandths than the diameter of the largest ring on the tool, so that the size of the latter has to be determined by experiment. This allowance varies slightly also, as may be imagined, with the thickness of the wall of metal being pressed. In such a part as that shown in Fig. 11, for instance, after drawing through

suitable clutch connection, the pinion shafts by which the spindle quills are fed up and down. It is thus possible to give a rotating and reciprocating movement to the spindles, either together or separately.

Separating Piston Rings

Another milling operation is shown in Fig. 13. It is a common practice to make piston rings on an automatic machine specially rigged up for the purpose, separating the rings from the finished casting by means of a series of parting or cutting-off tools, each of which is set a little in advance of the other so that the rings will cut off in regular succession. The parting tool, however, especially when used in severing cast iron work like this, having an eccentric bore, leaves a considerable burr. In the method of severing the rings shown here, the eccentric cylinder is first finished complete on the turret machine. Then it is mounted on an internal expansion chuck on the face-plate of the cylindrical attachment of the Becker vertical milling machine, as shown. This chuck is provided with clearance grooves for the gang of saws shown in the engraving. These are sunk into the cylinder, and then the

work is rapidly revolved, cutting out the eight rings at once. The saws are permanently mounted on their arbor, with separating collars ground to the proper thickness.

Examples of Fixtures used for Drill Press Operations

The drilling department seemed unusually small, when compared with the size of the whole plant, and gave the appearance of being worked at high pressure. The large output required was evidently maintained by the universal use of highly developed jigs for all manufacturing operations. Multiple spindle drill presses are used to almost the entire exclusion of the single spindle type.

Fig. 14 is interesting as showing the development in the jig for a comparatively simple operation—that of drilling

Fig. 16. An Unusual Array of Automatic Chucking Machinee; Thirty-one are used in this Department

the cotter pin hole in a headed cylindrical stud. In the first apparatus employed (not shown) the stud was pushed into a hole up to its head, and held there by a lever, one piece being done at a time. This rigging had two faults. One piece at a time is held, and trouble with chips and burrs was experienced, as might be imagined. An improvement on this device is shown in the two jigs at the right, where a base with a set of V's is provided in which several of the pins may be placed, their heads being pressed up against the end of the V-block by springs. The cover being clamped down on the work, the parts are thus held for the drilling operation. This, however, was not quite easy enough to clean to suit the ideas of the tool designer, so the fixture shown at the left was used for the next tool of this kind that had to be made. Here hinged sides are used instead of springs as in the previous

Fig. 17. The Engine Assembling Department

case. These sides fold up and press the heads of the work against the edges of the V-block. When they are turned down and the cover of the V-block is raised, the top surface of the V-block is all clear, so that the presence of chips shows inexcusable carelessness on the part of the operator. When the sides are folded up against the work and the cover is brought down, the latter, by means of wedge surfaces, presses the sides in, holding the heads of the work firmly in place and clamping them down on the V-block at the same time.

The jig shown at work in Fig. 15 is used for drilling and reaming the connecting-rod holes. It is of the "four-legged table" variety, with suitable clamps and hook bolts for taking the strain of the cut without permitting noticeable deflection and consequent inaccuracy in the work. A feature of the construction which is probably old enough, but was new to the writer, is the provision made for both drilling and reaming with a fixed bushing, thus avoiding the use of slip bushings of different diameters. For drilling, the jig is used as shown in the engraving, with the work clamped beneath the plate and the jig bushings above, guiding the drills. For reaming, the jig is reversed and a reamer is used having a pilot, which passes through the work into the jig bushing (now on the under side of the plate) by which it is guided.

Fig. 16 shows what is by long odds the largest aggregation of automatic chucking machines the writer has ever seen. There are thirty-one of the Potter & Johnston type. Practically every turned part not made in the screw machine from the bar is produced on these machines. That old standby, the engine lathe, appears to be about the rarest machine tool in the shop.

Fig. 17 shows a section of the engine assembling room. It will be noted that machine tools are few and far between, the only ones in sight being a drill press, speed lathe, and two or three grinding stands for sharpening tools. This shows that the manufacturing operations have been performed with great exactness. The question of assembly is simply one of bolting and screwing the separate parts together. The engines here shown are of the four- and six-cylinder type. The overhead trolley lines should be noted.

One of the most interesting departments in this factory is that for testing the completed engines. This, however, deserves an article by itself, and will be so treated in a future issue.

* * *

AN EARLY DEVELOPMENT OF INTERCHANGEABLE MANUFACTURING

An interesting feature of trading and manufacturing in Siberia, also common in European Russia, is mentioned in an article on Siberia in the September issue of *Cassiers' Magazine*. The system is referred to as the "Artel" system. The Artels are combinations of artisans, representing individual occupations and handicrafts, and are especially common in village communities. They are cooperative associations, the work being parceled out among the members and the profits on the work being divided among them in accordance with the rules of the Artel. The members carry on their work in their own cottages, much of the work being done in the winter time during the season when there is no work required for cultivating of the land. One common industry is that of making winnowing machines used by farmers for separating the grain from the chaff after threshing. These are sold in thousands, and are manufactured both in Russia and Siberia by these peasant associations. The machines are very satisfactory for their purpose, and are sold at an extremely low price, due to the system of manufacture followed by the Artels. Each man has a special part of the machine to make, and is provided with a templet for its making. The parts are produced in lots of hundreds and are brought together from the various workers and assembled by another group of workmen who have specialized in this part of the work. This system is exactly the same as that known to modern industries as the interchangeable plan of manufacturing, but it has been in vogue in Russia in the form just described long before it was thought of elsewhere. The trade in this particular machine is so enormous that more than one firm manufacturing agricultural machinery has endeavored to secure a portion of the business, but so far all have failed because no one has been able to produce and sell the machines at the price at which the Artels are able to sell them. Of course, it is only the very simplest machines that can thus be made by the Artels, and they are not able to extend their operations in directions where a higher degree of skill is required, but it is nevertheless interesting to note that the underlying principle of modern shop practice has been applied to the very crudest form of manufacture in countries usually considered so far removed from industrial progress as Russia and Siberia. The recognition and application of the principle are the important facts.

CHAPTERS IN THE EARLY HISTORY OF MACHINE TOOLS—2

JOSEPH G HORNER*

In the lathe we see the earliest developments of machine tools, not only as the lathe and its allied forms are concerned, but because of the influence which this tool has had in the evolution of other types. The mandrel and its bearings occur in other machines, and the self-acting slide and tool-holder also, as well as many of the smaller details - lead screw,

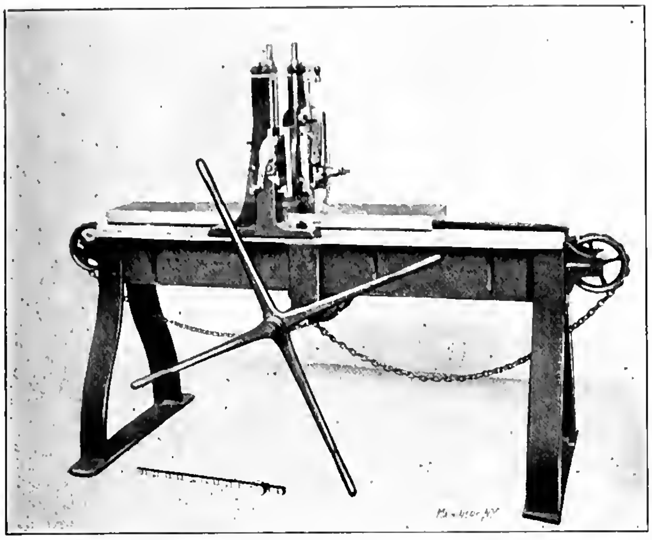


Fig 8. Roberts Planing Machine, Table 52 inches Long by 11 inches Wide (1817), South Kensington Museum

change gears, feed rods, methods of take-up, and so forth. The lathe preceded all other tools and influenced their design.

Planing Machines

After the slide-rest had become developed into a traveling element the principle was not long in being applied to other

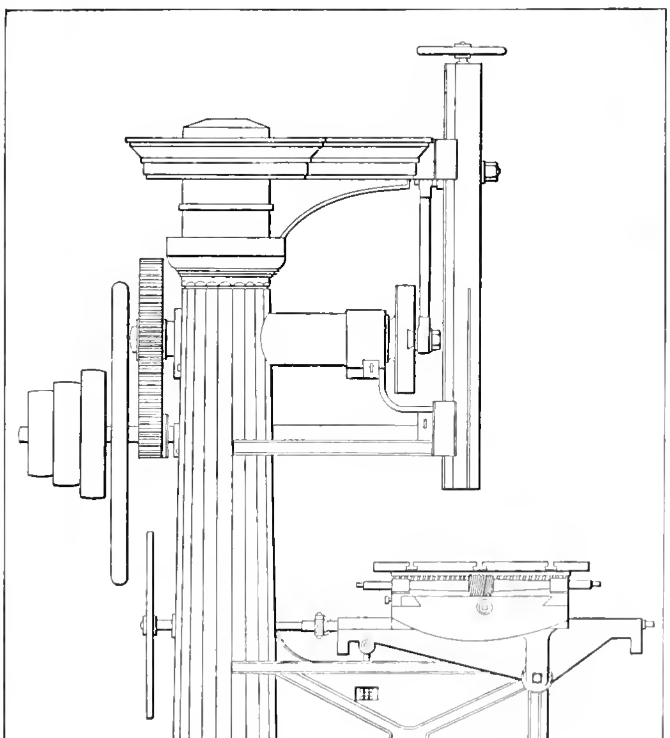


Fig. 9. Self-acting Slotting Machine, Caird & Co., Greenock (about 1846)

machines. First came the planing machine, pioneer of a long line of machines, the principal value of which is due to the coercion exercised on the tool by the sliding action. The honor of its invention appears to lie between four claimants, Roberts, Clements, Fox, and Murray, working during the period of about 1814-1820. This was a very prolific epoch in the history of machine tools; an age of great inventors, pupils, and followers of Bramah and Maudslay.

The planing machine by Richard Roberts of Manchester, now in the South Kensington Museum, Fig. 8, still bears evidence of the hand work done in fitting it up. It is chain-driven, the chain passing round a drum underneath, about the center, going thence over guide pulleys at each end, and attached to each end of the bed. The movements were operated by the large cross handle seen on the axis of the drum. The bed is cast in two parts, of angle section, bracketed and bolted to the legs. Its top edges are inverted vees, doubtless made thus with the intention of preventing lodgment of the chips.

The upper work is remarkable from the fact that the tool-holder is nearly as large as the standards. These are castings slotted on the front for the clamping of the cross-slide. This is elevated by means of independent screws. The tool-slide is traversed by a feed screw.

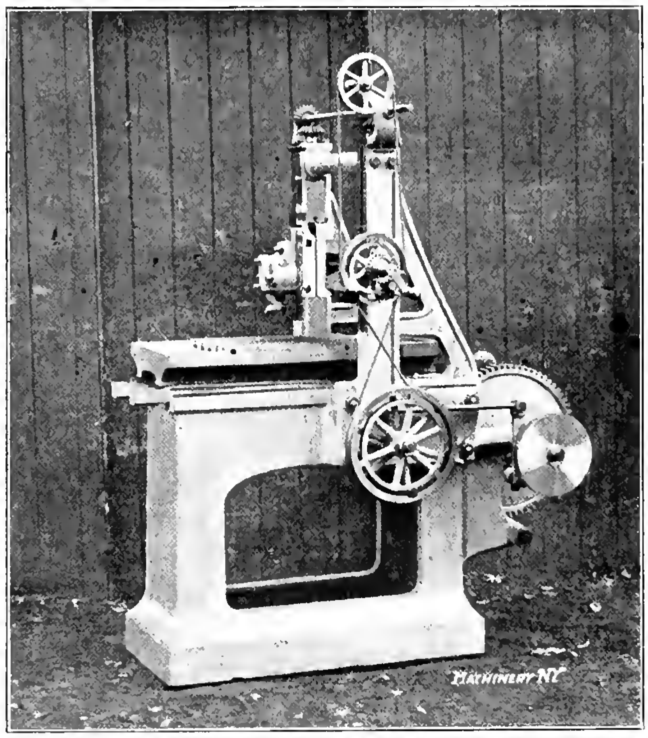


Fig. 10. Whitworth Crank-driven Planer (1868)

During the decade 1830-1840 the demand for high-class machine tools became pressing and extensive, due largely to railway developments. The firm of Sharp, Roberts & Co. was one of the earliest in the field. It had been in existence since 1828, having been engaged in the construction of cotton spinning machinery in Manchester. Roberts was the inventor of the firm, and he designed many lathes, machines for planing, slotting, the cutting of wheel teeth, punching and shearing. Roberts is credited with having invented the system of templets and gages to secure interchangeability of parts in locomotives. This last would be subsequent to 1831, when Sharp, Roberts & Co. started the Atlas Works.

Whitworth stands out a giant among the giants of the time, and his work has eclipsed in poular estimation that of most of his compeers. The period of his activities is marked by numerous improvements and inventions. But the three which have left the most lasting results are the standardization of screw threads, the method of production of a true plane, and measurement by micrometer instruments and by fixed gages. These were the advances which rendered accurate mechanical construction possible. They have been largely instrumental in the displacement of hand work in the construction of machines. They were the incentives to later developments, and they have in some degree dwarfed Whitworth's work in the improved designs of machine tools, or perhaps less attention has been attracted to these. But these are nevertheless very prolific and very interesting. His work has stood the test of time so well that most of the inventions and improvements which he devised have never been superseded. Machines, methods of manufacture, standardization,

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measurement, and test, bear the impress of his genius; and the great firm which he founded still fully maintains the old traditions and high reputation of its originator.

Whitworth seems to have been the first to design that form of planer in which the work remains stationary while the tool travels. He had patented a machine of this kind in

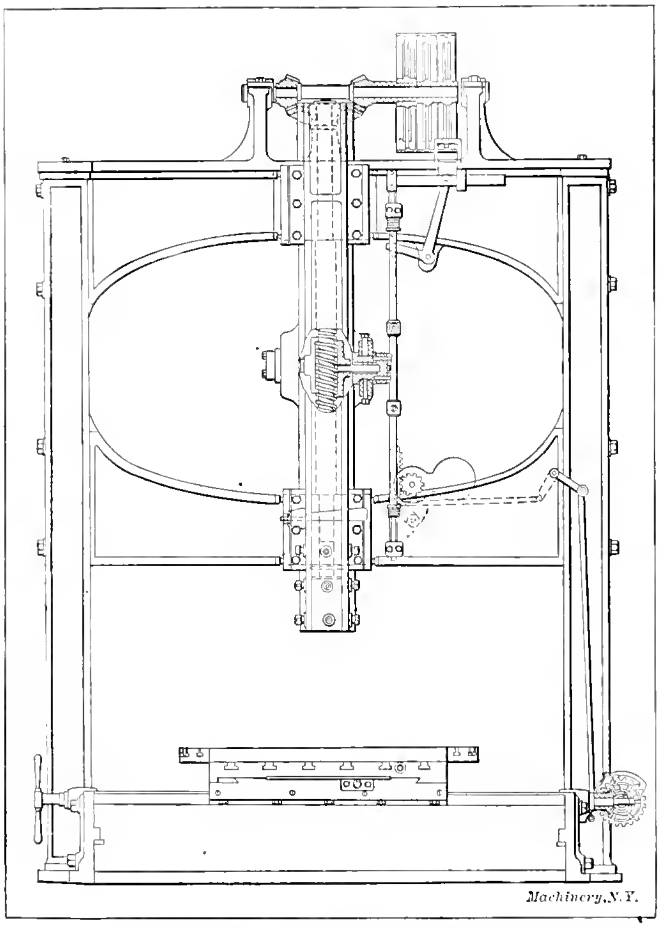

Fig 11. Slotting Machine, Screw-driven. Front Elevation. Joseph Whitworth & Co.

1835, in which the side frames carrying the cross-rail traveled on large wheels on rails low down on each side of the fixed work table.

This Whitworth planer of 1835 was very skeleton-like, if judged by our standards, as indeed all the early tools were; but the resemblances to some features of present-day machines are striking. The lightness of build is illustrated by the fact that flanges were cast on the outside of the framing, and flanges on the traveling heads came just underneath them, with the object of preventing the traveling mechanism from tipping under heavy duty!

Being a traveling head machine, provision was made by three sets of flanges forming ledges within the cheeks for receiving the work tables at three different heights. The cross-rail was elevated by vertical screws and bevel gears, and the cross-slide could be bolted at any height on the face of the uprights.

The crude beginning of the screw worm drive which Whitworth subsequently used on the planers and drilling machines may be traced to this early machine. Two square-threaded screws ran alongside, one flanking each upright and reversing the travel at equal rates. The two side screws were driven from bevel wheels, the transverse shaft having three reversing bevel wheels with claw clutches at the center. Curious recessed rollers were used to transmit the motion of the screw to the uprights, the edges of the rollers, which were set at any angle, entering into the thread spaces. From this device the worm-wheel engagement would naturally follow in time, as it did.

This machine embodied also the reversible tool-box in a crude form, but reversed similarly to later ones by means of a cord round a pulley. The pulley was not in the axis of the rotating box, but on a spindle in front, whence the movement was transmitted through spur gears. The down-feed was accomplished through ratchet mechanism acting on a screw at the head of the tool holder.

In 1837 Whitworth modified the tool-box, introducing the cam groove cut on the rotating body, and which when acted on by a pin operated by the vertical movement of the feed rod imparted the rotary movement. This device has remained permanently embodied in the firm's planer tool boxes of this type.

The fitting of two tools in the box to avoid the rotation of the holder was patented by John Roberts in 1838. In its essentials it is like double cutting holders of to-day, the box being pivoted to throw off the tool which is not in action.

The design of planing machine which has come into considerable prominence lately, in which the tool is reciprocated instead of the work, was being worked out about 1840 by M. Decostre, of Paris, M. Cave and Mr. Hick of Bolton. The first was chain operated, the second by means of a leather belt, the third by a steel belt. In M. Decostre's machine two endless chains were used running the whole length of the machine. The bed was V-grooved, carrying supports, and a cross-rail with the tool-holder. In the machine of M. Cave an endless belt ran over fixed and tension pulleys communicating motion through gears to two racks.

The planing machine had been nearly crystallized in its present design in the forties. The method of driving still lay between rack and screw, for Whitworth had then applied the screw drive to both planing and slotting machines. Quick return in rack-driven machines was effected by larger and smaller fast and loose pulleys driving through gears to the rack pinion. There were three designs of racks then. There

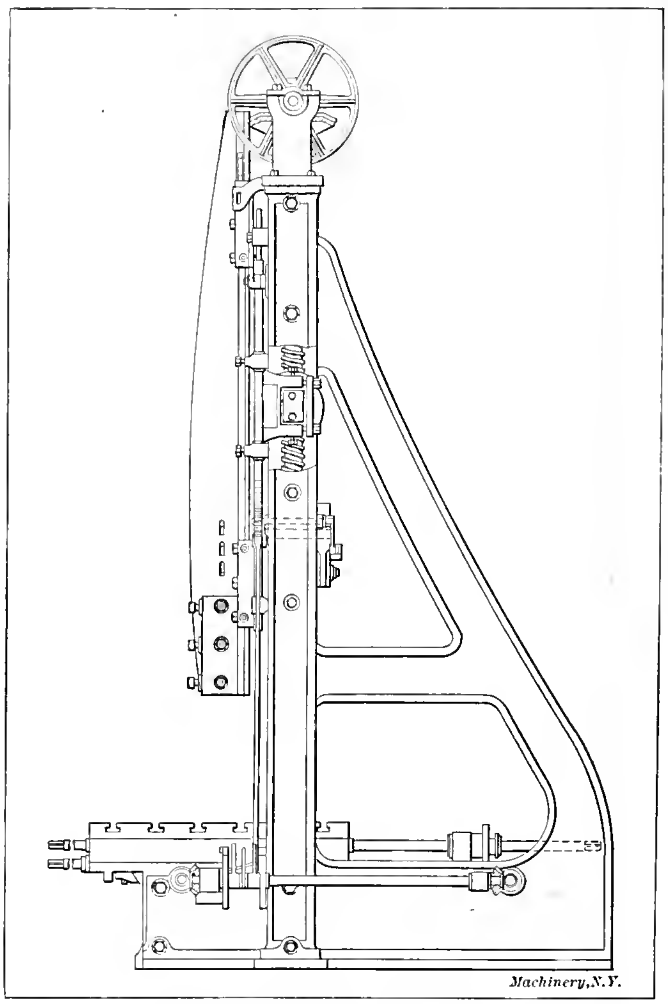

Fig. 12. Early Self-acting Slotting Machine, Screw-driven. Side Elevation. Joseph Whitworth & Co.

was the simple single rack, there were the two racks bolted to the under side of the traveling table with the teeth set to hit-and-miss, and there was the stepped rack with three steps, each step having its teeth equal in length of face to one-third the width of the rack, being set behind its fellow at a distance equal to one-third of the pitch. This was introduced by a Mr. Collier of Manchester.

To the screw reversal the objection was that the return speed was not accelerated, the bevel wheels being of equal sizes. Mr. Shanks of Johnstone modified the gear by placing two bevel wheels of different sizes on the end of the screw, the diameters of which bore the same relation to each other as the speeds of cutting and reverse did. These were operated by pinions on solid and hollow shafts, and the device has been fitted to many machines.

The earliest Whitworth screw did not engage with nuts as at present, but with worm-wheels, being the same device as the rack worm-wheel applied to the lathe lead screw, but duplicated. Two worm-wheels on opposite sides of the screw, and having their spindle bearings secured to the under side of the table, were revolved by the rotation of the screw, and thus carried the table along. The same method was applied to the spindles of drilling machines. The device was first applied by Whitworth in 1835 for the motion of the carriage of a self-acting spinning mule.

A favorite type of small planing machine in and around the Manchester district is the crank-driven design. One of these of date of 1868 by Whitworth & Co. is shown in Fig. 10. It is driven by a cone pulley through crank-pin and slotted link, adjustable for stroke, and giving quick return. The slotted link is provided with a connecting-rod, one end of which is attached to the table. The feed is operated from an edge cam keyed to the crankshaft. This rotates at each end of the stroke through bevel gears the cord pulley at the bottom of the upright. The cord fixed to this pulley passes round the several pulleys shown, and gives a variable horizontal feed by means of the ratchet gear on the end of the cross-slide, and a variable vertical and angular feed by ratchet gear on top of the tool slide.

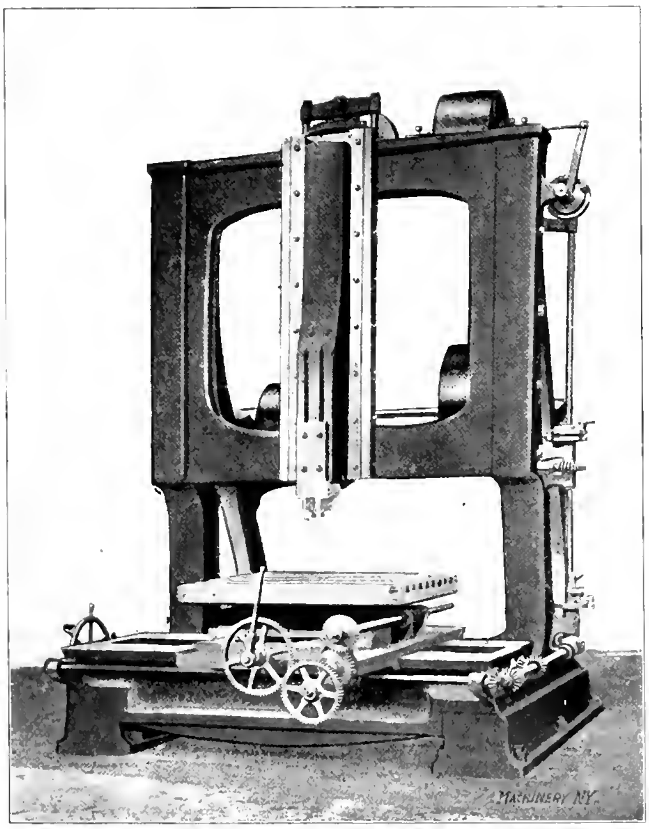

Fig. 13. Slotting Machine. Joseph Whitworth & Co. (1874)

At an early period the American planing machines were improved and developed on different lines from the English ones. Some of the early chain machines remained in use in England, and in the States as late as about 1880, side by side with many of the improved forms which are even now regarded as modern. The Sellers' drive was then in existence—the spiral pinion working diagonally in its rack, an improved form of Bodmer's worm and rack. The rack-and-pinion drive was also in use. The plain rack and the stepped rack divided favor in England, but the pinion was always small, with a tendency to lift the table. The large driving or bull wheel was early adopted in America. The single belt for driving and reversing was early abandoned in America for two belts, one driving, the other for reversing; and high speeds and narrow belts also were adopted, and the shifting of one belt at a time. The feed gear was operated from the driving gears instead of by tappets on the table.

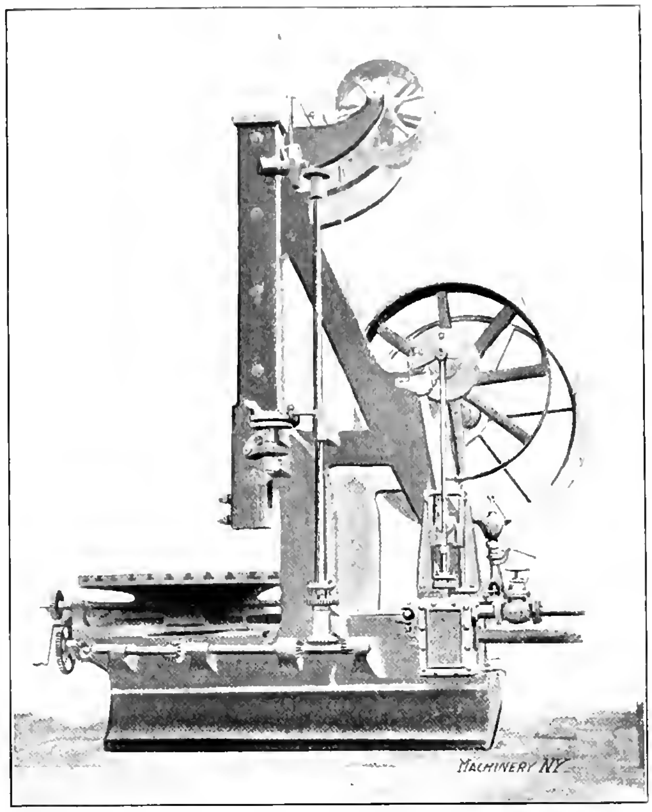

Fig. 14. Slotter driven by Steam Engine. Joseph Whitworth & Co. (1867)

Mr. Richards has a hit in an old pamphlet at the ornamentation which was a common feature in early machine tools. He said "The strains that fall upon the standards of planing machines are so obvious that there should be no difficulty in determining the best form; but these standards offer so inviting a field for architectural ornament that only a few tool makers forbear adding some filigree work. The beads, moldings, and ornaments of cast-iron machine parts were long ago discarded by the better class of engineers, and are at present seldom seen except in New England or in France.

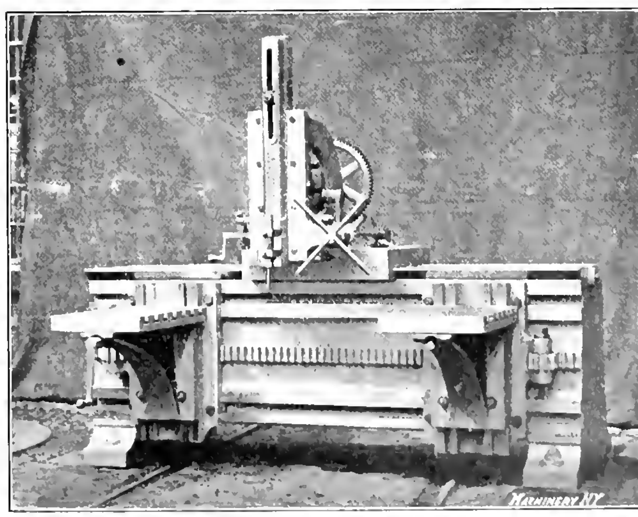

Fig. 15. Special Slotting Machine with Lateral Feed. Joseph Whitworth & Co (1865)

As a rule the want of good fitting and want of true proportions in machine tools is directly in proportion to the amount of attempted ornament."

Three large wall planing machines were among the equipment at Soho. The largest covered a wall space of 27 feet by 9 feet. The traversing screw was 4 inches diameter, of 5/8-inch pitch, double threaded, and the nut of 2 feet in length embraced only the upper part of the screw. An interesting feature was the double cutting tool box of the rocking type

reversed by a trip lever, and it carried four tools, two facing in each direction.

The Richards side planers were first described in a pamphlet printed in Philadelphia in 1882. They are there termed combination, or compound planing machines, because they perform the functions of both planing and shaping machines, and the features there described, now familiar, had the claim of novelty: "The time required to fasten work is not one-half as much as with a common machine. The tools always

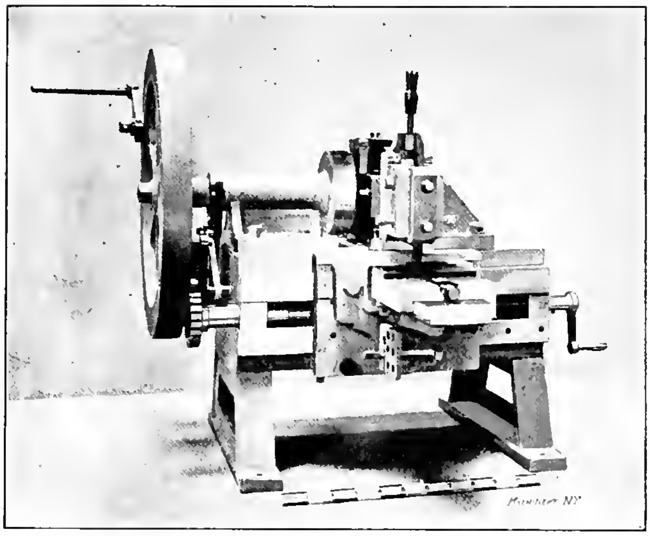

Fig. 16. Shaping Machine designed by James Nasmyth. South Kensington Museum

operate at the same level, and the range of movement is nearly as accurate as with crank motion. The stroke is as complete at 2 inches as at 50 inches." The entire absence of gear wheels is mentioned, and the noiselessness of running. Two sizes of machines only were made at first, one to plane 50 inches by 20 inches, weighing two tons; the other to plane 60 inches by 25 inches, and weighing three and a half tons. Mr. J. Richards, who did so much for machine tool development in America, early advocated the fixed work, and the traveling tool embodied in his side planer. He said in a paper published in San Francisco in 1880: "When work becomes many times as heavy as the implements required to cut it, there are good reasons for moving the tools instead of the piece. The principle is traceable through all machine tool practice of our day, but is especially marked in the case of planing appliances. Mammoth machines with running platens to plane eight, ten, or twelve feet square are now seldom made except in this country. Four feet square may be called an economic limit for moving platen machines. . . . A large sole plate with portable tools for planing and boring is in most cases all that is required."

Slotting Machines

The slotting machine was invented by Richard Roberts, but the idea was borrowed from a machine by Maudslay used for cutting the mortises in ship's blocks. Roberts' machine was in general appearance and design similar to present-day machines, but there was no quick return. Nasmyth, seeing the objection to the limitations in diameter due to the presence of the gap, designed in 1836 a table machine in which the slotting ram was placed below in a pit. The advantages which he claimed were that it was capable of operating upon wheels of any diameter, that it would take a much deeper cut, there being an entire absence of any source of springing or elasticity in its structure, that it operated with more precision, occupied less space, and did not cost above one-third of the other machines. This might be regarded as the prototype of the keyway seating machines.

There was a slotting machine at Soho foundry attached, like so many of the machine tools there, to the wall. The base-plate, with table and slides was on the floor. The ram moved in dovetailed slides, and was driven by a single threaded screw of $4\frac{1}{2}$ inches diameter and 1 inch pitch, the cutting and return movements being effected by a nest of bevel gears at the top of the machine. The screw ran in a nut at the head of the ram, the weight of which was counterbalanced. Power feeds were fitted to the table slides.

The early form of slotting machine was obviously an adaptation of the planer, but crank-driven. Though it had no quick return, and no self-acting table feeds it had the two rectilinear and the circular movements imparted by hand, and a tilting table, and thus marked a very great advance in the methods of the machine shop. An example by Caird & Co., Fig. 9, previous to 1847, is curious for its architectural features, its fluted column, and architrave on the overhanging head.

One of Whitworth's early slotting machines with the ram, screw-driven as previously mentioned, Figs. 11 and 12, avoided the difficulty of the obstruction of the standard by employing two uprights bolted to the base, and leaving a clear space between them from front to back. Two stretchers bolted between the uprights provided the guides for the ram. Fig. 13 is a similar machine of date 1874.

Among the tools at the old Lambeth works was a slotting machine by Sharp, Roberts & Co. of Manchester, bearing date 1840. The framing was arched at the top. A six-stepped belt cone drove the ram through a slotted crank and connecting-rod arranged at the back, but at the side of the main frame, which was a very skeleton-like affair. The table was provided with all motions, including the circular, and an elevating motion of its base between the main framing. Feed was self-acting from a cam on the cone shaft. A trunnion fitting to the table provided for taper slotting.

A large Whitworth slotting machine (1867) for general and locomotive work is shown in Fig. 14, driven by a steam engine with governor attached. The stroke was about 4 feet. The tool ram is actuated by means of a quick threaded screw from the drum of the engine crankshaft by shifting belt to top pulleys, thence through bevel gear for the cutting stroke, and miters for quick return. The bottom of the main screw is

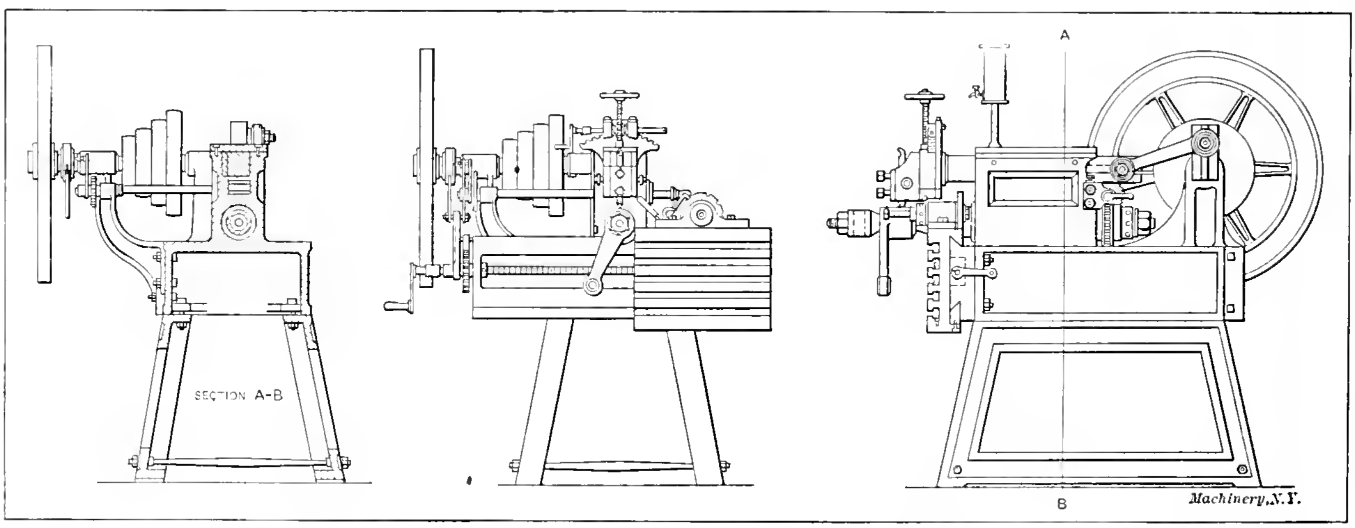

Fig. 17. Compound Planing Machine or Shaper. Nasmyth & Gaskell

fitted with small bevel gears giving motion to a worm and worm wheel which rotates the slotted disk. This is provided with tappets adjustable for length and position of stroke. The tappets actuate the long vertical shaft, the top of which is coupled to the belt striking gear, and the bottom to the variable reversible feed motion in the longitudinal, transverse, and circular directions. The table is 6 feet 6 inches diameter and the distance between the uprights is 8 feet 6 inches.

A Whitworth machine which embodies features of the shaper and slotter is shown in Fig. 15. It was a special slotting machine (1865) made for slotting out the port holes in the cylinders of locomotives, and doing ordinary work on the table of the machine. The tool ram is driven from a balanced counter-shaft by means of the single pulley seen at the back of the head, thence through the spur gears, slotted disk, and connecting-rod, adjustments for length and position of stroke being provided for. The variable feed is operated from an edge cam on the disk shaft through the slotted lever seen on the right-hand side of the head; thence by ratchet wheel, miter wheels, and revolving nut on the screw in the bed, for longitudinal feed; and by the left-hand ratchet gear, miter, and screw, for the transverse feed.

Shaping Machines

Nasmyth invented the shaping machine in 1836 with the object of tooling the smaller details which were not suitable to go on the planing machines. It was known as "Nasmyth's steam arm," of which the arbor for segmental work formed an important element. Said he: "None but those who have had ample opportunities of watching the progress of executing the detail parts of machines can form a correct idea of the great amount of time that is practically wasted and unproductive, even when highly skilled and careful workmen are employed. They have so frequently to stop working in order to examine the work in hand, to use the straightedge, the square, or the calipers, to ascertain whether they are 'working correctly.' During that interval the work is making no progress; and the loss of time on this account is not less than one sixth of the working hours, and sometimes much more; though all this lost time is fully paid for in wages."

An early form of the Nasmyth shaper, hand operated, is in South Kensington, Fig. 16. A somewhat later design, power driven, is illustrated by the drawing Fig. 17. This was termed a compound machine, because it included circular tooling on the mandrel, which did away with a deal of hand chipping and filing on lever ends and similar work. It had no quick return at first. Whitworth was the first to fit that. It was just a short stroke machine substantially like present day successors only of rather bizarre appearance. It was belt-driven on cones, with adjustable stroke and self-acting feed to the arbor.

Yet the original of the shaper may be traced to a machine in Maudslay's shop. Two girders supported on legs carried the sliding work bed, over which the the tool-box was traversed and reciprocated between two round bar guides. These movements were derived from a large cord-driven stepped pulley, crank and connecting-rod, to the tool-box. The latter with its guides could be adjusted vertically by four screwed pillars, with nuts above and below the bosses of the guide bars which fitted over the pillars. An interesting feature is that the tool box was rotated through 180 degrees at the end of each stroke, to cut on each stroke.

* * *

The question of supplying power to Paris by means of an electric generating plant at the Rhone falls now appears to have reached the stage of probability. It is planned to transmit 150,000 kilowatts direct current at a voltage of from 120,000 to 200,000, although there is doubt on the question whether the three-phase system would not be preferable. The capital cost for the whole project is estimated at $20,000,000 and an important factor yet to be decided is whether it will be possible to deliver current at the capital at lower cost than when generating locally by steam. It is, however, probable that manufacturing towns would grow up around the falls, similarly as has been the case around Niagara, and in this case the project of establishing a large power station would be entirely feasible.

STRESSES PRODUCED BY SHOCKS

A. P. ELTOFT*

A. P. Eltoft†

The opinion that, in general, a certain static load can be substituted for a shock produced by a body in motion, is often met with among engineers. This opinion, however, is true only within certain limitations; that is to say, in each concrete case there exists a certain force which will produce the same maximum stress as that due to a given shock, but this force may vary greatly in different cases even if the energy, by which the shock is measured, remains the same. The magnitude of a shock must be measured in units of energy, and, therefore, cannot be directly compared to a force.

Although in some cases a close approximation to an exact calculation of stresses produced by shocks may be attained, it is often found a complicated, and sometimes an impossible, task to determine, even theoretically, the effects of a shock, and the object of the present article is more to give a clearer understanding of the principles involved, than an attempt at exact calculation.

TABLE 1. STRESSES PRODUCED IN BEAMS BY SHOCKS

Method of Support, and Point Struck by Falling Body.	Fiber Stress p produced by Weight Q dropped through a Distance h.	Approximate Value of p.
Supported at both ends; struck in center.	$p = \frac{QaL}{4I}\left(1 + \sqrt{1 + \frac{96hEI}{QL^3}}\right)$	$p = a\sqrt{\frac{6QhE}{LI}}$
Fixed at one end; struck at the other.	$p = \frac{QaL}{I}\left(1 + \sqrt{1 + \frac{6hEI}{QL^3}}\right)$	$p = a\sqrt{\frac{6QhE}{LI}}$
Fixed at both ends; struck in center.	$p = \frac{QaL}{8I}\left(1 + \sqrt{1 + \frac{384hEI}{QL^3}}\right)$	$p = a\sqrt{\frac{6QhE}{LI}}$

I = moment of inertia of section; a = distance of extreme fiber from neutral axis; L = length of beam; E = modulus of elasticity

A number of formulas, however, are included, because many interesting conclusions can be drawn directly from these formulas, which probably also will be of interest to many of the readers of MACHINERY, who, like the writer, have often felt the need of some formulas directly applicable to shocks.

Any elastic structure subjected to a shock will deflect until the product of the average resistance, developed by the deflection, and the distance through which it has been overcome has reached a value equal to the energy of the shock. It follows that for a given shock, the average resisting stresses are inversely proportional to the deflection. If the structure were perfectly rigid, the deflection would be 0, and the stress infinite. The effect of a shock is therefore to a great extent dependent upon the elastic property (the springiness) of the structure subjected to the impact.

The energy of a body in motion, such as a falling body, may be spent in each of four ways:

1. In deforming the body struck as a whole.
2. In deforming the falling body as a whole.
3. In partial deformation of both bodies on the surface of contact (most of this energy will be transformed into heat).
4. Part of the energy will be taken up by the supports, if these be not perfectly rigid and inelastic.

How much energy is spent in the last three ways it is in most cases difficult to determine, and for this very reason it

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is safest to figure as if the whole amount were spent, as in case 1. In cases where a reliable judgment is possible, as to what percentage of the energy is spent in other ways than the first, a corresponding fraction of the total energy can be assumed as developing stresses in the body subjected to shocks.

Formulas for Stresses due to Shocks

If, in the accompanying illustration, the weight Q be dropped from a height h to the end of a bar of the length L and cross sectional area A, then the static load P which would produce the same elongation as the maximum elongation produced by the dropping of Q, would be determined by the following formula:

$$P = Q\left(1 + \sqrt{1 + \frac{2\,h\,A\,E}{Q\,L}}\right) \qquad (1)$$

For $h = 0$ this gives $P = 2\,Q$, or a suddenly applied load will produce the same elongation and therefore the same stress as a static load twice as great.

If the elongation y of the bar is small compared to the height h, the formula may approximately be written

$$P = \sqrt{\frac{2\,Q\,h\,E\,A}{L}} \qquad (2)$$

If the unit stress $p = \dfrac{P}{A}$ be introduced in this formula, we get

$$p = \sqrt{\frac{2\,Q\,h\,E}{L\,A}} \qquad (3)$$

From this formula, the interesting conclusion can be drawn that the unit stress p for a given load producing a shock, varies directly as the square root of the modulus of elasticity E, and inversely as the square root of the length L of the rod and the area of section A. Thus, for instance, if the sectional area of a column be increased four times, the unit stress will diminish only one-half. This is entirely different from the results produced by static loads where the stress would vary inversely with the area, and within certain limits be practically independent of the modulus of elasticity and the length L of the rod.

TABLE II. STRESSES PRODUCED IN SPRINGS BY SHOCKS.

Form of Bar from which Spring is made.	Fiber Stress f produced by Weight Q dropped a Height h on a Helical Spring.	Approximate Value of f
Round	$f = \dfrac{8\,Q\,D}{\pi\,d^3}\left(1 + \sqrt{1 + \dfrac{G\,h\,d^4}{4\,Q\,D^3\,n}}\right)$	$1.27\sqrt{\dfrac{Q\,h\,G}{D\,d^2\,n}}$
Square	$f = \dfrac{9\,Q\,D}{4\,d^3}\left(1 + \sqrt{1 + \dfrac{G\,h\,d^4}{0.9\,\pi\,Q\,D^3\,n}}\right)$	$1.34\sqrt{\dfrac{Q\,h\,G}{D\,d^2\,n}}$

G = modulus of elasticity for torsion; d = diameter or side of bar; D = mean diameter of spring; n = number of coils in spring

Similar formulas may be developed for stresses produced by shocks in beams or other members subjected to bending, and supported in various ways. The accompanying Table 1 gives the unit stress p in beams of length L produced by a weight Q falling a distance h. Only the simplest cases have been considered. It is interesting to note that the approximate value of the stress produced by the shock is the same, irrespective of how the beam is supported. This again shows how the effects of shocks and the static load differ. As a matter of fact, the expression for the approximate value of p will be the same for beams supported on both ends and subjected to a shock at any point between the supports.

Effect of Shocks on Helical Springs made from Round or Square Bars

A load suddenly applied on a spring will produce the same deflection, and therefore also the same unit stress as a static load twice as great. If, however, the load Q falls from a height h before striking the spring, it will produce a stress equal to that of static load P, according to the formula:

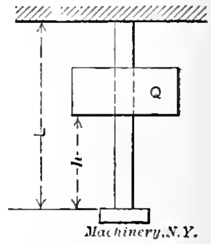
$$P = Q\left(1 + \sqrt{1 + \frac{2\,h\,G\,d^4}{C\,Q\,D^3\,n}}\right) \qquad (4)$$

in which G = modulus of elasticity for torsion,
d = diameter of round spring or side of square spring,
C = a constant, which is 8 for round bar, and $1.8\,\pi$ for square bar,
D = mean diameter of spring,
n = number of coils in spring.

If the deflection y of the spring is small compared to h, an approximate formula may be written

$$P = \sqrt{\frac{2\,Q\,h\,G\,d^4}{C\,D^3\,n}} \qquad (5)$$

Table II gives the fiber stress f produced by weight Q dropped a distance h before striking a helical spring. The main conclusion arrived at in these formulas is that the fiber stress for a given shock will be greater in a spring made from square bar, than in one made from a round bar, if the diameter of coil be the same, and the side of the square bar equal the diameter of the round bar. It is, therefore, decidedly more economical to use round stock for springs which must withstand shocks.



Stress due to Shock

This is due to the fact that the deflection for the same fiber stress for a square bar spring is smaller than that for round bar spring, the ratio being as 4 to 5. The round bar spring is therefore capable of storing more energy than a square bar spring for the same stress.

Shocks from Bodies in Motion

The formulas previously given can be applied, in general, to shocks from bodies in motion. A body of the weight W moving horizontally with the velocity of v feet per second, has a stored up energy

$$A = \frac{1}{2}\,\frac{W\,v^2}{g} \text{ foot-pounds, or } \frac{6\,W\,v^2}{g} \text{ inch-pounds.}$$

This expression may be substituted for $Q\,h$ in the previous equations for unit stresses containing this quantity, and the stresses produced by the energy of the moving body thereby determined. The formulas in this case are no longer approximate, but correct, as there is no work corresponding to $Q\,y$.

It will be noticed that in all these formulas, the stress is directly proportional to the square root of the energy consumed. Therefore, if it is assumed that only a certain percentage, as p per cent of the energy developed, is consumed, then the stress will be diminished from the first value obtained, to the first value multiplied by $\sqrt{\dfrac{p}{100}}$

The writer is fully aware of the limitations of the applications of the formulas given. They give, however, a maximum value of the stresses, thus giving the designer something definite to guide him even in cases where he may be justified in assuming that only a part of the energy of the shock is taken up by the member considered. If the quantity $Q\,h$ be taken as representing the energy consumed by the member in question, then the formulas are perfectly correct. The conclusions drawn, therefore, hold good, as for this purpose, no other significance need be given to the quantity $Q\,h$. The deductions of the formulas given have not been included, as these deductions are rather lengthy. They are, however, all deduced by the simple principle that the work performed by the weight Q acting through a certain distance must equal the work consumed by the internal stresses. The work performed by the weight, of course, is the weight multiplied by the distance through which it falls before striking the body plus the amount of deflection. The work of the internal stresses equals the mean stress produced by the shock times the deflection. This mean stress is ½ of the maximum stress, or the stress P produced by the maximum deflection.

AUTOMOBILE FACTORY PRACTICE*

THE DAYTON MOTOR CAR CO., DAYTON, OHIO

ETHAN VIALL†

The recent hard times, as many in the machine tool line have known them, have as a rule, been regarded as a huge joke by the big automobile builders, for a large majority of them have run full or double time and then could not fill all their orders promptly. So far behind have many of them been that they had to get some of the parts made elsewhere, and the Dayton Motor Car Co., Dayton, Ohio, maker of the Stoddard-Dayton automobiles, has been no exception in this respect. In fact, the company has found it necessary to extend its plant by the erection of an immense steel and concrete structure, now nearing completion, that will nearly double its already tremendous capacity.

This firm actually makes, as the word is understood in the manufacturing world, about 95 per cent of its car, which is a high percentage when one considers the average automobile shop, or even some of those of national reputation, which in many cases are little more than assembling plants. The firms in the same class with the Dayton Motor Car Co., when it comes either to size, methods, quality, or output can be numbered on the fingers, with several to spare. The forging department alone is as large as some good-sized factories. Here everything in the nature of a forging which is used on the automobiles, with the exception of the crank-shaft, is made; even the big elliptical side springs are made up complete in this department from the plain steel strips to the finished article which is tested out in actual service.

This firm is also one of the few which has its own foundry, thus insuring a more nearly uniform product than can be obtained from a jobber. Then, too, the body tops are cut, sewed and finished and cushions are made in their respective departments. Wood is bent into shape for the bodies and top braces and, of course, all painting and finishing is done in the plant. There is, besides the complete line of manufacturing departments, a big garage and repair shop maintained especially for the quick repairing of disabled machines of their own make that may be shipped or brought in.

Crowded as are the conditions in the factory just at present, the shop practice itself stands out clear and strong, the equal of anything in the country. This does not mean that every machine is original or built especially for the work to be done, for at the present stage of the automobile business this is no longer necessary, but where special machines or tools have been needed they have been built, and built in a way that speaks well for their efficiency and length of usefulness.

The most vital part of an automobile is the motor and it is around this part of the machine that the interest of a mechanic usually centers. Many of the parts cannot, for lack of space, be followed through the various routes they take in the shop, but the practice of different factories varies to such an extent regarding piston rings, pistons and cylinders, that these parts will be taken up pretty much in detail, and a few other more or less important or interesting points will also be touched upon.

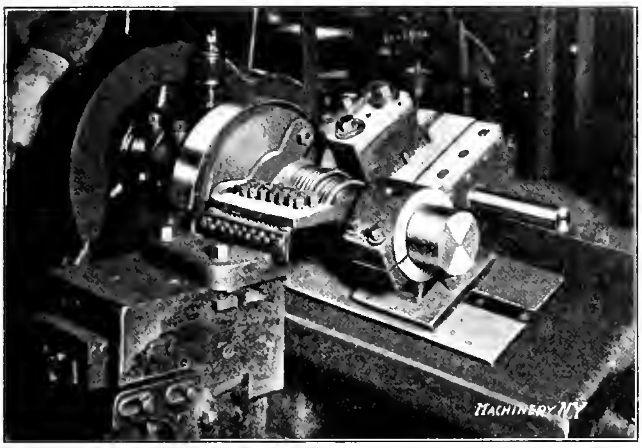


Fig. 1. Turning, Boring and Cutting-off Piston Rings in a Gridley Machine

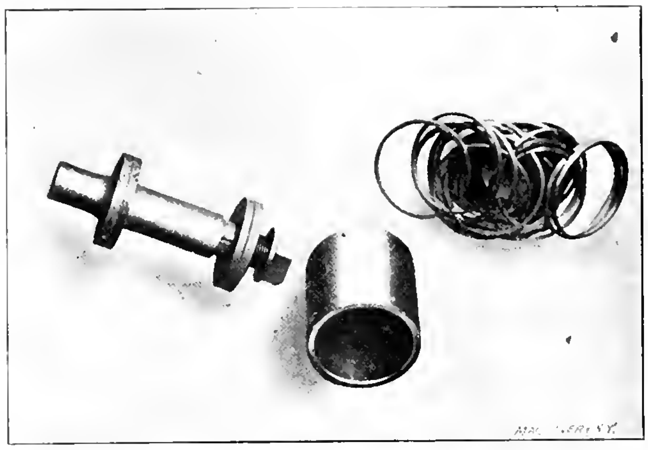


Fig. 2. Mandrel for Holding Rings when Grinding the Outside

Fig. 3. Facing the End, breaking the Inside Edge and boring out the Piston

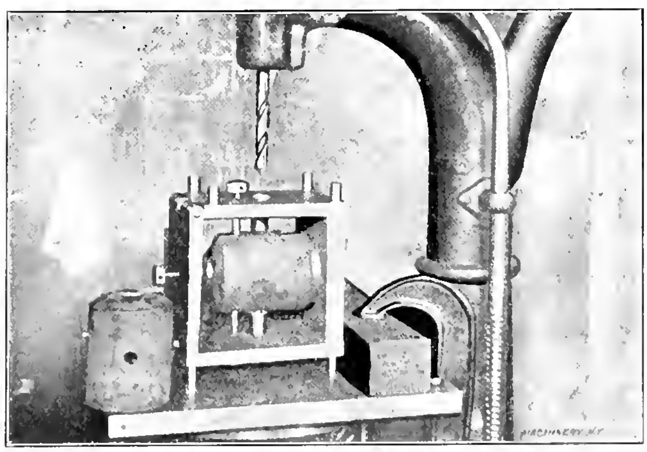


Fig. 4. Jig for Drilling the Wrist-pin Hole in the Piston

Making Piston Rings

Piston rings go through comparatively few separate operations, as three of the operations are done simultaneously on one machine. The piston-ring casting is made with three large flanges or lugs on one end for the purpose of bolting it to the face-plate. The holes in these lugs are laid out by hand and drilled in a drill press and the casting is then bolted to the face-plate of a Gridley semi-automatic piston ring machine which is shown in Fig. 1. This machine bores out, turns eccentric and cuts off the rings, all the operations going on at once. The motion of the turning-tool carriage which turns the outside of the casting eccentric while the inside is bored concentric, is obtained by a cam on the back of the face-plate. After leaving this machine, the rings are taken to the grinding department which is in charge of Mr. C. A. Smith, and placed one at a time on the magnetic chuck of a Heald grinder, and the sides are ground. They are next split with a milling saw and are then ready for the finishing of the outside, which is done by filling the cast-iron sleeve,

* For additional information on this subject, see "Machines and Tools for Automobile Manufacture," June, 1909, and articles there referred to.

† Associate Editor of MACHINERY.

shown in Fig. 2, with the split rings, placing it over the mandrel, putting on the loose flange and screwing on the nut. The sleeve is then removed, the mandrel placed on centers and the outside of the rings ground. The rings are now ready for the final inspection from which they are passed to the assembling department.

All of the operations on piston rings which have been just described, as well as the following ones on pistons, except the grinding operations, are done in what is known as the screw and turret department, in charge of W. F. Hittle.

The Piston Processes

The first machining operation done on a piston, is to place it in a four-jawed lathe chuck as in Fig. 3, with the open end outward, and true it up by the cored hole. The outer end is then faced off, the inside edge broken or beveled slightly with the same tool and the inside bored out to the wrist-pin bosses by the boring head shown in the tail spindle. The casting is next placed in the drilling jig, Fig. 4, and the wrist-pin hole is drilled. The work is located in the jig by means of a plug which fits the hole just made by the boring tool. Next, the piston is placed in a Gridley automatic and

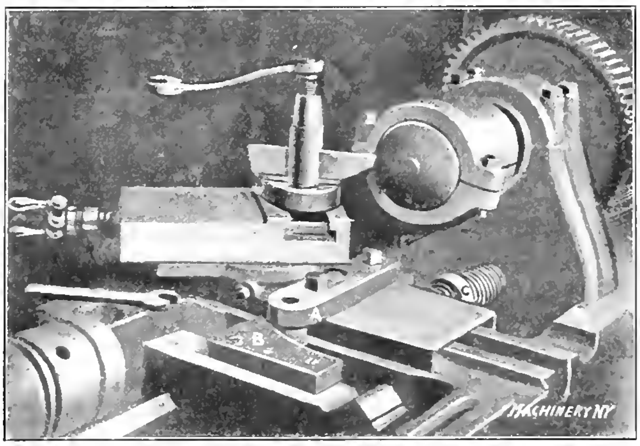


Fig 5 Lathe equipped with Forming Slide for Turning Spherical End of Piston

the outside, the piston ring grooves, and body clearance are turned. The piston is held in the machine by means of a stub mandrel, on the nose of the spindle, to which it is fastened by a long eye-bolt running through the spindle and tightened by a hand-wheel at the back. A short piece of heavy iron rod is also inserted through the wrist-pin hole in the piston and the loop of the eye-bolt. The piston is steadied on the cut by a follow rest.

From the automatic, the piston is taken and placed in the hollow chuck shown in Fig. 5, and the closed end rounded. The cross-slide of this lathe is especially fitted with a bracket *A* carrying a roller which is pressed against the former *B* by the heavy spring *C*. On being taken from this lathe, the piston is placed in another and held in the same way as on the automatic, while the end is centered and the ring grooves

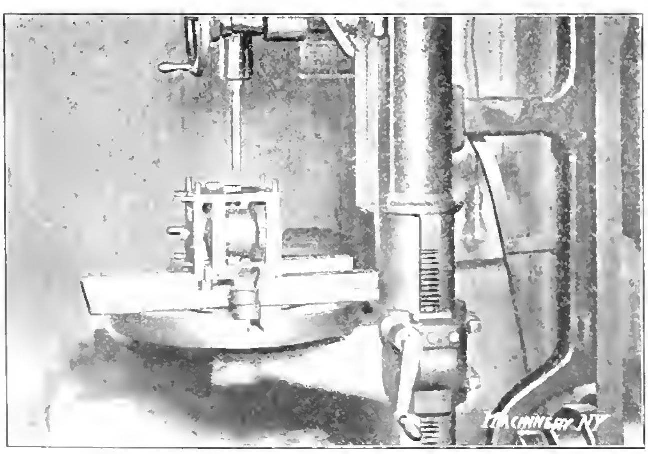


Fig. 6. Jig in which Wrist-pin Holes are Reamed

are carefully trued and sized. The piston is then placed in a Brown & Sharpe grinder, between a large and a small center and the outside ground to size; then it is inserted in the jig shown in Fig. 6 and the wrist-pin hole is reamed out. The final machining operation is to place the piston in the special machine Fig. 7, for the purpose of milling out the space between the wrist-pin bosses for the end of the connecting-rod. In this machine the work is held and located

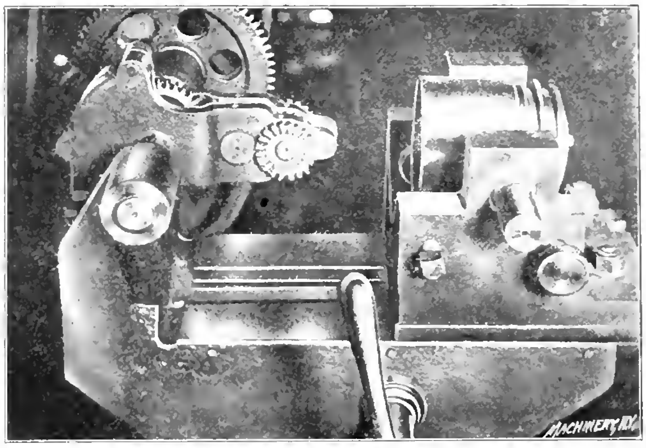


Fig. 7. Special Machine for Milling the Space between the Wrist-pin Bosses

between V-jaws with plugs inserted in each end of the reamed wrist-pin hole. The mechanism operating the mills is too plainly indicated to need further explanation. Just before the last inspection, the pistons are placed in the jig shown at *B*, Fig. 8, and the wrist-pin hole is carefully hand-reamed with a pilot reamer.

Machining Cylinders

Cylinders of the several types used on the different models of Stoddard-Dayton motors, are all machined in the machine shop which is in charge of Mr. Walter Sigler. These cylinders are of two general types: One having the water jacket cast in one piece around the cylinder with no openings other than the pipe openings, while the other type has a large opening fitted with a removable cover, both types being cast in units of two cylinders each, so made that they may be easily

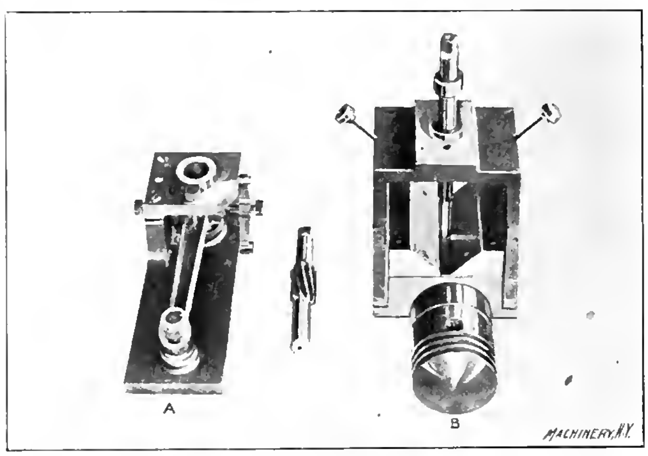


Fig. 8. Reaming Jigs for the Crank End of the Connecting-rod, and the Wrist-pin Hole in the Piston

grouped in multiples. The first machining operation on the first-mentioned type, consists in boring out the cylinders on a regular Beaman & Smith cylinder boring machine Fig. 9. This machine is arranged to hold four two-cylinder units at a time; two of the units being in position for boring while the other two are being set into the fixture. After one set has been bored, the fixture is reversed and in this way no time is lost in setting up the work. The second operation consists of drilling and reaming the valve holes in a turret-head drill press Fig. 10, the cylinder unit being held in a jig as shown. In the third operation, the water-pipe holes are drilled and tapped, and then the cylinders are strapped onto an angle-plate and the spots for the exhaust pipe flanges are surfaced off in a vertical mill. They now pass through several minor drilling operations before they are ground and given their final inspection.

The second mentioned type of cylinders, having the water-jacket covers on the sides, are bored out on the Beaman & Smith machine in the same way as the first type. The cover seats are then surfaced off in a mill and the cover holes

drilled and tapped using the jig shown in Fig. 11. The work is next placed in the indexing or tilting jig, Fig. 12, and the valve holes drilled, bored and reamed. In all, ten holes are finished in this jig. Instead of using an angle-plate to hold these cylinders while surfacing the exhaust pipe flange spots, as in the first instance, they are placed in a special fixture shown in Fig. 14.

leather padded cover, being clamped over the two large ones, then filling the jacket with water, attaching a pressure gage, connecting to an air hose and running the pressure slowly up to seventy pounds, all the time watching for any indication of a leak from a crack or a flaw. A similar preliminary test is also made in the machine shop on all cylinder water-jackets before machining and after boring out the cylinders.

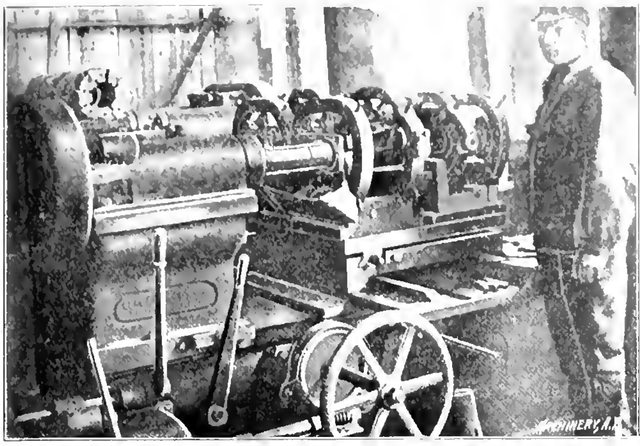


Fig. 9. Boring out Cylinders on a Beaman & Smith Machine

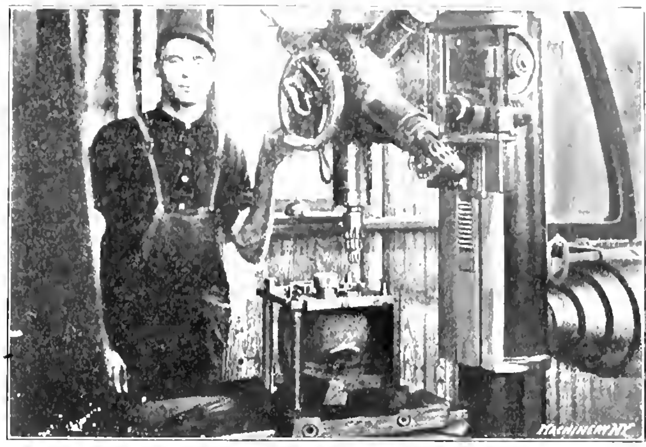


Fig. 10. Drilling, Reaming and Seating Valve Holes

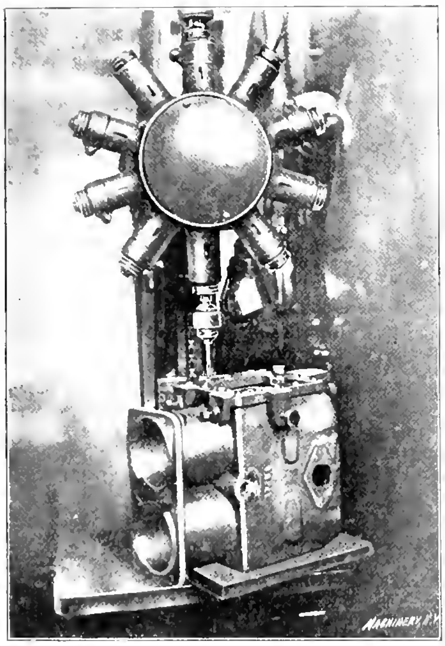


Fig. 11. Drilling and Tapping Holes for Water Jacket Cover

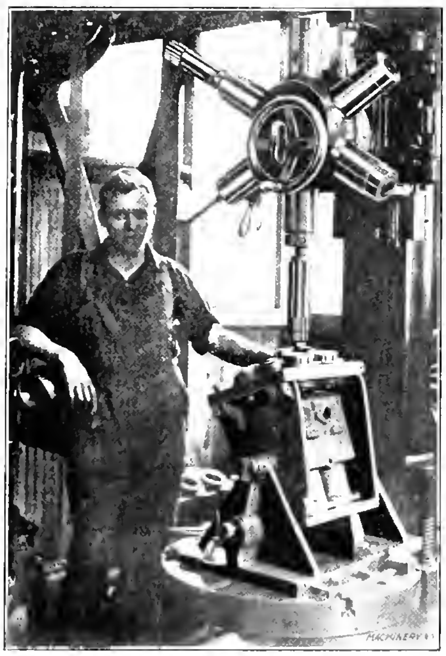


Fig. 12. Tilting Jig for Holding Cylinder while Drilling and Reaming Valve Holes

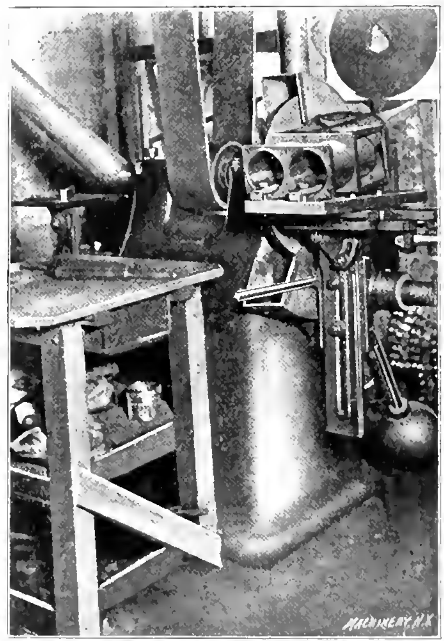


Fig. 13. Finishing Seats for Water Jacket Cover on a Besly Disk Grinder

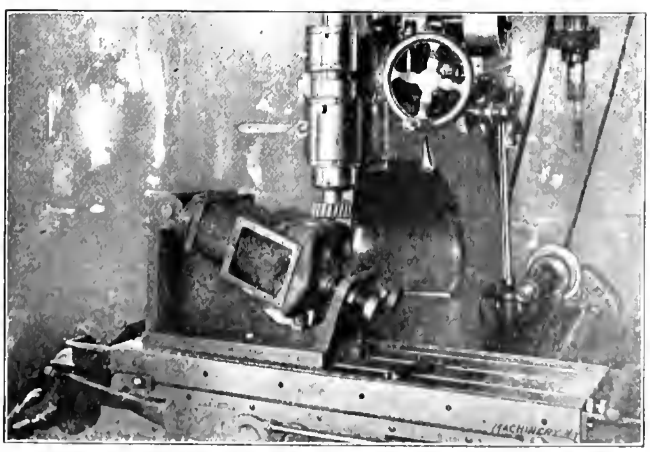


Fig. 14. Fixture for Holding Cylinder while facing Exhaust Pipe Flange Bosses

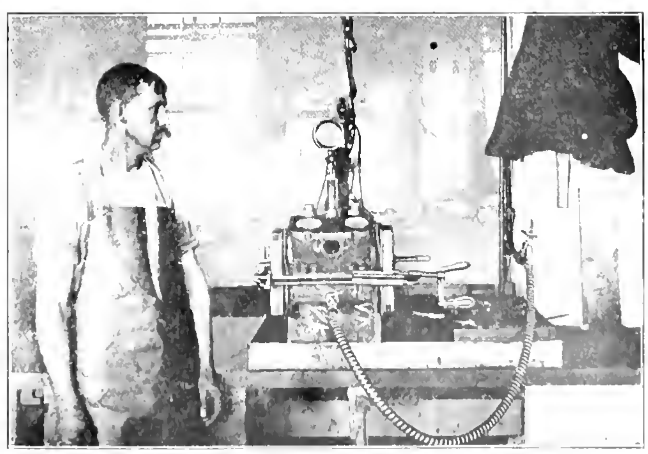


Fig. 15. Testing the Water Jackets

After all the machining operations are finished, these cylinders are sent to the grinding room and the water-jacket cover-seats finished smooth and true on a Besly disk grinder, as shown in Fig. 13. The cylinder bores are ground on a Heald grinder.

Before being assembled in the motor, the cylinder water-jackets are tested under seventy pounds water pressure, as shown in Fig. 15. This is done by stopping up all openings,

After the connecting-rods are drilled and reamed in a box jig, the final reaming is done in the motor part assembling department, the jig shown at A, Fig. 8, being used for this purpose.

Cover-seats on the differential cases, are surfaced off on a Becker-Brainard vertical milling machine as shown in Fig. 16, only the cross and table feeds being used to mill the almost circular rim of the cover seat.

Push-rod fork-ends are milled with a gang mill, eight at a time, on a Le Blond milling machine as in Fig. 17, the clamps of the jig being arranged so that the tightening of one nut clamps two rods as shown.

Milling Drive-gear Clutch Teeth

In Fig. 19 is shown the way the three clutch-teeth are milled in the gear-clutch end of the drive-gear sleeve, using a three-spaced indexing jig. Fig. 20 shows the same sleeve reversed for milling the teeth in the drive-shaft end, while Fig. 21 shows the way the clearance is milled on the teeth. A wedge is inserted under the bottom of the fixture so as to give it the proper angle, and a wider mill is used. It will be noted that clearance is shown on the teeth in all three engravings. This is because a finished sleeve was used while taking the pictures, no partly finished ones being available, but of course in actual work the clearance is milled in the order given.

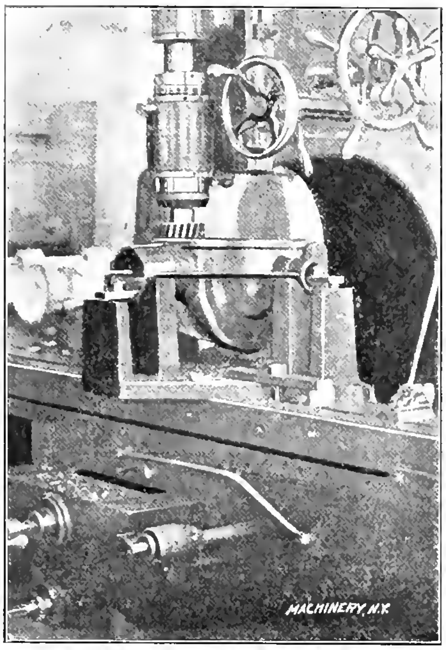


Fig. 16. Facing Seats of Differential Covers in a Vertical Milling Machine

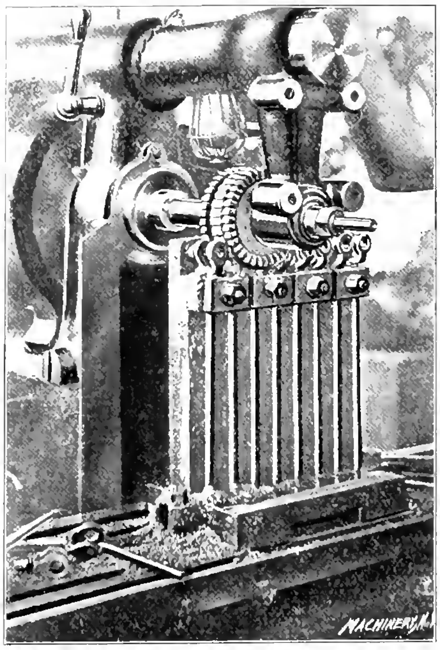


Fig. 17. Milling Eight Push-rod Fork Ends at One Time

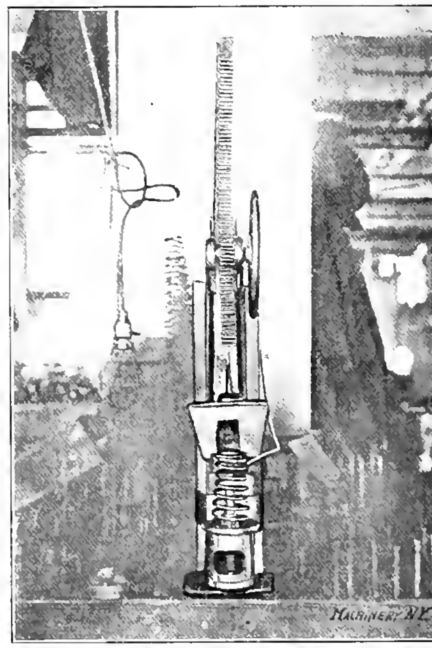


Fig. 18. Device for Compressing Valve Springs when Assembling Cages

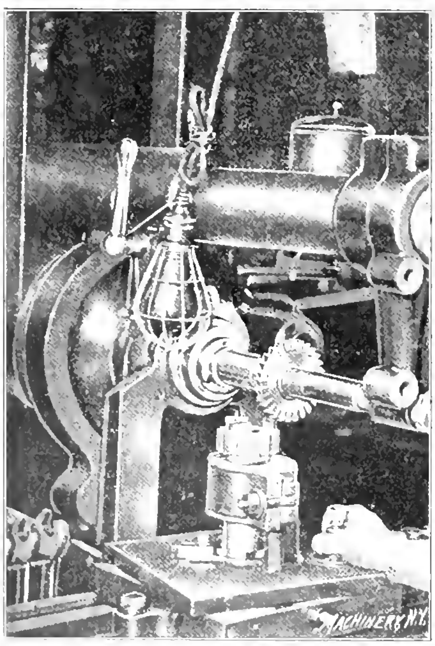


Fig 19. Milling Clutch Teeth in Gear-clutch End of a Drive-gear Sleeve

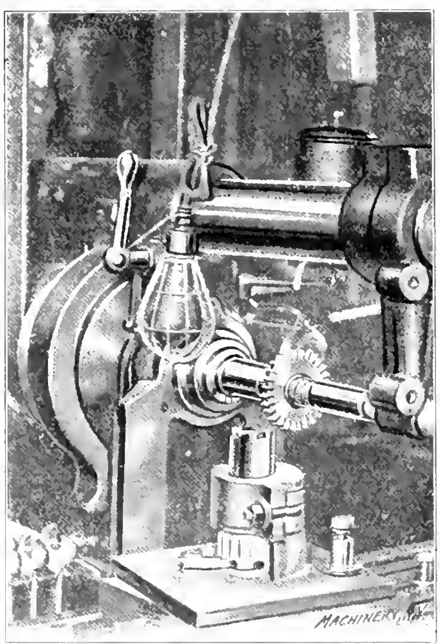


Fig 20. Milling Clutch Teeth in the Drive-shaft End of the Sleeve

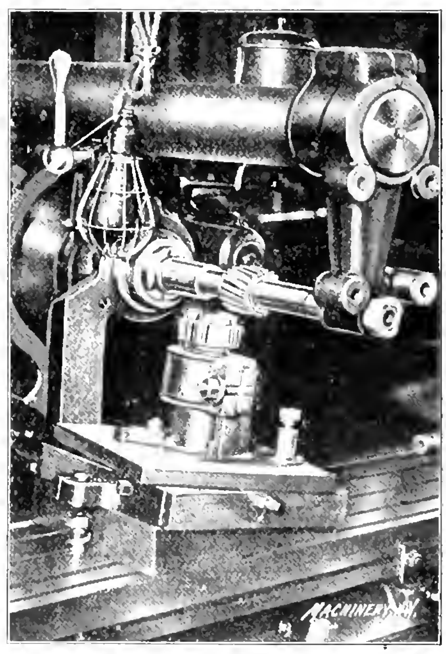


Fig. 21. Milling the Clearance on the Clutch Teeth of a Drive-gear Sleeve

Small valve cams are milled on a Garvin milling machine fitted with a Brown & Sharpe cam attachment (Fig. 22); they are then ground on a special grinder. On the new models, however, the cams and shaft are forged in one solid piece and are to be ground on a new, special grinder, now almost completed.

Crank-shaft bearings are bored out and then hand reamed in the reaming jig shown in Fig. 23; they are then broached out on a La Pointe broaching machine, the broach and guides shown lying on top of the crank-case in Fig. 24 being used. This unusual way of finishing the bearings, saves hand scraping and does a better job in far less time.

In the motor parts assembly department, in charge of Mr. L. C. Miller, there are a number of interesting things devised to expedite assembling; one of them, shown in Fig. 18, is an old paint-press made over to compress the valve springs so that the retaining washer and cotter-pin can be easily placed on the end of the valve stem, when assembling the valve-cage parts. The engraving shows a lower valve-cage and parts in position in the press ready for the compression of the spring and the placing of the washer and cotter-pin.

Crankshafts are held as shown in Fig. 25, while fitting the connecting-rods, which is much better than the usual method of holding them in a vise.

The adjustable motor assembling stands Fig. 26, are as convenient as any I have seen in use anywhere. As the engraving shows, the bed of the motor is bolted to the stand top which may be placed in a horizontal, 45-degree or vertical position on either side, as desired.

The forging department or steel shop as it is called, in charge of Mr. F. E. Sellars, is one of the most complete of any similar department of an automobile factory in the country. It is fitted with big steam hammers, board drops, forging machines, punch presses, bulldozers, special benders and

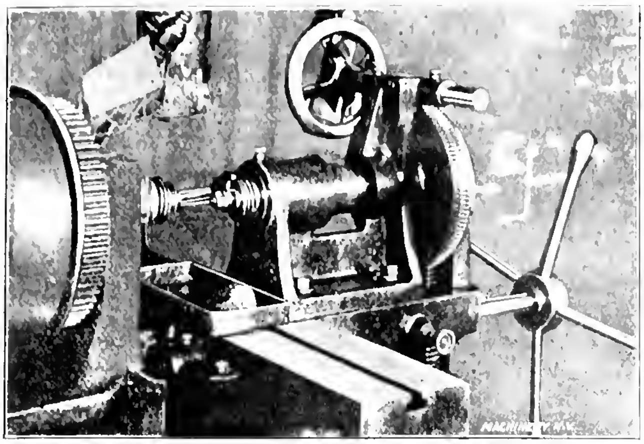


Fig. 22. Milling Small Cams on a Machine equipped with Brown & Sharpe Cam Attachment

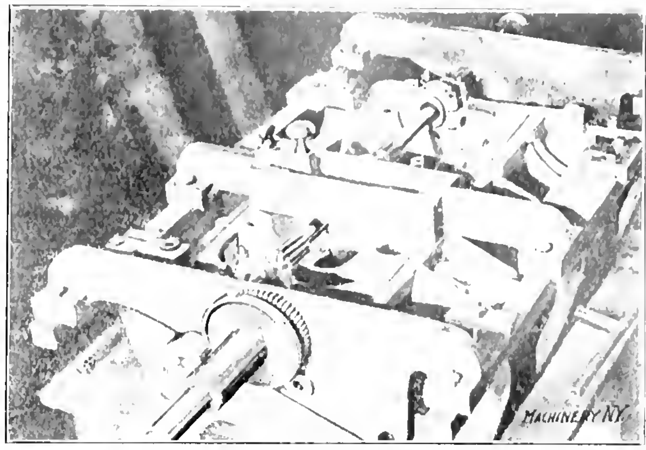


Fig. 23. Reaming Jig for Hand Reaming Crank-shaft Bearings after the Boring Operation

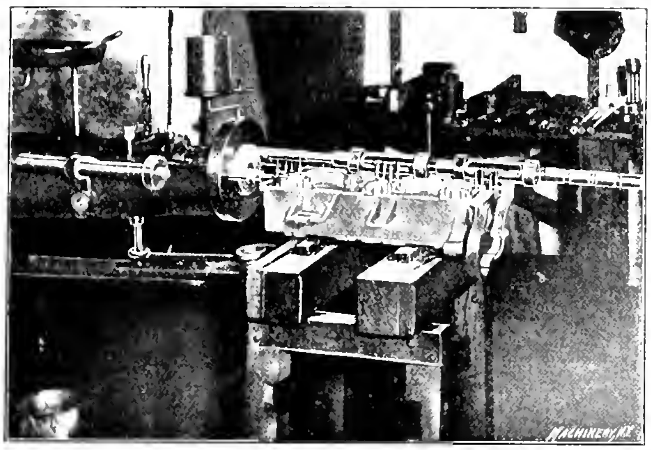


Fig. 24. Special Broach for Broaching Crank-shaft Bearings after they are Reamed

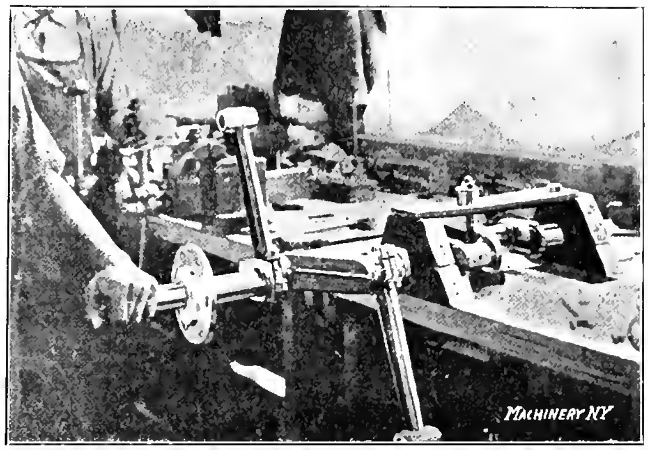


Fig. 25. Bench Clamps for Holding Cranks while Fitting the Connecting-rods

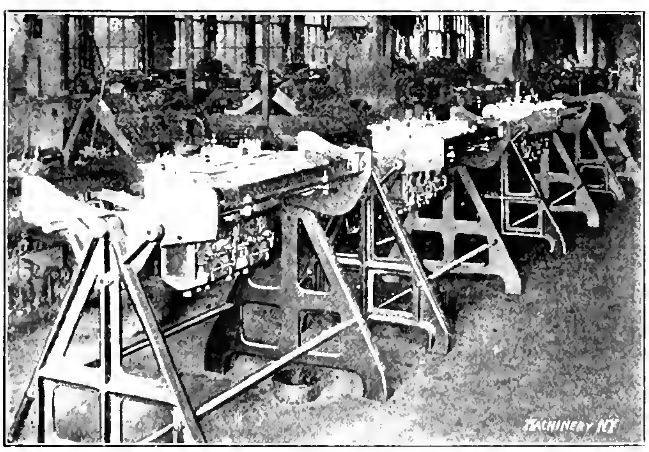


Fig. 26. Adjustable Stands for Motor Assembling

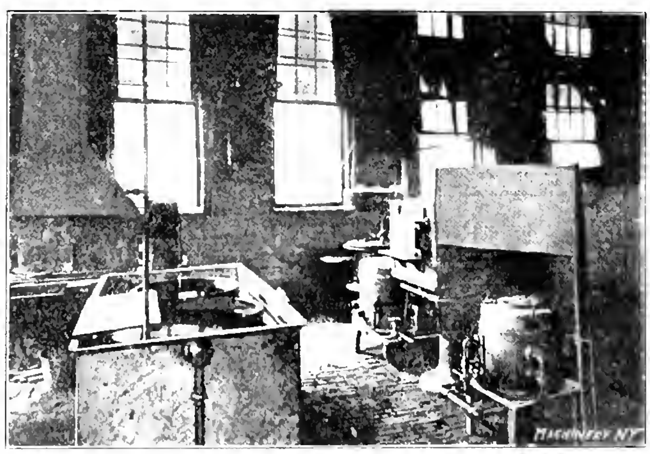


Fig. 27. Barium-chloride Hardening Furnaces and Cooling Tanks

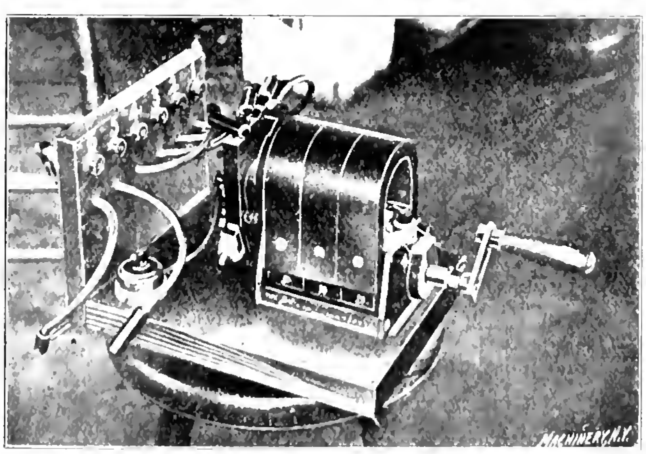


Fig. 28. Apparatus for Testing Magnetos

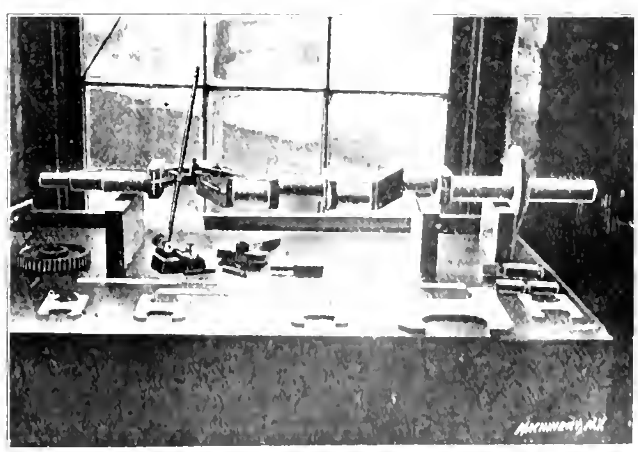


Fig. 29. Various Gauges used for Testing Crank-shafts

heating furnaces, and everything that is used that is a forging, as was previously stated, except crankshafts, is made here. Even the long, channeled frame-slides are formed out of the heavy steel bands in which form they come from the steel mills, and the holes in them are punched, using a big templet as a guide instead of laying out the holes and drilling as fre-

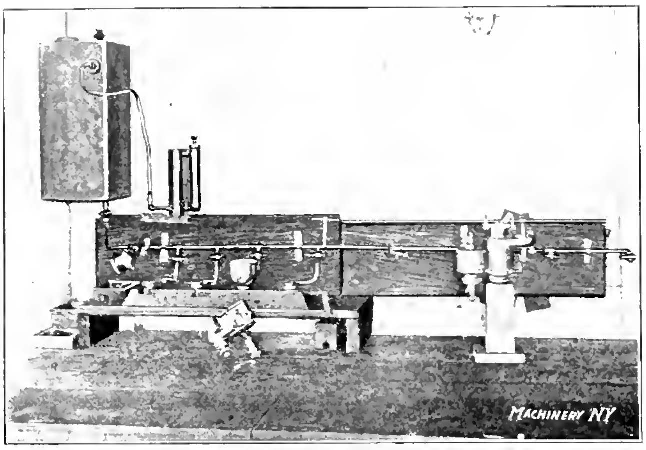


Fig. 30. Apparatus for Testing Carbureters

quently is the case. This department also contains the most complete barium-chloride tool-hardening plant in the West, with the possible exception of that of the Firth-Sterling Steel Co., in Chicago. A partial view of this department, showing the oil heated crucible furnaces used for melting the barium chloride, is shown in Fig. 27.

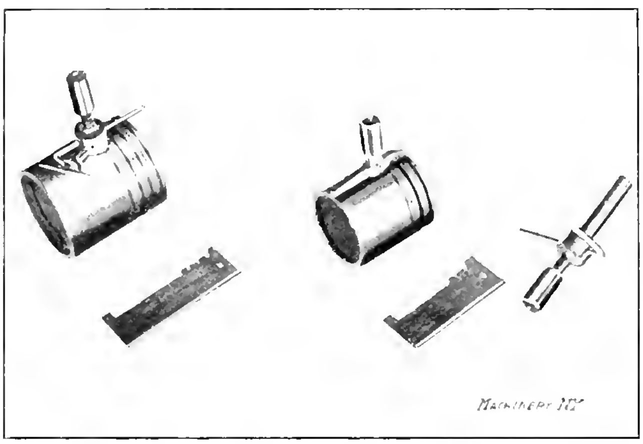


Fig 32. Piston Gages

The motor testing department, in charge of Mr. George Gorton, is also very complete, being fitted with all the necessary testing apparatus and a French manograph. As in all factories doing high class work, the testing and inspecting departments are the ones on which the reputation of the product depends, for no matter how good the design is, if

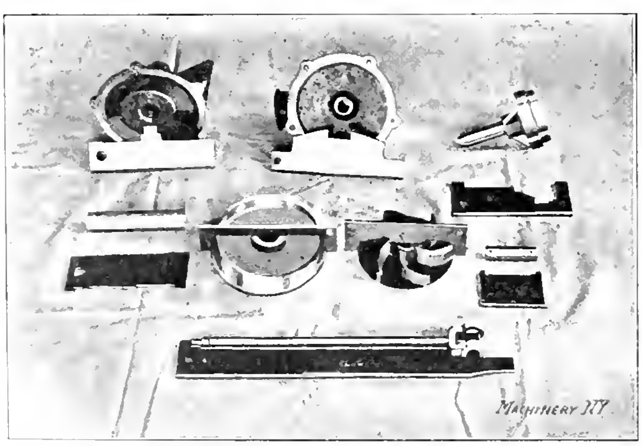


Fig. 34. Some of the Parts which are tested by the Templet Gages

the testing or inspecting is not thorough, the good designing soon is lost sight of by dissatisfied users. Recognizing this, the most rigid inspection is given all parts between each operation and before they are used or sent out. Of all the inspecting departments, that of the motor parts inspection in charge of Mr. M. Manny will probably be of the most interest to readers of MACHINERY. In this department, purchased parts are given an especially careful test as to material, workmanship and efficiency. Magnetos and their timers are carefully tested as shown in Fig. 28. This apparatus consists principally of a board with spark-plugs numbered to corre-

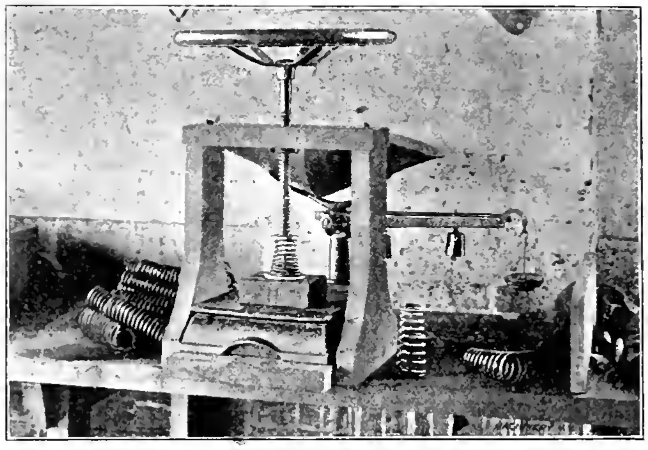


Fig. 31. Spring Testing Device

spond to the number of cylinders to be operated. These plugs are joined to the timer by suitable connections and a crank is fastened to the spindle of the magneto, so that by turning this crank and watching the resulting sparks, the tester can easily see if the spark-plugs respond in the correct order and with a spark of the proper "fatness."

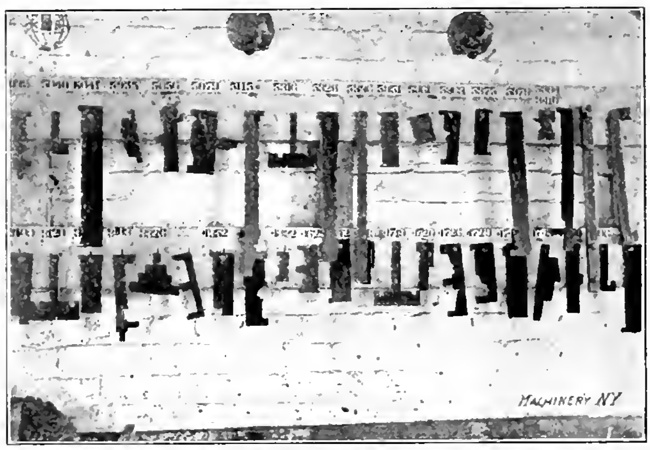


Fig. 33. Group of Miscellaneous Templet Gages

Crankshafts are tested on the large surface-plate shown in Fig. 29, the parallels, limit gages, indicators, scales and parts shown being used.

Carbureters are tested for leakage as shown in Fig. 30, a gasoline tank and pump to give the proper pressure together with a pressure gage and suitable fittings making up the

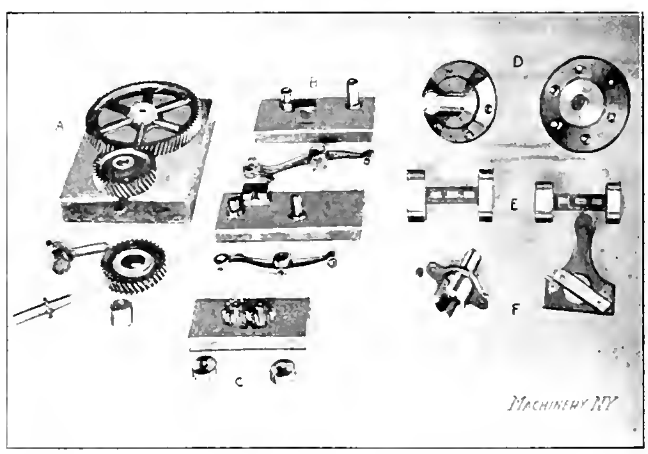


Fig. 35. A Number of Gages used in Testing Motor Parts

apparatus. Schebler carbureters are tested at $\frac{3}{4}$ pound pressure, and Stromberg's at 2 pounds.

Valve and push-rod springs, are tested as shown in Fig. 31. These springs are tested according to certain tabulated data. For instance, the spring shown must give a pressure of 60

pounds when compressed to $2\frac{1}{8}$ inches, a slight variation being, of course, allowable.

Pistons are measured for diameter, and the angularity and size of the wrist-pin hole, the length of the piston, the depth, spacing and size of the grooves are tested with the gages and templets shown in Fig. 32.

A group of flat metal templets, used for various purposes is shown in Fig. 33, and the way some of them are used for testing pump and other parts is shown in Fig. 34.

At *A*, Fig. 35, is a device for testing the center distance and proper meshing of the timing gears, the small gear being mounted on an eccentric pin with a small lever attached, and the center distance being obtained by calipering the centers when the gears are properly meshed. At *B* are two rocker-arm contact gages; *C* is for testing small pump gears, the disks being used to test the accuracy of the pins from time to time; at *D* are two flywheel bore and drilled hole gages; at *E* are two Brown & Sharpe limit plug-gages and at *F* is a valve plunger guide and gage.

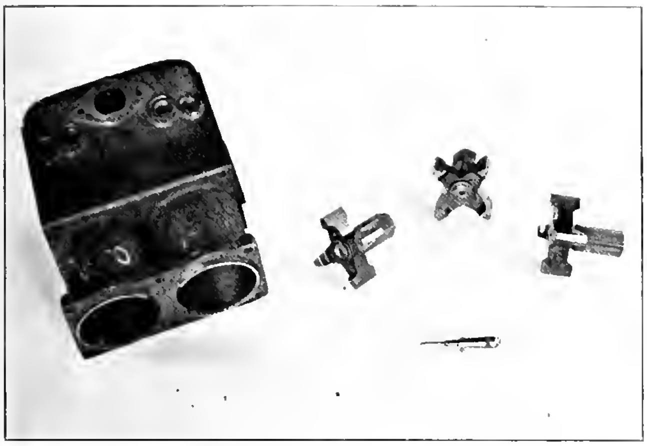


Fig. 36. Cylinder Bore Limit Gages

Fig. 36 shows a cylinder and three bore gages. The middle one is standard, the one at the left is 0.002 inch small, and the one at the right is 0.002 inch large, while in case of doubt the inside micrometer is used.

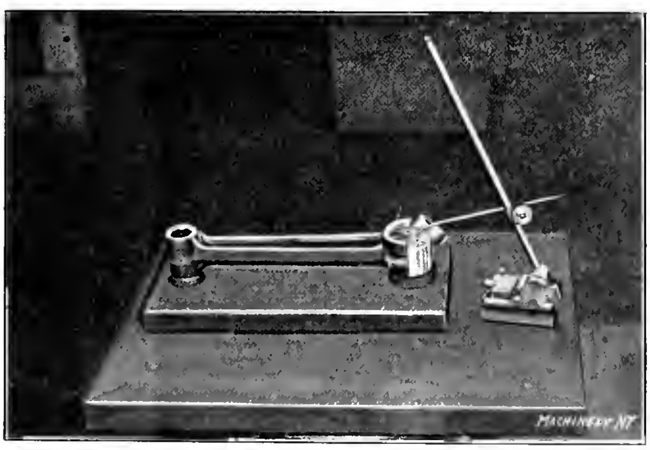


Fig. 37. Method of Testing Connecting-rods

Connecting-rods are tested as in Fig. 37, the pins in the plate being exactly the proper distance apart and of the correct diameter. The surface gage is used to test the amount of offset at the large or crank end.

In preparing this brief description of a few of the interesting things to be found at the Dayton Motor Car Co.'s plant I am especially indebted to Mr. Harry Tuttle, Chief Engineer Edwards, Supt. Houk, and also to Mr. A. C. Miller, the well-known racing man, who acted as guide.

* * *

According to the *London Financial Times* a new patent law was enacted in Austria last December which came into force in June this year. This law contains a section similar to that of the new British patents act by which patents in Austria will be revocable at the expiration three years from the date of publication, without any notice, if the patent is not worked in Austria to an adequate extent.

FACE-PLATE FOR ECCENTRIC PISTON RINGS

CONTRIBUTOR

The design of a special plate to be secured to an ordinary face-plate for holding any work to be either bored or turned eccentric, is shown in Fig. 1. When turning eccentric piston rings, for example, any degree of eccentricity can be obtained from zero to the maximum amount that the plate is designed to give, and, in addition, all the operations such as boring, turning and cutting off the rings can be performed at one setting of the casting.

The construction of the plate is clearly shown in Fig. 1. The outer part *C*, to which the work is attached, is secured to a plate *D* by the bolts *E* and *F*. The bolt *F* acts as a fulcrum for the plate *C*, which swings upon it to either of the extreme positions of eccentricity indicated by the dotted lines *B*. The hole in the part *D*, for the bolt *E*, is elongated as shown in the elevation so that the bolt is free to move when the plate is being set over for eccentric turning or boring. The spring *H* serves to keep the faces of the two plates in contact when the nuts are slacked off to permit the plate *C* to be moved. This prevents the possibility of any dirt getting between the plates. Assuming that it is first

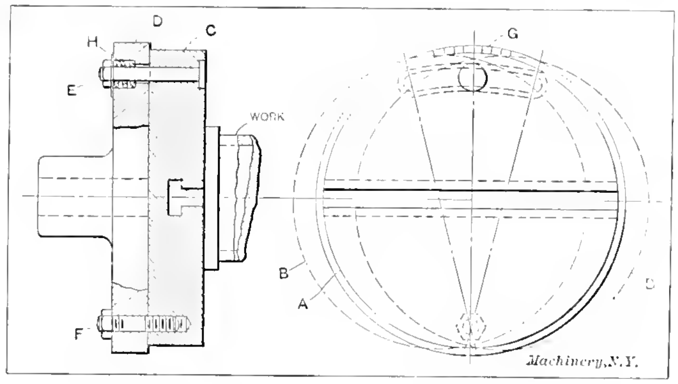


Fig. 1. Special Lathe Face-plate for Turning Eccentric Rings, etc.

necessary to turn a piece of work, the casting would be set true by the outside, with the locating plate *C* in its central position *A*, in which it runs true with the face-plate proper. After the turning operation, the two nuts on bolts *E* and *F* would be slacked off slightly, and the locating plate pushed over the required amount. The nuts would then be tightened and the inside bored to the size required; the outside, of

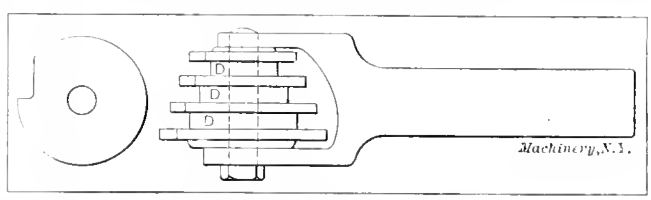


Fig. 2. Cutting-off Tool for Piston Rings

course, would be running eccentric. By graduating the plate as shown at *G*, it can be quickly set to any desired amount of eccentricity.

The tool-holder shown in Fig. 2, which is equipped with circular cutters, may be used to part the rings to the correct width. As will be seen in the illustration, the distance pieces *D* determine the width of the rings. These distance pieces should be made of mild steel as it affords a better surface grip than if hardened steel were used. The shape of the cutters is shown by the outline to the left of the engraving.

* * *

The number of automobiles in use in Germany slightly exceeds 20,000. The number in use in the United States has been estimated to be 160,000, or twice the number of the automobiles in use in the whole of Europe. There are 69,000 automobiles registered in New York state alone. In a statement recently published by the American Motor Car Manufacturing Association, the number of concerns building automobiles in the United States is given as 253, and the capital invested in the automobile industry, including that of kindred trades, sales-rooms, garages, etc., is nearly $200,000,000.

SUGGESTIONS FOR A MODEL BLACKSMITH SHOP*

JAMES CRAN†

Buildings for manufacturing purposes are as a rule constructed more or less in accordance with recognized standards that have been adopted on account of their adaptability for the particular class of work they are to be used for. In plants of the larger machine-building concerns and similar industries usually all buildings are of the same general style throughout with the exception of the blacksmith or forge shop, which is often entirely different. Why this should be, no good reason is apparent from a practical point of view, as the style adopted is often less suitable for the purpose than that of the other buildings, and the result is that very often blacksmiths and forge men have of necessity to work under conditions that are anything but an incentive to the best results. Workmen, no matter what the nature of their occupation may be, will do more and better work under pleasant and attractive conditions than they can be expected to do in a gloomy atmosphere. In this respect blacksmiths are no exception to the rule. As their art is indispensable to all other industries, a few practical suggestions that would have a tendency, if adopted, to reduce cost, increase and improve production for the employer, and bring about better conditions for the blacksmith, may not be out of place.

The principal essentials of a blacksmith shop where maximum production at minimum cost is expected are light, ventilation, sanitary arrangements and sufficient space to accommodate a full equipment of machinery and appliances systematically arranged and installed. What the writer considers a basis that could be worked from in constructing, equipping and arranging blacksmith shops from a few forges capacity to the largest is shown and described in the following:

Foundations and Walls

To begin with, the foundation has first to be considered. Where a rock bottom can be had very little preparation for building is necessary, but where building has to be done upon sand, clay or swampy ground it is important that the foundation be made thoroughly solid, otherwise the jar from steam hammers and other machinery will have a tendency to warp and crack the walls. The construction, in general, like buildings used for other purposes, should be governed to a certain extent by the class, size and weight of the work that has to be done. If used for light forging exclusively, the walls need neither be as high nor as heavy as where the work is varied or of large proportions. For light and medium weight work walls need not be more than from 15 to 20 feet in height, but for heavy work or where it is of a wide variety as in railroad or heavy machine building shops the walls should be from 20 to 25 feet in height so that there would be sufficient space between the tops of large steam hammers and the roof trusses for the free use of jib cranes or other overhead lifting and conveying devices.

Very little can be said regarding the foundation specifically, as general conditions and the nature of the site would have to be taken into account before any authentic information could be given, other than that it should be made as solid as possible. The walls, preferably of brick or reinforced concrete, should be of a more substantial nature than is generally required for other purposes. The piers between windows may be supported either with pilasters or buttresses or a combination of both. For the admission of plenty of fresh air which is essential in all manufacturing buildings, especially in blacksmith shops where more or less heat is radiated from forges and furnaces, the windows should not be over 36 inches above the level of the floor. If placed higher in the walls, which is often done to save their being broken by flying pieces of iron or steel, or to conform with a pet theory of protecting the men employed from drafts, they are too high to be of much benefit other than admitting light, as the greater portion of the air admitted enters at a point too high to benefit the workman or to keep the lower portion of the shop where heat is generated cool enough to be comfortable. Plain sash windows that can be raised from the bottom and lowered from the top are the best type to use and can be protected inside and out with wire screen. In locating doors it is well to have one in each end of the building large enough for the admittance or removal of any kind of work or material and to have others in the side walls where they may be required.

Forge Space and Arrangement

The next thing that calls for attention is the amount of space that is necessary for each forge. This depends very much upon their arrangement. If they are grouped as is customary in some shops, a saving of space is effected, but work in general cannot be so conveniently or economically handled as when they are arranged in rows, for the reason that in groups men from some of the forges will either have to pass between other men and their forges or anvils or take a long roundabout way to and from steam hammers; not only this, but work is often of a shape that can only be handled to advantage on forges with at least three sides accessible. It is therefore advisable that they be arranged in rows sufficient distance from the walls to allow of portable vise benches, surface plates, etc., being used where the light is best and moved from place to place as they are required without necessarily taking them into the center of the floor or between blacksmiths and steam hammers. With forges installed from 5 to 6 feet from the walls and 16 feet of space allowed for each as shown in Fig. 1 there would just be sufficient space around them for the tools generally used at the anvil and the convenient handling of all ordinary blacksmith work. For light work they may be placed a little closer than 16 feet, but more difficulty is experienced in trying to do work in limited space than where there is sufficient room. Wherever conditions will permit it is preferable to have blacksmith shops, if they exceed the capacity of 10 forges, wide enough for a row on each side with corresponding rows of steam and power hammers facing the forges on the side of the shop in which they are installed.

Forges used for the average range of blacksmithing are from 36 to 48 inches in width. With these placed 5 feet from the walls and anvils from 18 to 24 inches out from the line of forges the distance from wall to anvil will be approximately 11 feet. At least 12 feet of clear space should be allowed between the line of anvils and steam or belt-driven hammers, the bases of which are anywhere from 5½ to 8 feet in length. As a certain amount of space behind the hammers is necessary, 10 feet more may be added. Thus a shop of approximately 40 feet in width is required for single rows of forges and hammers and 80 feet for double rows. The advantages of a short wide shop over a long narrow one are obvious. It is more compact and better under the observation of the man in charge. The space back of the steam hammers is doubled, making the center of the shop wide enough for a line of car tracks which may be standard or narrow gage, and the handling of work too long or of a shape that could not be advantageously handled by ordinary means. Not only this, but the saving in actual construction, which would amount to about one-third, is an item too important to be overlooked.

There are, however, certain elements to be contended with in the construction of a wide building that can be entirely dispensed with in a narrow one. When a building exceeds a certain width some supports for the roof other than the walls are necessary if cost, which is a prime factor, is to be kept at the lowest margin. These roof supports are generally in the form of columns so arranged that the weight is evenly divided. In blacksmith shops columns or supports should be located where they would offer the least obstruction to the handling of work which is almost invariably hot, and the success of the various operations of shaping it depends upon reaching a steam hammer in the least possible time after it is removed from the fire. It is therefore obvious that the fewer obstructions there are to be avoided the greater the probability of the work being successfully accomplished. Just behind the line of steam hammers, columns would be entirely out of the way and would serve the double purpose of supporting the roof and traveling cranes or trolleys.

* For data previously published on this subject, see MACHINERY, February, 1904, "Machine Shop Equipment—Equipment of the Forge Shop."

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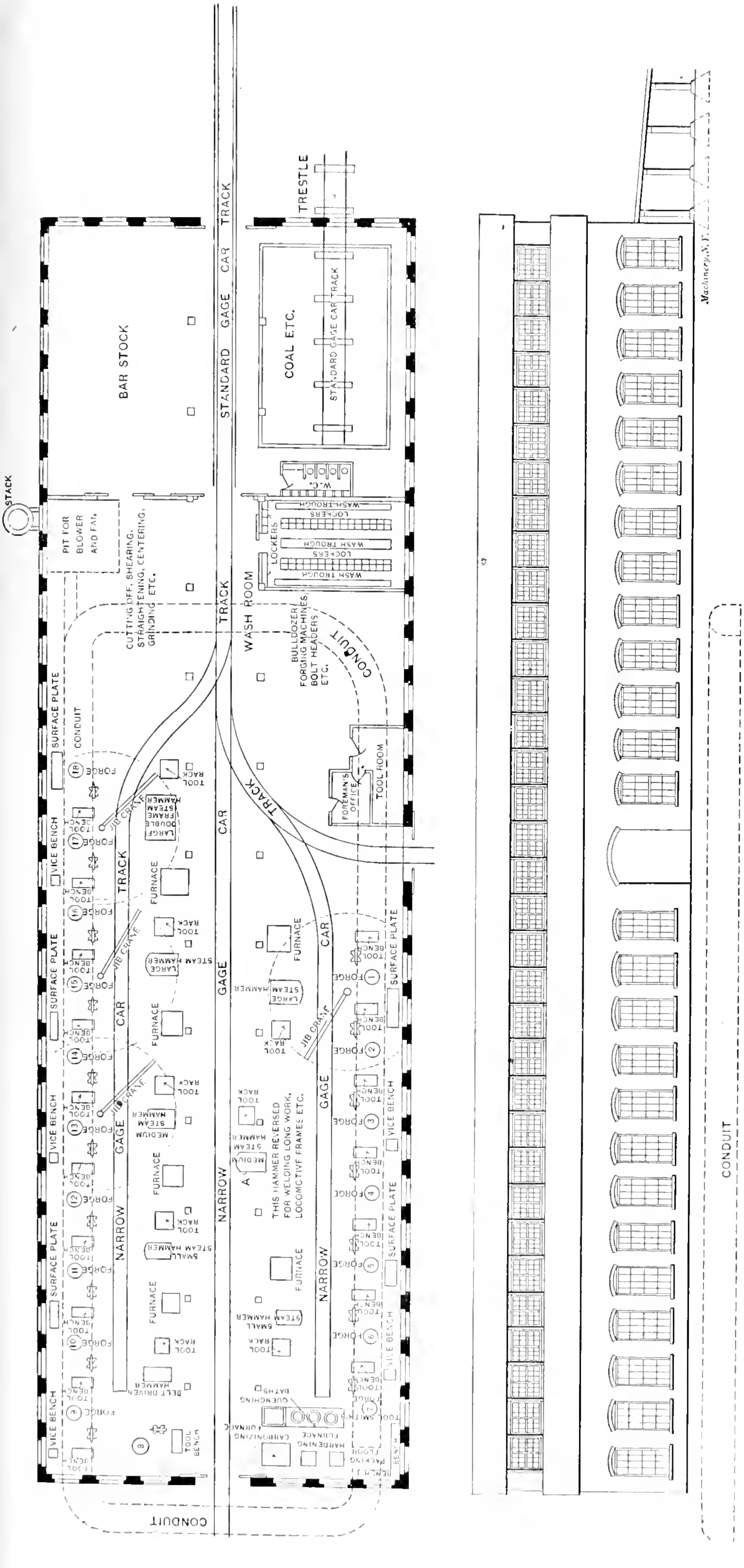

Fig. 1. General Layout and Side Elevation of Blacksmith Shop

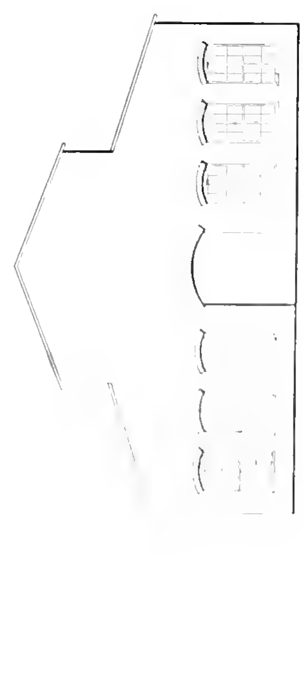

Fig. 2. End View of Blacksmith Shop

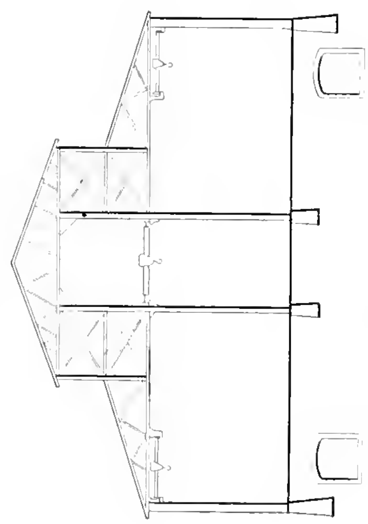

Fig. 3. Cross-section, showing Travelers

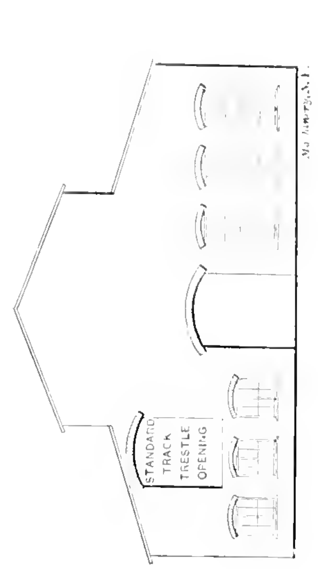

Fig. 4. End View, showing Car Trestle Opening for Discharging Fuel

These points considered and provision made for the storing of bar stock, coal and other materials used in blacksmithing in the same building or adjacent to it constitute the most important features of an ideal blacksmith shop, which may be constructed, laid out and arranged as follows, or the general idea used as a basis to work from.

The general arrangements of a shop of 18 forges in which provision has been made for a full equipment of appliances generally used in a shop of that capacity are shown in Fig. 1. One end is assigned to material, as bar stock, coal, etc., and space for cutting off and centering machines, in short all that is required for putting work in proper condition to be work that can be heated in them and have them as near to steam hammers as is practicable. In most of the blacksmith shops connected with manufacturing plants one or more toolsmiths are employed and more or less carbonizing, heat treating, annealing, hardening and tempering has to be done. This class of work should be as much concentrated as possible, located in the shop where it would be least likely to conflict with other work and be under the charge of a sub-foreman. Saws, shears, cutting-off, straightening and centering machines, together with any other machine tool that may be used, should be located near the stock supply and if possible near the point from which finished work is forwarded

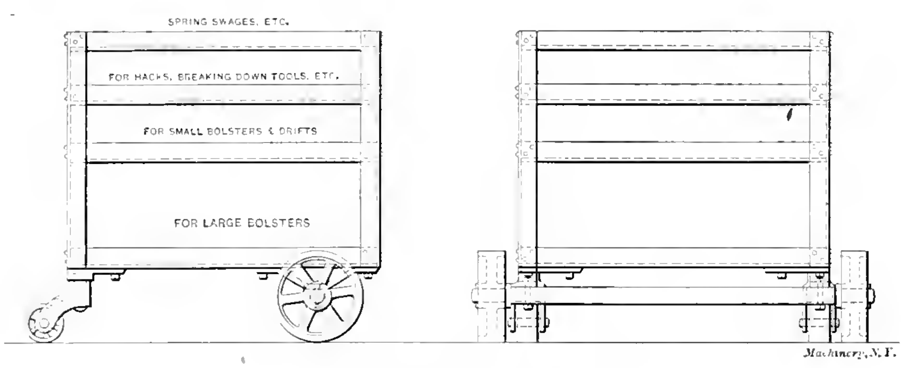

Fig. 5. Portable Rack for Steam Hammer Tools

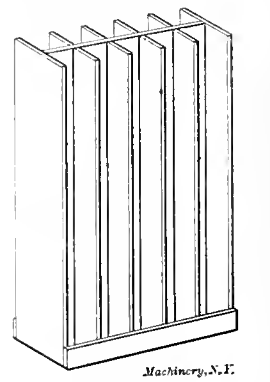

Fig. 6. Upright Rack for Light Bars

turned over to the machine shop without workmen having of necessity to go outside the building. Forges are arranged in rows 5 feet from the side walls, with those intended for the largest and heaviest work nearest to the stock supply for which one end of the building is exclusively assigned. All forges are served by an overhead trolley system, one cross section of which is assigned to each forge for lifting and supporting work at the anvil. Forges for the larger work are further supplied with jib cranes so arranged that the column is well out of the way of work so that one can be used for conveying to and supporting at the steam hammer the work of two forges, the furnace being located near the hammer that it serves.

Arrangement of Steam and Belt-driven Hammers

All power hammers, steam and belt-driven, with the exception of one, which will be referred to later, are installed in rows facing the forges at a distance of 12 feet from the line of anvils, which is just sufficient space for the general range of blacksmith work being done at steam hammers without conflicting with that being done at forges. The steam hammer *A* which is reversed and out of alignment with other hammers can be used for such work as welding long shafts, leadscrews for long lathes, locomotive frames or any other work too long or of a shape that could not be advantageously handled by ordinary means. This class of work is supported by hooks from an overhead trolley and heated in a portable forge so arranged that it drops clear of the work when it is ready to be conveyed to the hammer by turning a lever. This forge was shown and described in MACHINERY, December, 1908, in connection with an article on welding. No definite information can be given upon the number of steam or power hammers necessary for any given number of forges, as that would depend very much upon the class of work to be done. Sometimes three or more blacksmiths could use the same hammer to block out their work without wasting time in waiting for turns or one man's work conflicting with another's, while on other kinds of work one man may monopolize one hammer for a time. In any case the equipment of hammers and other power appliances should be ample for the requirements, otherwise much time may be wasted in men having to wait after their stock is heated before they can have access to a hammer or in having to leave it before an operation is completed. In a shop of 18 forges where work is of a wide variety of shape and size, from 6 to 9 hammers will be required. Generally a great part of machine blacksmithing, especially blocking out, can be much more economically heated in furnaces than is possible when forges are used exclusively. It is therefore advisable to use furnaces for all

to the various departments where it is wanted. These machines and all bar stock would constitute a department that could be attended to by a sub-foreman.

Location of Blowers—Conduits—Piping

The blower for supplying forges and furnaces with blast and the fan for mechanical draft, if a down-draft system of carrying off smoke and gases is to be used, may be installed as near to each other as is practicable and operated by the same mechanism, preferably motor drive. Common practice is to elevate blowers and fans above the level of forges; sometimes they are placed upon a platform in the roof trusses to save floor space. This practice is not to be com-

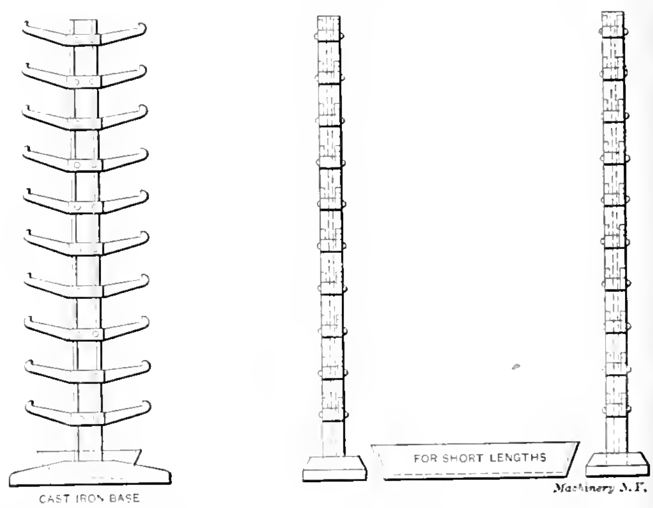

Fig. 7. Rack for Round or Square Bar Stock up to Four Inches

mended for the reason that when the wind gate of a forge or furnace happens to be left open when the blower is closed gas generated by the still ignited fuel upon the forge enters the pipes and naturally rises. It may escape through the blower unless it happens to be started up before the fire upon the forge has died out. When this happens the gas is forced back upon the still burning fuel where it is ignited, causing an explosion which may ruin pipes and damage the blower. If blowers and fans are installed in a pit below the level of the floor they are more accessible and the danger of being damaged by explosions is minimized from the fact that gas will not descend except when forced. Generally blast is conducted from the blower to forges and furnaces through a main pipe which is reduced in size as it passes the various branch pipes which connect with the forges. This has a tendency to make the pressure greatest near the terminal

of the main pipe. To equalize the blast pressure at all points the main pipe should be in the shape of a loop, both sides of which may be of equal capacity to the discharge of the blower so that it would act as a reservoir permitting of branch pipes being connected with it at right angles instead of the more acute angles generally used, and should it be necessary to increase the blowing facilities or enlarge the capacity of the shop this could be done without changing the blast pipe. In an ideal blacksmith shop all piping should be where it is least likely to be in the way and still be accessible. For this purpose an underground conduit in the shape of a loop directly under the line of forges as shown by dotted lines in Fig. 1 and in cross-section in Fig. 3 of a size sufficient to accommodate the entire piping system including blast, steam, water, gas, oil, compressed air, heat for warming

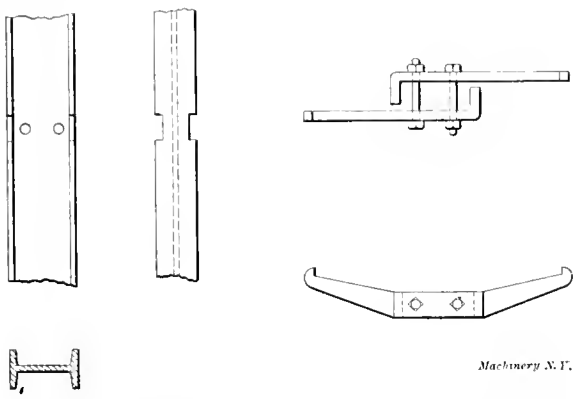

Fig. 8. Detail of Upright and Arms for Rack shown in Fig. 7

the shop in cold weather, smoke, sewer or any other piping or wiring that may be necessary and to which access may be had through openings in the floor between forges. These openings should be lined with concrete covered with slatted platforms upon which blacksmiths could stand at their work and through which heat could be admitted in cold weather and cool air in warm weather either through the heating system or openings in the walls fitted with gratings and shutters that could be opened and closed at will. The water supply which is essential in all blacksmith shops is more important than is generally supposed; each forge ought to be provided with a slake tub, the water in which should be kept fresh. If this has to be carried from a general supply pipe as is customary in most shops, much time is wasted both in emptying and refilling the tubs that could be turned to good account if a faucet and sewer connection is located near each forge and elsewhere about the shop where they may be required.

steam and power hammer there should be a tool rack, preferably portable, of which Fig. 5 is an example, that would accommodate a full set of spring swages, fullers, breaking down tools, hacks, bolsters or any other appliances that may be used in connection with hammers, each tool as far as possible being assigned to its own place upon the rack. This would overcome the disadvantage of having to turn over a miscellaneous heap of tools usually stacked upon the floor to find the one that is wanted and to move them individually should the space they occupy be temporarily wanted for some other purpose.

To get the greatest efficiency from steam power hammers the foundations upon which they are mounted must be solid. Concrete resting upon hard pan has given better results than the combination of heavy wooden beams and concrete commonly used. In installing solid concrete foundations there should be several inches of cement placed over the concrete and a cushion of wood at least three inches in thickness placed between the cement and the base of the anvil to give the necessary resiliency and prevent the concrete being pulverized by the impact of the blows. Back and front of the hammers there should be openings down to the level of the anvil base so that it could be leveled or adjusted by wedging up and grouting with cement if for any reason it should get sagged or out of alignment with the upper parts of the hammer. These openings should be covered with hatches level with the floor.

By conducting steam to hammers from the main steam pipes in the underground conduit through branch pipes provided with traps the disadvantages and annoyance caused by condensation are practically obviated, providing the supply pipes are enclosed in non-conductive casing until they are connected with cylinders. The exhaust and all other pipes leading from hammers may be accommodated in the same casing down to the floor level, where they may be conducted outside the building through conduits and allowed to discharge in the usual manner or be turned into a condenser and ultimately into the sewer.

Foreman's Office, Wash Room, Lockers, Etc.

The foreman's office and the room used for special tools, fixtures, formers, welding compounds, etc., should be connected, if possible, and located centrally in a position from which the whole or the greater part of the shop could be easily seen and if possible near the door that is used the most. If that happened to be a side door, office and toolroom may be as shown in Fig. 1. Should an end door be more convenient the office and tool-room may occupy the space assigned to forge No. 8. For convenience as well as

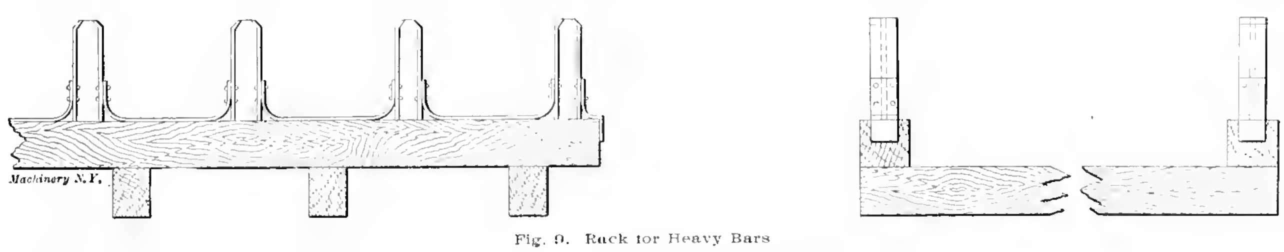

Fig. 9. Rack for Heavy Bars

These connections should not be made directly with the tubs, except at forges used by tool-smiths or where hardening has to be done, as it is often necessary to move tubs and other appliances at forges used for regular forging to make room for work of unusual shape.

Furnaces—Tool Racks Hammer Foundations and Piping

Furnaces to be used for heating work that is to be blocked to shape in quantities at steam hammers and those used for heating material to be drop-forged or shaped in forging machines, bolt-headers or bulldozers may be heated either with solid fuel or oil. Oil is preferable for several reasons. It is conducted from the supply tank to where it is to be used automatically through pipes. Once ignited the supply can be regulated and the heat maintained at an even temperature for any length of time. There is practically no refuse to be removed and no time is wasted in waiting for a fresh supply of fuel reaching the proper temperature for the work to be done as is the case with any kind of solid fuel. For each

economy blacksmith shops should be provided with washing accommodation, locker rooms and lavatories, which would not only add to the comfort of the men employed, but would be the means of saving the time that is wasted in going to other buildings. In a shop of 18 forges there should be locker and washing accommodations for at least 60 men. This at a conservative estimate would occupy at least 650 square feet of floor space. The lavatory for obvious reasons should be separate from the locker and washroom, but in close proximity, and is therefore shown in the floor plan just beyond the partition that separates the shop from the coal storage.

Flooring

There is much difference of opinion as to the material that is best adapted for the flooring of blacksmith shops. Wood is too inflammable, bricks crack and break from the heat and impact of work being laid upon them, cement or concrete is poorly adapted for the same reason, and asphalt is out of the

question. Nothing that has been tried so far has given better satisfaction or can be installed at less cost than dirt mixed with ashes. If kept moist by being watered at least once every day it is more comfortable to stand upon than anything else that can be used for the purpose. It is easily repaired and leveled should holes or irregularities get worn in it, and it is not affected in the least by hot or heavy pieces of work or material being dropped or laid upon it. The space between walls and forges, however, may be covered with concrete and cement to facilitate the handling of such appliances as portable surface-plates and vises, and the floor of wash-rooms and lavatories may be of asphalt, while the foreman's office and tool-room may be of wood.

The spaces assigned to cutting-off machinery, etc., and that for drop-hammers and other machines used in making die forgings has not been laid out in detail for the reason that machines for that class of work vary so much in general outline and in size that it would be difficult to arrange them satisfactorily except by knowing their makes and the size of work they are to be used for.

Bar Stock Racks and Storage

In storing bar stock several things have to be considered if time is to be saved and the chances of making mistakes in using wrong material minimized. Racks are necessary for the purpose and should be constructed in a manner best suited for the accommodation of the various kinds of material and so that bars can be lifted from the sides instead of having to be pulled from the end, as must be done when the common lattice pattern rack is used. For tool steel or any other special material racks of the type shown in Fig. 6 will be found to be the most convenient, as bars can be stood on end irrespective of length, and short pieces kept in the enclosed portion at the bottom. For the more ordinary grades of stock up to a certain size a rack of the type shown in Figs. 7 and 8 will be found to be very convenient, as bars can be removed from the sides, which is much more expedient than pulling them from the ends. Lengths too short to be supported by the arms can be placed in the box-shaped receptacle at the base. For bars too heavy to be stored upon racks of the types already shown a platform raised a little above the level of the floor and divided into sections by upright stakes, which may either be of cast iron or steel of structural shapes as shown in Fig. 9, may be used. All material to be designated by colors on the ends of the bars to correspond with the colors of the racks in which they are stored.

Communication between the stock-room and cutting-off department should be through sliding doors that would permit of bars too heavy to be lifted by hand, being lifted and conveyed between the two places by an overhead trolley system, to pass through the sliding doors at the point where they come together.

Fuel Storage—Roof Construction

On the opposite side of the building from the bar stock store are the pockets for storing coal, coke, charcoal or any of the other solid fuels that may be used. The approach to these pockets is a line of standard gage car tracks elevated upon trestle work and entering the building through a door in the end wall above the level of the pockets as shown in Fig. 4, this door to be large enough to admit locomotive and cars so that coal, etc., could be dumped directly into the pockets from which it could be supplied to forges or furnaces by hand cars.

The roofing of a building as here depicted apart from general outlines is a subject upon which the constructing engineer ought to be left with a free hand, as stresses must be calculated and tension and compression members of the trusses arranged accordingly. The sides of the ventilating monitor, however, should be at least 6 feet in height to admit of the windows used being of a size sufficient to throw good light upon the anvils at the opposite sides of the shop. These windows should be balanced upon horizontal trunnions so that they could be opened and closed by means of cords or rods operated from the floor.

* * *

The value of the present output of automobiles is estimated to be about $130,000,000 yearly.

HOW OLD SI WAS NEARLY "OSLERIZED"

A. S. ATKINSON*

Native ability is something that is quite scarce in the average machine shop, or at least if it is there it is smothered up or held in check or choked by too much rule-by-measurement practice. Of course I don't mean the ability to run a machine, cut after a pattern, or do any of the other routine work that must make up most of the day's labor in nine cases out of ten. Old Si Smith used to define native ability as "the knack of making something out of nothing." Si had this kind of ability. He was of the old school, hadn't been trained and schooled in an industrial college, and when he served his apprenticeship in the shop there weren't one hundredth as many machines to do your work as there are to-day. A man then had to get out and be his own boring machine, lathe, and planer. There wasn't any monotony about a machinist's job then. Likely as not one day you'd have to weld together a broken rod in the blacksmith's shop or hammer a new point onto a broken bit, and the next you'd be patching up a boiler plate or riveting a steam box to keep it from bursting, or you'd be doing almost anything from filing and scraping down a rough piston to making a new sheet-iron box. There was no standing before a huge machine and watching its rhythmic cutting and pounding, hour after hour.

The old school developed native ability, if one had it in him, and sometimes it knocked a little into one who didn't inherit any from birth. It may be the new method is better for turning out great quantities of exact work, but the day of the man with the knack for doing things has gone for good. Not entirely though—at least one such man is essential to the success of every shop. Just to prove this I will recall some little experiences in which old Si figured. The old superintendent understood Si, and instead of looking upon him as a back number who ought to be "Oslerized," he valued his services for all they were worth. He was always sure of his position in that shop. But the old superintendent died, and another, a stranger to most of us, came to take his place, and with him a new foreman who was about as much a stranger as the head boss. They were both younger than their predecessors, and they believed in hustle and bustle, and method and system. They put everything and everybody to checking off everything and everybody else. They said they wanted to know how much each man was doing, and how much each article cost. I suppose it was all right, as it was modern and progressive. Most of us were young enough to adapt ourselves to the new way and not let it bother us. But it came rather hard on old Si Smith. Si couldn't understand it. He didn't know why he had to be watched and why he had to jot down on a paper everything he did—the time, date, and number of minutes. He protested in vain. "I've been here forty years, an' I never cheated the boss out of an hour of time. I do my work honestly." But this was of no use. "I believe you're honest, Si," the foreman replied not unkindly, "but how do we know whether you're doing your share of the work. It's not so much a question of good intentions as of capacity and efficiency." That stumped Si, and he only stared back stupidly. "What does he mean?" he asked appealingly of us at the noon hour. "Does he mean I don't understand my job or that I ain't up to date, or—or—or—"

Poor Si! We tried to relieve his mind, but it was a dismal failure. Si's particular specialty was fine, careful work. He was not a fast worker, but nothing left his bench until it was perfect. He loved it, and when he did a bit of welding or polishing or cutting with hand tools, it was a pleasure to look at it. He had the machines beat to a standstill. If a machine could cut out a die to a hundredth of an inch, Si could cut another by hand that would come within a thousandth of an inch of perfection. Why, tools in his hands took life and precision that made the work of the rest of us clumsy and bungling. Of course that didn't count in a shop where a new and unsympathetic foreman and superintendent had taken charge. Si couldn't keep up with the pace. His time cards soon showed that. He was slow in his fine work, and at the end of each week the record went against him. You

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see, by their new system, they could tell just how much work each man was doing, and if one was loafing on his job he was told to hustle. It was all intended to increase the speed and weed out the slow ones. The most of the trouble fell upon Si, and within a few months we began to feel sorry for the old fellow. The constant prodding and reprimanding was getting onto his nerves, and that made him slower than ever. This increased his disgrace, and then one day the crisis was reached. Old Si was to be "Oslerized," but owing to his long service in the shop it was only a modified process. He was given a month's vacation on full wages, and at the end of that period he was to return as watchman at a big reduction in wages. We didn't hear the words of the interview. Si was too surprised and dumbfounded to say much; he had to get out and think it over. Then he exploded before us. "They make me watchman on half pay," he said angrily. "Me a watchman, an' too old an' slow to do anything else. I'll go an' drown myself first. No, I'll go to another shop an' get work."

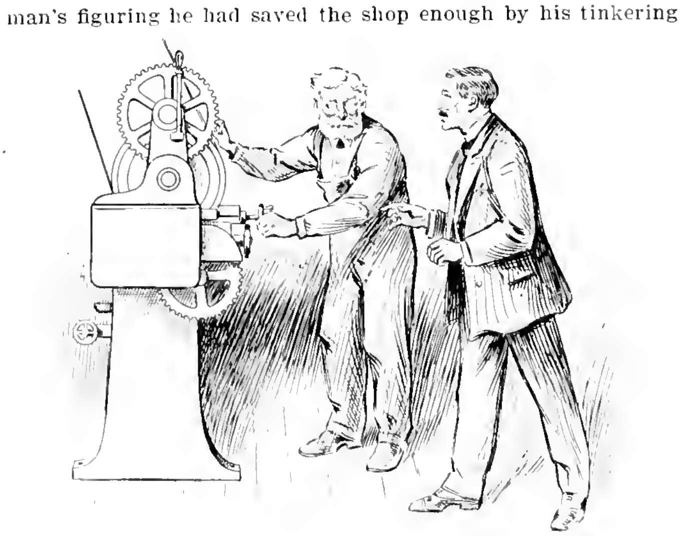
"Does he mean I don't understand my job, or that I ain't up to date?"

This determination we tried to combat, advising Si to think it over and not decide too hastily. He had a month to decide. But he was angry, and he spent a week going from shop to shop for work. But nobody wanted a machinist of Si's age, and they knew nothing about his skill. The following Monday morning Si returned to the shop. He was crestfallen and quiet; he knew now that he had little chance in the new industrial work. "But, Si," we protested, "you have three weeks more of vacation. What are you doing here?" "Vacation?" he stammered. "Oh, yes, I'm having a vacation; I'll spend it here roun' the old shop. There ain't nothing to do but sit aroun' an' look on. I get homesick when I'm away, but I'll have my vacation all right." This, in substance, he repeated to the foreman when he asked Si why he was back. The foreman smiled, and let the old fellow have his way. He was harmless, and so long as he didn't interfere with the work of the others he could hang around and look on. Probably he wanted to get some points from the younger men about increasing his capacity and efficiency.

Now Si's method of looking on was quite different from that of most men. If anything went wrong with a machine he would jump up and look for the trouble. He had an ear tuned so exactly that he could almost anticipate trouble with a machine. The lineshaft couldn't miss a revolution or a gas engine skip once in the most distant part of the building without Si knew it. Once a belt slipped so near the edge of its pulley that it came into contact with a loose guide and bent it out of position. The operator didn't notice it, but Si did. In another minute there would have been trouble, but old Si jumped up and stopped the machine just as the belt slipped off and landed where it would have been caught in another machine. The foreman came up frowning and Si offered only as an explanation: "I saw that belt slipping and stopped it. Them guides ain't no good anyway." The foreman understood the importance of this sudden interference, but said nothing. Si disappeared then into the forge shop. That night after work hours he appeared with a new set of guides which he proceeded to put up. They were so strong and good that they are doing service to-day. Si had forged them out of old metal, and they cost the firm nothing.

On the third day of Si's vacation in the shop a big turret lathe snapped one of its back gears and put it instantly out of commission. We had rush orders on hand, and the crippling of this machine put us in a bad position, as there were no duplicate parts on hand. The foreman was upset, and the superintendent, too. Orders were telegraphed to the manufacturers, but it would mean a loss of several days at least. While the others were bemoaning the fact that the turret lathe would shut down a good deal of the work, old Si was peering into the machine and taking mental notes. When the old thing was abandoned, Si took the fractured parts into the blacksmith's shop, and for several hours was busy. Toward night he returned, black with dirt and grime, and the perspiration running in streaks down his face. He carried something in his hands. Nobody noticed him particularly, but just before the hour for shutting down arrived we were all surprised by hearing the old turret lathe start up and begin rhythmic operations again. The foreman rushed to the place, and there he found old Si beaming happily. "I guess she'll run all right for a few days," he said, pushing his spectacles up on his greasy forehead.

The foreman could hardly believe his senses. He had to stop the machine and get Si to show him what he had done. Oh, it was simple. He had brazed the broken gear until it was almost as strong as a new one—certainly good enough for an emergency. That night a volunteer crew ran the old turret lathe and caught up with the rest of the work. It was nearly a week before the manufacturers' expert appeared on the scene with new back gears, and it took him two days to put them in and finish his job. The foreman after watching the repairs, took a pencil from his pocket and began to do some figuring. We could only guess what it was about. Si didn't know either, but the next day the foreman and superintendent had a conference, the result of which was that old Si was called in the office for a short talk. They had decided that they couldn't afford to lose Si. According to the foreman's figuring he had saved the shop enough by his tinkering



"The foreman could hardly believe his senses"

to pay for his salary several months. There had been danger of losing an important order through the mishap, and Si saved that for them. Si was put back into the machine shop, and he is there now. The Lord knows how old he is; he must be long past the sixty mark, and yet he's as useful as ever. He can't hold his end upon piece work to-day, and nearly every youngster in the shop can beat him. But when they want some very fine piece of work done it is turned over to old Si, and when there's trouble with the machines Si is the expert called in, and its a pretty bad case of breakdown that he can't fix up. He can turn his abilities to almost anything, and when he prescribes medicine the patient generally recovers in a short time.

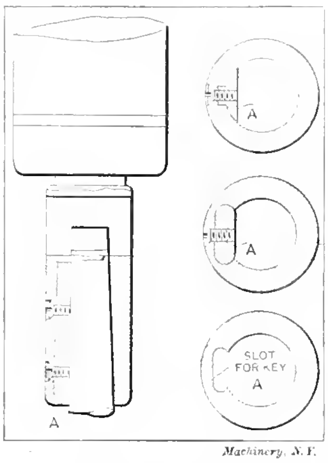
We called him "old saw bones," for he was a surgeon—more than a physician. He could fix up a broken leg or rod or weld together any fracture so that you would hardly see a scar. That is what I call native ability. Si had it, and it certainly was "the knack of making something out of noth-

ing." If he didn't have the right piece of metal to fix a thing he'd make a piece out of old scrap or anything else handy. A shop that doesn't have an "old saw bones" in it is minus one of the most important factors. Give me one of the old school machinists who knows how to handle tools for mending anything, and in the end he will save more than his salary is worth twice over. There are a good many such old men tinkering around, but unfortunately their breed is dying out, and I suppose in time there will be none left. Then we'll have to depend upon the experts from the manufacturers, who will charge a big price and hold up operations for several days or a week every time something goes wrong.

* * *

DRILL SOCKET

Harold E. Bradley has assigned to the Morse Twist Drill Co., New Bedford, Mass., his patented drill socket described in U. S. patent No. 926,845, July 6, 1909. The object of this invention is to provide a drill socket or collet which in addition to its regular function of driving the drill by the tang or flattened end, is also adapted to receive and drive a drill with a broken tang, thus utilizing drills which would otherwise be worthless. The illustration shows a vertical section of the improved socket, and also horizontal sections of alternative designs. The novel feature is the key A, which can be readily inserted in grooves in the socket and held in position by screws. After one side of the drill shank is ground or flattened off to correspond with the flat of the key, the drill may be again inserted and driven by the socket.



Drill Socket adapted for driving Reguler Teper Shank Twist Drills and Drills with Broken Tangs

* * *

DIES AND PUNCHES FOR MAKING NUTS

One of the latest improvements for automatically making nuts from a bar of metal by dies and punches was patented by George Dunham, Unionville, Conn. (U. S. patent No. 928,509, July 20, 1909). The dies and punches are adapted for an ordinary double crank machine having two horizontally moving punch slides.

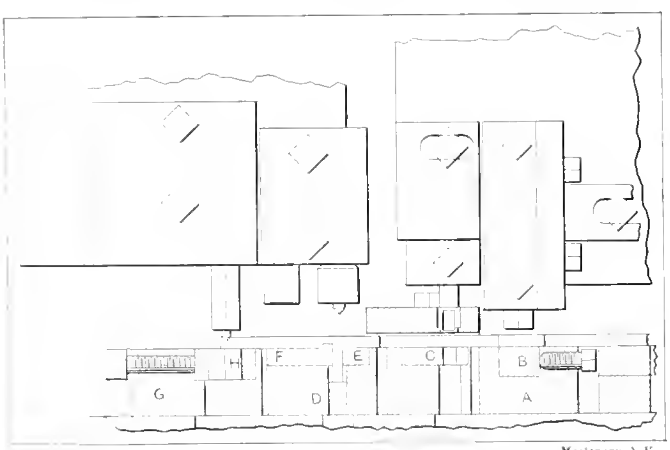


Fig. 1. Sectional View of Dies and Punches for Making Nuts

Fig. 1 is a vertical section of the dies on the bed plate with the punches above. At the right is a die holder A with a die B having two V-shaped cutting edges, the apices of which face each other. This die cuts V-shaped notches in the opposite edges of the bar and is called the notching die. While each notching punch has four cutting edges, only two of the edges can be used at one time. Adjacent to the notching die is a die C with a die block; this die has a round hole for punching the center hole of the nut blanks. The next die holder D has a crowning die E and a flattening die F, the two preferably being made in one piece. The fourth and last die holder G has a die H for cutting the nut from the bar.

Fig. 2 is a bar illustrating the various steps taken in making the nuts. The notches d and the round hole in the nut blank are made by one blow of the right-hand slide. The blank b is crowned and the blank c flattened by one blow of the left-hand slide. The nut blank a is then cut off and trimmed. The next blow of the two slides will form one more pair of notches and perform the previous operations on the blanks f, g, h and k. By changing the dies and punches any desired form of nut may be obtained. Square nuts may be made by omitting the notching punches and substituting a trimming die and punch of a square form for the hexagonal one shown.

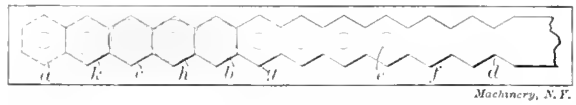


Fig. 2. Bar, showing Different Stages in the Making of Nuts by Punching

* * *

BORING ELLIPTICAL HOLES

A lathe attachment for boring elliptical holes is described by James Shaw, Dauphin, Manitoba, in U. S. patent No. 928,404, July 20, 1909. The attachment as fitted to a lathe is shown in Fig. 1, and consists essentially of movable supports A and B, and a boring bar C with eccentric end bearings. Fig. 2 is a longitudinal section through the bearing brackets showing boring bar C. The ends D and E are eccentric to C and are in alignment longitudinally the one with the other. It will be noticed that D and E are carried by bearings which can be raised vertically in guideways at the rear face of the supports, while at the other face the main shaft has bearings with horizontal guideways. When the device is in operation the sliding bearings are free to move in their respective ways. In the main shaft is a hole for the cutting tool (see Fig. 2), and in Fig. 1 the tool is shown in position boring an elliptical hole in the work on the lathe carriage.

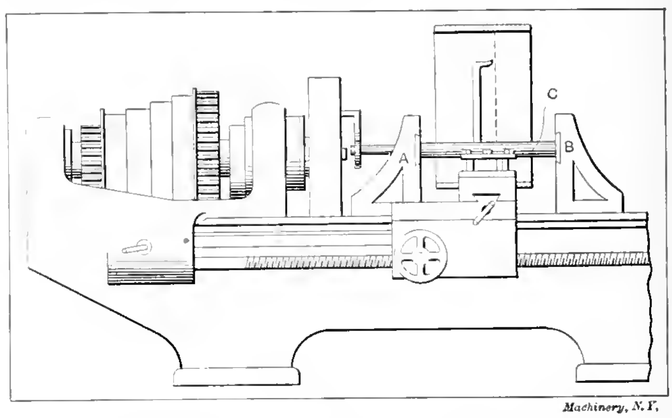


Fig. 1. Device for Boring Elliptical Holes in Place on the Lathe

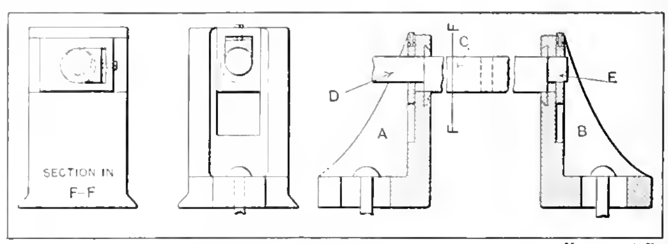


Fig. 2. End and Sectional Views of Elliptical Boring Device

* * *

The chief item of expense in the maintenance of automobiles is generally the tires. Mr. Charles Clifton, president of the Association of Licensed Automobile Manufacturers, says that there are three prime factors responsible for short tire life: First, excessive speed, especially in hot weather; second, rounding curves at a high rate of speed; and third, unnecessary use of mechanical brakes.

MAKING PISTON PACKING RINGS

E. B

The accompanying engravings illustrate a cheap and rapid method of making expansion rings. This method has been used for some time by a certain gas engine company, and has done much toward reducing the costs of this class of work. Referring to Fig. 1, the dotted lines *A* indicate the shape of the casting from which the rings are made. This consists of a cast-iron cylinder with a flange on one end to facilitate clamping in the chuck for turning and boring. Having chucked the casting in the lathe, the rings are then turned and bored in one operation by means of the tool shown. This tool consists of a frame *D*, which is rigidly connected to the tool carriage and is fed along in the same manner as any other tool. Through this frame passes a spindle *C*, which turns freely in the frame and is held from moving lengthwise by means of a pin *K*, which fits into a recess cut in the spindle. On one end of this spindle there is an eccentric collar *D* which is rigidly held by a pin, thus turning with the spindle. The other end of the spindle is cut square or to some other shape to fit a block with a hole of the same shape, which is fastened to the chuck head. Therefore when the tool is fed along, this spindle slides into the chuck head, and at the same time revolves with it, as does the casting *A*.

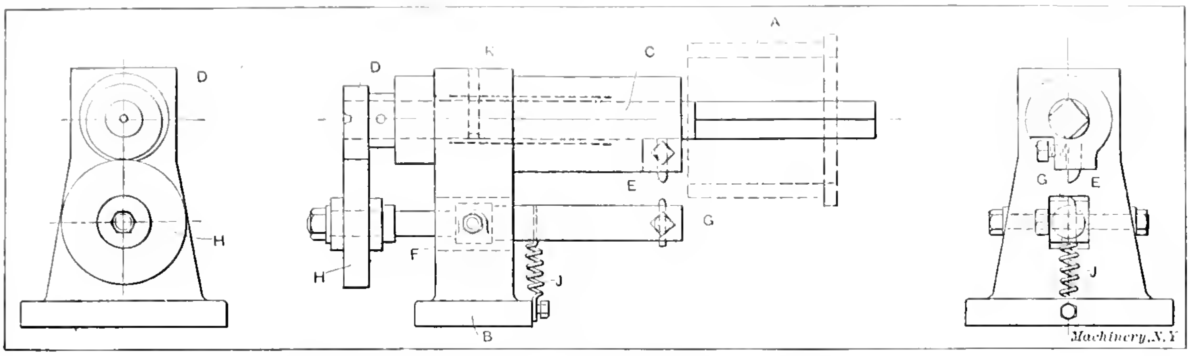


Fig. 1. Tool for Boring and Turning Eccentric Rings simultaneously

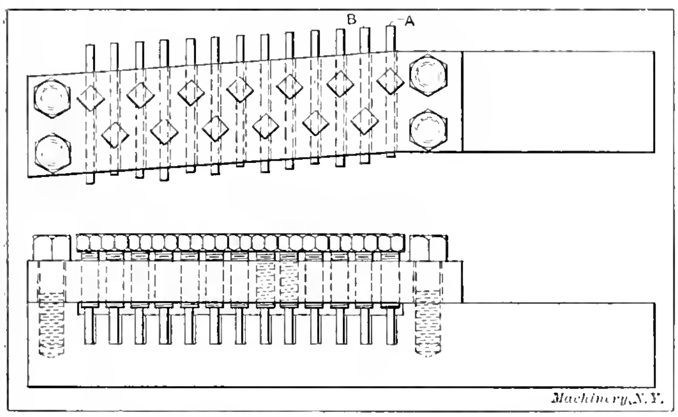


Fig. 2. Cutting-off Tool for Severing the Rings successively

When the casting makes one revolution, the spindle and eccentric also make one revolution. In the frame is set a tool *E* which bores the casting. Through the lower part of the frame passes another spindle or lever which is hinged at *F* and has a tool *G* on one end and a roller *H* on the other end which turns freely on this lever. A spring *J* holds the roller *H* up against the eccentric *D*. As stated before, the eccentric makes one revolution to each revolution of the casting, therefore the lever and tool *G* perform one complete oscillation to every turn of the casting. The tool therefore turns the casting eccentric to an amount depending on the location of the fulcrum *F* and the eccentricity of the cam *D*. This can be better understood if we assume the casting *A*, spindle *C*, and eccentric *D* to be stationary, and the frame *B* to revolve about the spindle. The path of the turning tool would then be in a circle eccentric with the axis of *C*. Therefore, if the frame *B* is stationary and the work *A* revolves, then the outer surface of the cylinder will be cut eccentric to its axis. In this way the casting is turned and bored in one operation.

The next operation is to cut off the rings, and this is done by means of the tool shown in Fig. 2. This tool consists of a bar in which are mounted a number of cut-off tools spaced the proper distance apart to give the desired width of ring. The holder is bent and the tools are set successively at greater distances from the axis of the work. Therefore the tool *A* gets through first and the first ring drops off, and the other rings, throughout the entire length of the casting, are severed in succession.

The next step is to split the rings on the thin side; they are then ready to be ground on the outside. To facilitate this operation a casting, Fig. 3, is bored to such a diameter as will allow for the amount to be ground off. The rings are then sprung into this cylinder as shown by the dotted lines.

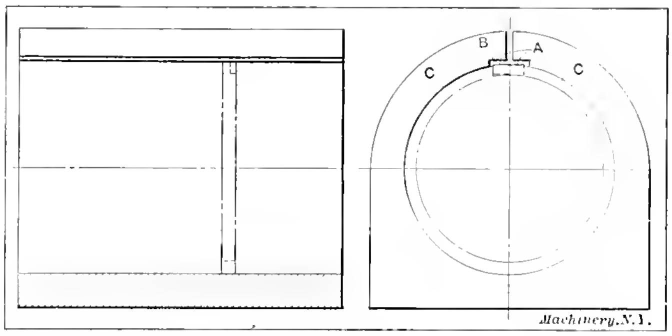


Fig. 3. Fixture for Holding the Rings while they are being secured in the Grinding Arbor

In springing the rings together the points *A* move outside the circle of the bore and the slot *B* is cut in the casting to allow them to do so. This is an important point because if this slot were not provided the points *A* would be forced in and ground to a true circle with the remainder of the ring, with the result that when the rings were placed on the piston and inserted in the engine cylinder the points *A* would rub on the cylinder walls and a part of the ring, say from *A* to *C*, would be held away and the fit would not be perfect. But if these corners are allowed to project as shown, they will be ground away and will therefore not rub afterward.

Having placed a number of rings in this assembler, an arbor, Fig. 4, is inserted and the rings clamped together between the collars *A* and *B*. The arbor is then placed in the grinding machine and a light cut is taken off the rings. These collars *A* and *B* just fit the cylinder, Fig. 3, and the rings are therefore accurately centered at once. The collars are cut away at *C* to allow the grinding wheel to pass over the rings without cutting away the collars and destroying their usefulness as a centering device.

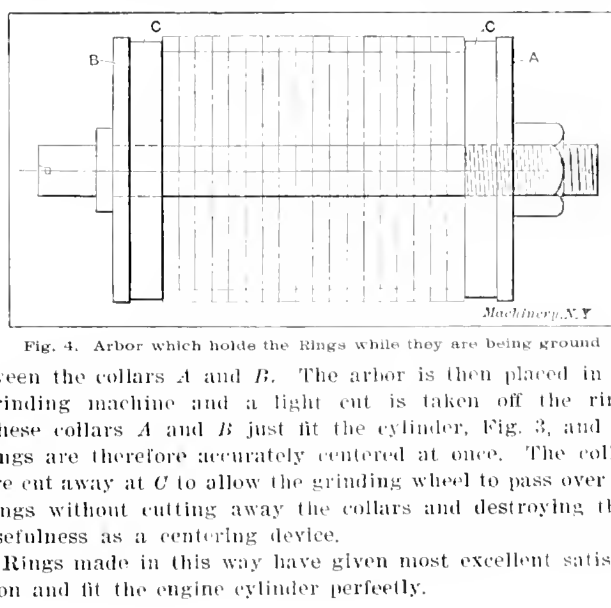


Fig. 4. Arbor which holds the Rings while they are being ground

Rings made in this way have given most excellent satisfaction and fit the engine cylinder perfectly.

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OCTOBER, 1909

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HEAT TREATMENT OF ALLOY STEEL

The rapid development of the automobile industry in America has awakened a quick, keen appreciation of the great importance of proper heat treatment of steel. It is pointed out by Mr. Henry Souther that scientific heat treatment is quite as essential as the quality of steel. Ordinary steel may acquire good physical qualities with proper heat treatment, and the best of steel can be ruined by defective methods. There must be thoroughness in the various operations of annealing, hardening and tempering, for treatment carried on with care only makes uniformity of product possible. This is particularly true in the production of drop forgings.

The difference between ordinary steel and the best is great. For example, the elastic limit of ordinary steel is about 40,000 pounds per square inch with a reduction of area of, say, 50 per cent. Nickel steel properly heat treated has an elastic limit of 80,000 to 100,000 pounds per square inch of section, with a reduction of area of 50 per cent, or more. Brittleness does not follow proper heat treatment, the enduring quality being increased in a greater ratio than the elastic limit. Consequently crystallization, fatigue, or whatever we name the cause of breakage, is less likely to develop in a properly heat-treated and tempered material than in an annealed and soft material. This fact, discovered in the laboratory and established in actual practice, is now commonly accepted by metallurgical experts, notwithstanding that it completely overturns previous general belief. Another commonly accepted belief disproved is that strength and stiffness are coordinate, or "the stronger a piece of steel, the stiffer it is." To illustrate, it was thought if one piece of steel were twice as strong as another, it would bend only one-half as much under a given weight. But actual test has shown that a chrome-nickel steel having an elastic limit of 150,000 pounds or more per square inch of section, bends under a given load the same amount as a carbon steel specimen, and this condition holds true as long as the load is within the elastic limit of the weaker material. The elastic limit of a well-tempered steel spring is about 150,000 pounds per square inch, but a spring can be made of soft steel. If it is not loaded beyond its elastic limit, the spring will return to its original shape after every deflection, but the deflection would not be sufficient to make a good spring. In fact, it would be hardly noticeable, and of course, would be of little value.

Between these extremes lie the steels used by the spring makers in the past. Not only has the automobile industry forced the spring makers to depart from their old materials and methods, but the "shake-up" extends all along the line. Assume that a 0.20 carbon steel has been used with advantage for a given design of crank-shaft, neither bending nor breaking through long continued use, and that the bearing surfaces are as small in area as can be used without heating or excessive wear. A crank-shaft of properly treated chrome-nickel steel, having an elastic limit four or five times as high as the 0.20 carbon steel would be no stiffer, but would have greatly increased life and reliability. The steel makers must be prepared to meet these new conditions. Sound knowledge of steel has spread fast among intelligent manufacturers; from the knowledge obtained in the laboratories established where all materials are physically and chemically tested they have learned to discriminate in selection. With known characteristics, heat treatment scientifically conducted is sure of results that make high-grade steels comparable with ordinary steels in about the ratio they, in turn, bear to cast iron.

* * *

THE VALUE OF THE TRADE PRESS

The following quotation from the *Journal of Commerce*, New York, is an unprejudiced statement of the functions of the trade press:

In the very nature of things the man of affairs, with multitudinous and various cares pressing sorely on his time and attention, necessarily becomes self-centered and preoccupied. This is the man for whom the trade press stands as an invaluable ally. While he digs and delves in his own tasks, the trade press is his reliance for more basic information than he imagines. The ordinary press gives him the products of its daily observations in the doings and misdoings of the big round world of politics and society, but what it brings is only a diversion; a stepping aside from his grind. It may refresh him, but it does not aid him in his money-making slavery. But the trade press has an entirely different function in his life. While he toils in his office or warehouse the trade press is performing for him the task of confidential messenger to the rest of the commercial world. Its human machinery is finely tempered and carefully adjusted. Its men are trained, not merely in the collection of interesting facts of ordinary happenings, but in the observation of those events and developments which have a direct bearing on the commercial side of life. The trade press is his organ of communication outward as well as inward. Circulating, as it does, both in a local field and throughout the country, he has but to say the word and his message is disseminated among the very men most interested in his ideas. No man who has ever watched the development of any great trade movement can deny that, without an intelligent, trustworthy trade press, it would have been impossible.

Especially applicable is the description, "an intelligent, trustworthy trade press." The value of the trade journal to the industry it represents is based almost entirely on its trustworthiness. The same carelessness in regard to fact and the tendency to exaggeration which characterize the daily press, would so affect the influence of a trade journal with its readers as to materially reduce its value as a property in a short time. Trustworthiness, accuracy and the qualities which make for reliability, are demanded by the readers of the technical press; and the smallest mistake in a figure or calculation seldom escapes attention.

It is a noteworthy fact that no house organ, or publication issued in the interests of a manufacturer or dealer, has yet developed into a great trade journal. The publications to which the latter term may be applied, we believe, without exception, have started as independent journals, and their development has been strictly along that line. The stronger they grew, the more truly independent they became.

* * *

The growth of the automobile industry is one of the most amazing features of modern manufacturing industry. About 75,000 cars were built in 1909, and, according to the statement of Mr. Alfred Reeves, general manager of the American Motor Car Manufacturers' Association, manufacturers plan to place 200,000 automobiles on the market in 1910.

THE PNEUMATIC TIRE AND THE AEROPLANE

It seems a far cry from the bicycle tire to the aeroplane in the sense that the former is to any degree concerned with the development of the latter, but, according to one who has given the matter some serious thought, it appears that the connection between the pneumatic tire and the flying machine can be logically established. The fact that the automobile is an intermediary in the evolution that has made the latest mechanical triumph possible is interesting now, and it will not be unprofitable to briefly trace the evolutionary process that has made flight actually possible under favorable conditions, and which has aroused high hopes of ultimately making it a practicable means of travel.

The early bicycles of the high-wheel variety were facetiously named "bone-shakers," and bone-shakers they were in truth. The bicycle was only moderately popular in favored places having smooth roads and specially constructed tracks, until the advent of the "safety" and pneumatic tire. The new tire transformed the bicycle from a hard-riding machine, extremely fatiguing to all but those of strong physique, to a vehicle of business and pleasure for young and old of both sexes.

The wonderful improvement in riding quality made in the bicycle by the pneumatic tire stimulated the efforts of inventors and designers to produce a practicable four-wheel carriage driven by power to replace the horse-drawn wagon, and the "tires of air" literally smoothed away some of the great difficulties that had made the horseless wagon impracticable before.

When the running-gear problem was in a fair state of development, attention was concentrated on the motive power, and after a few years of strenuous competition the steam engine gave way to the internal combustion motor which won out because of its simpler control, higher efficiency and greater power per unit of weight. To-day the automobile gas engine is the world's wonder for concentration of power and simplicity of construction. In the space occupied by a Saratoga trunk can be placed a motor capable of generating 40 to 50 H. P. and weighing only from 8 to 10 pounds per horse-power.

Observers of birds and bird flight long ago took note of the strength of their wing muscles and apparent ability to exert great muscular effort in proportion to weight. Whether birds actually exert much power to sustain themselves when once in flight is a mooted question, but it is easily proved that they must expend great effort in the first few moments when rising in the air and getting in motion.

The heavier-than-air flying machine requires a powerful, light motor to launch it into the atmosphere and to sustain motion. The gas motor developed to meet the needs of the automobile required only further development to fit the special needs of aviation. As a matter of fact that development has been going on simultaneously in automobile, motor-cycle and aeroplane motors, and the leaders in mechanical flight might well contend that their share in the development of the gas engine is by no means small. Whether the chain of events thus outlined actually put the aeroplane in debt to the pneumatic tire, we shall leave to our readers to decide for themselves; but whatever the conclusion, the tracing of mechanical developments to imagined or real sources leads to some curious discoveries. One is forced to believe that many of the apparently trivial devices, in their infancy, have been the germs from which the most important developments have come.

* * *

THE COST OF SPECIAL TOOLS

Before deciding upon the design of special tools for manufacturing purposes, it is very important to compare the saving expected to result from the use of the new tool, with the cost of building the tool itself. A writer in MACHINERY in a recent series of articles on jigs and fixtures refers to this matter as follows: "Before planning the design of a tool, compare the cost of production, using present tools, with the expected cost of production using the tools to be made, and see that the cost of building the new tool is not in excess of the expected gain." This rule seems so simple and elementary that it is difficult to explain why it is so often disregarded.

As a concrete example of the meaning of the rule laid down above and the results produced when it is disregarded, the following occurrence in a prominent machine tool building shop may be of interest: A certain machine detail was produced in a slotting machine by means of a fixture costing $35. Ten pieces were produced per hour, the price per piece, including over-head expense, but not interest and depreciation of the fixture, being eight cents. The head tool-designer of the concern conceived the idea of a special fixture for producing these parts much more rapidly on a milling machine. Considerable experimenting, however, was necessary, and the total cost of the new fixture when completed was $518. This fixture made it possible to produce twenty pieces per hour, or double the number made by the old fixture. Consequently the price per piece is only four cents when the new fixture is used, interest and depreciation of the fixture itself not being considered, and a saving of four cents a piece is made possible. This would be a considerable saving if the fixture were constantly in use, but only 300 of these parts are required each year, so that the total saving resulting from the use of the fixture amounts to only $12 a year, and the fixture is in use for only fifteen hours during the whole year. Five per cent interest on $518 is $25.90, and if the manufacturing company expects this rate of interest, at least, on its investment, it will be seen that the use of the new fixture actually entails a loss of $13.90 per year, not considering depreciation and the fact that the labor necessary to build it could have been used to better advantage for other purposes. The depreciation may perhaps be considered as practically eliminated, because the fixture is used only for a few hours during the whole year.

This incident plainly illustrates the importance of determining closely the cost of a tool before it is designed and built, and the saving to be effected by its use. The designer, however, is not always directly responsible for the waste entailed when this cardinal principle of economical tool designing is overlooked. As is well known, the designer is often not permitted free access to the cost accounts, and this policy is largely responsible for some misdirected efforts of his energy. Often he does not know the present cost of doing certain work, and is given no opportunity to find out; yet he is expected to design tools for improved methods of performing the work. In such cases the designer cannot be held wholly responsible for inefficient and uneconomical results. That responsibility then falls on the man "higher up," who considers that anything relating to the economics of the concern should be strictly confined within the four walls of the cost-keeping department.

* * *

PRIZE FOR A SAFETY AUTOMOBILE CRANK

A French association for the prevention of accidents in industrial work has offered $300 in prizes for a crank or safety device for hoists, cranes, and all forms of lifting apparatus, and also for explosion motors, which shall, in the first case automatically stop the descent of the load, or in the second case, throw out of gear the driving action when not required. The invention remains the property of the competitor, who must himself be responsible for its due protection by patents. Drawings of competitive devices should be sent to the office of the Association des Industriels de France contre les Accidents du Travail, 4, Boulevard Saint-André, Paris, France. A non-return starting crank for gas engines, of simple design, was illustrated in the January, 1906, issue of MACHINERY; prospective competitors may be interested in studying this design in order to see what has already been done along these lines.

* * *

"John Brown, Practical Plumber," "James Smith, Practical Horseshoer," "Robert Jones, Practical Gunsmith," etc., are samples of signs found wherever we go that show a misunderstanding of the word "practical" or a deliberate misuse of the word for which there is no good excuse. If a man is a plumber, or a horseshoer or a gunsmith, he must be practical and follow practicable methods. Who ever heard of a theoretical plumber, or a horseshoer who shod horses by absent treatment, or a gunsmith who took dents out of gun barrels by suggestion? Drop the misused word "practical" from signs and see if they are not just as strong and comprehensive as before.

EFFICIENT SYSTEM FOR THE RAPID ASSEMBLY OF MOTOR CARS*

HAROLD WHITING SLAUSON†

From a mere corner in the machine shop in the days when the automobile was built in lots of but two or three at a time, the assembling room has grown to such an extent that, in many factories where the output is large, it occupies an entire floor of the main building, and has come to be considered as one of the three or four most important departments of a modern motor car factory. A corresponding increase in responsibility has attended the growth in size and importance of the assembling room, and today, unless well managed and equipped with the most up-to-date devices for the convenient and rapid handling of parts, it can easily "eat up" the profits on a whole year's output of low or medium-priced cars. Without requiring the services of an excessive number of men, it must take care of the parts from the machine shop and the parts-assembling room as they are turned out, and not allow a great number of finished pieces to accumulate at any time in the stock room. The work of assembling must also be done thoroughly, so that, when tested, the complete car need not be sent back for overhauling and readjustment of parts. In short, the assembling room must work in harmony with each of the other departments in doing its share toward producing a car of maximum quality at minimum cost of production—and that share is by no means small. But not alone are the best systems and business management, proper interior arrangement and most up-to-date devices necessary, but the highest class of skilled mechanics must be employed as well. A motor and transmission may be composed of the best of materials and have bestowed upon them the most skilled workmanship available, but unless they are placed together in the completed car with each shaft lined up, each bearing scraped and fitted and each gear in position to mesh properly, all this expensive material and labor may count for naught. The assembling room cannot, to any great extent, compensate for poor machining, but it *can* absolutely ruin the best products of the machine shop.

That the leading automobile manufacturers have been brought to a realization of the importance of the use of the best systems, equipment and labor in their assembling rooms is particularly well exemplified in the factory of the Chalmers-Detroit Motor Car Company at Detroit, Mich. Probably the most convincing proof of this statement will be fouud in the fact that, for the 3,000 complete cars turned out by this company last year, not more than 30 men were employed at any one time on the assembling room floor. More remarkable than this, however, is the high record established for a day's work. In ten hours, the 30 men in this department assembled 35 complete cars! Of course this does not include the assembling of the various small parts of the motor, transmission and rear axle, as these are taken care of in other departments, but when it is remembered that the chassis assembly *does* include the installation of all these parts in the frame, the adjustment of each to its new position, the attaching of all springs, wheels, running-boards, foot-rests, steering gear, and the wiring and piping of the motor, it will be realized that the system and equipment employed in this department of the Chalmers-Detroit factory must be perfect in every respect in order to turn out this amount of completed work.

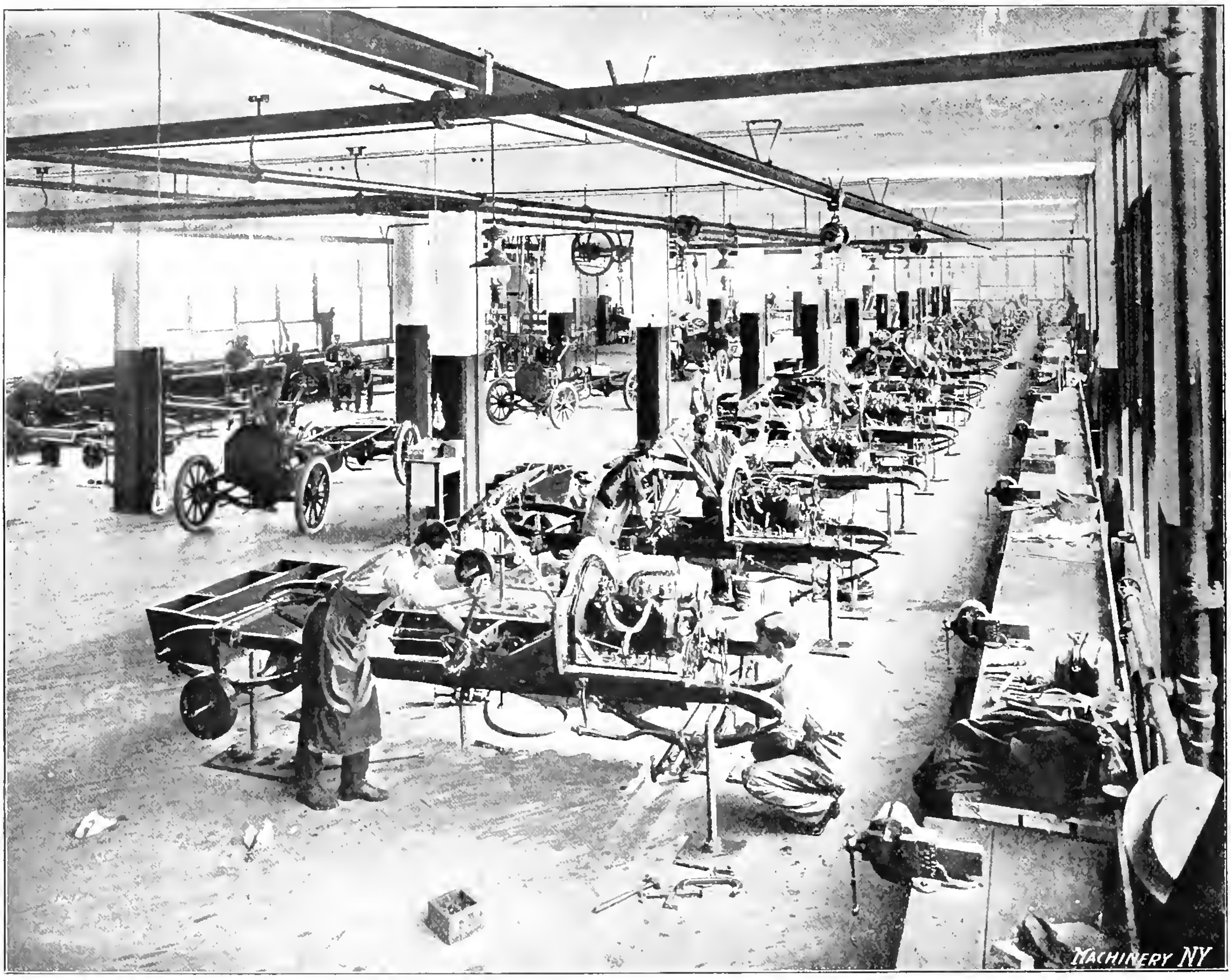


Fig. 1. View of the Assembling Room, showing Arrangement of Overhead Track and Differential Hoists; the Trucks, each of which holds the Parts for Two Cars, and the Adjustable Frame Supports

The headquarters of the assembling department may be said to lie in the finished stock room, which occupies a large section of the floor of the main factory on which the assembling room proper is located. To this finished stock room come all finished parts such as nuts, bolts, screws, front axles, springs, and wheels, and the previously assembled motors.

* For further information on this subject, see "Machines and Tools for Automobile Manufacture," June, 1909, and articles there referred to.
† Address: Box 27, Times Square Station, New York.

transmissions, steering gears, and rear axles. These are all classified and placed by themselves, the smaller parts being kept in bins which extend in long rows down one end of the room. Lists pasted in conspicuous places along these bins show the exact number of each size and kind of bolts, nuts and other pieces required for the various models of cars made here, and hand trucks having bodies divided into compartments are drawn down past the bins and filled with the necessary number of small parts for two cars. In the larger divisions of the truck box or body are placed the axles, steering gear, running boards, foot rests, and other bulky parts of the car. Each truck is filled with a sufficient number of the

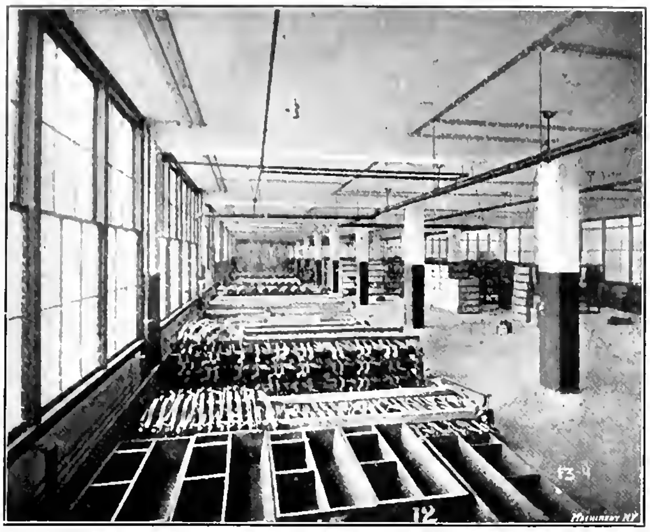


Fig. 2. View of Stock Room, showing Trucks in which Parts are taken to the Assembling Room, Assembled Parts, and Bins in which Smaller Parts are Stored

proper parts for the complete assembly of two cars and is then rolled into the assembling room, adjoining the stock room, and placed between two pressed steel frames which form the foundations, as it were, of the two chasses to be assembled. Having received the required number of parts of the proper kind, three men now devote their entire time to assembling the two chasses—and it is here that the advantages of "team work" are exhibited. Having become accustomed to this method of assembling, each man knows just what he is to do, and always has the other chassis at hand to which he can turn his attention when he is liable to interfere with the work of his two companions. It is highly specialized work, each team of three men devoting their whole time and energy to the installation and adjustment of the various parts of two cars until they are ready for the road test. As three men finish the first two chasses, another truck is brought in containing parts for two additional cars, and the team then devotes its attention to cars three and four. The motors are not included in the quota of parts comprising the truck load, but are carried in separately on differential hoists which travel on overhead tracks and pass in two lines down the sides of the assembling room in front of the two rows of chasses. When the frame is ready for the installation of its motor, the latter is lowered in place. This system renders each car independent of the stock room after the truck load of parts has been received, and the work bench, vise and kit of tools near every chassis reduce to a minimum the number of steps necessary to be taken by each workman.

The arrangement of the rests for holding the frames rigidly in place is very ingenious and entirely does away with the use of saw-horses or other movable and bulky supports. There are four of these supports for each frame, as shown in Fig. 1, and when not in use, one or all may be let down into the floor. Each of these supports consists merely of a vertical iron rod, bent at right angles at its upper end and forged into the shape of a hook. A corner of the frame rests on this horizontal portion of the rod, while the hooked-shaped ends of the two opposite supports prevent lateral motion in either direction. Each rod is supported by a pin passing through it at the proper distance from the end, which rests across the top of the base-plate which is bolted to the floor and through which the end of the rod passes. By giving a partial turn to the rod, the pin is allowed to pass through a slot in the base-plate, and the whole support is thus dropped until its top is flush with the floor. In order that the supports may accommodate themselves to various lengths of frames, the rear pair of every set of four base-plates is made with four sets of holes, in any of which the rods may be placed. The sets of supports are placed at such intervals along the floor that sufficient space between the frames is allowed to enable two teams of men to work on adjoining cars without interference. While it may seem a small matter, the facility with which these supports may be put in place, adjusted or removed from the floor, helps to make possible, in no uncertain degree, the record for the rapid assembly of cars of which this factory can boast.

Although not a part of the assembling room proper, the department in which the pressed-steel frames of channel-section are prepared for the chassis, has an important part in facilitating quick assembling. When the frames arrive at the factory, forty or fifty holes must be drilled for the various parts which are to be attached, such as the gear shift, brake levers and their supports, the motor, transmission, running boards, fenders, lamp brackets, springs, and the like. Most of these, with the exception of the motor and transmission, are riveted in place before the frames reach the assembling room. These operations are performed in the frame riveting room, which contains several unique and ingenious arrangements that, so far as efficiency is concerned, bring this department on a par with the assembling room. The frame is first placed on a set of supports similar to those used in the assembling room, except that a tension rod and turnbuckle connect both pair of rods for the purpose of holding the frame more rigidly in place. A single track over this set of supports carries a differential hoist, from which is suspended a large jig (see Fig. 3) containing a guide hole corresponding to every hole necessary to be drilled in the sub-frame, which carries the motor and transmission. This jig is clamped securely in place and the holes drilled by means of pneumatic drills connected to flexible piping. When all the

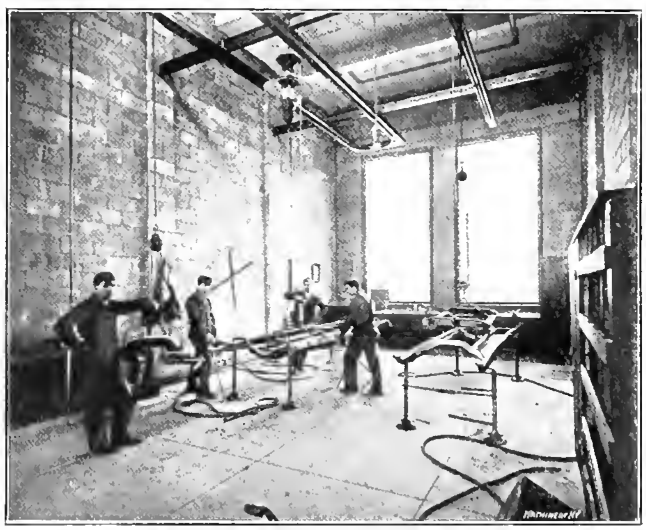


Fig. 3. Room in which the Frames are drilled and riveted by Pneumatic Tools

holes are drilled in this manner, the frame is removed to another set of supports a few feet distant where it is held rigidly in place in the same manner as that before described. Above this second set of supports is an oval track of the same length and width as the frame. From the traveler on this track is suspended a cable terminating in a single pulley through which passes a chain. On one end of this chain is a heavy, pneumatic riveter, which is counterbalanced by an iron weight attached to the other end of the chain. This enables the tool to be placed at any height desired without unnecessary exertion. A small forge (not shown in the illustration) in one corner of this room heats the rivets before they are driven into the frame. By means of the oval track and pulley, any vertical or horizontal plane bounded by the frame may be reached with the riveter, and four or five men

in this department are usually able to keep the assembling room supplied with the required number of frames. After being finished in this department, however, the frames in all cases are taken directly to the finished stock room, from which they are drawn out to the assembling room as needed. This stock room, in fact, acts as a sort of clearing house for the whole factory, and no part ever reaches the complete car until it has been inspected, checked and entered in the stock room records.

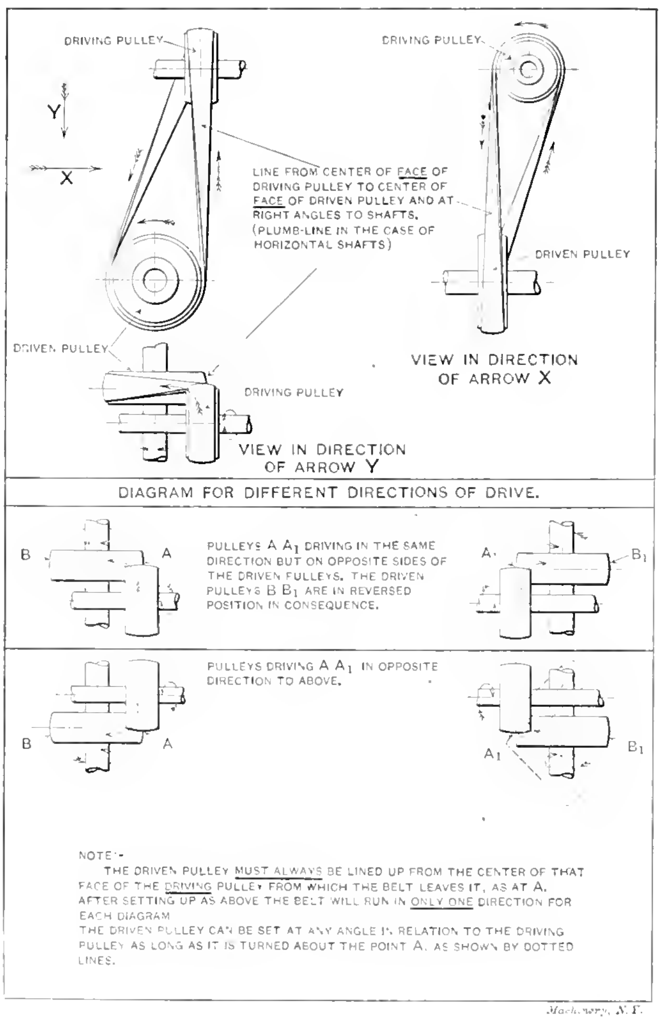
The keynote of this system is specialization. Every man knows what he has to do—and he does it. There is no overlapping of departments. It is scarcely ever necessary for the men in the assembling room to step into the stock room, and the men in the stock room are supposed to keep the men in the assembling department supplied with the necessary parts for the cars that have been ordered to be finished that day. Each team in the assembling room follows its two cars through until they are ready for the road test, and it is then easy to place the responsibility for any defect, where it belongs. When this system is supplemented with such labor and space saving devices as are used in the assembling and frame riveting rooms, and when, at the head of it all, is able, efficient and experienced management, one can begin to understand the conditions which allow the immense increase in production and the reduction in cost of the American-made motor car of today.

* * *

LOCATING ANGLE BELT DRIVES

GLASGOW

In answer to C. A. H.'s article in the August number, under the heading "What Would Jim Have Said," I submit herewith a data sheet of angular belt drives which was issued to



Locating Belt Drives when Shafts are not Parallel

the men here some twelve months ago. These diagrams show all the different positions of the pulleys for different directions of rotation of the shafts, and are also applicable to shafts in any position, vertical or horizontal.

ASSEMBLING MACHINE TOOL UNITS*

ALFRED SPANGENBERG†

In an article on "Elements of Assembling Operations" appearing in the September issue of MACHINERY, the writer laid down some fundamental principles relative to the methods and processes employed in manufacturing, and advanced the proposition that accurate drawings, accurate machine work and the use of jigs and gages are at the fonndation of economical assembling. Interchangeability, standardization, and duplication in quantities were also discussed. The present

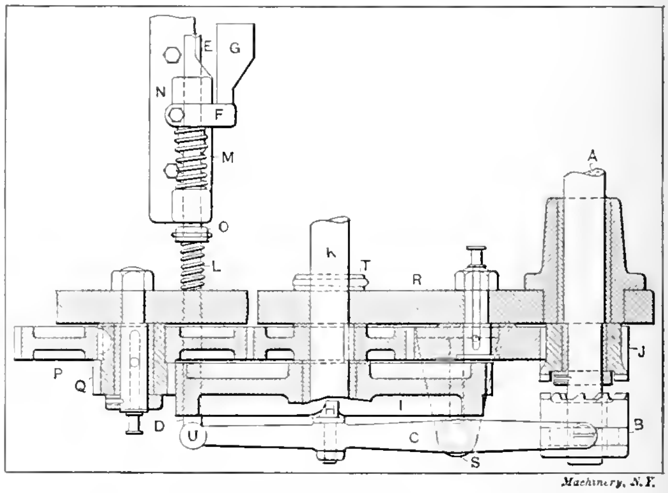


Fig. 1. Turret Lathe Indexing Mechanism to be assembled

article will deal with concrete examples illustrating the application of these principles in actual shop practice.

Assembling a Turret Lathe Indexing Mechanism

The turret lathe indexing mechanism shown in the line engraving Fig. 1 is presented to bring out clearly the necessity for analyzing the purpose of every part of a machine in order to machine and assemble the members so that they will function properly. In operation, the driving shaft *A* is constantly revolving in a certain direction. Keyed to this shaft is the sliding clutch member *B* operated by the forked lever *C*, link *D*, rod *E* and stop *F*. The dog *G* is bolted to the turret carriage and when the carriage is run back this dog strikes the stop *F*, thus withdrawing the indexing pin *H* from its slot in the index gear *I* and engaging the driven clutch member *J*. This starts the train of gears that revolves the turret by means of the worm shaft *K*, the worm-gear being bolted to the turret. An automatic knockout (not shown) stops the power traverse of the carriage the moment clutch *J* is engaged.

Fig. 2. Turret Lathe Indexing Mechanism shown in Detail in Fig. 1, Assembled

The turret continues to revolve until the carriage is run forward by throwing in the rapid power traverse mechanism which allows the indexing pin *H* to enter the slot in the index gear, and the turret stops revolving by virtue of the springs disengaging the clutch member *B*. The ratio of the back-gears is such that the index gear makes one revolution for each station on the turret. Spring *L* is for releasing the clutch and spring *M* keeps the stop *F* in position when the bracket *N* is moved along the bed in its T-slot. It is obvious that the springs should be as light as possible in order to avoid unnecessary wear on the indexing pin and face of the index gear and also to prevent a heavy pound when in

* For additional information on this subject, see MACHINERY, September, 1909, "Elements of Assembling Operations," and articles there referred to.

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operation, but the springs must have sufficient power to always bring the index pin to the bottom of its slot in the index gear.

The length of the springs, their stiffness, and the position of the collar *O* on the rod are determined in the beginning by experiment, and when found to be correct, their dimensions are marked on the drawing so as to provide for standardization. To permit the use of light springs, it is absolutely essential that the clutch-operating members be fitted perfectly free so that the mechanism will index properly. The function of these members requires no rigidity in fit and the looseness desired is provided for by limits on the detail drawings, so that when the work, properly inspected, comes to the assembler no special fitting is required. As a general rule such parts receive little or no oil when the machine is in the hands of the operator, and if the parts are naturally stiff, trouble will arise. It must not be inferred that the writer is advocating such looseness in fits as to indicate poor workmanship, but many similar mechanisms have failed to work properly because of being too stiff, which shows lack of judgment and experience on the part of the assembler. The trouble in some cases, however, was due to the parts not being in proper alignment.

Before starting to describe any of the assembling operations, it will be well to bear in mind that while the description necessarily gives the operations in sequence, it is probable that in actual practice a number of different operations will be carried on at the same time, depending on the number of men working on the job. The gear plate and its cover, the latter being shown at *A*, Fig. 2, come to the assemblers with all the holes jig drilled and reamed except the taper dowel pin holes *B*. All the oil grooves are machine cut except those for the worm-shaft in the gear plate and cover.

Assuming that the turret lathe beds are in process, the operations of assembling the mechanism complete will include bench and vise work, and also floor work, since some of the members are interdependent with others on the lathe bed. The bench work consists of assembling the three independent groups, *viz:* the back gear members *P* and *Q*, Fig. 1; the fork lever members, including the sliding clutch *B;* and the operating rod bracket members *D*, *E*, *F*, *M*, *N*, and *O*.

The floor work consists of lining up the gear plate *R* on the lathe bed and assembling the entire mechanism. The operation of lining up is accomplished by means of two special arbors, one of which fits the worm-shaft bearings in the turret carriage and the other fits the holes in the operating rod bracket *N*, the arbors being long enough to pass through corresponding holes in the gear plate. The arbors are placed in position, with the turret carriage and operating rod bracket moved as close to the gear plate as possible, the latter now being bolted to the lathe bed. For obvious reasons the lining up is done with special reference to the operating rod and worm-shaft holes, since the adjacent bearing on the bed for the driving shaft *A* is some four feet away from that on the gear plate. Alignment of the driving shaft is tested by surface gage measurements taken from the top and side of the V on the bed, a few thousandths "off" being permissible.

Referring to Fig. 2, the bolt holes *C* have 1/32 inch clearance in the gear plate to allow it to be shifted slightly, and when properly set, the taper dowel pin holes are drilled in the bed by means of a pneumatic drill, then hand reamed, and the taper pins driven in place. The subsequent operations consist of assembling the shafts, studs and gears in their places, the process being so simple that no explanation is necessary. Next, the operating rod bracket members are put in place and then, after setting the index gear, the fork lever bracket *S* (Fig. 1), with its members already assembled, is bolted on and the connection with the link *D* made by inserting its pin.

Setting the index gear is accomplished in the following manner: The worm-shaft is set so that one-quarter of its total amount of back-lash is on the driving side, *i. e.*, if a line is placed on the periphery of collar *T*, and the total amount of backlash in the worm between its bearings in the turret carriage allows the line on this collar to travel ½ inch, then the worm-shaft is turned so that the line on collar *T* moves back ⅛ inch from the side towards which the shaft revolves when in operation. Now, with the fork lever members in place, excepting the pin *U*, the index gear is set so that when the indexing pin *H* is in position in its slot, the pin *U* will enter freely in its holes by virtue of their being in line.

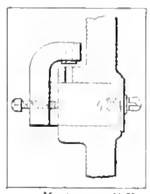


Fig. 4 Jig for Set-screw Holes

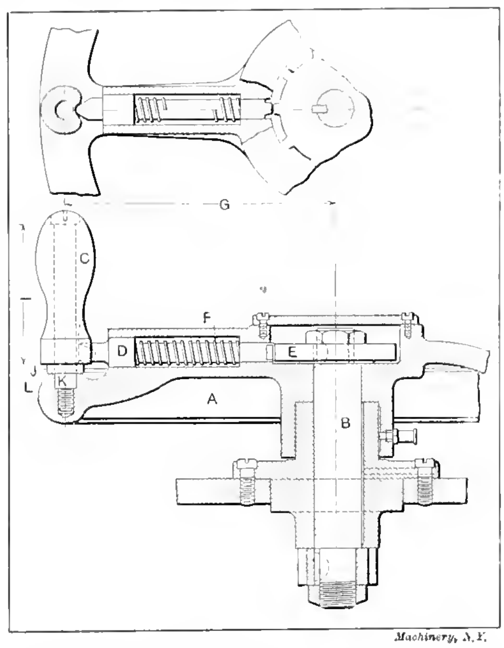


Fig. 5. Example of Device Difficult to assemble if Parts are not made in Jigs insuring Interchangeability

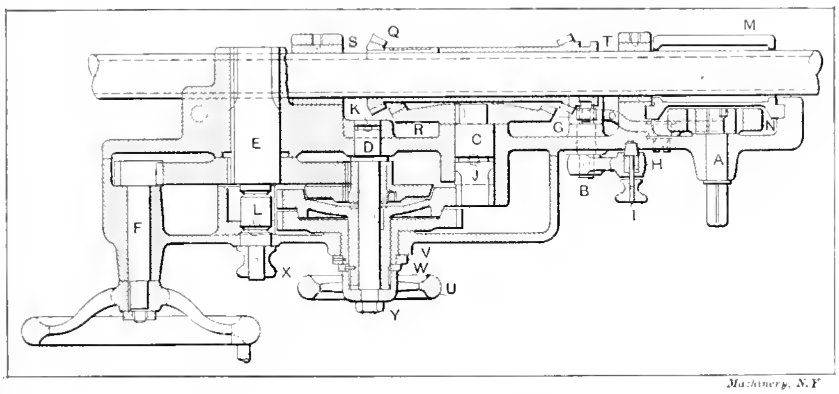


Fig. 3. Engine Lathe Apron to be assembled

The setting of the index gear to accomplish this is done by keeping the teeth of the index gear in mesh with its pinion and changing the teeth in the large back gear *P* in relation to those in its driving gear. Smaller adjustment of the index gear is obtained in this manner than by changing its teeth in relation to the teeth on the pinion *Q*, which fact is due to the ratio of the gears. Bolting on the cover is the final operation.

Assembling an Engine Lathe Apron

The engine lathe apron illustrated in the line engraving Fig. 3 is presented to show how machine tool units of this character are assembled on a manufacturing basis. Lathe makers, as a rule, build their lathe parts such as head-stocks, tail-stocks, rests and aprons in large lots so as to take advantage of the economy to be gained from carrying on the same operations on a large number of similar pieces in succession, both in machining and assembling; this has already been referred to.

It will be observed that the various shaft members are entirely independent of each other as far as their separate assembling is concerned, so that it is highly advisable to group these units to permit their being assembled at the bench as opportunity offers, which in most cases is while the aprons and covers are being bored and drilled. There are six distinct groups consisting, respectively, of the shafts *A* to *F* and their members. The assembling of these groups at the bench merely involves ordinary vise work so that little explanation is necessary. It will be well to state here that

when these parts are machined, particular attention is paid to the inspection of the length over shoulders, so that when the groups are assembled and put in place in the apron and cover no occasion will arise for any fitting or adjusting.

The method of testing shoulders on the friction gear shaft members, group *D*, in Fig. 3, is clearly shown at the right in Fig. 6; *A* represents a surface plate having a hole to receive the bearing end of the shaft. The double friction gear *B* when in its place in the apron has a lateral movement of 1/16 inch, the movement being controlled by the hand-wheel *C*. The dimension *D*, when all the friction surfaces are tight, being known, it is tested with a surface gage as indicated. The dimensions *E* and *F* are tested with ordinary length gages. A running fit is allowed on all shoulders while the length of the bearings in the apron and cover are made standard.

At the left in Fig. 6 is shown a jig for locating the levers *G* and *H* (Fig. 3) at the proper angle on their shaft while drilling and reaming the taper pin holes. This operation is done on a sensitive drill press to permit machine reaming.

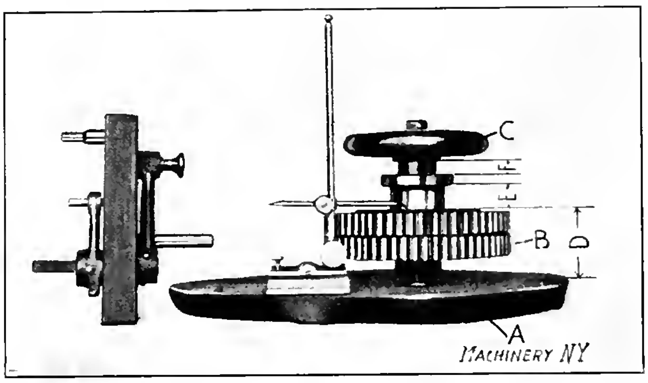


Fig. 6. Special Devices used in Assembling the Lathe Apron shown in Fig. 3

The jig is shown standing on end for the purpose of illustration, and its being used for two different sizes of levers accounts for the extra locating pins.

Referring now to Fig. 7, the method of testing the lead-screw nuts *M*, cam *N*, safety lever *O*, trunion lever *G* and the bevel gears *Q* and *R* is clearly indicated, the reference letters corresponding to those in Fig. 3. At *D* is shown a testing fixture in the form of an apron casting which is bored and reamed in the apron jig and is provided with supports at the back for holding it in the position shown. A short arbor representing the lead-screw is placed in the bearings *S* and *J* and holds the double bevel pinion *Q* (not in place in the engraving) in position.

It will be observed that the function of the safety lever is to prevent the double bevel pinion and the lead-screw nuts from accidentally becoming engaged at the same time, which

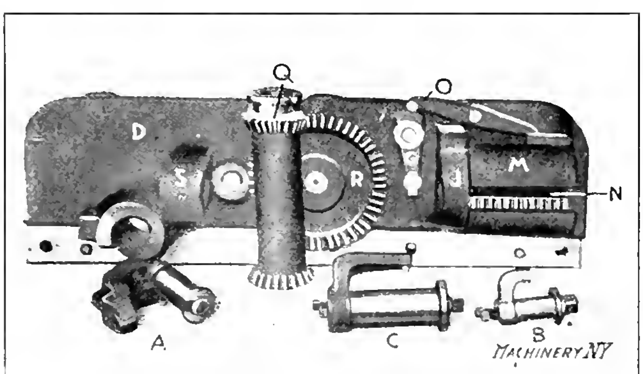


Fig. 7. Testing Fixture for Parts of Lathe Apron

would cause a breakage. Special milling fixtures are provided for milling the ends of the safety lever and the slot in cam *N* and lever *G*.

A babbitting jig is provided for the lead-screw nuts so that it is not necessary to babbitt them in place on a threaded arbor. The cam pin holes in the nuts are jig drilled. This has the advantage of making the nuts interchangeable besides avoiding the necessity for carrying hot babbitt any distance through the shop. If any of the members fail to function properly, the faulty member is, of course, replaced.

All the drilling, boring, and machine reaming on the aprons and covers is completed in the drilling department except the holes for the oil pipe (not shown) spring pin *I* and set-screws *J* and *K* (Fig. 3). Small holes such as these can be

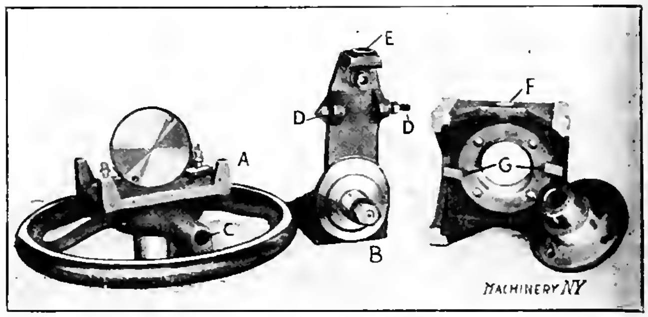


Fig. 8. Jigs for Drilling Parts of Device shown in Fig. 5

drilled cheaper with an air drill, due to the fact that the oil holes are comparatively short and are on an angle, while the spring pin hole *I* cannot be drilled until some of the assembling operations are completed.

When the aprons and covers are received in the assembling department, they are placed on special trestles for convenience in assembling. The castings are now painted, all of the chipping and cleaning having been done in the foundry. The next operation consists in drilling the oil holes and the holes for the set-screws *J* and *K*. Jigs for drilling the latter are shown at *A* and *B* in Fig. 7. Jig *C* drills the spring pin hole *L* in the apron cover which is machine drilled. The hole is at right angles to the top of the cover and the jig is easily set up as is evident by referring to Fig. 4 which shows jig *B* in position in the apron. It will be observed that these jigs permit the groove in the shafts to be cut standard size and the shafts made interchangeable.

After chipping the oil grooves and tapping the screw holes, the covers are bolted on for the purpose of hand reaming

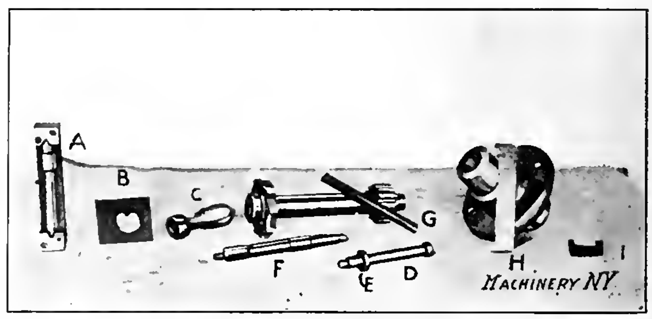


Fig. 9. Gages for Testing the Parts of the Device shown in Fig. 5

all shaft holes to standard size. The covers are then removed and the aprons laid face down for the purpose of fitting the lead-screw nuts *M* (Figs. 3 and 7). The nuts, babbitting jig and grinding ways in the apron being machined to gage, it is only necessary to smooth the surfaces on the nuts and apron to make the nuts slide freely.

When all of the members shown in Fig. 7 fitting the back of the apron have been fitted and tested at the bench, they are put in place in the aprons. In performing this operation the corresponding pieces are placed in each apron in succession. With the lead-screw nuts closed by means of the cam, a special tap, mounted on an arbor fitting the lead-screw bearings, is run through the nuts to clean out the threads.

The aprons are now turned face up for the purpose of fitting the oil pipes and drilling the holes for spring pin *I* (Fig. 3). There are three holes to be drilled in the apron for this pin to enter, one for the central position of lever *H* which operates the double bevel pinion, and one for each extreme position. A special center punch which fits the hole in lever *H* is used to lay out these. The central position is determined by the safety lever fitting into the notch in lever *G*; while the bevel pinion mounted on an arbor and alternately brought into mesh with the bevel gear, determines the extreme positions. After the holes are drilled by means

of a pneumatic drill, a reamer is substituted for the center punch in lever *H* and the holes reamed taper to fit the spring pin *I*. A collar on the reamer acts as a depth gage. It would, of course, be possible to drill these holes in the jig that drills and bores the aprons, but this is hardly deemed advisable as there are a number of elements that must be taken into consideration, an error in any one of which would prevent the bevel gears from meshing properly. Placing the spring pins *I* in position completes the work on the feed reversing mechanism.

The rack pinions *E* and gears are now put in place, then the friction gear shafts *D* and their members, except the hand-wheel *U* and collars *V* and *W*. After driving in the studs for the intermediate cross-feed gears (not shown because of the sectional view) the aprons are ready to receive the covers.

Work on the covers consists in placing the hand-wheel pinions and hand-wheel members in position and fitting the rack pinion spring pin members after which the covers are bolted onto the aprons. The rack pinion knob *X* is now put on and then the collars *V* and *W* are fastened onto the friction gears as shown in the line engraving Fig. 3. Screwing on the hand-wheel *U* and nut *Y* completes the apron and it is ready to be sent to the store room.

Assembling an Automatically-releasing Hand-wheel Mechanism

Unless jigs and gages are used in the machining process, the peculiar conditions encountered in assembling a mechanism such as shown in the line engraving Fig. 5 would call for a high degree of skill on the part of the assembler besides involving excessive cost. The half-tones Figs. 8 and 9 illustrate a set of jigs and gages for producing this mechanism, which enables the assembling to be done without any filing or fitting, the object being to illustrate that *interchangeable* manufacture is really *economical* manufacture.

It will be seen that the function of the device is to automatically engage and disengage the hand-wheel member *A* with its shaft *B*, the action being as follows: Turning the hand-wheel in either direction by means of the handle *C*, so that the latter does not rotate in the hand, engages the pawl *D* with the ratchet *E* which is keyed to the shaft *B*; on releasing the handle, spring *F* disengages the pawl.

The requirements are that the handle and pawl must work perfectly free so that no effort to grip the handle hard will be necessary; the axis of the handle and pawl must intersect so that each cam face will work equally well; when the pawl is fully engaged with the ratchet, the handle end of the pawl must still be on the cam face of the handle; the contour of the cam, length of the pawl, diameter of ratchet and center distance *G* must be within close limits. Referring to Fig. 8, *A* is a jig for drilling the hand-wheel cover and its screw holes in the hand-wheel. The jig is shown in position for drilling the latter, being located in the counterbore of the hand-wheel. Resting on top of the jig is the hand-wheel cover which fits into the recess shown and is held by the two straps and bolts. The hand-wheel and its cover are, of course, drilled separately.

At *B*, in the same figure, is shown a jig for drilling the handle stud hole and the pawl hole *C*. The hand-wheel is located on a stud through its bore, and clamped to the jig by passing a bolt through the stud, this bolt being provided with a split washer on the end. To bring the pawl hole central with its hub, two set-screws are provided at *D* which hold the hand-wheel in position while being drilled by clamping against the sides of the spoke. The jig is fastened on the edge of the drill press table, so that the table does not interfere with the wheel. The vertical hole, with the drill guided by bushing *E*, is now drilled and reamed in all the hand-wheels, this hole being the pawl hole. For drilling and reaming the small diameter, a long bushing is used in the large diameter of the hole to guide the tools. When this hole is drilled, the jig is then clamped to the side of the box table and the hole for the handle stud is drilled in all the wheels.

The jig shown at *F* in the same engraving is for drilling the shaft bearing which is seen to the right. The hub on the bearing fits into the jig, the straps *G* holding the work in place. Both this jig and the one at *A* are provided with complete sets of clearance and tap bushings so as to permit their being used on a multiple spindle drilling machine.

In Fig. 9 will be seen a set of gages for testing the component parts of the mechanism shown in Fig. 5. Gage *A* is for testing the length of the pawl which is shown in position in the gage. The ends of the pawl are milled with forming cutters. At *B* is shown a gage for testing the cam surface on the handle *C*. This cam is also milled with a forming cutter and when milled to the proper depth will just pass through the gage. The gage *D* is used to test the handle for length *I* (Fig. 5), the collar *J*, the depth of counterbore *K*. This gage represents a standard handle stud except that it is provided with a groove to fit the U-shaped collar *E* which is of the same diameter and thickness as the collar *J* in Fig. 5. To test the handle, the gage is inserted into the hole and the U-collars slipped into the groove; the collar *J* is tested for thickness by fitting the groove in the gage; to test the depth of the counterbore *K*, the gage is screwed into the hand-wheel and the collar *E* tried as before.

The tool shown at *F* is the counterbore used in connection with jig *B*, Fig. 8, for finishing the counterbore *K* and surface *L* in Fig. 5. At *G*, Fig. 9, is a length gage for the shoulders on the hand-wheel shaft against which the gage is seen resting. In the same engraving, *H* is a gage for testing the length through the bearing hole, while to the extreme right at *I* is shown a length gage for the hand-wheel shaft hole.

It will be observed that all of these gages, with one exception, that of the cam gage *B*, are length gages. Their use was found imperative for interchangeable work. This is due to the fact that errors in length are far more likely to occur and cause trouble in assembling than errors in diameter. All of the essential measurements of diameter on the component parts of the mechanism shown in Fig. 5, *i. e.*, the running and driving fits, are tested with ordinary limit and plug gages, while the threaded members are tested with male and female thread gages.

In assembling the mechanism, the pawl, its spring, and the handle members are first assembled. After fitting the Woodruff keys and the shaft members, the ratchet wheel is removed for the purpose of assembling the bearing and hand-wheel. The ratchet wheel is then replaced and the nut screwed down tightly with a socket wrench, the shaft being held from turning by engaging the pawl. Fastening on the cover and screwing in the oil cup finish the assembling operations. There is no adjusting or fitting to be done since the proper allowances for all fits are provided for on the detail drawings and the accuracy of the machine work is insured by a thorough system of inspection. Thus it will be seen that the work of assembling in this case merely consists in combining the separate elements in their logical order.

Summary of Principles of Assembling Operations

Summarizing the principles referred to in the previous discussion, we may state the following rules as being the main points to be considered in assembling work.

1. To secure economical results we must have accurate drawings, accurate machine work, and use jigs and gages.
2. The use of limits on detail drawings is valuable especially when supplemented with a thorough system of inspection.
3. Inspection, both in the machine and assembling departments, is absolutely necessary.
4. Before assembling any part of a machine, its function should be thoroughly understood in order to have the parts work properly and to avoid any unnecessary refinement.
5. Study carefully the question of rigidity in fits.
6. Plan quick and efficient methods of lining up.
7. Always follow the drawings. In no case should deviations be permitted.
8. Anticipate any extra chipping for clearance that may be necessary, and so avoid having to take the work apart.
9. Analyze the elements carefully, and see if it will not pay to substitute the machining process on pieces that are sometimes fitted by hand.
10. Standardization is one of the cardinal principles of economical assembling. Therefore, do not leave stock for adjustment when the pieces can be machined to standard size.

11. Provide for the duplication of parts in quantities so as to take advantage of the saving to be gained from performing the same operation on a number of pieces in succession.

12. Separate the assembling operations for any particular job so as to provide for a subdivision of labor.

13. Follow the unit system of assembling in order to permit a large number of workmen to be employed on a job.

14. The operations involved in assembling the units should be separated from the erecting process.

15. All chipping should be done before the parts are scraped.

16. Where it would be necessary to take the work apart to line up the brackets or bearings, perform the lining-up operation first.

17. Plan methods and processes so that the work can be assembled with the least amount of handling.

18. Provide ample handling facilities.

19. Make the laborious operations in scraping as easy as possible by providing efficient pulling devices.

20. Before sending the units to store or to the erectors see that the operations are completed as far as possible.

* * *

FORMULAS FOR CONE CLUTCHES*

There appears to be considerable misunderstanding, or perhaps rather, lack of understanding, of the formulas for cone clutches. A number of formulas are given in various handbooks and treatises on design, but at first sight they do not agree, and if the designer has not deduced any of the formulas for himself, he will naturally doubt the source from which he obtains them because of finding discrepancy between final results. However, the various authorities in general give correct formulas, and the difficulty met is caused by the fact that in cone clutch design different formulas are developed according to whether the clutch surfaces are considered to engage with or without some slip. In the following a set of formulas are deduced for both conditions, and a summary of these formulas is given in the accompanying Data Sheet Supplement:

Assume that:

H.P. = horse-power transmitted.

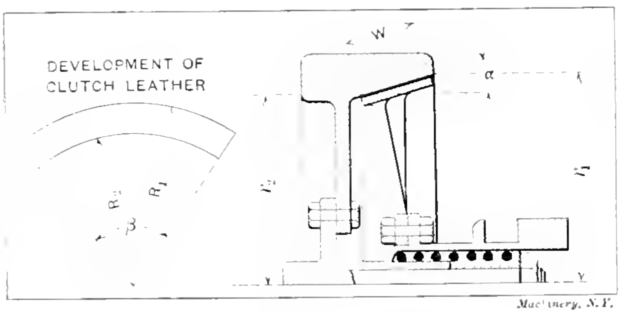


Fig. 1. Diagram of Cone Clutch

N = revolutions of crank-shaft per minute,

r = mean radius of friction cone, in inches,

r_1 = large radius of friction cone, in inches,

r_2 = small radius of friction cone, in inches,

R_1 = outside radius of leather band, in inches,

R_2 = inside radius of leather band, in inches,

v = velocity of a point at distance r from the center, in feet per minute,

F = tangential force acting at radius r, in pounds,

P_n = total normal pressure between cone surfaces, in pounds,

P_s = spring pressure, in pounds,

α = angle of clutch surface with axis of shaft = 7 to 13 degrees,

β = included angle of clutch leather, when developed,

μ = coefficient of friction = 0.20 to 0.25 for greasy leather on iron,

p = allowable pressure per square inch of leather band = 7 to 8 pounds,

W = width of clutch leather, in inches.

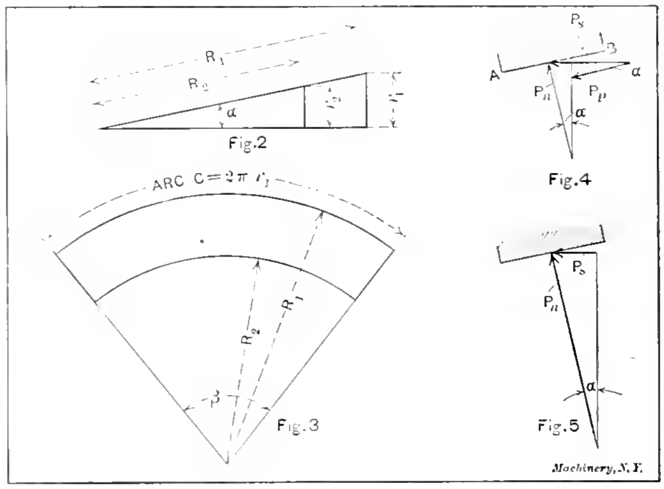
* With Data Sheet Supplement.

The relation between the outside and inside radii R_1 and R_2 of the clutch leather for covering the friction surface and the radii r_1 and r_2 of the friction cone are expressed by the following formulas, the deduction of which are clearly seen from Fig. 2.

$$R_1 = \frac{r_1}{\sin \alpha}$$

$$R_2 = \frac{r_2}{\sin \alpha}$$

The included angle β of the developed clutch leather (see Fig. 3) is found as follows: The length of the outside arc of the developed clutch leather surface equals the largest circumference of the cone clutch, or arc $C = 2 \pi r_1$. (See Figs.



Figs. 2 to 5. Diagrams for Deducing Formulas for Cone Clutches

1 and 3.) Angle β is to 360 degrees as arc C is to the whole circumference of the circle having R_1 for radius. Therefore,

$$\frac{\beta}{360} = \frac{2 \pi r_1}{2 \pi R_1} = \frac{r_1}{R_1}.$$

But it has already been shown that $R_1 = \frac{r_1}{\sin \alpha}$, or $r_1 = R_1 \times \sin \alpha$, and therefore

$$\frac{\beta}{360} = \frac{R_1 \times \sin \alpha}{R_1} = \sin \alpha, \text{ or } \beta = \sin \alpha \times 360.$$

It is obvious that the mean radius r of the friction cone equals the arithmetic mean of the largest and smallest cone radii, or

$$r = \frac{r_1 + r_2}{2}$$

The velocity v of a point on the friction cone at a distance r from the center is found by the well-known formula

$$v = 2 \pi r N$$

in which v and r are supposed to be measured in the same units. If v is in feet, and r in inches, the formula takes the form

$$v = \frac{2 \pi r N}{12}$$

The tangential force acting at radius r, in pounds, is found by the formula

$$F = \frac{\text{H.P.} \times 33{,}000}{v}$$

which is deduced directly from the familiar formula for horse-power when the torque is given in foot-pounds.

If the width of the clutch surface is W, the area of this surface is $W \times 2 \pi r$. The total pressure on the surface, P_n, must equal the pressure per square inch multiplied by the area, or

$$P_n = W \times 2 \pi r p.$$

From this we deduce the formula

$$W = \frac{P_n}{2 \pi r p}.$$

The horse-power transmitted equals

$$H.P. = \frac{P_n f \times 2 \pi r \times N}{12 \times 33{,}000}$$

in which r is given in inches. By inserting the value of π in this formula, and dividing numerator and denominator in the fraction by 2π, we get

$$H.P. = \frac{P_n f r N}{63{,}025}$$

In Fig. 4 let it be assumed that the clutch surfaces engage without slip. Assume further that the spring pressure is represented by line P_s, the pressure normal to the clutch surface AB by P_n, and the force tending to bring the clutch surfaces in closer engagement by P_p; this last force, of course, is parallel to AB. The force P_s is partly used for producing the normal pressure P_n and partly used for bringing the clutch surfaces in closer contact; consequently

$P_s = P_n \times \sin a + P_p \times \cos a.$

But $P_p = P_n \times f.$

Therefore

$P_s = P_n (\sin a + f \cos a)$

$$\text{and } P_n = \frac{P_s}{\sin a + f \cos a}$$

If we substitute this value of P_n in the horse-power formula just deduced, we have

$$H.P. = \frac{P_s f r N}{63{,}025 (\sin a + f \cos a)}$$

Transposing, we get

$$P_s = \frac{H.P. \times 63{,}025 (\sin a + f \cos a)}{f r N}$$

If we assume that there is some slip between the clutch surfaces, the force P_p in Fig. 4 becomes zero, and the whole of force P_s is used to produce normal pressure, as shown in Fig. 5. Then

$$P_n = \frac{P_s}{\sin a}$$

and, substituting in the horse-power formula, as before, we have

$$H.P. = \frac{P_s f r N}{63{,}025 \sin a}$$

and

$$P_s = \frac{H.P. \times 63{,}025 \sin a}{f r N}$$

The most important of these formulas have been collected in compact form and are given without their deductions in the Data Sheet Supplement. They will be found very convenient for ready reference when designing cone clutches or checking designs already made.

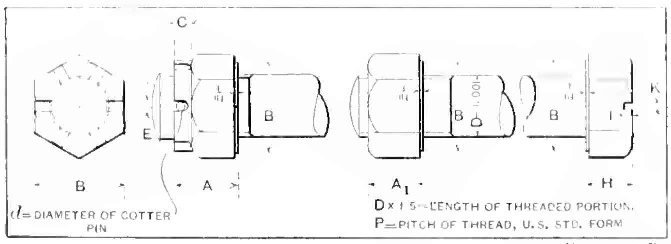
* * *

The export of automobiles from France, which declined in 1908, has shown a slight increase during the first months of 1909. During the first three months of the year 1907 France exported automobiles valued at approximately $10,300,000. During the first three months of 1908 the exports declined so that the total value of automobiles exported was only $8,700,000. During the first three months of the current year the exports again rose to $9,500,000. England is the best customer of France for automobiles, more than forty per cent of the exports being to Great Britain. The exports of automobiles to the United States are decreasing so that during the first three months of 1909 automobiles to a value of only slightly more than $500,000 were imported, as compared with over $800,000 in 1908, and nearly $800,000 in 1907. The Argentine Republic appears to offer a good field for the automobile trade, the French exports to that country during the first three months of the current year amounting to over $750,000. The imports of automobiles to France are almost negligible when compared with the exports. During the first three months in 1909 the total value of imported automobiles amounted to about $100,000, the United States supplying cars to a value of only $16,000. Germany and Italy supply the largest proportion of cars imported by France.

STANDARD AUTOMOBILE PARTS ADOPTED BY THE A. L. A. M.*

The Association of Licensed Automobile Manufacturers (A. L. A. M.) has, from time to time, standardized some parts which occur in automobile design, and which are likely to require frequent replacement or repairs. The most important of the standards adopted by the association undoubtedly are the standards for fine pitch threads, screws, castle and plain nuts, which were published in MACHINERY'S Data Sheet No. 63, accompanying the November, 1906, issue. In this issue an editorial was also published entitled "Automobile Fine Screw Threads" in which the new standard for screw threads was discussed. A table condensed from the Data Sheet mentioned, giving all the required dimensions, is published herewith.

STANDARD HEXAGON-HEAD SCREWS, CASTLE AND PLAIN NUTS



Machinery, N.Y.

D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1
P	28	24	24	20	20	18	18	16	16	14	14
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1
A_1	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	49/64	7/8
B	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1	1 1/8	1 1/4	1 7/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8

Since the adoption of the standard A. L. A. M. thread, the association has adopted a standard spark plug, the dimensions and special specifications of which are given in the accompanying supplement. Standard designs for adjustable and solid yoke and eye rod ends have also been adopted, dimensions for which are also given in the supplement, together with dimensions for the pins and washers used with these rods.

The horse-power of automobile engines has always been more or less indefinitely expressed, and until recently there has been no formula giving a satisfactory relation between the horse-power and the diameter of the engine cylinder and the piston speed. The association, therefore, some time ago adopted a standard horse-power formula, assuming a piston speed of 1,000 feet per minute. According to this formula, if

D = diameter of cylinder, and

N = number of cylinders,

$$\text{then } H.P. = \frac{D^2 \times N}{2.5}.$$

The table in the supplement giving horse-power of automobile engines has been calculated from this formula for engines having one, two, four and six cylinders, with the diameter of the cylinder varying from 2½ to 6 inches. It will be understood, of course, that this formula gives only approximate results, as the actual horse-power of any one automobile engine could not be expressed by so simple or general a formula. However, this formula is of great assistance in estimating in a general way the probable horse-power of an automobile engine.

* * *

A commission has been at work for the last two years in Sweden preparing a new schedule for import duties. The new tariff, which has not yet been adopted, proposes increases in the import duties imposed on machinery, the avowed purpose being to protect home industries.

* With Data Sheet Supplement.

TREATMENT OF GEARS FOR AUTOMOBILE MOTORS AND TRANSMISSIONS

HAROLD WHITING SLAUSON*

There is probably no part of an automobile that is subjected to more use or greater abuse than the transmission. Carrying as it does practically all of the power developed by the motor, and, receiving at the hands of a careless driver the strains imparted by a suddenly applied load or a too rapid shifting of the speeds, it is small wonder that the gears of the transmission must be made of the highest grade of materials, and that the care and workmanship bestowed upon each must be of the best. The ordinary automobile transmission consists of a series of different sizes of spur gears mounted on two parallel shafts with means for sliding the gears on one shaft into mesh with those on the other, as desired. In this manner various speed ratios are transmitted from the motor to the main driving shaft, although on the majority of automobiles the high speed drives the car direct, without the interposition of any of the gears of the transmission.

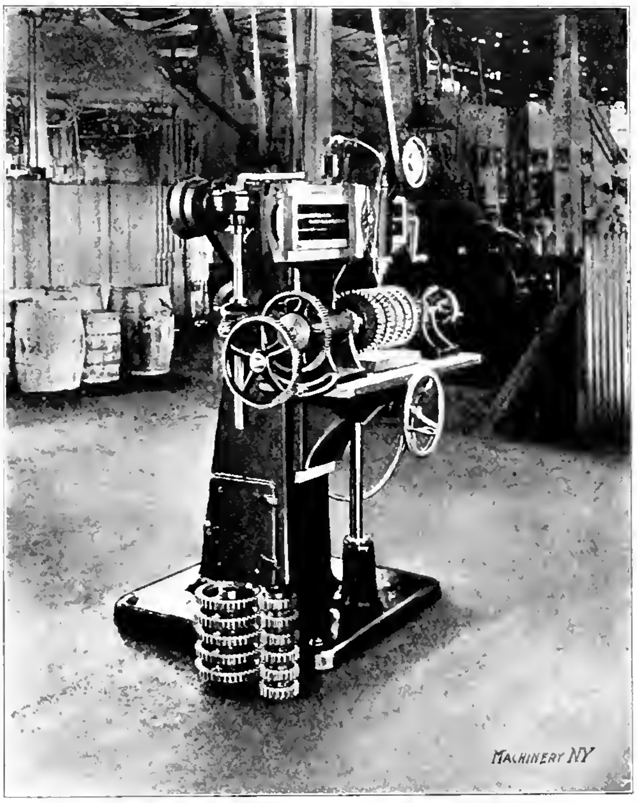


Fig. 1. Chamfering the Teeth of Spur Gears in the Winton Factory

As a saving in weight is an important factor to be considered in the design of a transmission, the gears must be made as small as possible and yet be sufficiently strong to carry suddenly-applied loads with no attendant danger of breaking. Owing to the methods by which the speeds are changed, and the clashing and "bruising" which take place when the gears are shifted, the transmission must also be made of a material which is hard as well as tough. Different kinds of steel have been used and each has been treated by various methods in an effort to discover the perfect gear material, but although this is yet to be found, the transmission of a modern, well-made automobile, when intelligently handled, will last nearly as long as the car itself. Of the various kinds of carbon steel which have been employed for transmission gears, nickel, chrome-nickel and silico-manganese seem to have more adherents among the leading builders than any other materials. In most factories the gears are case-hardened after being cut, and in this manner the combination of toughness with the desired hard surface is obtained. Gears which have been treated in this way have been taken out of cars after having been run many thousands of miles, and in some instances, the original tool marks on the faces of the teeth were still visible.

Methods employed for cutting gears in automobile factories do not differ in any essential features from those used in any well-equipped machine shop or manufacturing concern. Most of the automobile makers purchase their transmission gear blanks outside and cut and finish them in the factory. Many of these blanks of special steel are imported from France, but a few of the leading factories have laboratories of their own in which experiments on high-quality materials for transmission purposes are continually in progress. Six or seven spur gear blanks of the same size are generally placed on the mandrel of the cutter at once. A continuous cut extending throughout the width of all of these blanks is then taken for each tooth, and in this manner six or seven gears are finished at once and are made absolutely uniform.

After the teeth have been cut, the gears are taken to the heat treating room to be case-hardened. In the Middle West, and a few other sections, many of the case-hardening ovens are heated by natural gas obtained from near-by wells. In the Maxwell factory, at Newcastle, Ind., a special machine has been installed for the manufacture of gas from "distillate"—a hydro-carbon obtained from the oil refineries. This machine is set up in the power house connected with the factory, and the gas is stored in a tank located in the same building. It is conducted from here to the heat-treating ovens in which it is used for case-hardening, tempering and annealing. Still another method for obtaining heat for the ovens is in use at the Ford factory, in Detroit. Petroleum, or crude oil, is vaporized and forced by air pressure into a series of special burners located under the ovens. By regulating the amount of air or vapor or both, the ovens can be kept at a uniform temperature, or the amount of heat generated may be varied at will between almost any limits. The temperatures of the ovens are indicated by an electric pyrometer connected with each, and pieces to be case-hardened are kept at a heat of 1,600 degrees F. for a length of time which depends on the depth below the surface to which it is desired to carry the treatment.

In several factories the final operation bestowed upon the gear, before assembly in the transmission or the motor, is the sand blast which serves to scour off any roughness or stains which may have been left on the surface during the cutting or the heat treatment. In the National factory, at Indianapolis, this operation is conducted in a small building separated from the remainder of the shop. The sand is kept in a bin in one corner and is sucked up by a centrifugal blower and forced by the air pressure through a pipe which terminates in a nozzle. The sand, being forced out at high velocity by the air pressure, may be directed at all parts of the pieces to be cleaned. This is one of the most efficient methods of polishing and finishing a gear and does not injure the hard metal surface in any way.

Fig. 2. Gear Case-hardening Room in the Premier Factory

As silence of operation of all moving parts is one of the principal requisites for a motor car of to-day, it is necessary that the teeth of all gears shall be made to mesh perfectly and smoothly with all of those on the other gears with which they come in contact. In order to obtain silence of operation, the gears are run with each other for some time and each tooth is worn to a more perfect fit. The first few weeks of

* Address: Box 27, Times Square Station, New York.

operation by the customer would wear the gears in properly, but, in order to produce a perfect car, this is done before it leaves the factory. Most of this "running in" of the gears can be accomplished by the thorough road test to which the whole car is subjected before leaving the shop, but many of the leading factories supplement this with additional methods for bestowing the required wear on the transmission. A special frame is used in the Marmon factory, in Indianapolis (see Fig. 3), in which the transmission, driving shaft, differential, and rear axle and wheels are set up. An

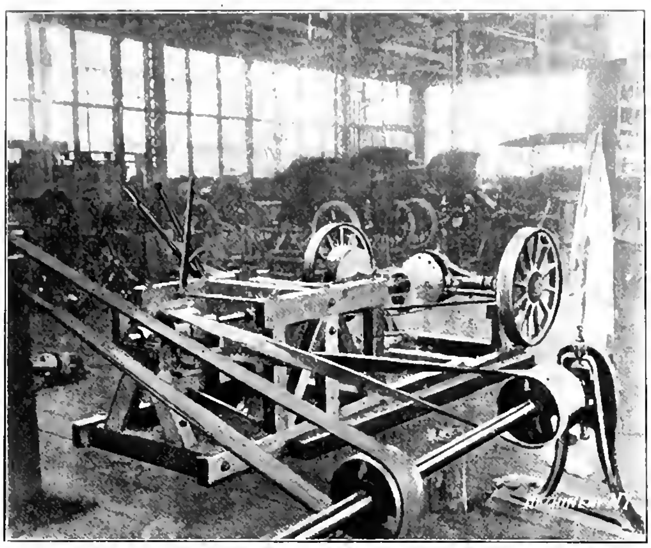


Fig. 3. Running in the Transmission and Differential Gears in the Marmon Factory

idler and a driving pulley, with a belt shifter, are attached to the front end of the transmission shaft and connected by belt to a countershaft driven from the main line shafting. When the power is applied and the different speeds of the transmission are thrown into mesh by the shifting lever, every gear of the whole car, with the exception of those used on the motor, will be set in motion. The gears of the engine are worn in when it is operated under belt power before installation in the chassis. Somewhat the same method is pursued in the Packard factory, in Detroit, the only difference between the two being that here, instead of allowing the wheels to run free, a brake is attached to the end of the driving shaft by means of which a variable load may be applied to the gears in mesh. A section of the testing room is devoted to this purpose, and as the transmission and rear axle are assembled, they are brought in, placed on special

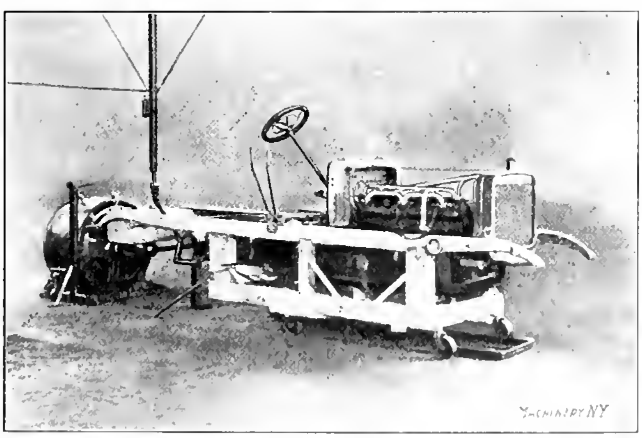


Fig. 4. Preliminary Run of Engine and Transmission to wear in the Parts

frames provided for the purpose and connected by belts to overhead shaftings. As the gears of the transmission and differential are run in, the loads are increased until all are worn perfectly smooth.

Before their final installation in the motor and transmission, all of the spur gears for the Winton cars, made in Cleveland, are set up in a special case and run in under belt power. The bearings in these special cases are set at the proper distances apart to accommodate the various gears of a train, thus wearing in the gears so that all of those for similar parts are absolutely interchangeable. The case is made oil-tight and a mixture of finely powdered emery and lubricating oil is fed through an opening in the top so that this grinding material will come in contact with all the teeth of the gears in mesh in the train. This grinding is continued until each tooth has been worn perfectly smooth and to an accurate fit with the teeth of the other gears with which it comes in mesh. For the gears used in the front of the motor to drive the cam, pump and magneto shafts—gears which always occupy the same relative position in regard to each other—a tooth of each is marked when in the grinding case with the corresponding teeth of the others with which it meshes. This is done so that each gear of the train may be set up in the motor in the same corresponding position as that occupied while being worn to a perfect fit with the others in the case. It is evident that every tooth cannot be of *exactly* the same size and shape, and if each tooth is allowed to mesh with those with which it came in contact while being ground, more perfect rolling contact will take place and less friction and noise will be set up. The marks made on the gears are also useful for timing the magneto and valve cam shafts when the occasion arises necessitating the removal of any of these parts from the motor. Of course, it is impossible to carry this practice to the transmission, for most of the gears on one shaft revolve independently of those on the other, and it is very seldom that the same teeth of two gears will come into mesh on succeeding occasions. This practice, however, may be applied to the bevel gears of the driving shaft and rear axle and the pinions of the differential. As a further means of wearing the gears of the transmission to a perfect fit, the motor, transmission and driving shaft are installed in the chassis as

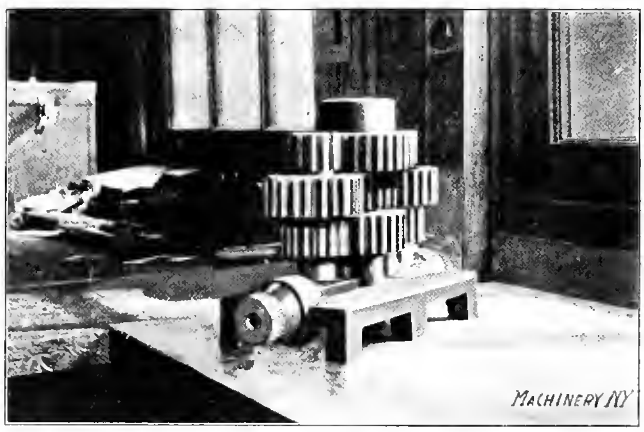


Fig. 5. Device for Testing the Accuracy of Gears

shown in Fig. 4, and the motor is run while the various speeds of the transmission are thrown into mesh in order to wear in every gear thoroughly. During this run an electric dynamometer, by means of which a variable load may be applied, is connected to the end of the driving shaft.

An ingenious device for testing the accuracy of gears is used in the factory of the Grabowsky Power Wagon Co., of Detroit. This consists of a standard having three pins or bearings set in it on which the gears of the transmission are placed as shown in Fig. 5, thus forming a replica of the planetary transmission as used in the car. The middle upright bearing is stationary while each of the other two is movable in a horizontal direction and is connected to a micrometer at either end of the base of the instrument. A master gear is set on one of these bearings, while the pinions to be tested are placed on the other two. When the two movable bearings have been so adjusted that all of the gears mesh perfectly, the readings of the two micrometers may be observed and the amount, in thousandths of an inch, by which the gears are "off" may thus be determined accurately. Certain limits of variation are necessarily allowed, but if any gear is below one or above the other, it is thrown out. Inasmuch as the distance between the centers of the gears must be constant in the transmission case, this instrument is useful in determining just what gears are acceptable without the necessity of installing them in the case.

Many of the gears used in the forward end of the motor for driving the cam, pump and magneto shafts are made of

manganese-bronze. The Premier car, however, made in Indianapolis, employs a laminated gear for the magneto shaft, built up of alternate layers of bronze and fiber. These layers are pinned firmly together and the gear is then cut by the usual methods. This makes an exceedingly quiet-running gear, as the layers of fiber or rawhide cushion the impact of the teeth as they meet, and the whirring or grinding sound familiar in many all-metal gears is practically eliminated. It has been found by means of a series of exhaustive tests conducted in this factory that the silent running of this gear is brought about by a slight rounding or "bulging" of the face of the rawhide sections caused by the absorption of the lubricating oil in the pores of the fiber and the pressure against its sides. This, as mentioned above, effectually cushions the impact of the teeth, but if this bulge becomes too great, the teeth will not mesh properly, there will be a tendency to "jam" and more friction will be set up than would be the case were an all-metal gear used. Of course the wider these fiber sections are, the greater will be the bulge to each, and it has been found as a result of these experiments that laminated gears composed of layers of rawhide about 1/8 of an inch thick, alternating with bronze disks of the same dimensions, give the best service for this purpose. When sections of this thickness are used, a sufficient bulge is formed to cushion the impact satisfactorily, and yet this is not great enough to change the shape of the teeth materially. These experiments are still in progress at the factory in question in order the more accurately to determine other facts and figures concerning the best form of laminated gears, and this is only one of the many instances which give evidence to the fact that the American motor car manufacturer is now fully awake to the importance of paying attention to the most minute detail of design.

* * *

SIMPLIFIED METHODS FOR FLY-WHEEL CALCULATIONS*

R. J. WILLIAMS†‡

In several previous issues of MACHINERY methods and formulas have been given relating to the design of fly-wheels and the size of motor required for giving out a certain amount of energy per stroke of the machine under consideration. In this article a method of calculation will be given whereby the work of finding the desired results may be considerably shortened.

In shears of large size cutting short pieces, where the maximum effort may be required almost continuously it is of great importance that motor and fly-wheel be of sufficient capacity to perform their work properly. Since the amount of energy to be given out by the fly-wheel depends upon the size of the motor, this should always be determined first.

Let

E = total energy required per stroke,
E_1 = energy given up by motor during cut,
E_2 = energy given up by fly-wheel,
T = time in seconds per stroke,
T_1 = time in seconds in which E_1 is given up,
T_2 = time in seconds in which E_2 is restored to fly-wheel,
V_1 = initial velocity of fly-wheel in feet per second,
V_2 = velocity after cut in feet per second,
R_1 = initial revolutions per minute of fly-wheel,
R_2 = revolutions per minute after cut,
R = revolutions per minute after n cuts,
W = weight of fly-wheel rim in pounds,
D = mean diameter of fly-wheel rim in feet,
H_1 = horse-power required to cut every stroke,
H_2 = horse-power actually used,
a = width of fly-wheel rim,
b = depth of fly-wheel rim,
g = 32.16,
n = number of cuts shear will make for a total given reduction in speed.

In the July, 1907, issue of MACHINERY this formula for horse-power was given:

$$\text{H. P.} = H_1 = \frac{EN}{33{,}000}.$$

and since $N = \dfrac{60}{T}$ we have

$$H_1 = \frac{E}{550T} \tag{1}$$

$$H_1 = \frac{E_1}{550T_1}$$

$$E_1 = 550\,T_1\,H_1 = \frac{550\,E\,T_1}{550\,T} = \frac{E\,T_1}{T}$$

$$E_2 = E - \frac{E\,T_1}{T} = E\left(1 - \frac{T_1}{T}\right) \tag{2}$$

Having now the energy that must be given out by the fly-wheel, we can proceed as follows:

We know that $E_2 = \dfrac{W}{2g}(V_1^2 - V_2^2)$ and that

$$V_1^2 = \left(\frac{D \times \pi \times R_1}{60}\right)^2 = 0.00274\,D^2\,R_1^2$$

$$V_2^2 = \left(\frac{D \times \pi \times R_2}{60}\right)^2 = 0.00274\,D^2\,R_2^2$$

$$V_1^2 - V_2^2 = 0.00274\,D^2\,(R_1^2 - R_2^2)$$

$$E_2 = \frac{W}{64.32} \times 0.00274\,D^2\,(R_1^2 - R_2^2)$$

$$E_2 = 0.0000426\,W\,D^2\,(R_1^2 - R_2^2) \tag{3}$$

$$W = \frac{E_2}{0.0000426\,D^2\,(R_1^2 - R_2^2)} \tag{4}$$

Making $0.0000426\,(R_1^2 - R_2^2) = CR_1^2$ we have

$$E_2 = CWD^2R_1^2 \tag{5}$$

$$W = \frac{E_2}{CD^2R_1^2} \tag{6}$$

In cast-iron fly-wheels it is usual not to exceed a speed which represents a fiber stress of more than 1,000 pounds per square inch of rim cross-section. The stress in pounds due to centrifugal force equals $0.0972\,V_1^2$ for cast iron, and for fly-wheels having a maximum stress of 1,000 pounds per square inch we can develop the following formulas:

$0.0972\,V_1^2 = 1{,}000$; $V_1 = 101.5$.

But $V_1 = \dfrac{D\pi R_1}{60}$, therefore we have

$$101.5 = \frac{D\pi R_1}{60}$$

$$R_1 = \frac{101.5 \times 60}{D\pi} = \frac{1940}{D} \tag{7}$$

$$D = \frac{1940}{R_1} \tag{8}$$

Squaring (7) we have $R_1^2 = \dfrac{1940^2}{D^2}$

Substituting this in (6) we have

$$W = \frac{E_2}{C\,D^2\,\dfrac{1940^2}{D^2}} = \frac{E_2}{1940^2\,C}$$

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Safe Form of Fly-wheel, July, 1899; Fly-wheel Designing, October, 1899; Safe Speed for Fly-wheels, November, 1902, engineering edition; Fly-wheel Explosions and their Cause, January, 1903, engineering edition; Fly-wheels, June, 1903, engineering edition; Gyroscopic Effect of Fly-wheels on Board Ship, May, 1904, engineering edition; The Bursting of Four-foot Fly-wheels, January, 1905, engineering edition; Sixty-ton Fly-wheel, July 1906, engineering edition; Size, Weight, and Capacity of Fly-wheels for Punches, July, 1907, engineering edition; Formulas for Gas Engine Fly Wheels, August, 1907, engineering edition; Fly-wheels for Planers, November, 1907; On Determining size of Fly-wheels for Motor-driven Planers, December, 1907. See also MACHINERY'S Reference Series No. 40, Fly-wheels.

† Address: Wheeling Mold and Foundry Co., Wheeling, W. Va.

‡ Roy J. Williams was born in Syracuse, Ohio, 1884. He received a high school education and became a mechanical draftsman through home study. He has worked as draftsman with the Labelle Iron Works, Steubenville, Ohio; Mutual Electric & Machine Co., Wheeling, W. Va., and the Wheeling Mold & Foundry Co., Wheeling, W. Va. His specialty is rolling mill design.

Making $1940^2 C = C_1$, and $\frac{1}{C_1} = C_2$ we have

$$W = \frac{E_2}{C_1} = C_2 E_2 \qquad (9)$$

The following are the values of C, C_1, and C_2 for different reductions in speed:

Per Cent Reduction	C	C_1	C_2
$2\frac{1}{2}$	0.00000213	8.00	0.1250
5	0.00000426	16.00	0.0625
$7\frac{1}{2}$	0.00000617	23.20	0.0432
10	0.00000810	30.45	0.0328
$12\frac{1}{2}$	0.00001000	37.60	0.0266
15	0.00001180	41.50	0.0225
20	0.00001535	57.70	0.0173

Size of Rim

Let us assume that the depth of rim equals 1.22 times the width. We have then these formulas for size of rim:

$$a = \sqrt{\frac{W}{12D}} \qquad (10)$$

$$b = 1.22\,a \qquad (11)$$

These two formulas can be changed to suit any required ratio of depth to width of rim.

Let y = required ratio.

$$a = \sqrt{\frac{1.22W}{12Dy}} \qquad (12)$$

$$b = ya \qquad (13)$$

Effect of Changing Size of Motor

Let us now suppose that we do not wish to use a motor large enough to cut continuously, and desire to find how many cuts the machine would make continuously without drifting down more than a certain percentage of the original speed. Transposing (3) we have

$$R_1^2 - R_2^2 = \frac{E_2}{0.0000426\,WD^2}$$

$$\text{Let } \frac{E_2}{0.0000426\,WD^2} = K,$$

$K = R_1^2 - R_2^2$, and

$R_2 = \sqrt{R_1^2 - K}$

$$R_3 = \sqrt{R_1^2 - n\,K + (n-1)\,K\frac{H_2}{H_1}} \qquad (14)$$

After several reductions we have

$$n = \frac{\dfrac{H_1\,(R_1^2 - R_3^2)}{K} - H_2}{H_1 - H_2}$$

and since $K = R_1^2 - R_2^2$ we have

$$n = \frac{\dfrac{H_1\,(R_1^2 - R_3^2)}{R_1^2 - R_2^2} - H_2}{H_1 - H_2} \qquad (15)$$

The time now required to bring the fly-wheel up to full speed again after n cuts will be

$$T_2 = \frac{E_2}{550\,H_2} \qquad (16)$$

Examples

We will now work out some examples illustrating the use of these formulas.

Example 1.—A hot slab shear is required to cut a slab 4×15 inches which, at a shearing stress of 6,000 pounds per square inch, gives a pressure between the knives of 360,000 pounds. The total energy required for the cut will then be

$360{,}000 \times \frac{4}{12} = 120{,}000$ foot-pounds. The shear is to make 20 strokes per minute, and with a six-inch stroke the actual cutting time is 0.75 second and the balance of the stroke is 2.25 seconds.

The fly-wheel is to have a mean diameter of 6 feet 6 inches and is to run at a speed of 200 R. P. M.; the reduction in speed to be 10 per cent per stroke when cutting.

$$H_1 = \frac{120{,}000}{3 \times 550} = 72.7 \text{ horse-power.}$$

$$E_2 = 120{,}000 \times \left(1 - \frac{0.75}{3}\right) = 90{,}000 \text{ foot-pounds.}$$

$$W = \frac{90{,}000}{0.0000081 \times 6.5^2 \times 200} = 6570 \text{ pounds.}$$

Assuming a ratio of 1.22 between depth and width of rim.

$$a = \sqrt{\frac{6{,}570}{12 \times 6.5}} = 9.18 \text{ inches,}$$

$b = 1.22 \times 9.18 = 11.2$ inches.

or size of rim, say, $9 \times 11\frac{1}{2}$ inches.

Example 2.—Suppose we wish to make the fly-wheel in Example 1 with a stress of 1,000 pounds, due to centrifugal force per square inch of rim section.

C_2 for 10 per cent = 0.0328,

$W = 0.0328 \times 90{,}000 = 2{,}950$ pounds,

$R_1 = \frac{1{,}940}{D}$. If $D = 6$ feet, $R_1 = \frac{1{,}940}{6} = 323$ R. P. M.

$$a = \sqrt{\frac{2{,}950}{12 \times 6}} = 6.4 \text{ inches,}$$

$b = 1.22 \times 6.4 = 7.8$ inches,

or size of rim, say, $6\frac{1}{4} \times 8$ inches.

Example 3.—Let us now suppose that in Example 1 we wish to use a 50 H. P. motor, and wish to find how many cuts the shear will make continuously without drifting down more than 20 per cent in speed? And what time must be allowed for the motor to restore the fly-wheel to its original speed?

$R_1^2 - R_3^2 = 200^2 - 160^2 = 14400$

$R_1^2 - R_2^2 = 200^2 - 180^2 = 7600$

$$n = \frac{\dfrac{72.7 \times 14400}{7600} - 50}{72.7 - 50} = 3.86 \text{ cuts}$$

Allowing the shear to make 4 cuts we have

$$R_3 = \sqrt{200^2 - 4 \times 7600 + 3 \times 7600 \times \frac{50}{72.7}} = 159 \text{ R. P. M}$$

$E_2 = 0.0000426 \times 6570 \times 6.5^2 \times (200^2 - 159^2) = 175{,}000$ foot-pounds, about.

$$T_2 = \frac{175000}{550 \times 50} = 6.4 \text{ seconds.}$$

Example 4.—Let us now suppose that in Example 2 we wish to use a 50 H. P. motor under the same conditions as in Example 3.

$R_1^2 - R_3^2 = 323^2 - 258^2 = 37750$

$R_1^2 - R_2^2 = 323^2 - 291^2 = 19650$

$$n = \frac{\dfrac{72.7 \times 37750}{19650} - 50}{72.7 - 50} = 4 \text{ cuts, nearly.}$$

$E_2 = 0.0000426 \times 2950 \times 6^2 \times (323^2 - 258^2) = 170{,}000$ foot-pounds, about.

$$T_2 = \frac{170{,}000}{550 \times 50} = 6.2 \text{ seconds.}$$

These examples show the possibilities of the formulas as time-savers for the designer, by reducing the calculations to the smallest possible number, and at the same time reducing the possibility of error.

* * *

Vice-Consul-General Richard Westacott reports that on July 1 there were 3,391 public motor cabs in use in London, this being an increase of 1,886 over the number one year ago. In other words, the number of motor taxicabs has more than doubled in a year, while the number of licensed horse-drawn hansom cabs decreased 1,290 in one year, and the number of four-wheeled horse-drawn cabs decreased by 389. The total number of all kinds of public cabs in London is nearly 11,000.

GLENN H. CURTISS

THE MAN, THE AEROPLANE AND THE MOTOR

Glenn H. Curtiss

Glenn Hammond Curtiss was born May 21, 1878, at Hammondsport, N. Y. Here he received his early education and planned for the future, although he hardly could have dreamed of what he has actually been able to accomplish, namely to go faster on the ground than any other person, and to fly through the air and win in competition over the best aviators of the world.

Mr. Curtiss attended school in Rochester, N. Y., and started in the bicycle business in Hammondsport in 1900. It was at this time that he built one of the first motor cycles ever constructed in this country, and he says that he never since has had such pleasure from any of his successes as came to him when, for the first time, the motor made a few explosions and ran for half a block.

On January 23, 1907, at Ormond Beach, Fla., Mr. Curtiss made a record for the distance of one mile in the extraordinary time of 26 2/5 seconds with a 40-horse-power air-cooled motor cycle which he had built entirely in his own factory. This is the fastest speed ever made with any form of vehicle, and means a speed of about one hundred and thirty-seven miles an hour.

Mr. Curtiss' first interest in aeronautics came from Captain Thomas S. Baldwin who, in seeking a good motor to drive his airships, found the Curtiss the best and most reliable for the purpose. Mr. Curtiss built the first water-cooled motor to be used in the dirigible balloon which Captain Baldwin built for the United States Signal Corps and which made 19.61 miles an hour in its official speed test and flew in its official endurance trial for two hours. Mr. Curtiss operated the engine while Captain Baldwin steered the airship during its flights which were held at Fort Myer, Va., near Washington. These flights, and one made a short time previously, were the first opportunities that Mr. Curtiss had to navigate the air.

In the latter part of 1907 the Aerial Experiment association was formed by Dr. Alexander Graham Bell, the inventor of the telephone, who is greatly interested in the subject of aeronautics, and Mr. Curtiss was appointed the director of experiments. The other members of the association were Mr. F. W. Baldwin, M.E., Toronto University, chief engineer, who made the first public flight in America in a heavier-than-air flying machine, March 12, 1908, in the first machine built by this association, Selfridge's *Red Wing*, which flew over the ice on Lake Keuka, near Hammondsport, N. Y. The treasurer of this association was Mr. J. A. Douglas McCurdy, M. E., Toronto University, who was also assistant engineer and secretary since the death of Lieut. Selfridge. Mr. McCurdy made over three hundred successful flights, averaging nearly nine miles each and covering in the neighborhood of three thousand miles. These flights were made over the ice in Baddeck Bay, Nova Scotia, in his machine the *Silver Dart*, built by the association. The other member of this association was Lieut. Thomas E. Selfridge, military expert in aeronautics detailed by the United States government to observe the experiments of the association, in the interest of the United States Army and acting as secretary of the association. Lieut. Selfridge was killed September 17, 1908, in the accident to Orville Wright's flying machine at Fort Myer, Va., near Washington, D. C. This is the first and only serious accident recorded in the recent* work of aviation, and of many thousands of flights in public in heavier-than-air machines there are only six recorded fatal accidents.

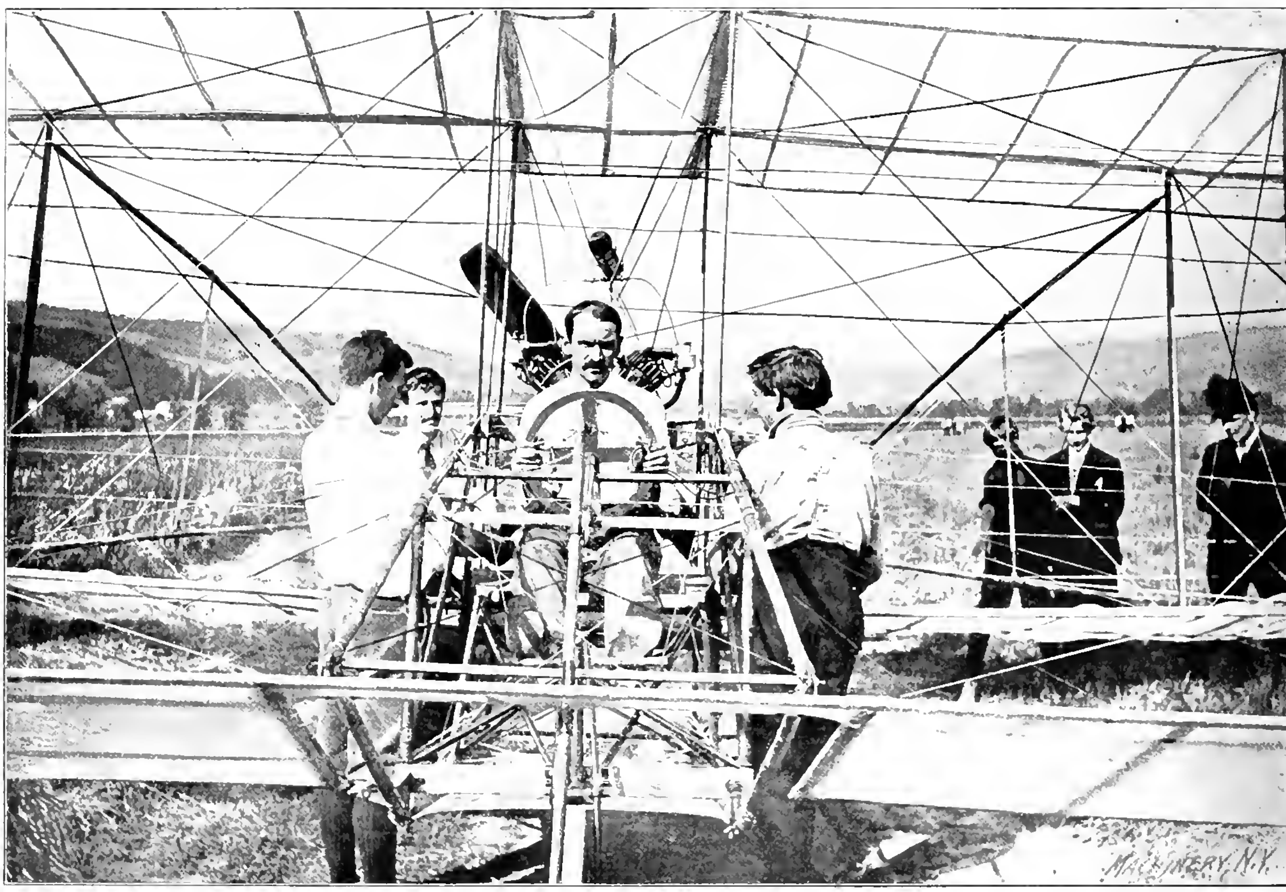


Fig. 1. Glenn H. Curtiss in the "June Bug," Ready for Flight

The third machine built by the association was the *June Bug* and on July 4, 1908, with it Mr. Curtiss contested for and won the *Scientific American* trophy, offered to the first machine heavier than air to fly one kilometer in a straight line. In this contest he made a record of 1¼ mile in 1 minute 42 2/5 seconds.

Three more machines were built, including the machine which one year later made a second record for the *Scientific American* trophy, July 17, 1909, flying 24.7 miles in 52 minutes

See article, "Aeroplane-Type Flying Machines," December, 1908

* Since this article was written S. Lefebvre was killed at Juvisy-sur-Orge, France, September 7.

30 seconds, and the machine in which, representing the Aero Club of America, Curtiss won the Gordon Bennett International Aviation Cup at Rheims, August 28, 1909, flying 20 kilometers (12.42 miles) in 15 minutes 50 3/5 seconds, a speed of 47 miles an hour, bringing this famous cup and contest to America where the race for it will be held next year. Mr. Curtiss also won, during the "Aviation Week at Rheims," the Prix de la Vitesse by flying over a course of 30 kilometers in length, in 23 minutes 29 seconds, surpassing the best records of the foremost aviators in the world.

A description of the machine with which Mr. Curtiss accomplished these wonderful results will be interesting:

The Herring-Curtiss No. 1, as it is now called, is a biplane with front control, rear control, side control or wing tips, starting and landing wheels, and motor. The main surfaces are 28 feet 9 inches by 4 feet 6 inches, one superimposed upon the other and separated by vertical struts, 4 feet 6 inches being the distance between the two planes. These planes are

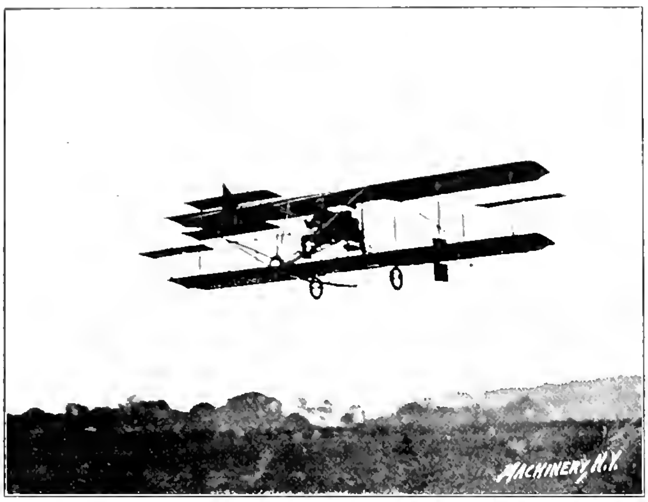


Fig. 2. The "Gold Bug" in Flight

covered with Baldwin rubber-silk material and the total area is about 258 square feet. There are twenty-two ribs used in the surfaces made of spruce and ash laminated and formed to a curve; they are spaced 15 inches apart and the covering material is laid over them and fastened by a strip of featherbone, laid on the upper side of the material and tacked to the ribs. The angle of these surfaces to the direction of motion is between 4 and 5 degrees when flying. The front control consists of two surfaces each 6 feet wide and 2 feet deep and 2 feet apart and placed about 12 feet in front of the main planes. This whole structure, like a box-kite, is pivoted ten inches back from its front edge upon the frame-work which extends in front of the machine; a rod is connected to the upper part of this control and extends to the steering wheel which can be moved forward or back, thus turning the

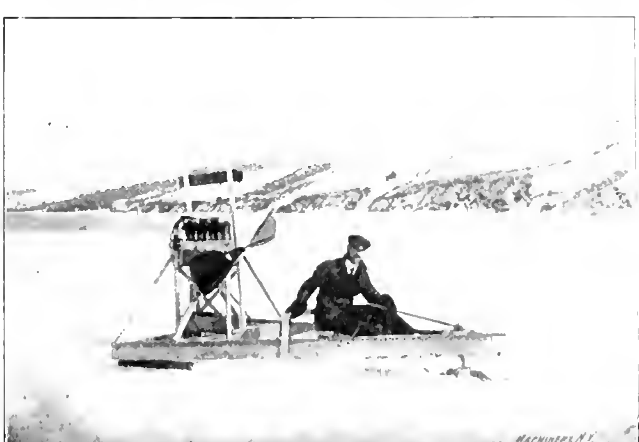


Fig. 3 Glenn H Curtiss on a Motor-driven Ice Boat, on Lake Keuka, near Hammondsport, N. Y

front control or rudder on its axis making the surfaces point up or down. This tends to raise or lower the front of the machine as, according to its positive or negative inclination, the wind blows against the upper or under side of this front rudder. The rear control consists of a horizontal surface or tail 2 feet 3 inches by 6 feet at the extremity of the framework, about 12 feet in the rear of the main planes, about the same distance to the rear that the front control is ahead of the

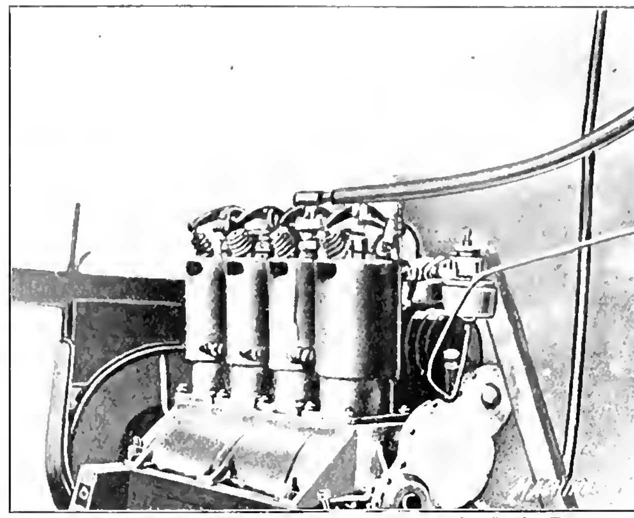


Fig. 4 A Four-cylinder Aeroplane Motor under Brake Test

machine. There is also a vertical rudder 2 feet by 3 feet 4 inches, pivoted 8 inches back from its front edge which is connected by wires to the steering wheel which turns and steers the aeroplane in the horizontal plane in the same manner that a rudder steers a boat in the water.

The side control or wing tips which govern the balancing are perhaps the simplest form of apparatus for accomplish-

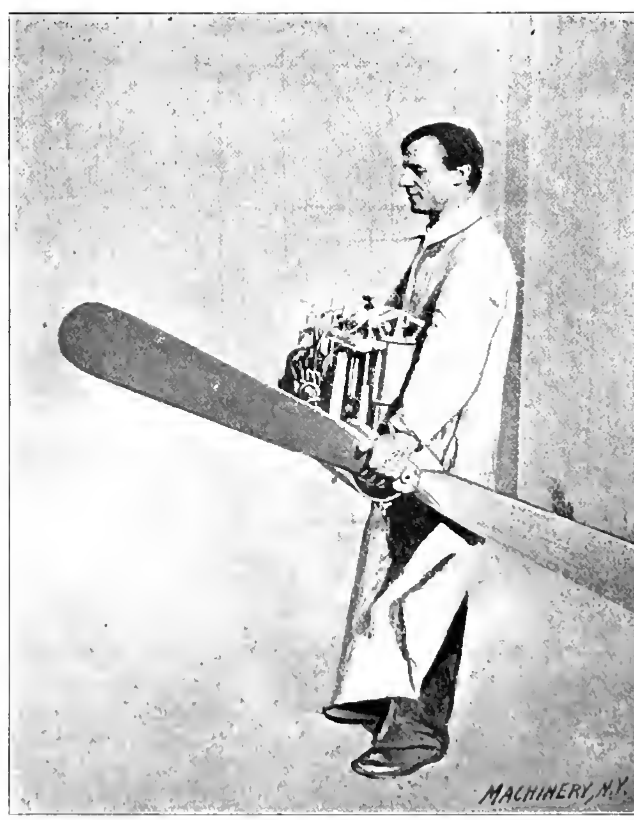


Fig. 5. G. von Rattweiler, Designer of the first Three Curtiss Motors, holding a Four-cylinder Motor and Propeller in his Hands

ing this most essential feature and one that has baffled inventors of flying machines more than any other one point. These small surfaces are placed between the main planes at their outer extremity and are 6 feet wide and 2 feet deep. They are hinged at their front edge and both are connected to a pivoted lever in the center of the machine which has a yoke or fork extending on each side of the operator's shoulders in such a manner that when he leans to one side or the other this movement will cause the side planes to act in unison, one, however, pointing down as the other points up. If the machine tips so that the right-hand side is lower than the other, the operator naturally leans to the left or highest side. This movement causes his shoulder to press against

the lever, thereby moving it to the left, and by means of the wires which extend to the planes the right-hand plane is turned to a lifting angle and the left-hand plane to the contrary or a depressing angle in such a manner that the wind will blow against the under side of the right-hand plane and against the upper side of the left-hand plane, thus forming a "couple" tending to right the machine.

The materials of which the machine is constructed consist of Oregon spruce, which is used in the main frame-work, and bamboo which is used in the frame-work supporting the forward and rear controls; steel wire is used for the main bracing and a fine strand wire cable for other bracing and to operate the rudders and controlling planes. The structure for mounting the three 20-inch pneumatic tire wire wheels upon which the machine runs when starting and alighting is made of steel tubing and wood. These wheels are provided with extra wide hubs in order to enable them to withstand any severe lateral strain in landing, and a long skid or reach bar of wood extends from the center of the axle of the two rear wheels, which are directly under the lower main supporting plane, to the single front wheel from which wooden braces extend directly to the engine bed and the upper plane to take up the shock of landing.

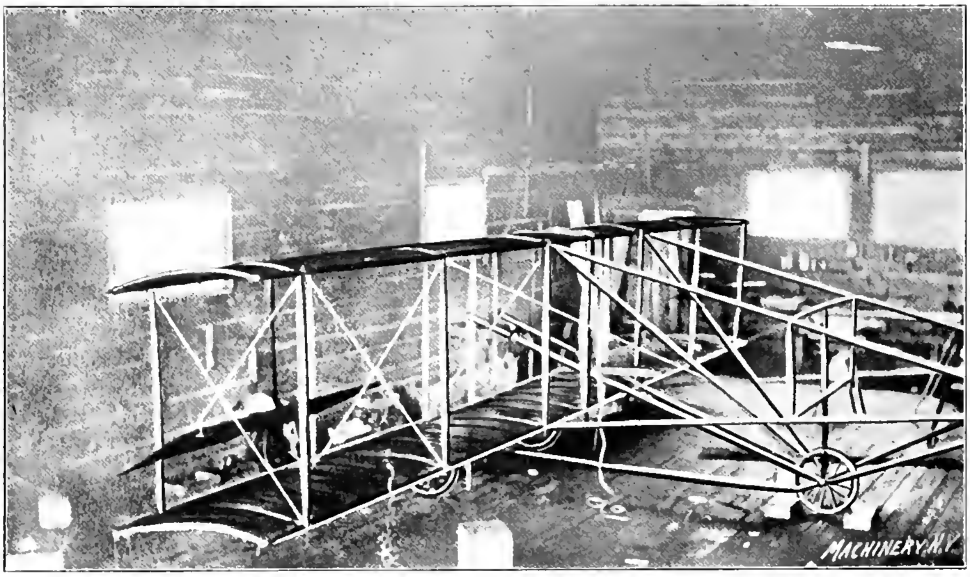


Fig. 6. The "Gold Bug" in Curtiss' Shop at Hammondsport, N. Y.

The operator's seat is just in front of the motor and in the center of the main planes, slightly toward the front of the central panel. The steering wheel is directly in front of him, which he pushes away from him to go down and pulls back to go up, and turns to the right or left to steer in the horizontal plane. At his right foot which rests on a cross-bar is a pedal operating a brake on the front wheel used to bring the machine more quickly to a standstill after landing, and at the same time operating a switch to cut off the motor. The left foot has a small pedal operating the throttle and governing the speed of the engine.

The Curtiss motor is perhaps as important, if not more important, than any other part of the aeroplane. Very few flying machine builders build their own motors, and many were delayed or kept from success by the lack of a good motor. The Wright brothers built a flying machine and then built their motor, while Mr. Curtiss had developed his motor to a state approaching perfection and then built his flying machine.

The motor ordinarily used is a four-cylinder, four-stroke cycle engine, water-cooled by geared pump, with gray iron cylinders 3 7/8 by 4 1/8 with steel water jackets, giving 28 horsepower at 1,450 revolutions per minute on a water-cooled brake test of six hours continuous running. The compression is high, being about 92 pounds. The lubrication is by high pressure oil system, the pump being built in the crank-case and operated from the cam-shaft, the oil being forced through the cam-shaft which is made of one piece with a 5/16 hole. The oil passes to the main bearings which are plain and to the hollow crank-shaft, 1 7/8 inch diameter, which is made of Krupp chrome nickel steel. The oil returns to a reservoir underneath the engine and is pumped over again through the system. The ignition is by Simms-Bosch high-tension magneto. "Mercedes" spark plugs are used, and a Curtiss carbureter. The valves, both in the head of the cylinder, are mechanically operated, very ingeniously, by a rocker arm and a single push rod and cam. The crank-case is of aluminum alloy, also the pistons and connecting-rods. The weight of the engine complete with propeller, carbureter and magneto is about 92 pounds. The propeller is made of wood 5 feet 4 inches in diameter with a five-foot pitch and gives a thrust of 225 pounds pulling against a scale.

The total weight of the machine with operator is about 550 pounds and the complete power plant, including radiator, water and oil, weighs about 195 pounds.

The machine used in Rheims were fitted with an eight-cylinder motor, with cylinders 4 by 4.5 inches placed together like the letter V. It is practically two of the four-cylinder motors put together, weighs, complete, about 200 ponuds, and develops about 60 H.P. A large thirteen-gallon and a small three-gallon fuel tank were fitted for the long races and the speed tests respectively. Fifteen inches of surface were taken off each main plane, and the side controls were arched and placed a little further out at the extremities. The propeller gave a thrust of 280 pounds, and the total weight of the whole machine loaded was about 700 pounds. Mr. Curtiss also made some changes in his propeller at Rheims to get the highest efficiency out of his machine, for the relation of speed of the machine, speed of the motor, and size and pitch of the propeller is very important. A. P.

* * *

Many hospitals in England, says the *Scientific American*, are provided with a special apparatus for extracting iron and steel chips from the eye by means of powerful electro magnets. The magnet employed has a core three feet long and six inches in diameter of the best Swedish soft iron. Two hundred pounds of insulated wire are wound in two coils about the core. The end of the magnet is threaded to receive terminals of different shapes to suit various conditions. The magnet is mounted on ball bearings, and can be moved in any direction. The strength of the magnetic field may be varied at will by means of a rheostat. When used at its maximum power, the magnet exerts a pull of 30 pounds per square inch at a distance of an inch. A special type of apparatus is provided for reclining patients; in this case the magnet is mounted on trunnions, and is tilted by means of suitable gearing operated by a hand crank.

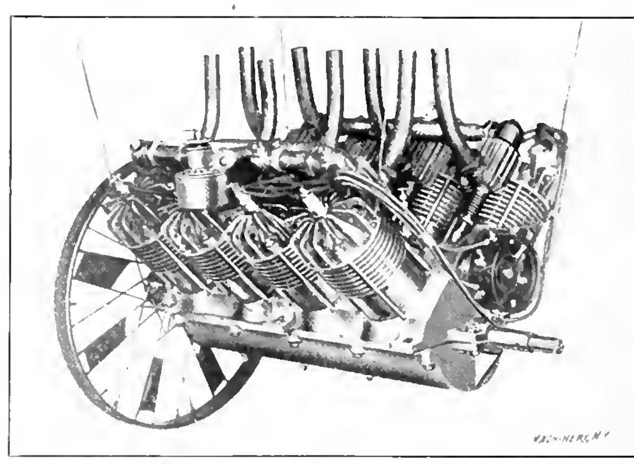


Fig 7. Forty Horse-power Eight-cylinder, Air-cooled, Curtiss Motor, weighing 145 pounds

BEGINNING OF STEAM NAVIGATION*

Robert Fulton

The one-hundredth anniversary of the successful application of steam to the propulsion of ships by Robert Fulton, and the three-hundredth anniversary of the exploration by Henry Hudson of the river that bears his name, is now being commemorated by a great celebration given by the state of New York. This dual celebration, which is under the auspices of the Hudson-Fulton Commission, began on September 25 and will continue until October 9. It will doubtless surpass, in magnitude and grandeur, anything which has been held on this side of the Atlantic, as every detail which would contribute to its success has been carefully planned and a vast sum of money, roughly estimated at one million dollars, has been expended. As far as possible, exact replicas of Hudson's vessel, the *Half Moon*, and Fulton's historic *Clermont* with which he demonstrated the practicability of the steamboat, have been built. These quaint craft will, in connection with a great naval parade, be convoyed on October 1st by a fleet of American and foreign men-of-war, up the Hudson.

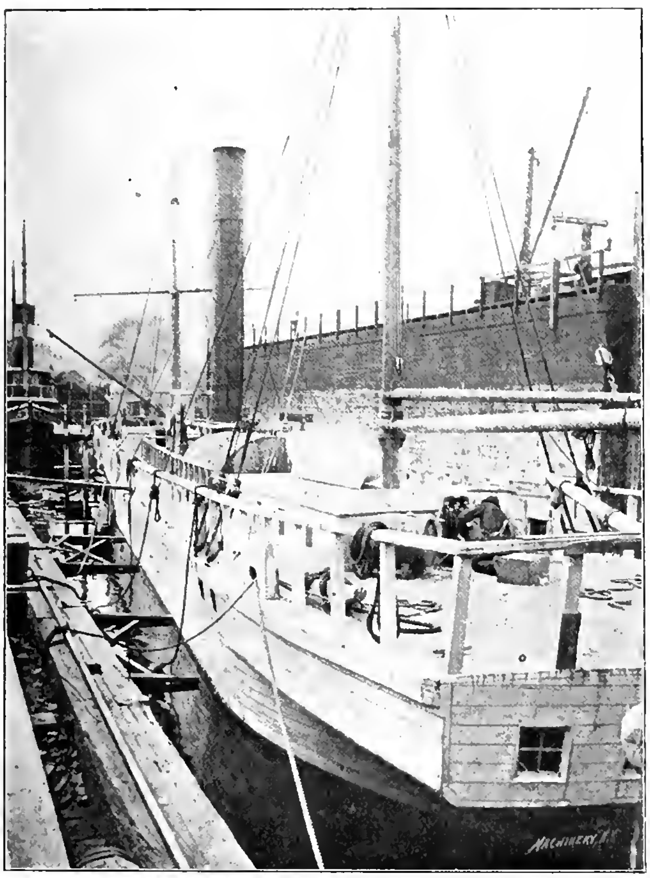


Fig. 1. The Replica of the Clermont

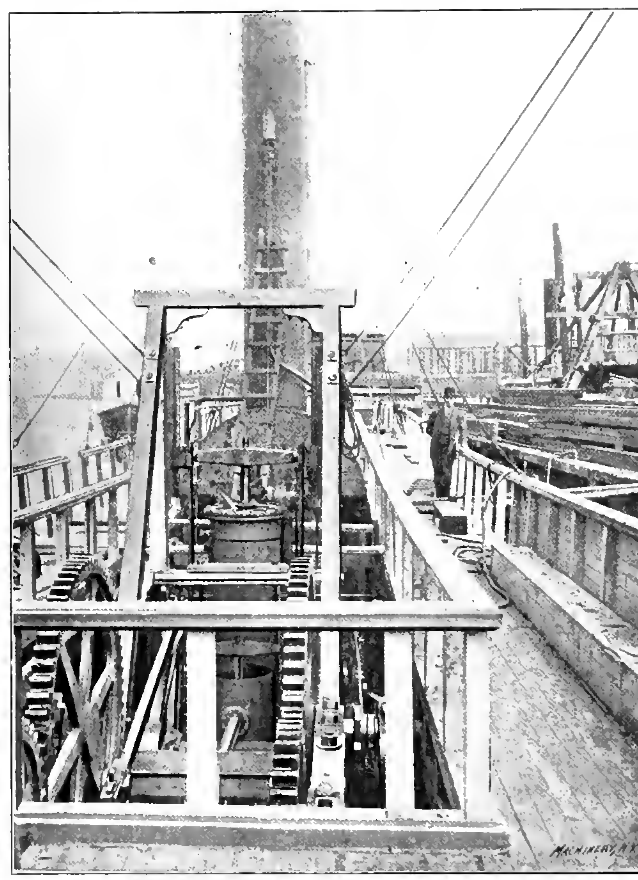


Fig. 2. View of the Engine after Installation

As is well known, Robert Fulton was not the first man to build a steamboat, a number of other boats using steam having preceded the *Clermont*; but if we may judge from descriptions and models of some of these, their priority detracts but little from Fulton's achievement, as he constructed the first boat that was a commercial success. Nevertheless, much that Fulton accomplished was undoubtedly due to the ideas he obtained from those whose experiments antedated the construction of the *Clermont*. James Rumsey began experimenting as early as 1785, and a year later John Fitch is said to have constructed the first steam-propelled craft which met with any degree of success in America. It was a most clumsy contrivance, however, being propelled by gangs of oars arranged in a frame-work at the sides. The second American steamboat was run by Fitch on the Delaware at Philadelphia in 1787. In the same year Rumsey is said to have built the third boat which operated on the Potomac. The propulsion of this novel craft was accomplished by sucking in water at the bow and expelling it at the stern—a method which has been tried in recent times, but without success. In the two following years Fitch built two other steamboats, after which Samuel Morey built a stern-wheeler, which made a trip from Hartford to New York. Fitch, who had been conducting his experiments on the Delaware at Philadelphia, came to New York where he operated the seventh American steamboat on the old Collect Pond, a small body of water which then existed where the City Prison and Criminal Courts Building now stand. This boat was propelled both by paddle wheels at the side and a screw propeller. The construction of the mechanism was exceedingly crude and primitive, the boiler being made from a ten-gallon iron kettle, which was closed by a heavy plank lid. The factor of safety was probably a most uncertain quantity.

John Stevens began his work in steam navigation in 1791. In 1798, a steam-propelled vessel was tried on the Passaic River. The New York Legislature was petitioned by Stevens for a monopoly of steam navigation, but the petition was not granted. In 1804 a 68-foot boat, 14 feet wide, fitted with a single-screw propeller, was built by Stevens and in 1805 a twin-screw boat was launched on the North River. The machinery of this boat was afterward placed in a larger boat, the *Phœnix*, which was 103 feet 3 inches long, 16 feet wide, and 6 feet 9 inches deep. While the launching of the *Phœnix* occurred after that of the *Clermont*, if one may judge from models, the lines of Steven's craft were much superior to those of the *Clermont*. The engine also shows greater simplicity. In the spring of 1809, the *Phœnix* made a number of trips between New York and New Brunswick, a distance of 37 miles, in $9\frac{1}{2}$ hours including stops, but perhaps owing to the fact that the nearly completed *Raritan* (Fulton's second boat) was intended for operation over this course, it was decided to sail the *Phœnix* to the Delaware River by way of the Atlantic. She left New York on June 8, 1809, arriving at Philadelphia on June 17. Thus was accomplished the first sea voyage of a steam-propelled vessel. The *Phœnix* ran as a passenger boat on the Delaware, stopping at Philadelphia,

* For additional information on this subject, see the article on "Early Steam Navigation," published in the May, 1902, number of MACHINERY.

Bordentown, and Trenton where connection was made with stages across New Jersey to New Brunswick, one of the terminals of the *Raritan*. After running for a number of years over this route the *Phoenix* was wrecked at Trenton in 1814.

The original *Clermont* was built at Charles Brown's shipyard near Corlear's Hook, New York. According to a letter written by Fulton to James Watt, she was 175 feet long, had a beam of 12 feet, and a depth of 8 feet. After making four trips the length was reduced to 150 feet and the width increased to 18 feet. The hull was flat bottom, and wedge shaped at both the bow and stern. The sides were nearly vertical, the width across the main deck being only a little more than at the bottom. As there was no keel, two steering-boards or leeboards were provided to prevent drifting sideways. The propulsion was by paddle wheels, 15 feet in diameter, which were placed well forward. These were driven by a single-cylinder condensing engine of the side-lever type, which was imported from England, as the facilities in this country at that time for engine building or similar work were very poor. This engine with its driving mechanism was located amidships, and was uncovered. An idea of its construction may be obtained by referring to Fig. 3 which shows an elevation and plan of the engine built for the new *Clermont*. Fig. 2 shows the appearance of the engine after installation. The cylinder, which was designed for a working pressure of 20 pounds, is mounted vertically on a cylindrical condenser, which is connected to the air pump by a channel-way of cast iron, which forms the bed-plate of the engine. The valves, which are of the single poppet type, are located in cylindrical steam chests arranged at each end of the cylinder. The valve gear of the first *Clermont* required four men to start the engine. It was afterwards changed to the Stevens type, the fundamental principles of which are seen in the engines of the modern river boats. The diameter of the cylinder is 24 inches, and the length of stroke 4 feet. The fly-wheels are located outside of the hull, and are driven from the paddle-shafts on either side by two-to-one gearing. This gearing is of cast iron, and machine molded. The fly-wheels are also cast iron and have a rim section of 4 x 4 inches. It is said that upon one occasion when one of the paddle-wheels was disabled, paddles were attached to the fly-wheel and the voyage continued. The side-levers, which are connected with the cross-head and paddle-shaft cranks, are counterweighted as shown, to balance the weight of the piston-rod, crank, air-pump gear, etc. The air pump is single-acting and is connected with the side-levers by links. From the cross-head of the air pump the feed and bilge pumps are driven.

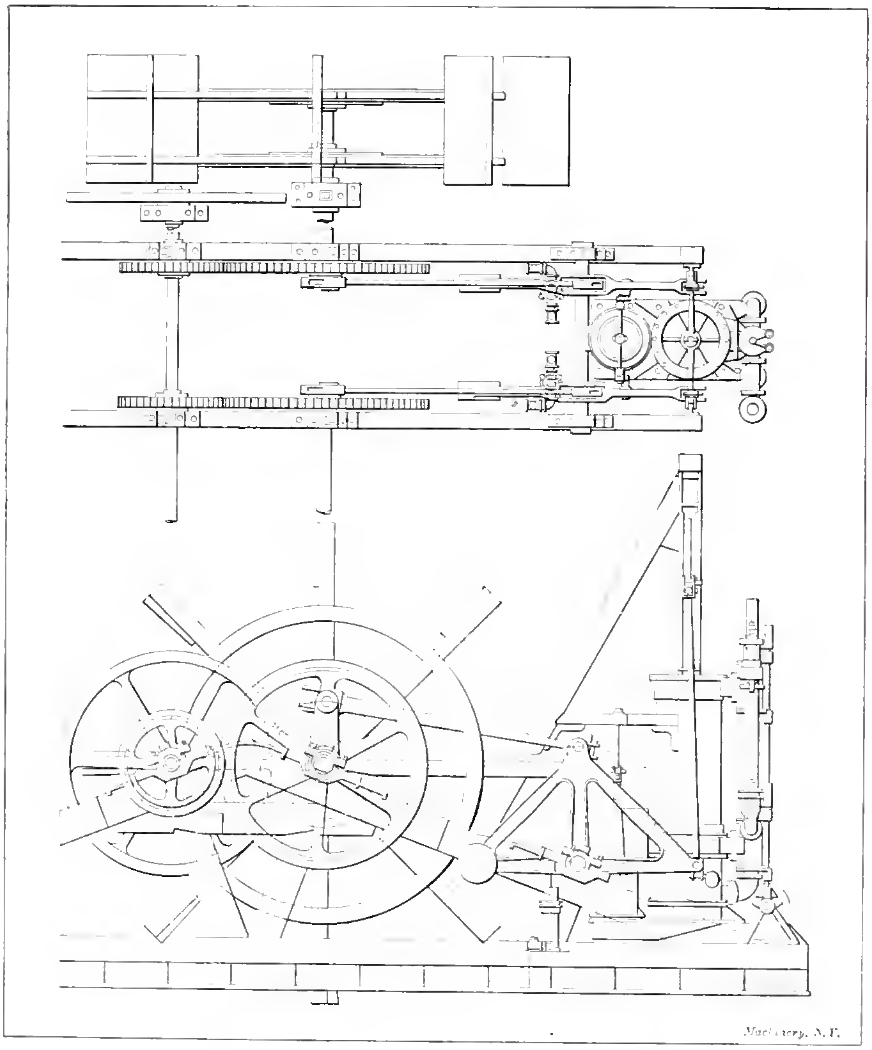


Fig. 3. Plan and Elevation of the Engine which was built for the new Clermont

The boiler of the original *Clermont* was of copper, but no attempt at an exact reproduction of this part has been made, as such a boiler would not pass the United States inspection laws. With this single exception, however, the new *Clermont* is said to be an accurate reproduction of the original. The problem of constructing such a boat was exceedingly difficult, for while drawings of the engine were in existence there was no contemporary picture of the hull. After a careful and painstaking investigation on the part of her architects, the firm of J. W. Millard & Bro. in conjunction with Mr. Frank E. Kirby, consulting engineer, sufficient data were obtained to accomplish the desired result.

The famous voyage of the original *Clermont* from New York to Albany began on August 17, 1807. The start was made from a point near the square, which is now bounded by Washington, West Tenth, West and Charles Streets. Leaving New York at one o'clock in the afternoon, the *Clermont* arrived at the estate of Chancellor Livingston, at 10 o'clock on Tuesday, having traveled 110 miles in 24 hours at an average speed of 4.6 miles per hour. On the remaining 40 miles of the journey to Albany, this speed was increased to 5 miles per hour, making 32 hours the total time for the trip. The next day the return journey began, and just 30 hours afterward the maiden voyage was ended.

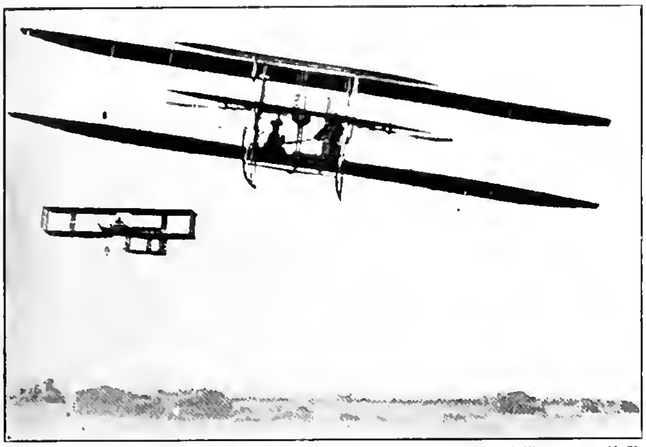
On returning from the first trip, the *Clermont* underwent some improvements to better fit her for regular passenger traffic. At the end of this time the following rates to various points from New York were advertised: Newburgh, $3, time 14 hours; Poughkeepsie, $4, time 17 hours; Esopus, $4.50, time 20 hours;; Hudson, $5, time 30 hours; Albany, $7, times 36 hours. Under favorable conditions trips were made to Albany in 28 hours, at a rate of 6 miles an hour. At times as many as 100 passengers were carried. These trips were continued until late in the fall of 1807, and the service was resumed in the spring of 1808. In writing to Livingston of the financial return from passenger traffic, Fulton says: "By carrying for the usual price there can be no doubt but the steamboat will have the preference because of the certainty and agreeable movement. I have seen the captain of a fine sloop on the Hudson. He says the average of his passages has been 48 hours. For the steamboat it would have been 30 hours certain. The persons who came down with me were so pleased that they said were she established to run periodically they would never go in anything else."

The construction of the *Clermont* did not mark the beginning nor the end of Fulton's achievements, for both prior and subsequent to the advent of this famous craft, his genius expressed itself in valuable pioneer work with submarine boats, torpedoes, inland canals, and in other directions in the realm of mechanics and marine construction; and, through the efforts of this early inventor, much was accomplished toward laying the foundation of our present nautical development.

AVIATION RECORDS AT RHEIMS

A. P.

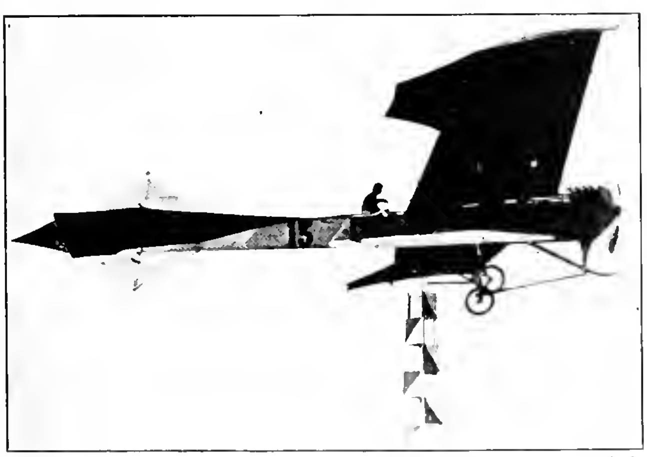
The international meet of flying machines or "Aviation Week," at Rheims, France, in the latter part of August, was the most notable event in the history of aviation. America was ably represented by Mr. Glenn H. Curtiss, who won the Gordon-Bennett International Aviation Cup, on August 28. He represented the Aero Club of America, with a machine of his own make, and defeated one representative of England using a French machine, and three representatives of the Aero Club of France. Mr. Curtiss flew 20 kilometers (12.42 miles) in 15 minutes 53 3/5 seconds, his speed being about 47 miles an hour. His nearest rival was M. Louis Bleriot who made the course in 15 minutes, 56 1/5 seconds, while Mr. Latham got third place, his time being 17 minutes, 32 seconds. M. Lefebvre made fourth place, his time being 20 minutes, 47 seconds. Each contestant was allowed only one trial. The prize was a trophy valued at 12,500 francs ($2,500), which goes to the club of which the contestant was a representative, and a cash prize of 25,000 francs ($5,000) to the winner.



Paul Thompson, N. Y.

Fig. 1. The Wright Machine at Rheims followed by Paulhan. Two Machines caught by the Photographer in the Same View

The Gordon-Bennett contest was the culmination of the most intensely interesting sporting event ever held in the history of the world, and was epoch-making in the annals of mechanical flight. The contest revealed a new field of sport and pleasure heretofore absolutely unknown except to scientists and inventors.



Paul Thompson, N. Y.

Fig. 2. Bleriot rounding Turn at Rheims. View taken from Paulhan's Machine

Curtiss also won the Prix de la Vitesse of 20,000 francs ($4,000), making 30 kilometers (18.63 miles) in 25 minutes, 29 3/5 seconds with the penalization of one-tenth. Bleriot won the prize for the fastest time for one round of the course, 10 kilometers (6.21 miles) in 7 minutes, 47 seconds. Henry Farman won the Grand Prix de Champagne, 50,000 francs ($10,000) by a world's record flight of 180 kilometers (111.98 miles) in 3 hours, 4 minutes, 56 seconds. He flew after the official hour for the timers to leave, 7:30 o'clock, until he had covered 190 kilometers, the time being 3 hours, 15 minutes. The excess distance, however, is not a part of the official record. Mr. Farman also won the passenger carrying contest, carrying two passengers 10 kilometers (6.21 miles) in 9 minutes, 52 seconds. Herbert Latham won the Prix de l'altitude, 10,000 francs ($2,000), reaching a height of 155 meters or over 500 feet.

There were six principal types of machines used, the Wright and the Curtiss biplanes (American), and the French biplanes of Farman and Voisin, and the monoplanes of Latham (Antoinette) and Bleriot. It is estimated there were altogether 1,300 flights made during the aviation week. The following is a tabulated record of the principal events, competitors, and time:

GRAND PRIX DE CHAMPAGNE

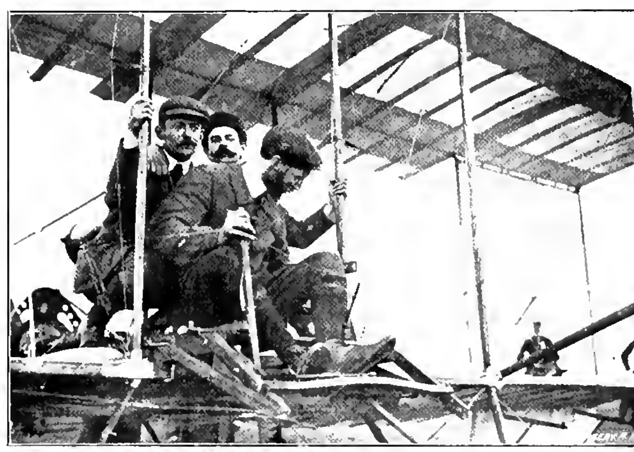
(Long Distance Test)

	Competitor	Machine	Kilometers	Time	Prize, Francs
1.	Farman	Farman	180	3h. 4 m. 56s.	50,000
2.	Latham	Antoinette	154½	2h. 1 m. 19s.	25,000
3.	Paulhan	Voisin	131	2h. 43m. 24s.	10,000
4.	De Lambert	Wright	116	1h. 52m.	5,000
5.	Latham	Antoinette	111	1h. 38m. 15s.	5,000
6.	Tissander	Wright	110	1h. 46m. 52s.	5,000

PRIX DE LA VITESSE, 30 KILOMETERS

(Three Lap Speed Test)

	Competitor	Machine	Time	Prize, Francs
1.	Curtiss	Curtiss	23m. 29s.	10,000
2.	Latham	Antoinette	25m. 18s.	5,000
3.	Tissander	Wright	28m. 59s.	3,000
4.	Lefebvre	Wright	29m.	2,000



Paul Thompson, N. Y.

Fig. 3. Henry Farman about to engage in the Contest in which he carried Two Passengers and made the Circuit in 10 minutes 39 seconds

PRIX DE TOUR DE PISTE, 10 KILOMETERS

(One Lap Speed Test)

	Competitor	Machine	Time	Prize, Francs
1.	Bleriot	Bleriot	7m. 47s.	7,000
2.	Curtiss	Curtiss	7m. 49s.	3,000

COUPE INTERNATIONAL GORDON-BENNETT TROPHY AND 25,000 FRANCS

	Competitor	Country	Machine	Time
1.	Curtiss	America	Curtiss	15m. 50s.
2.	Bleriot	France	Bleriot	15m. 56s.
3.	Latham	France	Antoinette	17m. 32s.
4.	Lefebvre	France	Wright	20m. 47s.

PRIX DE L'ALTITUDE, 10,000 FRANCS

(Soaring Test)

	Competitor	Height		Competitor	Height
1.	Latham	155 meters	3.	Paulhan	90 meters
2.	Farman	110 meters	4.	Rougier	55 meters

PRIX DU PASSAGERS, 10,000 FRANCS, 10 KILOMETERS

(Passenger Carrying Test)

	Competitor	Machine	Passengers	Time
1.	Farman	Farman	1	9m. 52s.
2.	Farman	Farman	2	10m.39s.
3.	Lefebvre	Wright	1	11m.20⅗s.

* * *

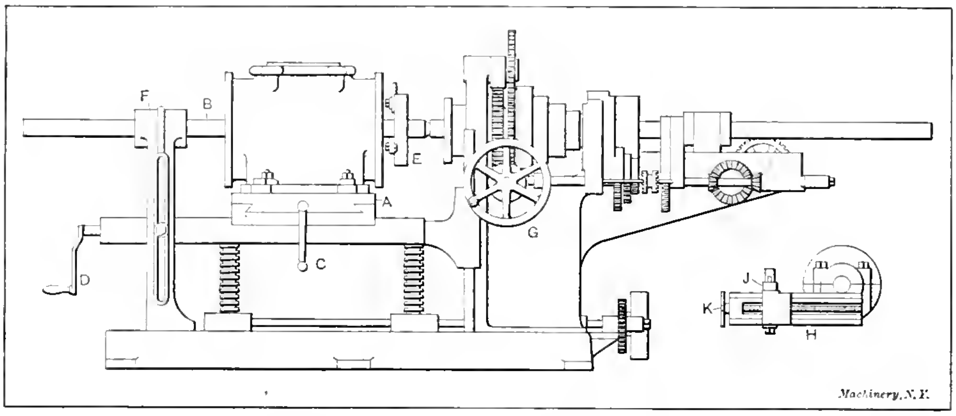
A centennial exposition and world's fair will be held in Winnipeg, Manitoba, in 1912, according to a report by Vice-Consul-General Carl R. Loop.

* The following notes and articles giving records obtained with aeroplanes and airships have previously been published in MACHINERY: Delagrange record, August, 1908; Zeppelin, August, 1908, engineering edition; various aeronautic records, October, 1908, engineering edition; miscellaneous records mentioned in an article entitled "Aeroplane-Type Flying Machine," December, 1908, engineering edition; Wilbur Wright's record, March, 1909; Bleriot's flight across the English Channel, August, 1909.

MACHINE SHOP PRACTICE*

BORING CYLINDERS

The type of machine tool used for boring cylinders, and also the method of procedure is determined largely by the size of the work and the quantity which is to be machined. The lathe of both the plain and turret types, as well as horizontal and vertical boring mills are used for this work, and in automobile factories or other shops where a great many cylinders are bored, special machines are often employed. When a common lathe is used, the casting, providing it is too large to be bolted to the face-plate or held in the chuck, is clamped to the lathe carriage, with sufficient blocking beneath it to bring the rough bore in alignment with the lathe spindle. A boring-bar equipped with one or more cutters centrally located, is mounted between the lathe centers and driven by a dog. As the cutters revolve, the work is fed against them by the regular carriage feed. As the boring-bar is the only special tool needed when the work is done in the lathe, cylinders are often bored in this way in shops which do not have a boring machine. If cylinders are to be bored in quantity by this method, a special fixture should be provided for holding them upon the carriage, which is so designed that clamping and adjusting may be quickly done.



Horizontal Boring and Drilling Machine

The Shop Operation Sheet accompanying this number gives an example of small cylinder boring in the turret lathe; the cylinder being of the type used for gasoline engines. By referring to the illustrations and descriptions, it will be seen that the turret, which is, practically speaking, a large tool holder, is equipped with boring tools for both roughing and finishing cuts; also a reamer for finishing the cylinders to size. As these tools may be brought into position as needed by simply revolving the turret, it is possible with such a machine to do work with considerable rapidity.

The accompanying engraving shows the general construction of a common type of horizontal boring and drilling machine, and also the way a cylinder is set up for boring. The table *A* to which the cylinder is clamped, has a horizontal adjustment, both lengthwise and crosswise of the bed, and also a vertical adjustment so that the cylinder to be bored can easily and quickly be set in alignment with the boring-bar *B*. The horizontal adjustments are effected by the handles *C* and *D*, while the table is raised and lowered by power. The boring-bar is supported and kept in alignment with the spindle by an outboard bearing *F*, through which it slides as the cutters in the boring head *E* are fed through the work. This longitudinal movement of the bar is controlled by a feed mechanism which permits the amount of feed per revolution to be varied. Provision is also made for the rapid adjustment of the bar in or out by the hand-wheel *G*. Facing arms *H* may be attached to the bar on either side of the cylinder for facing the flanges after the boring operation. The turning tool is fastened to the slide *J* which is fed outward a short distance each time the star-wheel *K* is caused to turn by a stationary pin against which it strikes.

When setting a cylinder which is to be bored it should, when the design will permit, be set true by the outside of the flange, or what is even better, by the outside of the cylinder itself, rather than by the rough bore, in order that the walls of the finished cylinder will have a uniform thickness. The last or finishing cut, should invariably be a continuous one, for if the machine is stopped, even for a short time, there will be a ridge in the bore at the point where the tool temporarily left off cutting. This ridge is caused by the cooling and the resulting contraction and shortening of the tool during the time that it is stationary. For this reason, independent drives for boring machines are desirable. The position of large cylinders while they are being bored is an important consideration, the disregard of which has often caused trouble. Such cylinders should be bored in the position which they will subsequently occupy when assembled. For example, the cylinder of a horizontal engine should be bored while in a horizontal position, as the bore is liable to spring to an oval shape when the cylinder is placed horizontal after being bored while standing in a vertical position. If, however, the cylinder is bored while in the position in which it will be placed in the assembled machine, this trouble is practically eliminated.

There is a difference of opinion among machinists as to the proper shape of the cutting point of a boring tool for finishing cuts, some contending that a wide cutting edge is to be preferred, while others advocate the use of a comparatively narrow edge with a reduced feed. It is claimed that the narrow tool produces a more perfect bore, as it is not so easily affected by hard spots in the iron, and it is also pointed out that the minute ridges left by the narrow tool are an advantage rather than a disadvantage, as they form pockets for oil and aid in the matter of lubrication. It is the modern practice, however, to use a broad tool and a coarse feed for the finishing cut which is, of course, always right. When boring with machines which are equipped with bars not sufficiently rigid, the tool face will have to be made narrower than would otherwise be necessary, to avoid chattering.

* With Shop Operation Sheet Supplement

* * *

FULTON EXHIBIT, ENGINEERING SOCIETIES BUILDING

The Hudson-Fulton celebration is essentially a recognition of the explorer and the engineer. To show the relation of the latter to the celebration, models of the *Clermont* and other early steamboats, through the courtesy of the Smithsonian Institution, are now on exhibition at the rooms of The American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th St. The exhibit includes the *Clermont*; the *Phoenix*, built by John Stevens; and one of John Fitch's early types. Original drawings by Fulton, an oil portrait of Fulton painted by himself, Fulton's dining table, oil portraits and a bronze bust of John Ericsson, models of the *Monitor*, all owned by the society, and Ericsson's personal exhibit at the Centennial Exposition, are also exhibited. Through the courtesy of the Hamburg-American line, a beautiful model of the *Deutschland* shows the highest type of the development of steam navigation.

The model of the *Clermont* represents the boat as she was on her first trip before undergoing alterations to fit her for regular passenger service. The model of the *Phoenix* shows that boat at the time of making the first sea voyage ever made by a steam vessel. The trip was made in 1809, leaving New York on June 8 and arriving in Philadelphia on June 17. Fitch's boat was built in Philadelphia in 1786 and successfully tried on the Delaware River. In 1790 a similar boat carried passengers and freight on the Delaware River for several months.

The exhibition will be open to the public every week day from 9 a. m. to 5 p. m.

* * *

Further experiments in wireless telephony recently carried out in France proved it possible to exchange messages for several hours over a distance of 155 miles. It is proposed to extend the distance, due to the success already attained.

THE SPINNER VARIABLE SPEED INDUCTION MOTOR

On the occasion of the joint summer meeting of the Institution of Engineers and Shipbuilders and the Northeast Coast Engineers and Shipbuilders, in Scotland, the works of Messrs. Mavor & Coulson, Ltd., Glasgow, were opened and among the interesting novelties a three-speed 5 H.P. spinner motor was shown in operation illustrating the method of speed control for electric ship propulsion. The spinner motor, which is illustrated assembled and disassembled in Figs. 1 and 2, is an interesting example of the most recent development in the direction of variable speed induction motors. Although the spinner motor has been upon the market for some time, it is not so well known as more commonly used types, and a description of the machine exhibited, will undoubtedly be of general interest to our readers.

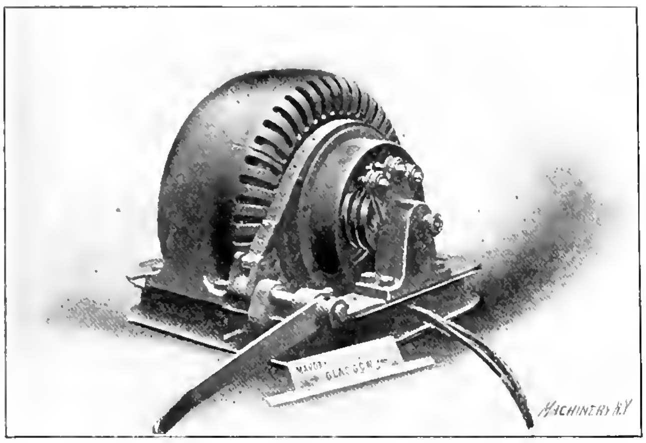


Fig. 1. Mavor & Coulson, Ltd., Variable Speed Induction Motor

There are two elements in the motor which may revolve, these being the ordinary rotor which is mounted on the main shaft, and the spinner. The spinner is cylindrical in form and fits between the annular space between the rotor and the stator. The spinner is carried on end brackets adapted to revolve freely upon extensions of the bearings of the main shaft. A brake wheel is provided on one of these end brackets over which is fitted a metal brake band whereby the spinner can be prevented from rotating when desired. On the outside periphery of the spinner there is a closed circuit or squirrel cage winding, and on the inner surface, next to the main driving motor, there is a winding like that on the stator. In order that the current may be supplied to this winding it obviously is necessary to connect the terminals through slip or collector rings. Both windings on the spinner are placed in slots in the usual manner.

It will be seen from the foregoing description that the machine consists of two motors concentrically arranged around the common axis. Starting from the outside and taking each part separately we first have the ordinary stator winding and then there is the closed circuit or squirrel cage winding on the spinner which together with the stator constitutes one motor. Next on the same spinner there is a winding which only differs from the stator winding in that it can revolve and that its ends are connected to slip rings. Lastly there is a squirrel cage motor mounted on the main shaft and revolving inside the spinner. The current is delivered from an outside source to the primary winding of the fixed stator and spinner respectively, passing in each case through a simple reversing switch.

To illustrate the action of the spinner motor it may be assumed that the primary winding on the spinner is wound so as to give four pairs of poles and that the stator proper of the other or outside motor is provided with eight pairs of poles. If, now, a brake is applied to the spinner and current at a periodicity of 25 cycles be supplied to the primary winding through the collector rings, the speed of the rotor and consequently the driving shaft (if we neglect the slip) will be 375 revolutions per minute. If the stator winding of the other motor with its eight poles be connected in circuit and the spinner simultaneously released, the latter can be made to revolve in the same direction as the main motor, or in a reverse direction. The direction is determined by the reverse switches. Now, since the outside stator has eight pairs of poles the synchronous speed of the spinner can be only 187.5 revolutions per minute, and it is evident that according to the direction of the rotation of the spinner this speed can be added to or subtracted from the 375 revolutions per minute of the rotor obtained when the spinner is held stationary. If, then, the switches are closed so that the spinner revolves in the same direction as the main motor the shaft speed becomes $375 + 187.5 = 562.5$ revolutions per minute. If the reversing switches are closed so as to cause the spinner to revolve in the opposite direction to the motor, then the lowest shaft speed is obtained, or $375 - 187.5 = 187.5$ revolutions per minute.

From the foregoing it is seen that this induction motor has three speeds which are obtained without the use of resistance

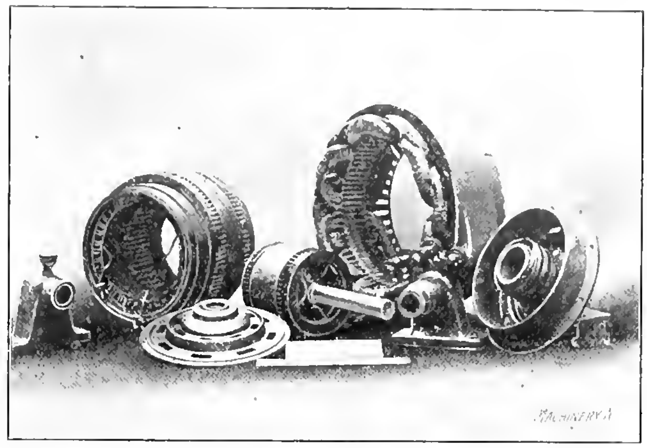


Fig. 2. Mavor & Coulson Variable Speed Induction Motor Disassembled

in the rotor circuit and without varying the periodicity of the main circuit, and without pole-changing in the ordinary sense.

Fig. 3 shows an interesting application of the spinner motor, wherein it is employed for starting purposes and not for speed regulation. By the use of the spinner, the motor may be started without the employment of resistances or an auto-transformer, and the load may be taken up gradually and without jerks, which is of great importance with colliery haulage gears, etc.

A simple switch is all that is required to manipulate. The rotor which is of the squirrel cage type is coupled to the

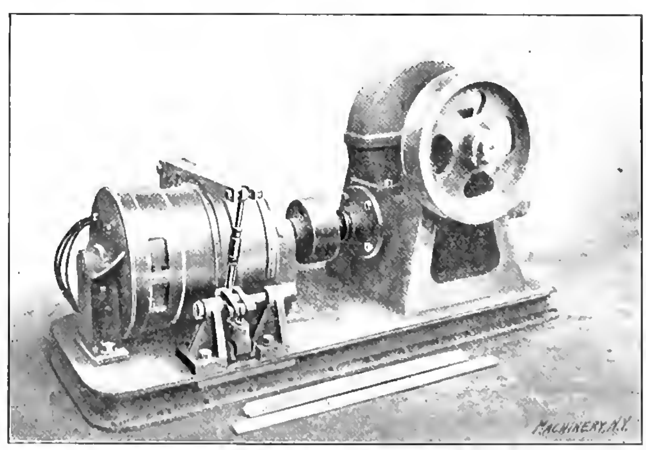


Fig 3. Application of One-speed Spinner Motor to Haulage Gear

driving shaft of the haulage gear. The spinner which encircles the rotor, and which is free to revolve when the brake is released carries a three-phase winding. The current is supplied to the collector rings of the spinner and at the moment when the gear is switched on, the hand brake is off so that the spinner is free to revolve. Now, if the spinner is free to revolve, it is evident that so long as the brake is off there is no tendency for the rotor to revolve, for in order to turn, it must exert a torque to overcome the load to which it is mechanically connected. If, however, the brake is applied so as to gradually stop the spinner, the rotor works up to speed and drives the haulage gear. This device may also be employed for reducing the speed of haulage when required.

DRAWING DIES FOR HOLLOW RIVETS

CHARLES WESLOW*

One day I stood in the doorway of a large factory "rubbering," when the boss came along and inquired of me if I wished to see anyone in particular. "No," I replied, "I am a toolmaker, and have just come from a neighboring shop looking for a job, and in passing I stopped to see what was going on in the building where I happened to learn my trade." "You learned your trade here?" he asked. I assured him that I did, but that I had been apprenticed to a concern which previously occupied the building, but which had since gone bankrupt. "Well!" he said, "if you are a toolmaker, I'd like you to come into the office." I went in with him, but under the impression that he probably knew of a place where I could get a job. Instead, he handed me a sample string of hollow rivets, such as those shown at *A* Fig. 1, which had just come from the die, and asked me if I thought they could be drawn out longer. An idea as to how this could be done instantly struck me, and as it would not be expensive, I was quite prompt in assuring him that the rivets could be lengthened without difficulty. He asked me if I would take the job fixing up the dies, or making new ones, and guarantee that the rivets would come a sixteenth of an inch longer. I told him that I would if it was worth while. He then asked me, with an air of incredulity, if I would do it on contract, and as I assented, he gladly agreed to pay me fifty dollars for the job, remarking that he had already spent about two hundred dollars on those dies, but to no avail. Before leaving to go home for my "kit" he remarked that all their "store" dies and presses gave pretty good satisfaction, except this gang die for rivets, the punch of which would break through before the work even reached the third operation.

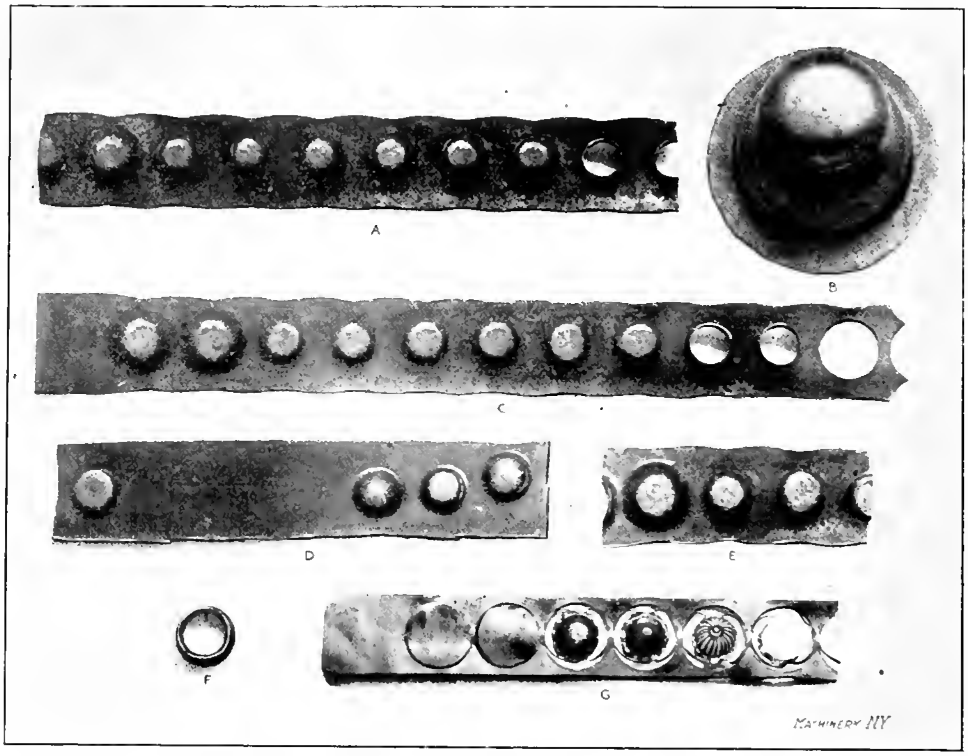


Fig. 1. Samples showing the Results obtained by both the Smooth and the Stepped or Roughed Punches

I reported the following morning and after examining the work of the dies in question, and watching their movements for awhile, I took down the set, and decided to change the shape and size of the second and third dies and punches. Fig. 2 shows the construction of the punches and dies as they were, each alternate die being shown in section. *K* indicates the "knock-outs." The stripper is not shown. Fig. 3 shows the changes made in both the punches and dies.

These dies were laid out to make two rivets at one throw. In Fig. 2 the order of the various operations, as originally performed, are indicated by the numbers there given. In the first operation a boss is created, the size of which is found by experiment (in some shops this is called "finding" the blank). The punches and dies number 2 then work this boss into a conical shell. The third operation was evidently intended to reduce the diameter of the cone, which was then converted by the next set of dies into a straight shell. The bottom was then cut out by set number 5, while the next and last dies blanked out the finished rivet. This die failed because the punches would break through the bottom of the shell before the latter was completed.

While I knew from experience just what was wanted, I really couldn't go right ahead and fix the dies in a couple of hours, and then have the nerve to ask for the "fifty." So, after much trying to conceal my zest and knowledge, I decided to "kill time" by doing "government work," as some of my own equipment needed repairs. After tinkering around four days, the boss came around and asked me, again in an incredulous manner, if I was confident of success. "Yes," I said, "as far as the dies are concerned," but I added that I didn't know how I'd manage to collect the "fifty." (I really wondered if he would pay it.) "Well," he said, "if you make those dies work in a week, you'll get besides your fifty dollars the price of a pleasant evening with your best girl. So, spurred on by this prospect, I decided that I would make one week the limit and then collect.

By referring to Fig. 3 the changes made in operations numbers 2 and 3 may be seen. It will also be noted that the original operation number 4 is omitted. Instead of making any alterations concerning the location of the fifth and sixth operations, I merely removed the number 4 dies and punches from the press, leaving it to the boss to decide about renewing the whole set, by his own die-maker, since my work ended as soon as I could demonstrate the style of die to use. Therefore the fourth operations on the string *A*, Fig. 1, are merely dummies in string *C*, which is a product of the dies after I had changed them. The stock used was number 18 of the cheapest cold roll that could be bought, but it made no difference how cheap the metal was when it was drawn by the improved method. The original dies, however, only worked successfully on good stock.

In another factory I have also seen the same trouble on brass shells, such as shown at *B*, Fig. 1. In this case the punch should simply have been made rough. I also happened to be poking in the junk pile, and picked up the piece shown at *D*. While I made no inquiry as to its origin, I did keep it as a keepsake, inasmuch as it showed someone's experiments on the same problem as the hollow rivets. This die-maker also got "stuck," since the punch broke the bottoms as shown in the engraving.

Referring to the particular style of punch I substituted for the third operation (see Fig. 3), it can be readily understood that as the punch is irregular in size it has a tendency to imbed its shoulders into the side of the shell, thus pulling the stock into the die as well as pushing it in, and distributing the strain throughout all parts of the shell. Of course this reduces the thickness of the stock on the sides, but when I showed the boss my sample he said that it was good enough for the purpose and just what he wanted. It might be well to explain that the steps on these punches are shown exaggerated in the illustration.

Fig. 4, at *A*, shows an end view of the string *E*, Fig. 1, with the finished shell sawed in half. This sectional view shows the shape of the shell after it is drawn by the stepped punches. Nothing could be done, however, until the die and punch for the second operation were properly formed, as shown in Fig. 3, where they are shown nearly straight. An-

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other mistake my predecessor made was in continuing the conical shaped die until the fourth operation was reached, and then changing to a straight die. The new die, as will be seen, begins in the second operation to form a nearly straight shell out of the conical boss, and then in the third the stepped punches are applied as previously described. If it were necessary to produce a still longer rivet, the first operation would need to be changed so that there would be a larger boss, and the whole gang would need to be separated more. Figs. 1 and 4 at *F* and *B*, respectively, show a rivet made by the improved dies, slightly curled over to prove its pliability after the stretch.

At *G*, Fig. 1, is shown a sample of a string of brass ornaments as they were manufactured in a fancy goods factory

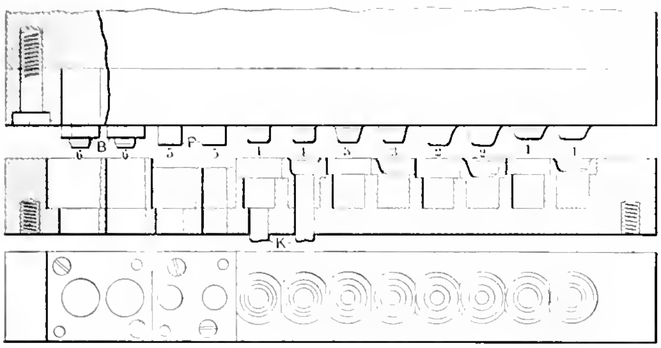


Fig. 2

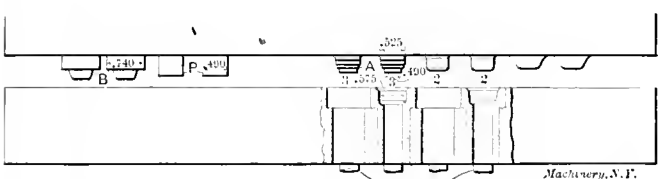


Fig. 3

Fig. 2. Punch and Die in which the Piece shown at A, Fig. 1, was formed. Fig. 3. Improved Punch and Die with Stepped Punches

I had been with. In this case the job is similar to the rivets, because they are also knocked out on a progressive die, but they are pointed cup-shape and easier to form. The first operation is to nearly cut the blank, leaving enough stock to keep it connected with the ribbon, in order to facilitate handling it. Six dies are used: the first and second to nearly blank out; the third to form a cup; the fourth to "coax" the cup to a point; the fifth to corrugate it and further its point, and the sixth to cut it through and trim it.

It may interest some readers to know that taper shells made of brass, silver or aluminum are made just the reverse

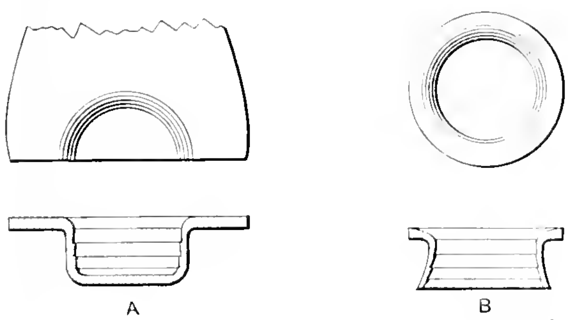


Fig. 4. Sectional View of Drawn Rivet Shell, showing marks left by Stepped Punch

of the way the improved dies described in the foregoing make hollow rivets. The shells are first drawn to the shape of a cone pulley, the number of steps depending on the length and taper of the shell. The corners of the steps are left rounded. This irregular sized shell is then placed beneath a drop-press containing a punch and die having the required taper, and it is "ironed out." The punch is prevented from sticking in the die by an adjustable collar that strikes the die harder than the taper punch. This collar is made in the form of two lock nuts.

SELDEN PATENT UPHELD

Decision was filed in the United States Circuit Court for the Southern District of New York, by Judge Hough, September 15, sustaining the famous Selden patent on gasoline automobiles. The decision holds that the claims of the Selden patent, on which suit was brought, are valid and infringed. The suit is that of George B. Selden and the Electric Vehicle Co., against the Ford Motor Co., C. A. Duerr & Co., O. J. Gude Co., John Wanamaker and others, Société Anonyme des Anciens Etablissements, Panhard, Levassor, Andre Massenat, and Henry and A. C. Neubauer. The decision is voluminous, reviewing the entire case and concluding that the invention of George B. Selden is a pioneer invention of great merit. It holds that Mr. Selden is first in this art and broadly construes claim 1 so that it covers all gasoline automobiles. Claim 1 reads as follows:

"The combination with a road locomotive, provided with suitable running gear, including a propelling wheel and steering mechanism, of a liquid hydrocarbon gas engine of the compression type, comprising one or more power cylinders, a suitable liquid fuel receptacle, a power shaft connected with and arranged to run faster than the propelling wheel, an intermediate clutch or disconnecting device and a suitable carriage body adapted to the conveyance of persons or goods, substantially as described."

The Selden patent No. 549,160 was granted November 5, 1895, and, therefore, expires in 1912. The remarkable feature about this patent aside from its broad claim is that the application was filed in the Patent Office May 8, 1879, and the application was kept alive during that period by the technicality of the patent laws, which allow applications to be renewed year by year provided an amendment is filed within two years of the date of rejection.

George B. Selden was a lawyer in Rochester, N. Y., during the seventies and spent his spare time experimenting with horseless carriages. After six years of hard work and the construction of five or six different engines he produced a carriage that would run, and finally applied for a patent on the same, submitting a model which is still in the Patent Office. (See MACHINERY, May, 1903.)

The American automobile manufacturers who will not be adversely affected by the decision are the licensees comprising the Association of Licensed Automobile Manufacturers, as follows:

American Locomotive Co., Apperson Bros. Auto Co., Autocar Co., Buick Motor Co., Cadillac Motor Car Co., Chalmers-Detroit Motor Co., The Columbia Motor Car Co., Corbin Motor Vehicle Corp., Elmore Mfg. Co., Everitt-Metzger-Flanders Co., H. H. Franklin Mfg. Co., Haynes Auto Co., Hewitt Motor Co., Hudson Motor Car Co., Knox Auto Co., Locomobile Co. of America, Lozier Motor Co., Matheson Motor Car Co., Packard Motor Car Co., Peerless Motor Car Co., The Pierce Arrow Motor Car Co., The Pope Mfg. Co., Royal Tourist Car Co., Alden Sampson, 2nd, Selden Motor Vehicle Co., F. B. Stearns Co., Stevens-Duryea Co., Studebaker Auto Co., E. R. Thomas Motor Co., Toledo Motor Co., Walter Automobile Co., Waltham Mfg. Co., Winton Motor Carriage Co.

Representative of defendant automobile makers assert that the decision will not affect their business, and that the case will be carried to the Circuit Court of Appeals, and if necessary to the Supreme Court.

* * *

According to *Frankfurter Zeitung*, the German railways occupy the leading position among the railways of the world in regard to safe traveling. The following figures apply to the year 1907 and give the number of passengers killed and injured per million passengers:

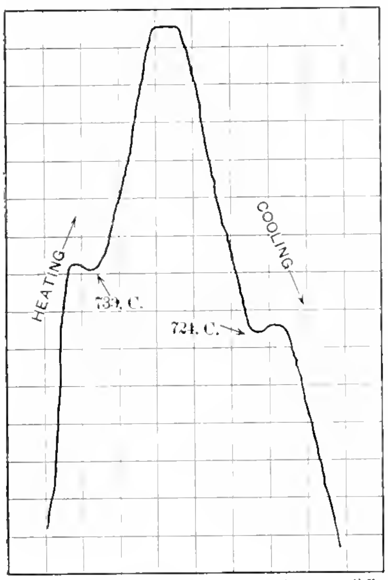
	Killed	Injured
Germany	0.08	0.39
Austria-Hungary	0.12	0.96
France	0.13	1.18
England	0.14	1.94
Switzerland	0.20	1.04
Belgium	0.22	3.02
United States	0.45	6.58
Russia	0.99	3.93

In Germany ninety-two per cent of the railways are owned and operated by the government.

RECALESCENCE AND ITS RELATION TO HARDENING

J. E. STOREY[*]

Everyone interested in the hardening of steel will have noticed the increasing frequency with which reference is made to the recalescence point of steel, in articles appearing in the technical press from time to time. It is only during the past few years that this peculiarity in steel has come to the front, and there are still very many who do not possess even a rudimentary knowledge of the subject. The somewhat obscure references one usually sees in articles on hardening will not help the man in the hardening shop very much to a better understanding of the matter, and therefore an elementary explanation of the phenomenon will be welcome to many. It may be quoted that, as a matter of history, hardening has been done with more or less success, from the days of the famous Damascus swords up to only a comparatively short time ago, without anyone having discovered that steel possessed such a peculiarity as recalescence, but nevertheless its relation to hardening has always existed, and its discovery paved the way for much scientific investigation into a subject that had been previously controlled by rule of thumb.



Curve made by a Recording Pyrometer, showing the Recalescence Points

The "recalescence" or "critical points" (also sometimes designated Ac. 1 and Ar. 1) that bear relation to the hardening of steel, are simply evolutions that occur in the chemical composition of steel at certain temperatures during both heating and cooling. Steel at normal temperatures carries its carbon, which is its chief hardening component, in a certain form—pearlite carbon to be more explicit—and if heated to a certain temperature a change occurs and the pearlite carbon becomes cementite or hardening carbon. Likewise, if allowed to cool slowly, the hardening carbon changes back again to pearlite. The points at which these evolutions occur are the recalescence or critical points, and the effect of these molecular changes is to cause an increased absorption of heat on a rising temperature and an evolution of heat on a falling temperature. That is to say, during the heating of a piece of steel a halt occurs, and it continues to absorb heat without appreciably rising in temperature, at the recalescence point, although its immediate surroundings may be hotter than the steel. Likewise, steel cooling slowly will, at a certain temperature, actually increase in temperature although its surroundings may be colder.

The accompanying illustration shows a curve, taken on a recording pyrometer, in which the recalescence points are well developed. From this it will be seen that the absorption of heat occurred at a point marked 733° C on the rising temperature, and the evolution of heat at 724 C on the falling temperature. The relation of these critical points to hardening is in the fact that unless a temperature sufficient to produce the first action is reached, so that pearlite carbon will be changed to hardening carbon, and unless it is cooled with sufficient rapidity to practically eliminate the second action, no hardening can take place. The rate of cooling is material and accounts for the fact that large articles require to be quenched at higher temperatures than small ones.

A very important feature is the fact that steel containing hardening carbon *i. e.*, above the temperature of recalescence, is non-magnetic. Anyone may demonstrate this for himself by heating a piece of steel to a bright red and testing it with an ordinary magnet. While bright red it will be found to have no attraction for the magnet, but at about a cherry-red it regains its magnetic properties. This feature has been taken advantage of as a means of determining the correct hardening temperature, and appliances for its application are on the market. Its use is certainly to be recommended where no installation of pyrometers exists; the only point requiring judgment is the length of time an article should remain in the furnace after it has become non-magnetic. This varies with the weight and cooling surface, but may be tabulated according to weight, leaving very little to personal judgment.

It is difficult to quote reliable temperatures at which recalescence occurs, as the observation of different investigators do not show concordant results, probably owing to the lack of uniformity in the means of measuring the temperatures. It varies with the amount of the carbon element contained in the steel, and is much higher for high-speed than for ordinary crucible steel. Special electric furnaces are generally used for obtaining recalescence curves, but with care it can be done in an ordinary gas furnace, with a suitable pyrometer. All that is necessary is to bore a blind hole in a piece of the steel to be treated, to form a pocket to receive the end of the pyrometer. This must be of sufficient length to cover the resistance coil in the end of the pyrometer. The specimen should then be put in the furnace, with the pyrometer in, of course, the gas applied, and, if the furnace is allowed to heat up very slowly toward a temperature of say 750° C., the recalescence curve will be developed, if the pyrometer is a recording one. In the same way, if the furnace is allowed to cool slowly it will be seen that at the second recalescence point, the specimen gives off heat and even increases in temperature for a time. Experiments of this kind are scarcely practicable for the average hardening shop, but when it is desired to find the lowest hardening temperature for a piece of steel, the magnet can be used to advantage.

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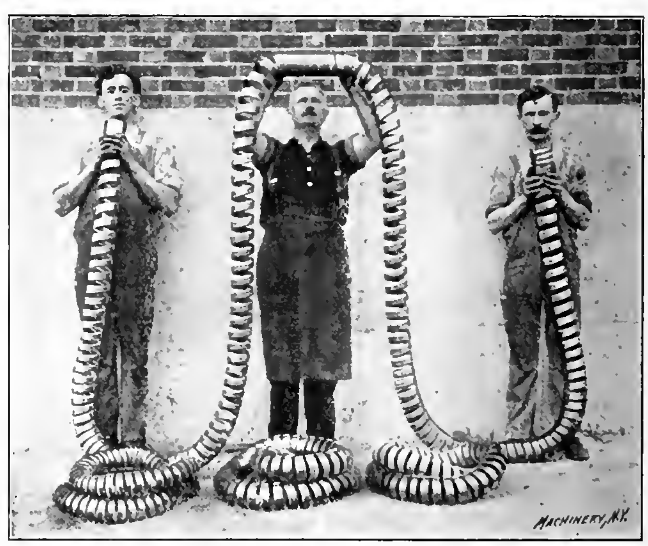
* * *

BRASS SPIRALS MADE ON SCREW-CUTTING MACHINE

The illustration shows four brass spirals supplied to the United States government by the Screw Cutting Company of America, 17th St. and Sedgley Ave., Philadelphia, Pa. The spirals were made by cutting a 1½-inch pitch thread, ¼ inch wide, on hard drawn seamless brass tubing 3¾ inch diameter,



Brass Spirals made from Tubing by the Screw Cutting Co. of America for the United States Government

No. 18 British wire gage (0.049 inch). The spirals are used for reinforcing hose, and the longest was cut from a brass tube ten feet long. The company was able to do this work rapidly and efficiently on its special screw cutting machines (see MACHINERY, April, 1909, for illustrations of products), and is prepared to produce similar work in brass, steel or other metal, and on any length of tubes that can be made and shipped. It is of the opinion that the proposition by any other process than its own would have been very difficult and costly.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

ACCURATELY LOCATING WORK ON THE FACE-PLATE

The object of this article is to show how easy it is to accurately locate work on the face-plate by the use of plugs and size blocks. The way in which the casting shown in Fig. 1, which is part of the milling fixture, Fig. 5, is located on a lathe face-plate so that it may be bored central with the end bearings, will be explained. By this method all chances of error which might occur in trying to center such a casting in the old way are eliminated. The function of the casting, when in the assembled fixture, is to hold the part shown in Fig. 4 while a groove *G*, 1/16 inch wide and 1/32 inch deep, is being milled on the inner surface, which is spherical. As this groove must have the same depth at each end, the reader will readily see the importance of accurately locating the

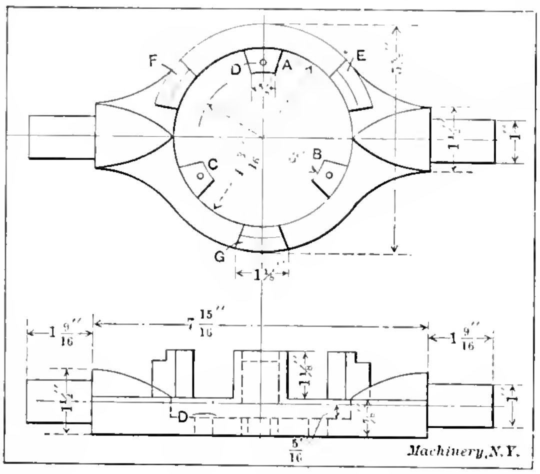


Fig. 1. Work to be Located with Reference to the End Bearings

fixture casting for the boring operation. A plug *A*, exactly one inch in diameter, was first inserted in the lathe spindle as shown in Fig. 2. The two V-blocks, also shown in this engraving, are used on regular tool work, and when made were planed accurately to 1⅝ inch wide, 1⅝ inch long, and 1⅝ inch from the bottom to the center of a one inch plug placed in the V. The distance, therefore, from the sides to the center of the blocks is 13/16 inch, and as there is a 1-inch plug in the spindle, the block to be used between the plug and the parallel upon which the V-blocks are to rest when

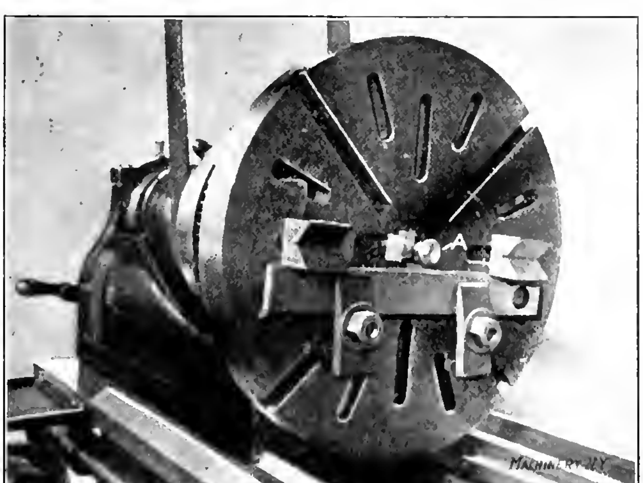


Fig. 2. Setting Parallel and V-blocks from a Central Plug

setting the parallel, would be 13/16 inch minus 1/2 inch, or 5/16 inch. By referring to Fig. 1, we find that the distance between the shoulders of the end bearings is 7 15/16 inches. One-half of this amount is 3 31/32 inches, which minus half the plug diameter leaves 3 15/32 inches, which is the required size of the blocks to be used between the plug and the V-block, only one of which was set in this way. When the casting was placed in the blocks, it was carefully set against the block which had been previously located. The other block was then brought up against the shoulder of the bearing on the opposite end. These V-blocks happened to be tapped in the bottom for a ⅜-inch screw, which, with clamps to hold them against the parallel, made it easy to locate them. The casting was set parallel with the face-plate by the use of a surface gage. Fig. 3 shows the work after the three projections

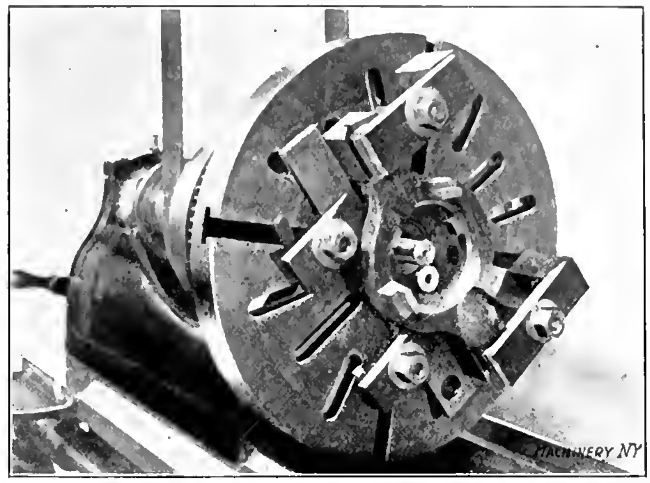


Fig. 3. Use of Central Plug and Ring Gage for Sizing Projections located 120 Degrees apart

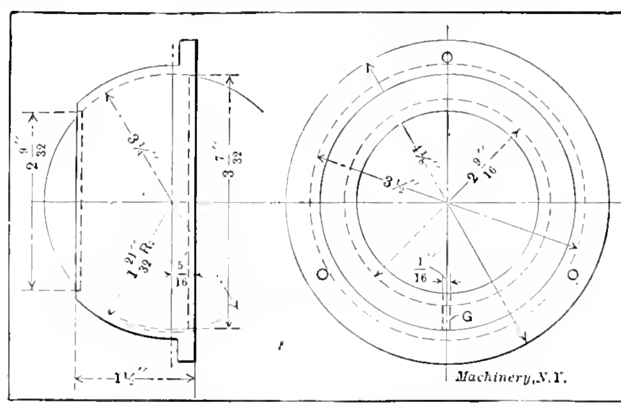


Fig. 4. Casting which is held in the Fixture, Fig. 5, while a Groove is being milled in its Spherical Surface

A, *B*, *C* and the surface *D*, Fig. 1, had been bored and faced. The inner projections were bored to a 3-inch circle by using a standard one-inch ring as a gage (as shown in Fig. 3) which, when placed against the plug, gave a radius of 1½ inch. By referring to the elevation in Fig. 1, it will be seen that the surface *D* must be 5/16 inch below the center line. As the distance from the base of each V-block to the center of a 1-inch plug resting in the V is 1 5/8 inch, 5/16 subtracted from this amount leaves 1 5/16, which is the thickness of the block to set between the point of the tool and the face-plate when setting the tool for the finishing cut. The projections *E*, *F*, and *G* were turned to fit a ring 5 inches inside diameter. A plug was made having one end 3 inches in diam-

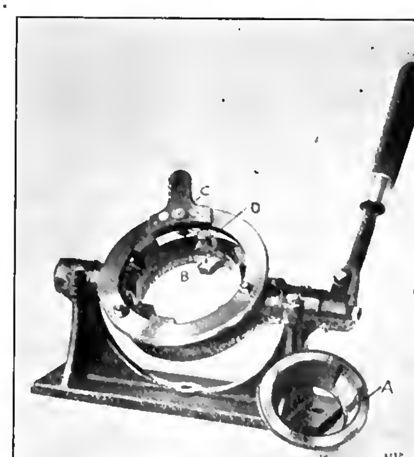


Fig. 5. Fixture of which the Casting shown in Fig. 1 forms a Part

eter to fit the inside of the lugs A, B, and C, Fig. 1, and the other end turned to fit the 3 7-32-inch bore of the spherical casting, Fig. 4. This plug was for locating the piece to be milled so that the pins in the projections A, B, and C would be in such a position that when the work was subsequently located by them, the center of its spherical surface would coincide with the axis of the rotating part of the fixture. Two of these locating pins were also set in a line parallel with the center line of the fixture. All this work was done before removing the casting from the face-plate. It will be understood that if the work should become shifted in any way it can be readily and accurately reset again by this method.

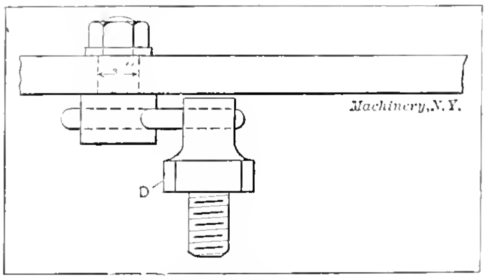


Fig. 6. Detail of Clamping Device for Fixture shown in Fig. 5

The completed fixture is shown in Fig. 5, with a sample of the work held by it at A. This illustration, as well as the detail Fig. 6, shows the locking device by which the work is clamped in place. After the casting is located by pins B which fit into holes bored in the casting flange, it is secured by a movement of the ring C to the right, which causes three locking screws D to turn simultaneously, and clamp against the flange. ALBERT C. SAWYER.

Dorchester, Mass.

TWO GAS ENGINE JIGS

In selecting the two jigs shown in the illustrations from among those in use in the manufacture of a well-known gas engine, I have digressed from the usual custom of choosing only the best for description, believing that there is as much to be learned from the mistakes as from the successes. These jigs while embodying some very good features, are offered as examples of jigs possessing points to be avoided.

Fig. 1 shows a piston boring jig. It is a well-designed jig in every respect except one, and that is in the method of clamping the work. This method is the one usually followed for securing cylindrical work, either in a jig or to the drill press table, and it is very effective—so effective, in fact, that more or less work is spoiled by being either cracked or sprung. Gas-engine pistons are necessarily rather light, and to hold them tight enough and still not injure them requires more care than the average operator can be depended upon to exercise. It is almost impossible to avoid springing the pistons, and often they take a permanent set. As an improvement in this and similar jigs I would suggest that the work be clamped longitudinally. This would probably not be as convenient as the method shown, but it should be as effective and certainly would not injure the work.

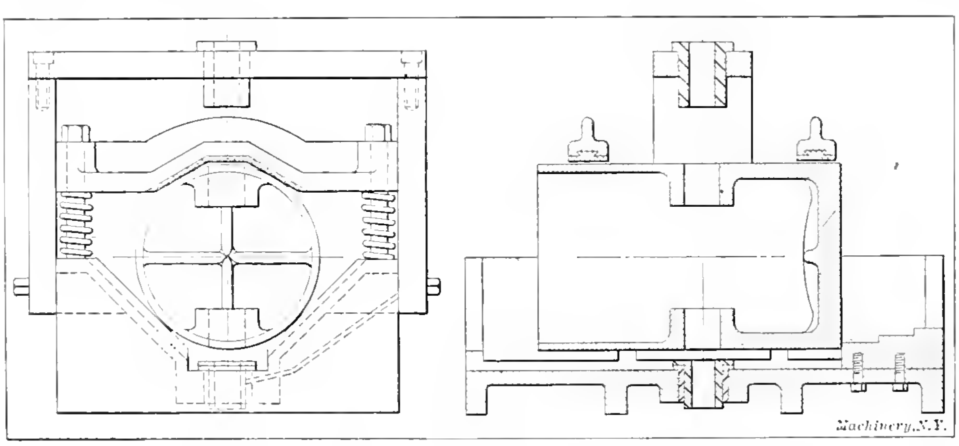


Fig. 1. Elevation and Section of Jig for Piston Boring with Work in Place

A good point of the jig is the springs to hold the clamps up while changing the work. In places where springs can be employed, they will save much time in avoiding the removal of the clamps each time the work is changed. Another good point of this jig is the babbitt metal facing of the clamps, which prevents scarring the pistons.

The fixture shown in Fig. 2 is a chuck for connecting-rods, for use on the milling machine. The method of clamping is quite ingenious, as the turned heads are used both to align and hold the rods. This looks all right on the face of it, but in actual practice it was found necessary to make the addition of adjusting screws under the heads of the rods to prevent them turning on their respective axes under uneven cuts. This added so much to the time of chucking that practically all the advantage gained by the manner of clamping was overcome. J. F. MIRRIELEES.

Cincinnati, O.

CLEANING MICROMETERS

In my travels I have seen many mechanics trying to get emery and grit out of micrometer screws and nuts, either by washing them in benzine, alcohol, kerosene, or other oils, or alkalis, or by digging out the dirt with pine sticks, or pith. At one time mine became clogged with emery, and I sent them to the manufacturer. It cost me 50 cents besides prepaying all charges. When they were returned to me they were worse than ever, so I decided to experiment. I placed the screws in benzine to remove the oil which had been collecting the emery. Then the parts were heated just enough to be held comfortably in the hand, and a coating of beeswax was applied to the screw and nut. The screw was then placed in the nut, after it was cold, which forced all the small particles of dirt out with the surplus wax, and closed up the slots, avoiding the possibility of dirt and emery becoming clogged in them. A small thin coating of wax was therefore left between the screw and nut. The screw was then removed from the nut, and all surplus wax removed, and a drop of thin oil applied. Anybody having trouble with their micrometers will find this remedy O. K. Mine have been in daily use for nearly three years, with the same coating of wax, and are to-day in good condition. FRANK G. STERLING.

Franklin, Mass.

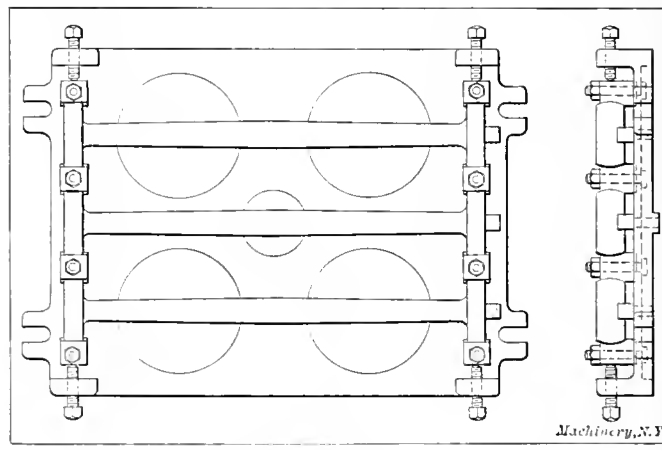


Fig. 2. Design of Fixture for Connecting-rods, which proved Objectionable

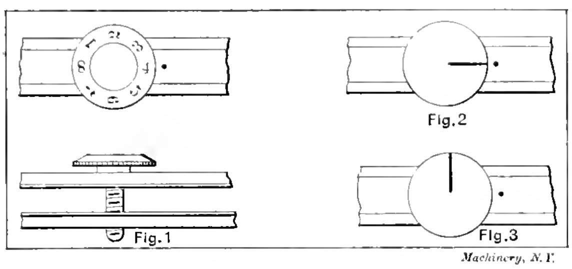
GRADUATED SCREW HEADS ON DRAWING PENS

Having had some difficulty in getting all the lines on a drawing of the same width, it occurred to me that it would be a good scheme to graduate the screw heads of the drawing pens, so they could always be set for some pre-determined width of line before beginning to draw. With this object in view, a bevel was turned on the upper faces of the screw heads which were stamped with numbers from 1 to 8, as shown in the plan view in Fig. 1, and a center punch mark was made on the blade of the pen, against which to

read the numbers. After the different pens in the set of instruments are marked, they can be adjusted by trial on a waste piece of paper until they all draw the same width of line, and a record made of the reading of each screw, as shown in the accompanying table, there being two records for each pen, one of which is for light lines, and the other for shade lines. There is not much use for a shade line adjustment on the compass pens, as nearly all draftsmen

	Small Compass	Large Compass	Straight Line
Light line..............	4	1	7
Shade line..............	6	3	1

shade their circles by springing the needle leg, but it is of occasional use in drawing short arcs. The record shown in the table can be hung up on the wall, placed in the cover of the instrument case, or anywhere that is convenient for reference. As the pens are sharpened, or the screws wear in the thread or under the shoulder, the record for the pen settings will have to be altered at quite long intervals, depending on how much use each pen gets. Some makers supply straight line pens with a graduated screw head somewhat larger than usual, but mine were of the kind that is ordinarily supplied with drawing instruments, and were rather



Ruling-pen Screw-heads Graduated to obtain Lines of Uniform Width

small in diameter, so the numbers were not very large; however, I find it a great help. Anyone not having facilities for stamping numbers can place two ink marks on the screw heads—one red mark for light lines and one black mark for shade lines; or only one ink mark can be used on the screw head, having it point as in Fig. 2 for light lines, and as in Fig. 3 for shade lines. This ink mark scheme is not original with me, as I am indebted to R. A. Gleason for it. The marks will last quite a while, as the ink is on the flat side of the screw head that is not supposed to be handled.

Brooklyn, N. Y. WALTER GRIBBEN.

CHUCKING TRANSMISSION SLEEVES FOR INTERNAL GRINDING

A special steady-rest and chuck for use in the grinder when grinding a certain make of automobile transmission sleeve, is shown in the accompanying illustrations. Fig. 1 shows a

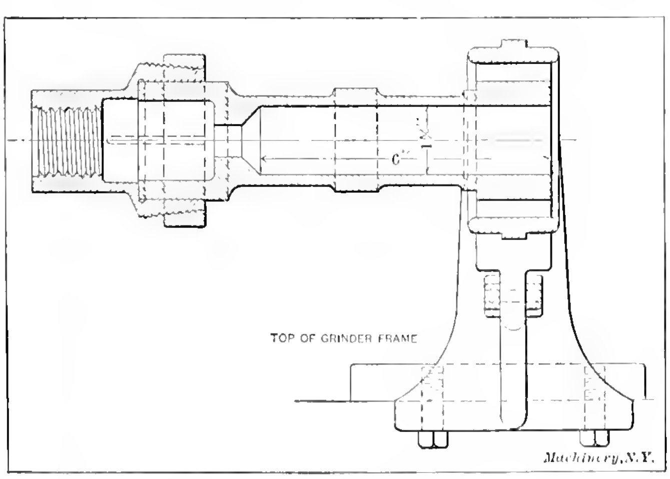


Fig. 1. Plan in Section of Grinder-Rest and Chuck with Work in Place

plan view in section of the chuck and rest with the work in place, and Fig. 2 an end elevation. The sleeve, which is a steel drop forging, is finished all over, after which the hole 1 5/8 by 6 inches long is ground to fit a plug gage. This method of holding the work enables it to be quickly set so that the hole will be finished perfectly concentric with the outside surfaces. The chuck which holds one end of the sleeve is of the ordinary spring collet type. It has six milled slots, and the chucking end has a taper of 7 degrees

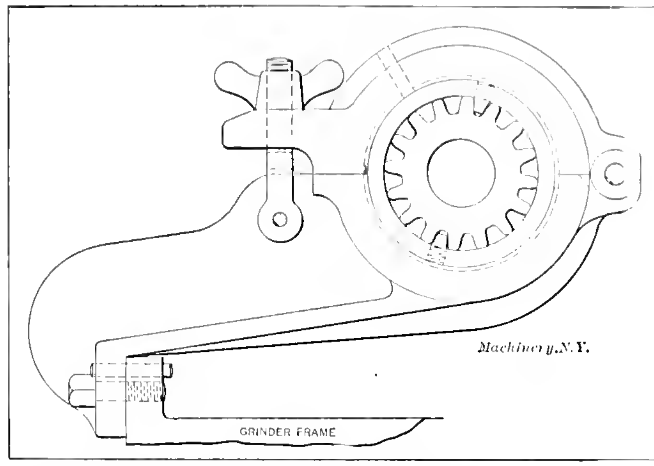


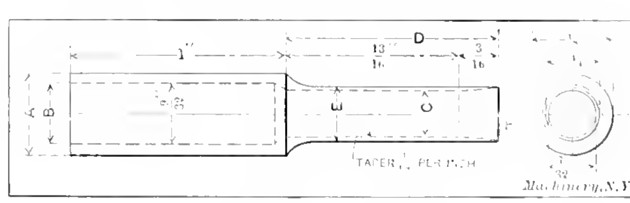
Fig. 2. End Elevation of Rest, showing Method of Holding End of Work

which is threaded. A machine steel ring-nut with holes for a spanner wrench is threaded to fit the taper part of the nut. Both the chuck and the ring are hardened and ground to size. During the grinding operation the outer or gear end of the sleeve is held in a one-piece bronze ring. This ring is provided with a tongue which is a neat working fit in a groove in the steady-rest. As shown in the end elevation, this rest has a hinged cap which is held in place by a hinged clamping bolt provided with a suitable wing-nut. Bolts and dowel pins secure the rest to a rib on the grinder frame. In the bronze ring there are two steel studs which are flush with the outside diameter and which protrude inward as shown in the end view. These studs are shaped to fit the teeth of the gear, thus causing the bronze ring to turn with the sleeve during the process of grinding. With this form of rest, the chucking, grinding the inside of the sleeve, and removing it, is all done in about eight minutes, which is seven minutes less than formerly required. There is also little danger of error because of an unskilled or careless operator, as he cannot make a mistake in chucking the work.

M. HEARTILLIIEN.

A DRILL FOR PAPER

The accompanying engraving illustrates a tool which is remarkable for its simplicity and efficiency. This tool was developed in a jobbing shop where tools were being made for loose leaf ledger work. There was considerable trouble with the tools for punching the ledger leaf holes, it being difficult to get the punches to cut "clean," through any considerable thickness of paper, so an attempt was made to drill the holes instead of punching them. It was soon discovered that the paper could not be drilled with any kind of lip drill, because, no matter how the lips were shaped, they would catch and tear the paper. After considerable experimenting, the tool



A Tool for Cutting Holes through Paper

shown in the engraving was developed, and it was found to be far superior to the ordinary method of punching. This tool requires but little explanation. To make it, take a piece of tool steel and catch it in the lathe chuck, allowing it to extend from the chuck far enough to permit of its being turned the full length, and then cut off. Next turn the diameter *A* allowing 1/64 inch for a finishing cut. Turn down the end to the diameter *E*, and to the length *D*, again leaving 1/64 inch for a finishing cut. Now drill through the full length of the

tool, a hole slightly smaller than C, so that it may be trued up with the boring tool. Before finishing this hole, bore out the clearance hole B which should be 1/16 inch larger than C to allow the scrap or paper cuttings to pass through freely. Next finish the hole C, making it 1/64 inch per inch taper, the largest part of the hole being at the back. This hole should be 1/32 inch smaller than the outside diameter E, which is the exact size of the holes to be drilled in the paper. The diameters A and E are next finished, E being made 0.001 inch smaller at the back than at the cutting end. Taper the mouth of the tool as shown at F, bringing it to a fine edge at the outside diameter. The tool may now be cut off and hardened. It should be hardened in oil, and drawn to a dark brown at the cutting edge, this color running off gradually to a blue at the back end of the tool. If care is exercised in hardening, there will be no necessity for grinding or lapping. The tool may be used in the drill press, and it should run about 1,500 revolutions per minute. The press or speed lathe in which the tool is used should have a hollow spindle to allow the paper cuttings to pass through. If, however, a hollow spindle machine is not available, a chuck with sufficient space to permit the cuttings to pass out between the jaws, may be used, or a special holder may be made, of simple design, to serve the purpose. One who sees this tool work for the first time will be surprised to observe how clean and freely it will cut.

C. W. D. and W. B.

ADJUSTABLE ELECTRIC LAMP BRACKET FOR THE SHOP

In many shops it is found to be quite a problem to construct an electric lamp bracket for the bench, which can easily and quickly be adjusted to any height and position. The Cincinnati Shaper Co. uses a bracket which fills the bill and the cost of which is trifling. The illustrations, Figs. 1 and 2, show this bracket assembled and in detail. The same reference letters are used in each illustration for corresponding parts, so that the construction of the bracket may be more easily understood. The small cast iron angle-plate A is screwed to the wall. The top of this plate, as shown in the plan view, Fig. 1, is serrated so that the arm to which the lamp is attached, will remain in the desired position. These serrations are cast in, and the only machining done to this

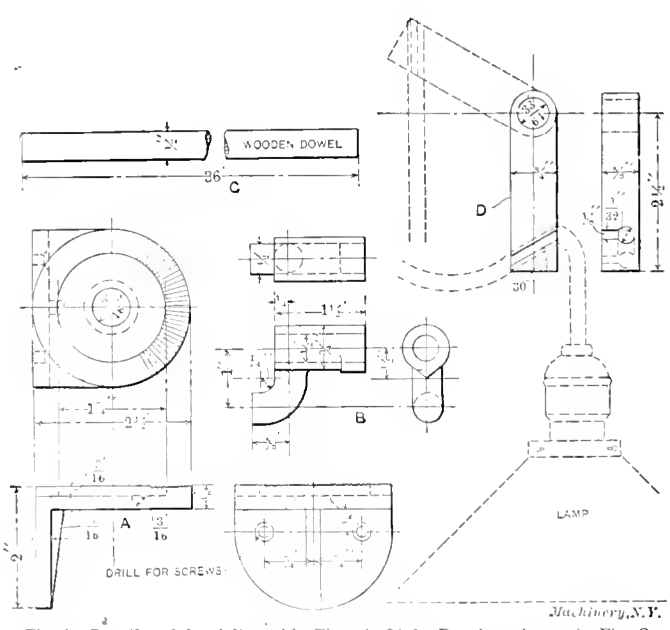


Fig. 1. Details of the Adjustable Electric Light Bracket shown in Fig. 2

piece is the drilling of the screw holes for fastening it to the wall or window sill. The small casting B, which is attached to one end of the wooden arm C, has a curved end which fits into a hole in A. A ½-inch hole is cored into casting B, and into this hole the wooden dowel C, which is about 36 inches long, is driven. As will be seen by referring to the end view, the casting B has a sharp V-shaped projection on the bottom of the front end; this rests in the serrated part of the angle-plate. The piece D, located at the end of the arm C, is of fiber. This is drilled 1/64 inch larger than C to permit it to slide back and forth easily. The hole through which the lamp wire passes is drilled at an angle of 30 degrees, as shown in Fig. 1, to prevent the wire from slipping. A slot is milled into this hole on one side so that

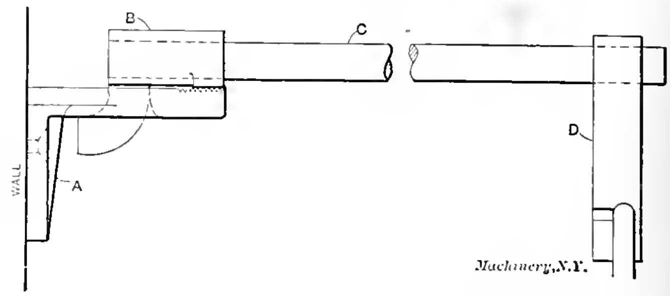


Fig. 2. Simple Design of Adjustable Electric Light Bracket

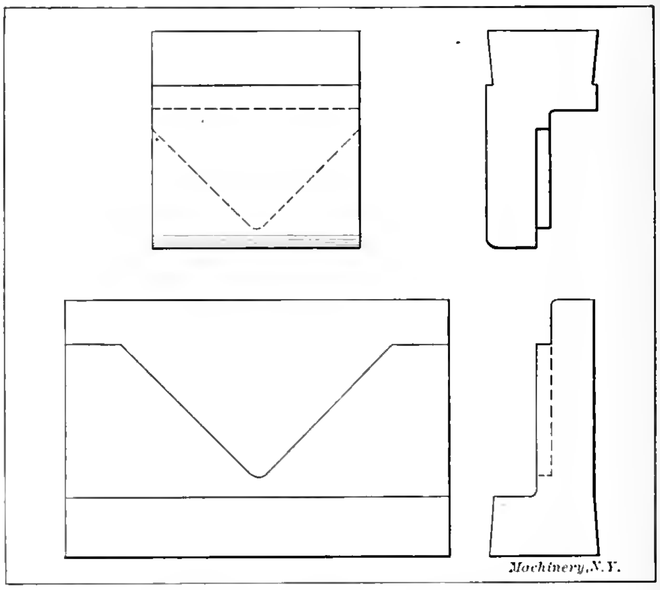
the wire may be placed into position. By raising the block, as shown by the dotted lines, the lamp can easily be adjusted to any height.

H. DONNERBERG.

Cincinnati, O.

A BENDING DIE

A type of punch and die that is adapted for bending at right angles, edgewise, soft steel strips, in size from ⅛ × 1-inch to ⅜ × 1-inch, is shown in the accompanying engraving. This tool commends itself from the fact that it is of simple design, easy to make, and that, in bending the stock,



Die for Bending Soft Steel Strips Edgewise

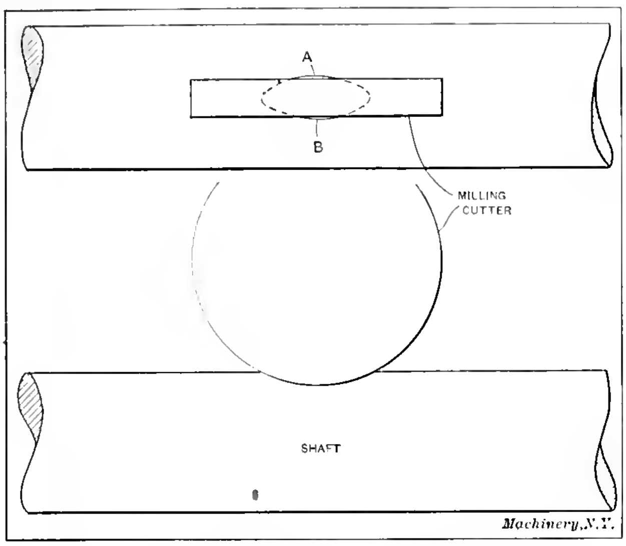
the inner angle does not increase in thickness to any appreciable extent. When accurate work is required and no increase whatever in thickness at the bend is allowed, the punch and die may be locked together by extending a part of the punch over the rear of the die. This will eliminate any tendency of the two members springing away from each other in action. As the stock bent in this die was in long strips and extended beyond the die, a stop (not shown) was attached to the side of the bolster. This tool is run in a press with a stroke of 4 inches. Both the punch and the die are planed at an angle of ten degrees to fit the holder, and they are both hardened.

ENGINEER.

CENTERING SHAFT WITH MILLING CUTTER WHEN KEYSEATING

The micrometer gage for centering work with milling cutters, described by Mr. Chapman in the July number of MACHINERY, would do this work with considerable precision were it not for the fact that in the present rush and hurry in manufacturing probably 80 per cent of the milling cutters do not run perfectly true on the arbor; and, in that event, there would be great chance that the accuracy of the micrometer would be useless. Assuming that the cutter runs perfectly true, then undoubtedly the tool referred to is all right

from a standpoint of accuracy; but I fear that in a majority of shops, it would be too fine a tool to suit the foreman, who is naturally supposed to be anxious to do things in a hurry. I recall one such foreman, from whom I received many a good lesson on economy and rapid production, and one of these was on how to locate a shaft with the cutter when milling a spline or key-seat. This method works equally as well on a planer as on a milling machine. After the shaft and the tool or cutter is in place, start the machine and either plane or mill a flat spot across the top of the shaft as wide or a trifle wider than the key-seat; then set the tool by this finished surface. For example, when a shaft is to be set central with a milling cutter, the latter is first sunk into the work as shown in the accompanying engraving. The shaft is then fed crosswise under the cutter and a spot milled as indicated by the dotted lines in the plan view. After this spot is milled a trifle wider than the width of the cutter, the work may be set by sighting down over the top of the cutter and adjusting the work until the same amount of



Method of Setting a Milling Cutter Central with a Shaft

milled space shows at A and B. The cutter should be revolving while this adjustment is being made so in case it runs out laterally, the high sides will appear at the bottom in such quick succession that it may be set the same as a true running cutter. After the first shaft is located, the operator should not move the cross-feed screw until all of the shafts are finished. Of course, on the planer the locating spot will have to be machined for each shaft. This should not be done by feeding down a broad nose tool, for while any kind of a tool may be used, it must be fed crosswise in order to finish a surface which is parallel with the planer platen. I have used this method for years and find it satisfactory both in regard to time and accuracy. Therefore I pass it along hoping that it may be of help to someone.

Bridgeport, Conn. H. E. Wood.

ACCURATE BORING ON THE HORIZONTAL BORING MILL

Among the standard tools of to-day in most machine shops is found the horizontal boring mill, and although not as old as the lathe, planer, and some others, it is equally as necessary on some classes of work as these older and more standard tools; but in operating this tool the workman generally finds great difficulty in obtaining an accurate hole of a very great length, especially if the equipment, including bars and guide bushings, are not absolutely new, in addition to being accurate. A simple equipment that is generally used is shown in Fig. 1. The bar A is made of annealed tool steel, and the cutter B is held in a central position by the wedge C and a fitting on either side of the bar. The bushing D is bored to fit the bar and turned to suit the hole in the yoke of the machine. This bushing is held in the yoke by two set-screws which are spotted into it to prevent any slipping or turning without subjecting the bushing to any great strain. Here lies the chief difficulty to which the writer desires to draw particular attention, and acquaint the reader with a very desirable and successful remedy.

As the bushing is always in the same position, a large portion of the wear comes on the bottom. This wear, in turn, allows the cutter to run closer to the table as it proceeds away from the machine until it reaches the yoke; then the work receives the full benefit of the worn or inaccurate bushing and a hole is produced which is not parallel with the table and of an elliptical shape, the vertical axis being the longest because of the play the bar has in the bushing. Even when the bushing is made a suitable running fit, a hole will show

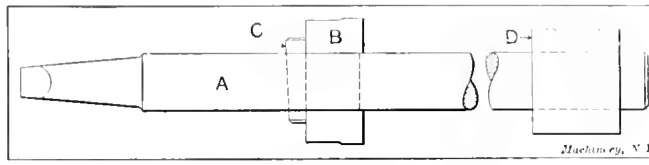


Fig. 1. Boring-bar with Solid Bushing

from one to four one-thousandths difference between the horizontal and vertical axis. From the foregoing it is readily seen that the object required is to maintain the bar in a perfectly central position with the spindle at all times, just enough freedom being provided to allow the bar to turn.

Fig. 2 shows a form of split adjusting bushing which is very old in principle, but which produces excellent results in this case. The outside bushing A is turned to suit the hole in the yoke of the boring mill, and it is bored parallel to receive bushing B which, in turn, is bored taper to receive bushing C, the inside of which is bored parallel to the exact size of the bar. This inner bushing is split in three parts. Two washers or end plates D are required, whose bore is 1/16 inch longer than largest bar; these are each secured to bushing A by four tap bolts, as shown, and they are also drilled and tapped for two set-screws E, which bear against bushing B. Two of these set-screws are required on one end for tightening and two on the other for loosening bushing B.

The pressure sometimes applied on these set-screws is enough to nearly burnish the bar with heat, when a particularly fine finish is required, so that the allowance for a running fit is reduced to an absolute minimum, and the resulting cut will be just as true as the machine, less the wear of the

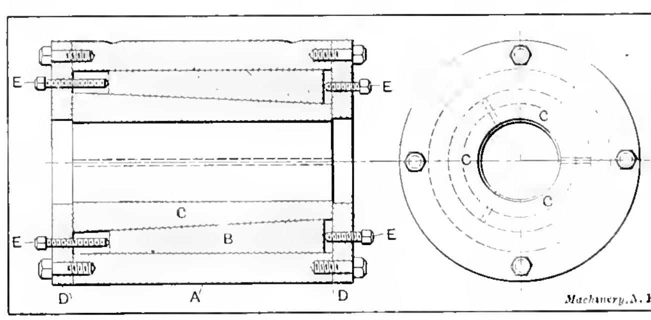


Fig. 2. Split Adjustable Bushing for the Boring-bar

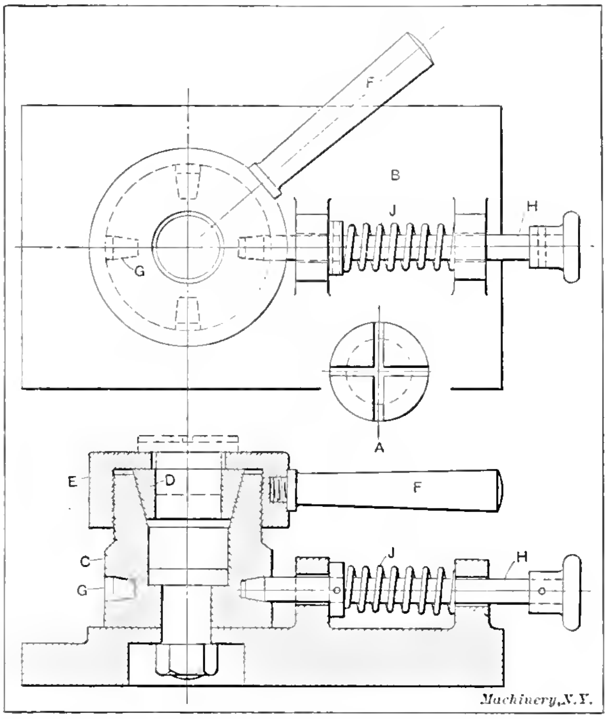
tool, which will vary slightly according to the quality of the steel in the tool compared with the material being cut; when these both agree, accurate work will result. The construction of the device is not confined to any set dimension or taper, but it is preferable that the taper be quite abrupt to obtain quick adjustment, to allow for a large take-up for wear, and to obviate too much of a wedging effect. The different diameters of bars are taken care of by having a number of split bushings C, the inside diameters of which correspond with each bar.

R. S. F.

MILLING FIXTURE FOR SMALL CYLINDRICAL WORK

A chuck for holding a small plug, a plan view of which is shown at A, while grooves are being milled at right angles across its upper face, is shown in the accompanying engraving. This chuck consists of a base B which is fastened to the milling table. On this base is pivoted a cylinder C which is threaded on the upper end, and turned tapering on the inside to receive a conical bushing D which fits the taper of the

cylinder. This bushing is split so as to allow it to be sprung together when forced down by the cover *E* which is threaded to fit the cylinder *C*. This cover is turned by means of the handle *F*. The taper of the bushing and the recess in *C* should be of such an angle that the two pieces will not grip and hold fast. An angle of from thirteen to fifteen degrees is about right. In the lower part of the cylinder *C* there are



Milling Fixture for Holding the Plug shown in the Plan View at A, while the Grooves are being milled

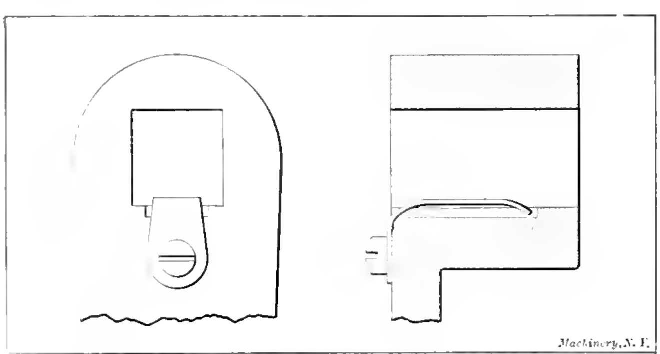
four holes *G* which serve for spacing the cuts. On the base *B* there is mounted a pin *H* which is held in one of the holes *G* by means of the spring *J*.

The operation of the fixture is as follows: By turning the handle to the left, the cover raises and the bushing *D* slips up and expands. The plug is then dropped in place, as shown by the dotted lines, and the handle turned to the right, which forces down the cover *C* and bushing *D*, causing the latter to spring together and grip the plug. A cut is then taken across the top. Then by pulling back the pin *H* and turning the handle *F* to the right until the next hole *G* comes in line with the pin *H* the work is indexed for the next cut. Then the handle is turned to the left again, and the plug released and another inserted.

This chuck could be used for many different kinds of work by having the proper bushings. E. B.

SECURING CRANK HANDLES

The crank handles supplied by many builders with their machine tools, soon find themselves as much at home on the floor as on the squared end of a feed-screw. In the course of



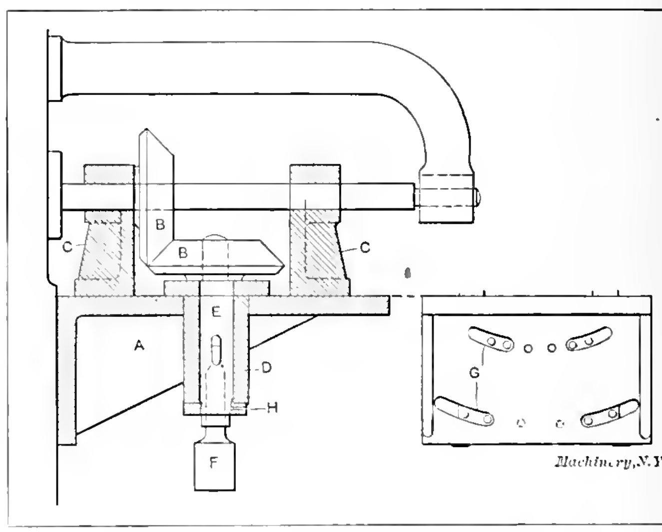
Crank Handle with Pressure Spring which prevents it from coming off

a year, a great deal of time is spent in picking up these fallen handles, to which must be added the cost of new ones to replace those of cast iron which still are sometimes foisted upon us. Half an hour's work will fix any handle so that it will not fall off. As seen by the illustration, a small groove is chipped part way through the hole for the squared end of the screw, and a bent flat spring is fastened to the handle. Unless the handle is very loose on the feed-screw, the spring need bear on the latter with but little pressure to keep it in its place. Then it can be slipped on and off almost as readily as without the spring, when it is necessary to do so to place it in a convenient position.

Middletown, N. Y. Donald A. Hampson.

MAKING A VERTICAL MILLING ATTACHMENT

Much has been done of late years in the way of developing the vertical attachment for milling machines, as this little attachment permits one to do a great variety of work. There are, however, thousands of milling machines in the field today which do not possess one of the model up-to-date vertical attachments, and therefore I shall give a brief description of how one of them was made in a rush one day when the occasion demanded it. As the draftsman and patternmaker both happened to be on a vacation, it fell to me to rig up the attachment with the things I had at hand, which I proceeded to do by retiring to the casting house, where the two brackets *C* and the flanged casting *D* were found. After some more rooting around the shop I dug up an old pair of miter gears that had been discarded from an experimental job. Then, taking one of the regular angle irons *A* away from a planer, I proceeded to lay out and cut the radial slots *G* shown in the end view. These were to allow the vertical



Vertical Milling Attachment made from Miscellaneous Scrap

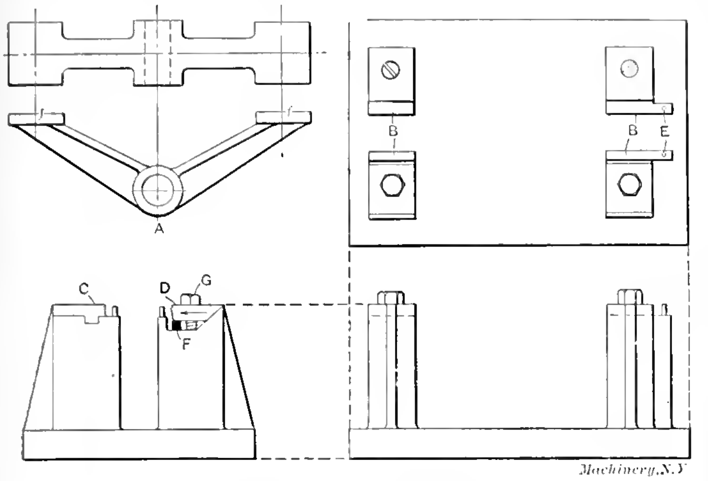
spindle to be tilted. During the time this was going on, another man was boring out and turning the casting *D*, but to no particular size, just enough metal being removed to clean it up. The feet of brackets *C* were also planed. The angle iron *A* was put on a drill press and drilled and bored to a driving fit for bushing *D*. The spindle *E* was next made, from a piece of scrap shaft, to match casting *D* and gear *B*, and then collar *H* was made to suit the spindle. When this was done, we were ready to assemble. To do this it was necessary to drill several holes in this milling machine column, and right here is where many of the machine owners and old-school mechanics would have objected and said: "Don't drill any holes in that machine; every hole you drill knocks $10 from its value if you ever want to sell it." Now let me say to them that a machine is in a shop for the purpose of earning all it can for the owner, and it is not an ornament to be kept nice so that it will sell for $19 more some day. Therefore it is up to the foreman to get all he can out of every machine, but of course he has no right to needlessly destroy it. Then again, in this particular case, the vertical attachment would add ten times more to the value of the machine than the holes could possibly take off. When assembling the attachment a makeshift boring-bar to bore out the castings *C* was used. We had to bore the holes larger and bush them down to match our regular arbor; the gear *B* had also to be bushed down. This article is offered in hopes that it may possibly suggest to someone else a method of getting around some of their milling machine troubles. Of course we know

that vertical attachments usually come now with new machines, but nevertheless there are thousands of milling machines without them, the owners of which do not care to expend the amount of money that one of them costs.

Bridgeport, Conn. H. E. Wood.

A SHAPER FIXTURE

The engraving shows a shaper fixture used for holding the bracket *A* while the feet are being planed, as indicated by the finish marks *f*. This bracket rests upon the surfaces *B*, and it is held in place by jaws *C* and *D*, and the pins *E*, which prevent the thrust of the cut from shifting it endwise. The steel stationary jaws *C* are held in place by a tongue which is re-



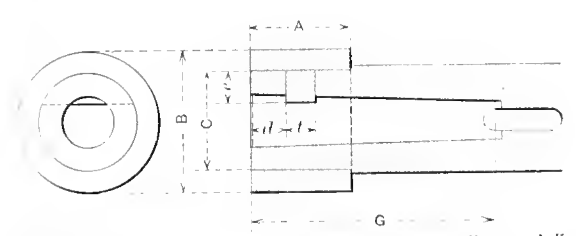
Shaper Fixture for Holding a Bracket

cessed into the jig body, and by the fillister head screws as shown. The steel jaws *D*, which are finished on one end to an angle of 45 degrees, are forced against the work by tightening the cap-screws *G*. The inside ends of the jaws *D* rest upon stationary blocks *F* of solid rubber. Both sets of jaws are hardened, and the working faces are serrated. This forms a very simple but effective way of holding the bracket, as the jaws *D* will have a downward and an inward movement when they are tightened, which, with the serrated faces, will cause the bracket to be gripped firmly. Jig and Tool Designer.

DRIVE FOR DRILLS AND REAMERS

Recently there have come upon the market several devices that are designed to eliminate the tang troubles commonly experienced in connection with the use of Morse standard

DIMENSIONS OF SOCKET AND KEY FOR MORSE TAPER SHANKS WITH FLAT SIDE



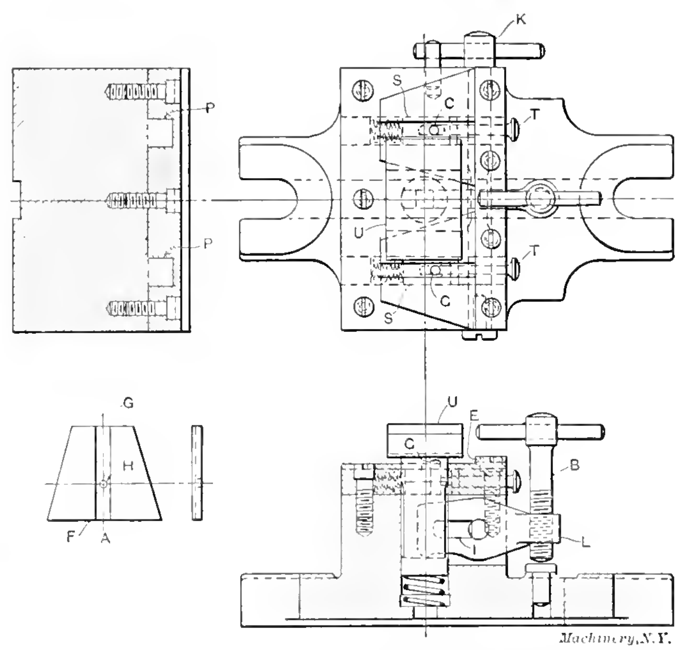
Taper No	A	B	C	G	d	t	e
1	7/8"	1 1/4"	7/8"	2 1/8"	5/16"	1/4"	9/32
2	1 [illegible]	1 3/4	1 [illegible]	2 9/16	1/2	5/16	7/16
3	1 [illegible]	1 3/4	1 [illegible]	3 3/16	1/2	[illegible]	5/16
4	1 [illegible]	2 1/4	1 1/4	4 1/16	1/2	[illegible]	13/32

taper shanks on drills and reamers for severe service. The apparent demand for some method to increase the strength of taper shanks suggests that a device which has been in use for a number of years in the factory where the writer is located, may be of interest. The accompanying engraving and table, taken from the writer's notebook, gives the dimensions of standard Morse sockets fitted with a key, which engages with a flat side on the drill or reamer shank. This key is inserted by milling a slot across the socket near the end, so that the slot will cut through into the tapered bore. A piece of flat steel, or a Woodruff key, is driven tightly into this slot, and then the outside of the socket, including the projecting part of the key, is turned off for a short distance from the end, and a steel collar driven over it. This collar retains the key in place and reinforces the socket. The shanks of the drills and reamers are milled flat on one side so as to fit against this key when driven into the socket. For milling the shanks so they will be interchangeable, master shanks are used, which are put on centers in the milling machine and used to set the milling cutter by. The master shank is then removed and the tool to be milled put on centers and milled with the tool setting obtained from the master shank. The flat on the side of the shank is milled parallel to the axis of the shank. For use in connection with the sockets described, the shanks are made without any tang upon the end, but in all other respects they are made according to the standard Morse tapers. As stated, this device has been in use for a number of years and the results are satisfactory. Bruce C. McAlpine.

Jackson, Mich.

EFFICIENT TYPE OF MILLING FIXTURE

The fixture shown in the engraving was designed to mill the groove *G* in the work which is shown at *A*. This groove is 0.187 inch wide and 0.042 inch deep, and it is necessary that it be central with the hole *H* and at right angles with the face *F*. The fixture was designed to hold two of these pieces at one time. It is composed of a cast-iron base on



Milling Fixture with Efficient Locating and Clamping Devices

the top of which is a steel plate held by fillister-head screws and located by the tongues *P*. These tongues or projections are cut away in the center, and into these spaces are fitted the slides *S* which carry a centering pin *C*, which fits the hole in the work. The slides, by means of the compression springs behind them, force the face *F* of the work against the shoulder *E* thus locating this face at right angles with the feed of the table. When the pieces are being placed over the pins *C*, the slides *S* are operated by the thumb-plungers *T*. The T-clamp *U* holds the two pieces of work, one on each side. It is operated by screw *B* through the lever *L*, and a spring underneath keeps it up when no work is in the fixture. The shaft *K* upon which *L* fulcrums extends through the fixture and it is milled flat on opposite sides at a point where it passes through the lever, to a little less than the width of slot *I*. When this shaft is turned 90 degrees from the position shown, these flat sides are in alignment with this slot and the lever can then be pulled out clear of the clamp so that the latter may be lifted out of the fixture. The advantages of a clamp of this style are that it can be quickly removed, thus making it easy to brush away chips. The milling arbor can also be brought close to the work, thereby allowing the use of small cutters when necessary.

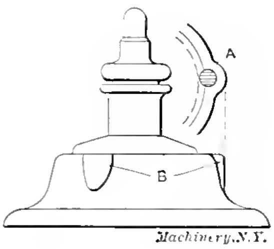
Athol, Mass. W. A. Sawyer.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

HOLDER FOR THE INK BOTTLE



The ink-bottle holder illustrated in the April number of MACHINERY is very similar to one brought out and patented in Scotland some three years ago, the difference being that instead of using a retaining spring to hold the bottle, round india-rubber inserts are used instead. These rubber retainers are inserted as shown at *A*, the bosses *B* on the side of the base being drilled to receive them.

BOTTLE HOLDER.

SCRIBER FOR SMALL HOLES

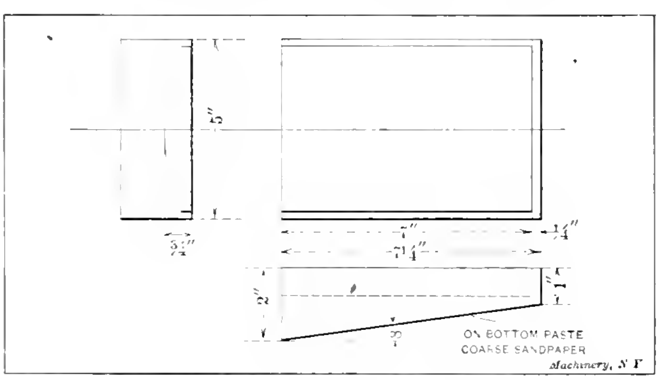
It is sometimes necessary to scribe holes in places where an ordinary scriber cannot be used, as through holes 1/16 inch diameter in a thick piece of metal. I overcame this difficulty by using a jewelers' pin-vise, with a darning needle held in it for a scriber. The darning needles used are about four

inches long and 0.040 inch in diameter. These needles cost five or six cents a dozen and they can easily be replaced when one is broken or dulled. I have shown this scriber to fellow tool-makers, and it is readily adopted wherever shown.

Passaic, N. J. L. ROSENTHAL.

DRAFTING TABLE PENCIL-HOLDER

The pencil holder shown in the illustration may be made of either wood, or aluminum. A very pretty effect is secured by making it of ½-inch strips of maple and cherry alternating. As an eight degree tilt is a convenient one for a table, this holder is made with the same angle so as to keep the



pencils from slipping out. By having sandpaper on the bottom, it can be used on a table that is considerably tilted by turning it around and having the cleat down. Most all draftsmen are subject to annoyances arising from having their pencils and pens scattered all over the table; this holder, as can readily be seen, will remedy that.

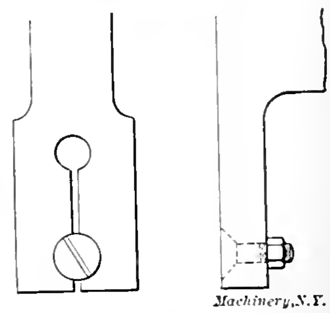
Three Rivers, Mich. E. G. PETERSON.

RESTORING OVER-EXPOSED BLUE-PRINTS

The average drafting office cannot keep a boy constantly making prints, and, consequently, when the boy is started tracing and intends to keep an eye on the printing frame, the print is often sadly neglected. Finding that in time this waste of paper was quite an expense item, we bought a quarter pound of potassium bi-chromate (a reddish crystal), dissolved it in a gallon of water, and placed the solution in a tray beside the wash tank. If a print is overexposed or "burned," it is first placed in this solution and then washed in clear water; in this way we seldom lose a print because of overexposure. It is, of course, possible to so burn a print that it cannot be bleached, but the ordinary burn of from two to ten times the required exposure, responds to the above treatment. The solution keeps indefinitely, if a few crystals and also water are occasionally added when required.

Rochester, N. Y. RALPH W. DAVIS.

ADJUSTABLE SLOT-FINISHING TOOL

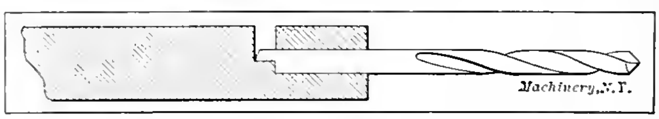


The accompanying engraving, which is self-explanatory, shows an adjustable slot-finishing tool for the planer. When much of this work is done, the dulling of the side edges will, in a few days, cause the tool to cut small, which, when the slots have to be exact, can be only remedied by forging. An adjustable finishing tool like this one will stay out of the blacksmith shop a dozen times as long as a solid tool.

Middletown, N. Y. DONALD A. HAMPSON.

AN EXTENSION DRILL

The accompanying illustration shows a way of making small extension drills, that may be new to some. In the extension rod a hole is first drilled which is a snug fit for the shank of the drill to be used. Then, after measuring the depth of this hole and marking it on the outside of the rod, a slot is filed at the farther side of the mark half way through the extension rod, so that it just meets the bottom of the hole. This slot should be approximately as wide as the diam-



eter of the drill. Next, the shank end of the drill is filed to the center for a distance equal to the width of the slot. After the drill is pressed into the extension rod as shown, it is ready for use. In this way an extension drill can be made much more quickly than by the old soldering method, and after using, it may be easily pulled apart without injury to the drill. CHESTER L. LUCAS.

East Saugus, Mass.

TO REMOVE BROKEN WOOD SCREWS AND NAILS

Perhaps nothing is more exasperating to the amateur wood worker than to have a wood screw break in hard wood just before it is screwed home, or to break off a nail where another nail must be driven. Such accidents are particularly provoking to a machinist. His experience on metal work is not of much assistance to him in overcoming such dilemmas, and to such the following kink is worth description. Secure a brass or steel tube slightly larger than the shank of the broken screw. File teeth in the end and give them the proper set, bending alternate teeth out and in. You thus are equipped with a hollow drill, which can be slightly squared at the other end to fit a carpenter's brace. With this tool the wood surrounding the broken screw can be trepanned out; the hole should then be filled with a plug of the same wood set in glue. After the glue has set a hole can be bored and a new screw can be put in, and no one will be the wiser.

M. E. CANEK.

* * *

The principal buildings, bridges, and other municipal structures of New York will be ablaze with lights during the Hudson-Fulton celebration. All bridges and principal buildings are outlined with rows of eight-candle power electric lights, and 1,500,000 lamps have been strung. The incandescent lights alone amount to 12,000,000 candle power, and will require about 42,000,000 watts or 56,000 horse-power. Beside the incandescent lamps there will be flaming arcs and other lamps of great power. The illumination will continue every night from September 25 to October 9 from 6:30 to 12:30.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BATH DUPLEX INTERNAL GRINDING MACHINE

An improvement on the duplex internal grinding machine brought out by the Bath Grinder Co., of Fitchburg, Mass., which was mentioned in a note in the April, 1909, issue of MACHINERY, has recently been placed on the market. This improvement embodies a number of new and interesting features which are illustrated in the accompanying half-tones, Figs. 1 to 4 and in the line engraving Fig. 5. This machine is distinctly a new departure in internal grinding machines, and places internal grinding on as practical a basis as that which external grinding has achieved during the last decade.

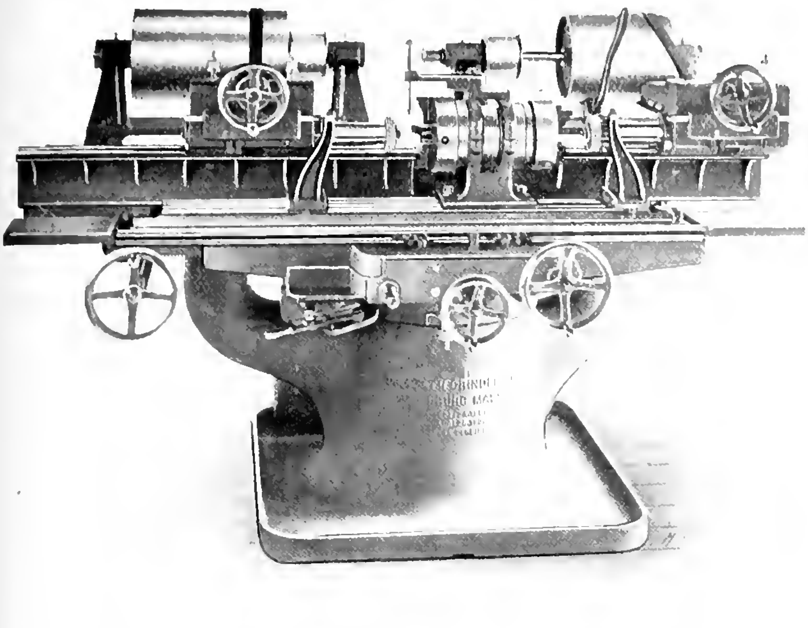


Fig. 1. Bath Duplex Internal Grinding Machine, having Two Wheel-spindle Heads

General Features

The principal advantage of the Bath duplex grinder is that the arrangement of the grinding spindles and the work-holding head or heads makes it possible to gain considerable time in the grinding and gaging of internal work; two pieces can be ground on the machines simultaneously, and it is not necessary to shift the reciprocating slide in order to gage, insert or remove the work. It is possible to use two grinding wheels at once, one operating from each end of the work. It is also possible to use a number of grinding wheels mounted on a supported spindle between the two grinding heads, and to quickly grind the inside of a sleeve or bushing by having one wheel after the other enter the work, the previous wheel, of course, leaving the work before the next one enters. This saves considerable time over the necessity of reversing the reciprocating table for each cut, as is necessary with grinding machines of the common type.

The novel feature which distinguishes this machine, in particular, from other designs, is that the grinding wheels and spindles pass in through the back end of the head-stock spindle as shown in Figs. 2 and 5, instead or running into the head-stock spindle from the front as in other grinders. Internal grinding has commonly been considered as a slow process when a large amount of stock has to be removed, but this objection is effectively overcome by the innovations in this design, and a considerable increase in production has thus been made possible.

Fig. 1 shows the machine set up for grinding bushings held in four-jaw chucks, one chuck being mounted on each end of the head-stock, and the grinding heads, wheels, and wheel spindles being shown one on each side of the head-stock. In Fig. 2 the machine is shown especially fitted up for automobile work, and is set up for grinding the bores of spur gears. In front of the machine on the floor, a variety of work that has been ground on this machine is illustrated.

The spur gear standing on its face in front of the machine is one of the pieces being ground at the moment in the machine. In this case, two head-stocks are mounted on the table, the spindles of these head-stocks being 8 inches in diameter. The object of the large head-stock spindle is to make it possible to grind large work, up to 6 inches in diameter, by holding it inside of the chuck spindle, thereby absorbing and eliminating the vibration and the twisting stresses when the wheel is brought against the work.

In front of the machine to the left of the handwheels is shown the reverse lever. This lever, by being turned one-quarter of a revolution, automatically stops the machine at the end of its stroke, and also reverses the reciprocating slide. The operator does not need to wait to operate the lever until the slide reaches the end of the stroke, but can turn the knob at any time during the stroke at the end of which it is wanted to stop the machine automatically. When the machine is stopped, the end of the work in one of the head-stocks is exposed to view, and is in position to be gaged instantly. To gage the work held in the opposite head-stock, the reverse lever is pushed over, which brings the other head in position to gage. The general relation of work and spindles is plainly shown in Fig. 5. The distance between the two head-stocks is sufficient so that when one of the spindles is in the position shown with the wheel to the right just projecting through the work and head-stock, the work in the other head-stock can be easily removed and a new piece of work mounted in position for operation. It will be also noticed that considerable time is saved by this construction when gaging the work, as it is not necessary to move the reciprocating slide away from the head-stock in order to measure the size, as is

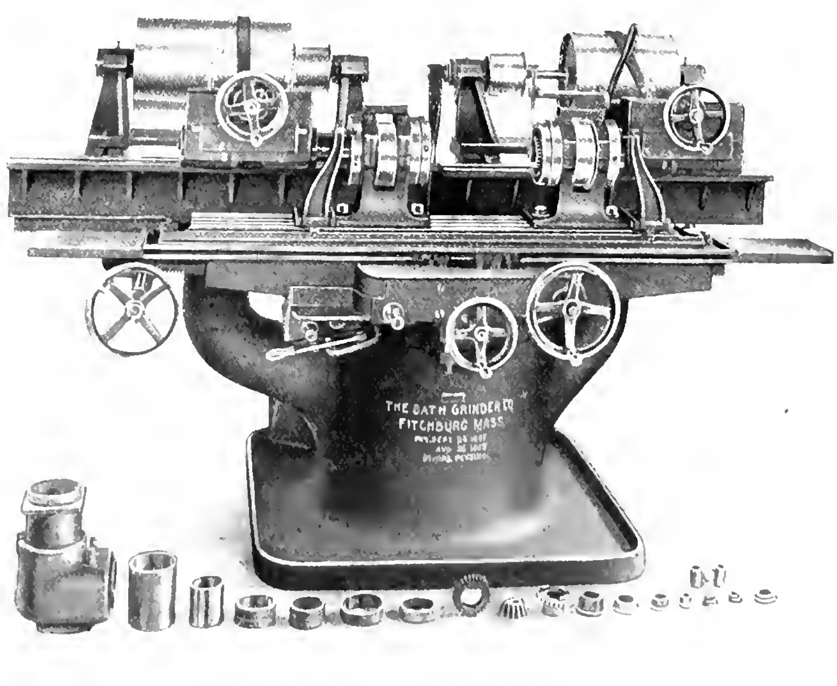


Fig. 2. Bath Internal Grinder Specially Equipped for Automobile Work

required in internal grinding machines of general design; the time consumed in measuring two pieces of work is practically no more than that required for measuring one in a single-spindle machine.

Head-stock and Spindle Heads

The head-stock spindles are driven directly from a drum counter-shaft, the same as in ordinary grinding machines, the only difference being that one belt is, of course, required for each head-stock. The grinding-wheel spindles are driven by a belt from drums provided directly on the machine as shown, the shafts on which these drums are mounted being provided with small pulleys driven directly from the counter-shaft. Thus the complete machine is driven by a two-piece counter-shaft, one for furnishing the power for the wheel-spindles and one for the head-stocks, in a manner similar to that of the ordinary type of grinders.

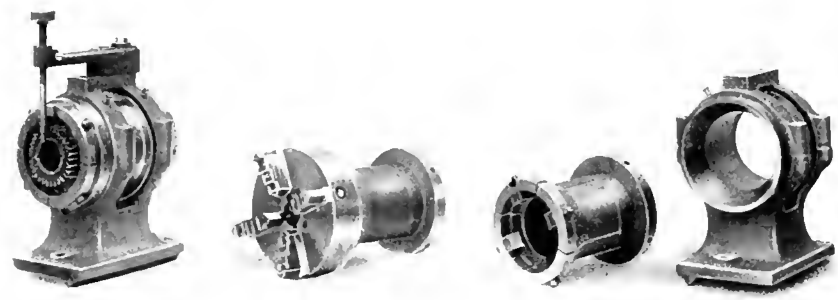


Fig 3. Assembled and Dismounted Head-stock and Parts

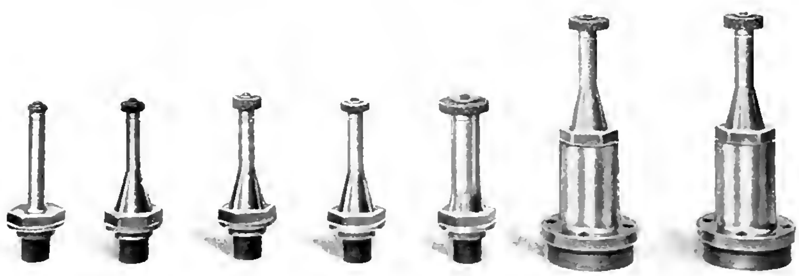


Fig. 4. A Set of Grinding Spindle Extensions for the Duplex Grinder

Each of the grinding-spindle heads is provided with an automatic sizing feed so that the wheels can be fed up to the work independently of one another. The automatic feeds are operated by hinged arms which come in contact with the ends of square rods on the head-stock, thus causing the automatic feed to be operated the same as the power automatic feed on grinders in general. Each spindle-head has a sizing device so that each slide can be set to remove a predetermined amount of stock, and when the required size has been reached the automatic throw-out arrangement disengages the feed. An adjustment is also provided for the variation in the diameter of the wheels.

The spindle-heads are carried on two long narrow slides instead of as formerly on one wide slide. On account of this construction the wheel-head is much more rigidly mounted and the deflection commonly met, due to the pressure of the grinding wheel, is largely eliminated. The narrow slides on which the spindle-heads are carried are mounted on a beam so that the spindle-heads can be placed in position longitudinally instead of moving the head-stock or vice versa.

In Fig. 3 are shown the two head-stocks shown in Fig. 2 with one of the head-stocks disassembled to show the method of holding the spring chucks. The four-jawed chuck is mounted in the same manner. At the outer end of the spring chuck there are four hardened steel jaws, which are detachable and which can be changed according to the diameter or size of work; special chuck jaws may also be furnished for holding either bevel or spur gears on the pitch line. The jaws are ground on the machine so that they are absolutely true with the spindle. The head-stocks shown in the illustrations are for straight work only, but swivel head-stocks of the type shown in Fig. 5 are furnished if required, so that straight or taper work can be ground, the tapers being set at any angle required. As the heads are entirely independent of one another, a straight hole can be ground in one head while a taper hole is being ground in the other. A traveling diamond is mounted on the top of the head-stock for truing the wheel whenever necessary.

The reciprocating slide is run at a speed of from 2 to 12 feet per minute. It has five changes of speed and is operated by a gear box underneath the cross-slide on the left-hand side, as shown in Figs. 1 and 2, and is controlled by a single lever.

Grinding Spindles

In Fig. 4 is shown a set of seven grinding spindles. The set of two spindles at the right, shown mounted on the extension arbor, are the two spindles shown in use in Fig. 2. The other spindles complete a special set furnished for automobile work, having lengths and diameters to suit the work to be ground. The extension arbor is attached to the wheel-head by fillister-head screws. Into this extension is threaded the secondary extension provided with a hexagon head on its end. This extension contains the bearings for the spindle proper, which revolves inside and which is driven from the main spindle by means of a projecting key or tongue on the end, engaging

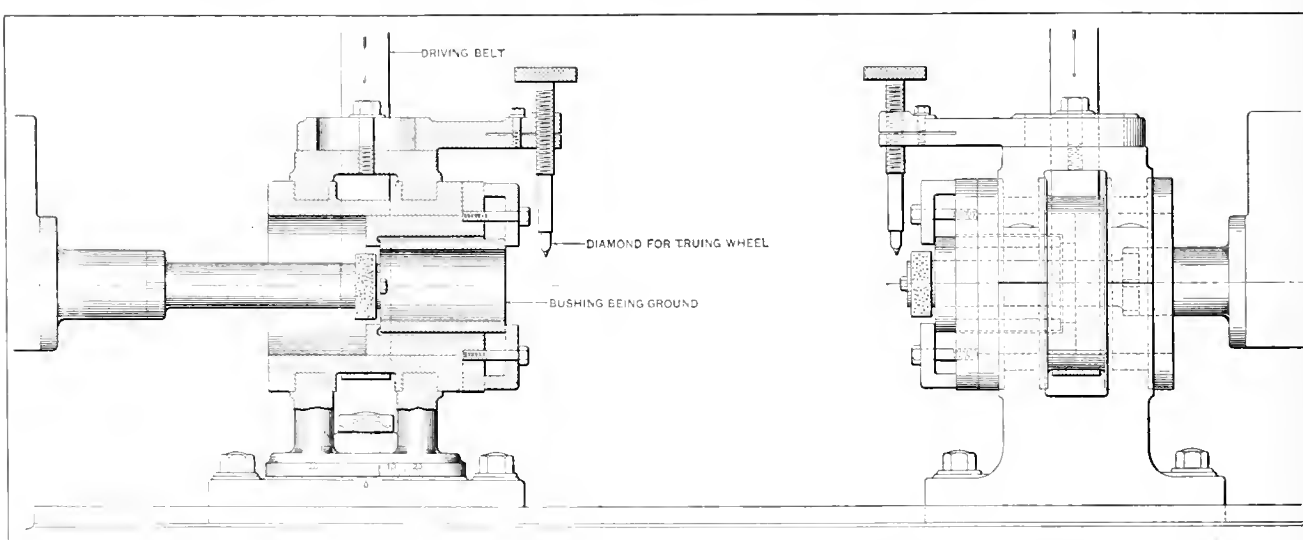


Fig. 5. Section and Elevation of Head-stocks and Work and Relation of Head-stocks to the Grinding Wheels

into a square slot in the end of the main spindle. The hexagon head on the secondary extension is a feature which was provided for special reasons. In changing these spindles, the operator of the machine many times loses the spanner wrenches, and to avoid inconvenience, a monkey-wrench can be used which at the same time assures that the spindle will be tightened up firmly.

The machine is also furnished with a supported spindle that can be mounted at each end in the spindle-heads and on which can be mounted from one to six grinding wheels. For example, in grinding a bushing 2 inches long, the wheels would be spaced apart the length of the bushing, and all six could pass through the bushing before being reversed. Another method that can be advantageously used is to hold the work to be ground in the spring collet and use the two single-ended grinding wheels brought up together and grinding at the same time, removing the stock within 0.001 or 0.002 inch of size. After this is done, one of the wheels can be stopped and the hole finish ground with a single wheel. Still another method advantageously used on this grinder is to employ a coarse wheel on the one head for roughing and a fine wheel on the other head for finishing the same piece of work. Parts like those for pneumatic hammers which have four bearings to be ground concentric with each other can be ground without reversing the work when once mounted, and the work can be gaged from either end of the chuck.

The amount of power consumed by the grinder is 2.7 H. P. By means of a brake provided, it is possible to stop the machine in four seconds with the belts at full speed. The machine in general has been rigidly designed so that it is possible to use larger and wider wheels and remove a larger amount of stock than with former designs.

Some examples of the capacity of the machine may be interesting. Some manganese car wheels having a bore of 3⅛-inch, 6 inches long, were ground in 55 minutes each, removing 5/32 inch of stock with a single spindle from a rough-cored hole. A 15/16-inch hole, 1¾ inch long, can be ground in two minutes with a single spindle removing from 0.006 to 0.008 inch of stock.

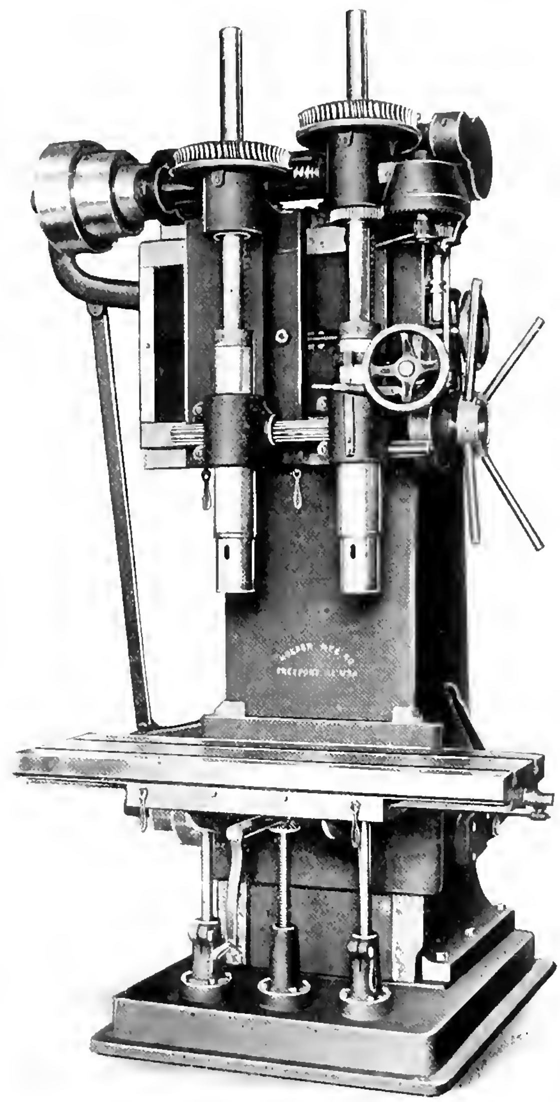
HOEFER VERTICAL TWO-SPINDLE CYLINDER BORING MACHINE

Considerable attention has been given by the Hoefer Manufacturing Co., Freeport, Ill., to the requirements of automobile manufacturers for a satisfactory cylinder boring machine. Such a machine must be able to finish the work both rapidly and accurately, and in order to accomplish these two objects the company has designed a very heavy two-spindle vertical automobile engine cylinder boring machine, an illustration of which is shown in the accompanying engraving.

The two heavy spindle heads are gibbed to a short stiff cross-rail. The right-hand spindle is solidly bolted to the rail and doweled with taper pins, while the left-hand spindle is adjustable by means of a screw operated by a hand-wheel, this adjustment providing for the variations in center distances in different sizes of engines. Tapered holes are provided in the adjustable head so that when jigs have been made for various sizes of engines, these holes can be drilled through into the cross-rail and pins inserted, thus providing positive stops for each size of engine cylinders, and a saving of time in locating the heads for each side.

The bearing of the spindle sleeve is slotted so as to provide for wear. The spindles themselves are made of high-grade crucible spindle steel, chosen with particular regard to its toughness, and are accurately ground so as to minimize the wear and insure the maintenance of accuracy, and are provided with No. 5 Morse taper sockets. The spindle sleeves are bushed with interchangeable phosphor bronze bearings, which can easily be replaced. The thrust bearings are also made of phosphor bronze. The spindles are driven through a pair of large double-threaded worms meshing with phosphor bronze worm-gears, the studs of which are ground and run in copper-hardened babbitt bearings. A substantial key in the driving worm-gear engages in a keyway in the spindle and insures that the drive is ample for any work within the range of the machine. The worms are encased in an oil pan provided with a felt oiler, thus securing sufficient lubrication. An oil pan is also placed under each worm-gear to return any oil to the worm oiling cases. The final drive is obtained through spur gearing and by means of a three-step cone pulley having wide steps for a belt of sufficient size.

A positive gear feed similar to that furnished with the company's regular line of drills is provided. This feed is driven directly from the main spindle, four changes are provided, and the entire gearing mechanism is encased in a feed gear box. The vertical worm is thrown into engagement with the phosphor bronze gear encased in the worm-wheel shell, by means of a small lever directly in front of the operator, and an adjustable automatic stop is provided for the disengagement of the power feed at any predetermined point. A long cross-spindle with teeth cut the entire length drives both spindles uniformly.



Two-spindle Vertical Automobile Engine Cylinder Boring Machine, built by the Hoefer Mfg Co., Freeport, Ill.

The table is made exceptionally deep vertically, to give it the necessary stiffness, and prevent springing when jigs are clamped to it. The bearings in the saddle are large, and proper provision is made for lubrication, the oil holes being in the front of the machine for convenience in oiling. The traverse of the table is obtained by means of a coarse lead-screw or by a rack and pinion, according to the requirements of customers. The table is gibbed to a rigid knee, which besides having ample vertical depth, is also provided with two supports in addition to the elevating screws. The bearings are wide both in the saddle and on the column, and stout ribs resist the twisting strains brought to bear upon the knee when the table is heavily loaded and at the end of the travel.

The method of operating the machine is very rapid and simple. Four units of two cylinders each can be placed in a properly designed jig, and cylinders Nos. 1 and 3, for instance,

are bored simultaneously. Then the table is moved over and cylinders Nos. 2 and 4 are bored. While the process of boring these cylinders takes place, cylinders 5, 6, 7 and 8 are placed in position in the jig. As soon as the work is completed on the first set of two units, the table is set over so that cylinders Nos. 5 and 7 can be bored, and then Nos. 6 and 8. Meanwhile new cylinders are placed in the jig on the opposite end of the table. Thus a practically continuous process of boring is made possible. The method, as described, insures great accuracy in the alignment of the bores.

The total height of the machine from the floor to the top of the column is 110 inches, and the maximum distance from spindle to table 39 inches. The maximum distance from center to center of the spindles is 19 inches, and the minimum 9½ inches, the distance from the column to the center of the spindle being 12½ inches. The vertical feed of the spindle is 19 inches, and the feeds per revolution of spindle are 0.062, 0.125, 0.187 and 0.250 inch. The size of the table is 18 x 56 inches, and the floor space 52 x 58 inches. The net weight of the machine is 8,000 pounds.

THE COIT TWENTIETH-CENTURY BALL-BEARING DRILL CHUCK

The drill chuck shown herewith is made by the Standard Machinery Co., Mystic, Conn. As may be surmised from a study of the parts, shown disassembled in Fig. 2, it is of the type in which the jaws are tightened on the drill by the resistance required to drive it. There is thus no possibility of its slipping, as the drive is proportioned to the work required of it.

The chuck consists, as may be seen, of a taper shank or mandrel (forming an integral part of the tool), a knurled shell or jaw holder free to revolve on the mandrel against a

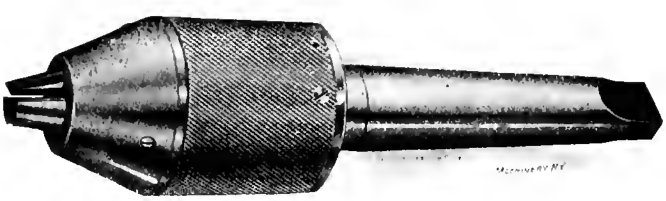


Fig. 1. Coit's Ball-bearing Drill Chuck, made by the Standard Machinery Co., Mystic, Conn.

ball thrust bearing, a collar provided with slots for the heads of the jaws, and the jaws themselves. The parts, it will be seen, are few, simple and of strong design. In operation, the turning of the knurled sleeve of the assembled chuck with its jaws, rotates also, on the threaded mandrel, the collar in which the heads of the jaws are contained. As the collar is thus screwed in or out on the mandrel, the jaws are screwed in or out of the chuck, and thus released or tightened on the work.

The use of a right-hand thread on the shank makes the chuck self-tightening for a right-hand drill. If the drill is barely caught in the jaws, the moment it strikes the work, resistance to turning is offered, and the rotation of the whole chuck sleeve and jaw is arrested. This screws the collar out on the mandrel, pushes the jaws forward, and thus tightens the grip. Any increase of resistance, accompanied by a corresponding slippage of the sleeve, is met by an immediate strengthening of the hold.

In spite of this positive drive, the operator can release the drill with a gentle twist on the knurled sleeve. This easy release is made possible by two things: first, the use of the ball thrust bearing; and second, the small diameter of the thread by which the adjustment is effected. This small diameter reduces the friction, and thus prevents jamming the chuck, no matter how strong the drive. It is, in fact, the practice of the workmen, in using this chuck, to insert and remove drills while the spindle is running, at all except the highest speeds.

Attention should be called to a number of points in the general design of the chuck. The end of the mandrel has a bearing in the sleeve, making a stiff unyielding journal for the turning of the one on the other. The jaws seal the only possible entrance for grit and chips into the interior, which is thus protected from injury and wear. One application of oil will last almost indefinitely. The mandrel is a part of the chuck, and is sold as such, so the expense of making it is saved. It will be furnished with any suitable taper, or with a straight shank. The separate jaws can be removed or inserted without taking the chuck apart.

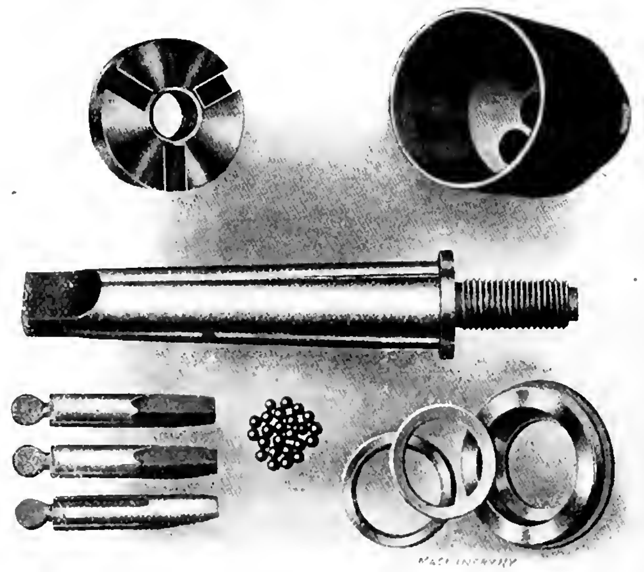


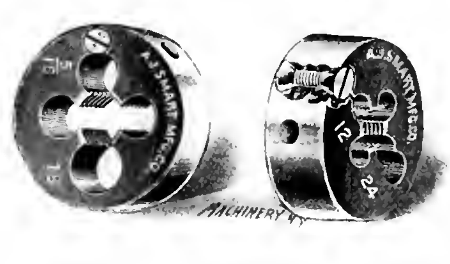
Fig. 2. Chuck Disassembled, showing Parts and Simplicity of Construction

Perhaps the most valuable feature of a tool of this kind is the saving of the drills. Since there is no slip, the shanks are protected from marring and stripping, and their useful life is greatly lengthened. It is possible to drill to a reasonable depth also with an old, short drill, as a very short drive in the chuck jaws does as well as a longer one.

These tools are made with great care, to judge from what can be seen on a visit to the factory. Special pains are taken to make them accurate and interchangeable. Five sizes comprise the complete line, ranging as follows: No. 1, 0 to 13/64 inch; No. 2, 0 to 21/64 inch; No. 3, 0 to 17/32 inch; No. 4, 1/16 to 3/4 inch; and No. 5, 5/16 to 1 inch.

SMART ROUND ADJUSTABLE DIE

The accompanying engraving shows the design of a line of improved round adjustable dies made by the A. J. Smart Mfg. Co., Greenfield, Mass. The dies are sawed through on one side as usual, while the opposite side is drilled out and spring tempered, leaving but a small portion of the metal. As seen from the illustration, the adjustment of this die consists of a taper-headed screw, provided with the required de-



Round Adjustable Die of Improved Design, made by the A. J. Smart Mfg. Co., Greenfield, Mass.

gree of taper to insure a quick and positive adjustment. This screw enters into a cone-shaped nut of the same taper as the head of the screw. When the screw is turned to the left, the head will rise relatively to the nut and the spring temper causes the die to close, thus making it cut a smaller size. By turning the adjusting screw to the right, the screw enters further into the nut, and on account of its taper head, it spreads the die open so that it will cut a larger size. One of the principal advantages of this die is that it can be adjusted from the face without being removed from the holder in which it is used. These dies are made with 13/16, 1, 1 15/32, 1 1/2 and 2-inch outside diameters.

NEWTON TWO-SPINDLE LOCOMOTIVE FRAME DRILLING MACHINE

The accompanying half-tones, Figs. 1 and 2, illustrate a new design of two-spindle drilling machine recently brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine has been designed with the object in view of giving it sufficient range and flexibility of operation for work on parts for all sizes and types of locomotives, and is, in addition, particularly adapted for drilling the holes in locomotive frames.

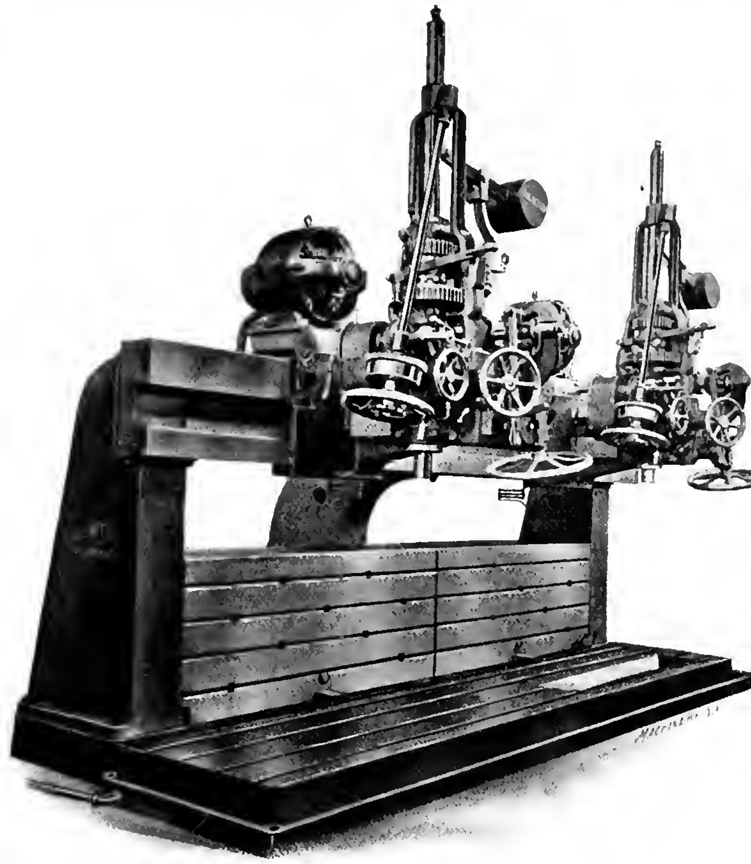


Fig. 1. Front View of Newton Two-spindle Locomotive Frame Drilling Machine

The spindles of the two drilling heads are 4 inches in diameter, and have an automatic geared feed of 18 inches, and a vertical adjustment of the same amount through direct connected gearing for the fast hand traverse, and through a worm and worm-wheel operated through a friction clutch for the slow hand adjustment. The range of the spindle speeds is from 28 to 456 revolutions per minute, and four changes of feed are obtainable, being, respectively, 0.0078, 0.0126, 0.0156, and 0.0225 inch per revolution of spindle. The spindle sleeves have a length over-all of 48 inches. The lower part of the sleeve bearing is in the head or saddle proper for a length of approximately 28 inches; this eliminates all unnecessary overhang. The spindle sleeve revolves in brass bushed bearings of ample dimensions, and the top of the sleeve is supported in brass bushed bearings in the rack sleeve yoke.

A departure from the common design of the driving mechanism lies in the fact that the spindle sleeve carries the clutch gears by which it is driven, and also the clutch for their engagement. The spindle is counter-weighted and is provided with a roller thrust bearing at the bottom of the rack sleeve. It is provided with a taper hole to take No. 5 Morse taper shank. Fast reversing traverse is provided for the saddle on the cross-rail by means of a double train of bevel gears and a clutch. A horizontal adjustment of the saddle is obtained by hand by means of the hand-wheels shown at the bottom of the arms in Fig. 1. The minimum distance between the centers of the two spindles is 4 feet, and the maximum distance 15 feet.

The spindles are driven by individual 10 horse-power electric variable speed motors, the speed variation being from 300 to 1,200 revolutions per minute. The motion is transmitted from the motor shaft to the horizontal driving shaft by spur gears. On the driving shaft is mounted a double train of bevel gears, and from here the power is transmitted to the vertical shaft on which the spur back-gears are mounted, giving two changes of speed in addition to the range of speed changes of the motor. The bracket on which the motor is mounted is cast solid with the arm, this giving a very rigid construction, which is, in particular, required when subjecting the machine to the heavy strains occurring when using high-speed steel drills.

As will be seen in Fig. 1, the gears controlling the feed mechanism are mounted in a gear box, the different combinations being engaged by a key controlled by a small hand lever, as shown. Lateral hand adjustment is provided for the spindle saddle on the arm, the range being from a minimum distance of 6 inches to a maximum distance of 24 inches from the face of the cross-rail to the center of the spindle. The arm has two bearings on the top of the cross-rail, these being removable for renewals and provided with brass taper shoes to compensate for wear. The cross-rail is of the box type construction and is of very heavy ribbed section.

The machine is furnished with two adjustable tables for holding the work, each being 30 inches wide by 36 inches high by 7 feet 6 inches long. These tables are of box type construction, having vertical and horizontal working surfaces provided with large T-slots for clamping the work. The machine is also provided with a floor plate, the front part of which is provided with T-slots and which provides for a work table 39 inches wide by 17½ feet long. This work table is entirely surrounded by an oil pan for receiving the lubricant. The bed plate also supports the three heavy uprights which hold the cross-rail. The upright in the center is of special construction in order to permit the two adjustable work tables to be adjusted or moved entirely out of the way, when the lower table is used, as shown in Fig. 1. In Fig. 2 are

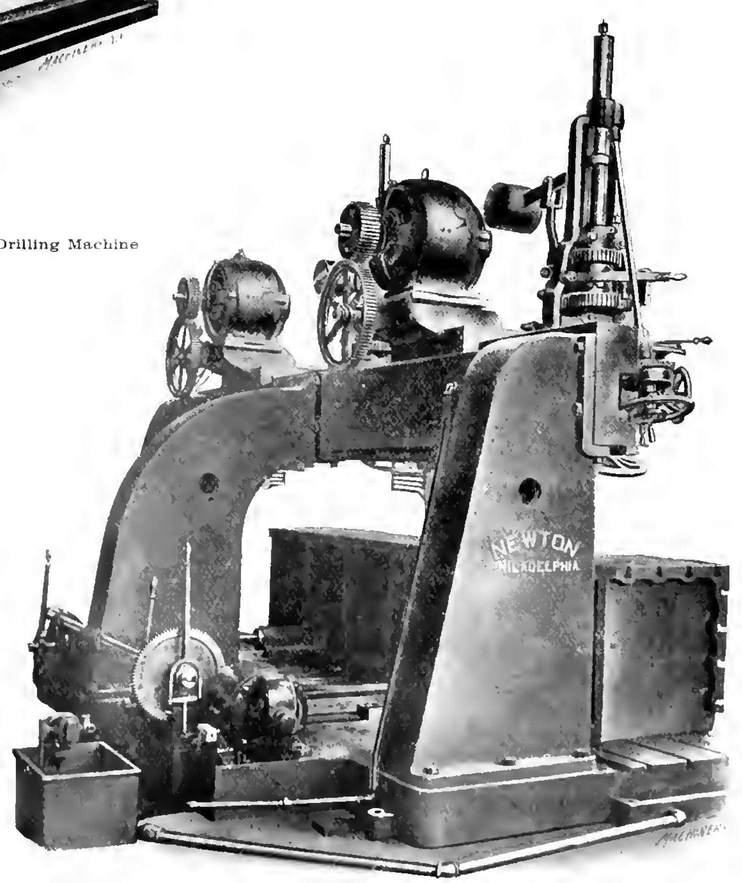


Fig. 2. Rear View of Newton Two-spindle Drilling Machine, showing Motor which operates the Adjustable Work Tables

shown the coarse-pitch screws provided for adjusting the work tables. The motion for this is transmitted through individual worms and worm-wheels from a five horse-power General Electric motor. This design permits of either simultaneous or independent power adjustment of the work tables. A pump, piping, and oil tank are also provided with the machine, as shown in Fig. 2. All bearings on the machine are bronzed bushed, and all gears are made either of steel or bronze.

The drilling mechanism is of the same general design as that provided for the radial drilling machines made by the Newton Machine Tool Works, with which it is possible to drill three-inch diameter holes at the rate of three inches per minute when using a flat twisted drill. Smaller diameter drills can be driven at a much higher rate of speed, in proportion. The maximum distance from the floor plate to the end of the spindle is 81 inches and the minimum distance 64 inches. The machine occupies a floor space of about 19 by 20 feet.

NOS. 3 AND 3A CINCINNATI AUTOMATIC GEAR-CUTTING MACHINES

In the May, 1908, issue of MACHINERY, we described an automatic gear-cutting machine built by the Cincinnati Shaper Co., Cincinnati, O. The making of this machine has since been transferred to the Cincinnati Gear-Cutting Machine Co., of the same city, which has brought out the smaller-sized

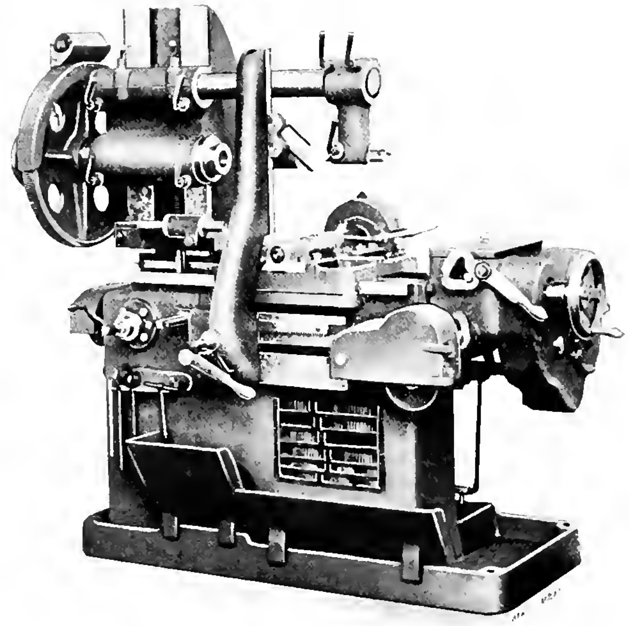


Fig. 1. A New Cincinnati Gear-cutting Machine, of a size well adapted to Automobile Work

tool illustrated herewith. This is made in two heights of column, giving maximum diameters of 26 inches and 36 inches respectively, for gears having any width of face up to 10 inches. It will be seen to be particularly adapted in its dimensions to automobile work, as well as to the general run of small and medium machine work.

The main features of the original design are retained. The machines are noticeable for their strength and simplicity. In the matter of rigidity attention is called to the carrying of the ways for the cutter slide beyond the column, and to the locating of the spindle bearing in the middle of the cutter slide. Fig. 3 shows the cutter slide turned bottom up, and gives a good idea of the construction of the full length taper gibs used. The principle of broad bearing surfaces with grinding surfaces located near together, is employed. The same principle applied to the work saddle prevents it from dropping out of parallelism when the clamps are loosened, to adjust the work to the required depth of cut. This adjustment is effected from the front of the machine, and is provided with a graduated index reading to one-thousandth of an inch.

The dogs for controlling the movement of the feed-slide are adjusted from the front of the machine, being mounted on threaded rods at the rear, connected by bevel gearing with crank-shafts at the front. A retractable tappet for these dogs is provided, so that the slides can be run to the extreme back position, for removing blanks without disturbing the setting of the dogs. There are twelve changes of feed. The cutter slide is fed forward and retracted by a screw, controlled by

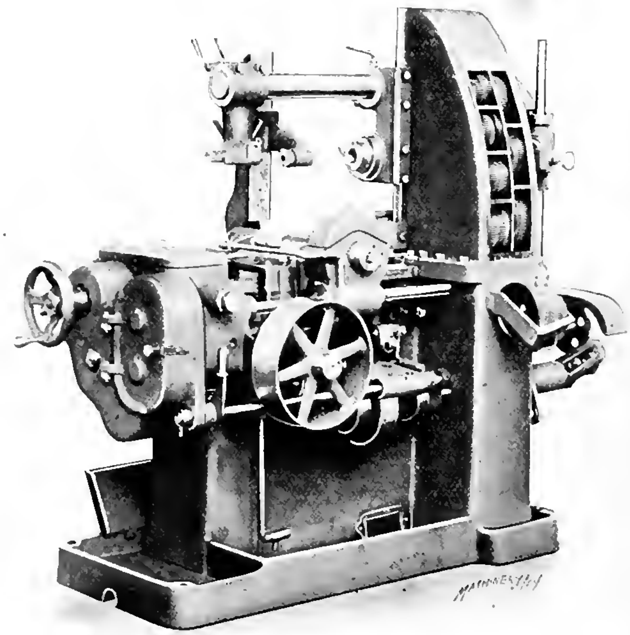


Fig. 2. Rear View of No. 3 Machine, showing Driving Connections

a reversing mechanism which gives a constant return speed, regardless of the feed. Twelve changes of feed are provided.

The cutter spindle shown mounted in its bearing in Fig. 5 is of large diameter, accurately ground and easily accessible for taking up wear. It is mounted in both taper and straight bronze bearings, and is adjustable endwise for centering the

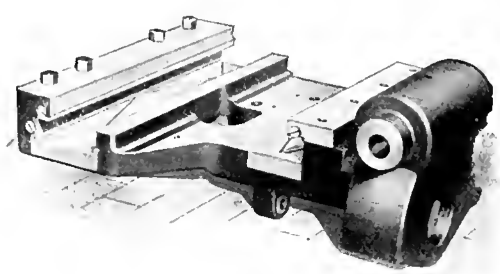


Fig. 3. Cutter Slide Reversed, to show Gibs and Bearing Surfaces

cutter. The drive, as shown, is through a worm and wheel, with means provided for taking up the end thrust of the worm. A removable outboard bearing for the cutter arbor is provided, the latter being drawn into place in the spindle or forced out by a threaded bolt. Six cutter speeds are provided.

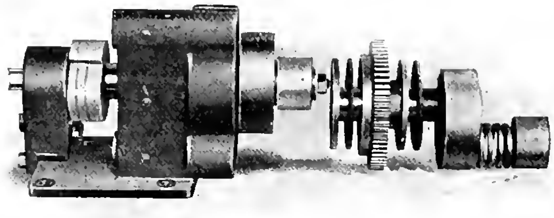


Fig. 4. Friction Stop Mechanism for Indexing; shown Assembled and Dismantled

The indexing mechanism is of unusually simple construction, there being fewer gears in the index train than on any other machine of this type. The motion is transmitted and controlled through a friction operated stop disk, simple and easily accessible. This mechanism is shown in Fig. 4. A spanner wrench is the only tool necessary for adjustment. The index worm can be disengaged from the wheel quickly,

and brought back into the exact meshing depth; or it can be disengaged from the index gears and rotated any desired amount for resetting work, after which it may be again secured. Besides provision for automatic indexing, it may be made to space once or revolve continuously, by a hand movement under the control of the operator. The mechanism is so interlocked with the cutter slide feed that the various movements must of necessity take place in proper sequence, thus making it impossible to spoil work from failure of the mechanism. The change gears furnished cut all teeth from 12 to 100, and all numbers from 100 to 450, with the exception of prime numbers and their multiples.

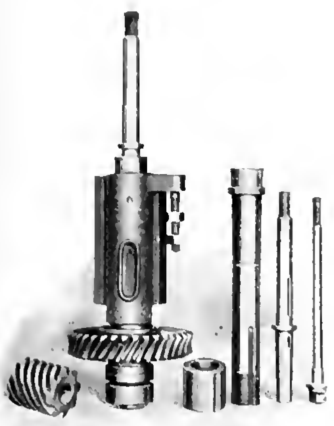
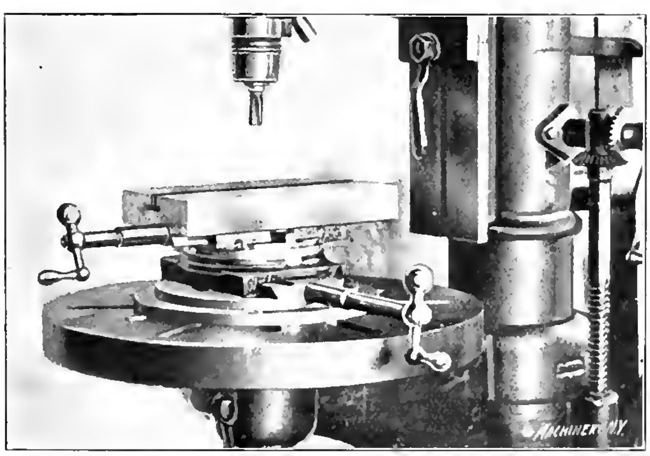


Fig. 5. The Cutter Spindle, its Worm-gear Drive and Axial Adjustment

As may be seen, the work arbor is provided with an over-arm work support, in addition to the regular outboard support. The machine is regularly equipped with a counter-shaft, though if desired it will be furnished with tight and loose pulleys mounted on the initial driving shaft. It can also be arranged for motor drive if desired. This is a very simple matter as all the changes of feed and speed are effected by convenient transposing gears.

DAVIS MILLING ATTACHMENT AND COMPOUND TABLE FOR THE DRILL PRESS

The accompanying illustration shows a useful attachment manufactured by the Hinckley Machine Works, Hinckley, Ill., and known as the Davis milling attachment and compound table for the drill press. This device has been designed with a view to furnishing an attachment for the drill press table which enables milling work, particularly end milling, to be done in the drill press advantageously, when the regular mill-



Milling Attachment and Compound Table for the Drill Press, made by the Hinckley Machine Works, Hinckley, Ill.

ing machines in the shop are tied up with other work, or for use in cases where a regular milling machine is not available. The device is simple in its construction and consists of a circular base which is clamped down onto the drill press table. This base is provided with a dove-tail cross-slide for the saddle, which, in turn, carries a swivel slide, the top of which is provided with a dove-tail into which fits the slide of the table proper. Both the saddle and the table are provided with hand feed adjusting screws having ball-crank handles. The swivel slide is graduated in degrees and can be set to any angle. The table is provided with a ½-inch T-slot longitudinally, as shown in the engraving.

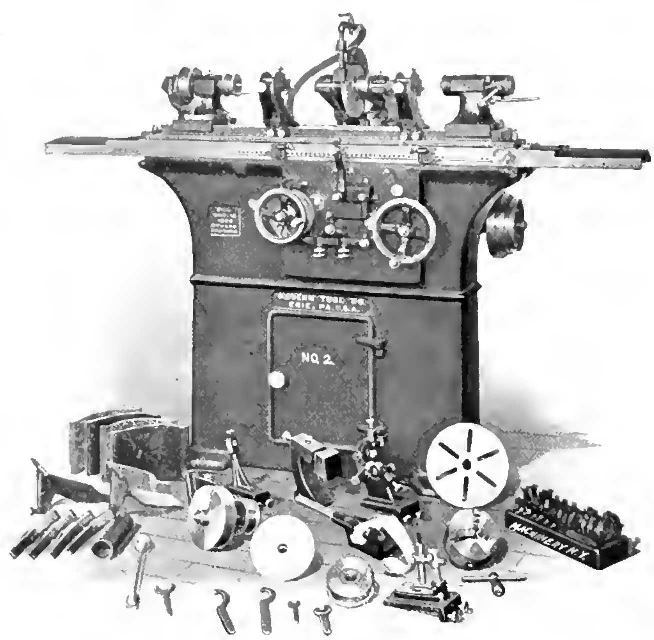
This device should prove a handy attachment for both large and small shops, and in repair shops where a regular milling machine is not available, in automobile garages, etc., it will prove of especial advantage on account of the simple and inexpensive substitute it provides for a regular milling machine.

MODERN UNIVERSAL GRINDER

The accompanying half-tone shows a universal grinding machine built by the Modern Tool Co., Erie, Pa., and designed with a view of placing on the market a heavy and rigid grinder with ample metal for absorbing the vibrations and preventing the ways from springing out of line.

The head- and foot-stock of this grinder are gibbed to the sides of the swivel table, this construction permitting of very large wearing surfaces, and making it possible to compensate for any wear which might occur on the head- or foot-stock. The head-stock is designed to swivel and is provided with a graduated base. The head-stock spindle is hardened, ground and lapped, and runs in phosphor-bronze bearing with means for taking up the wear. The end of the spindle is threaded and has a standard taper hole. Universal rests of new design, of great advantage when grinding long slender work, are furnished with the machine.

The driving and reversing mechanism is completely contained in and supported by a bracket bolted to the outside of



No. 2 Universal Grinder, built by the Modern Tool Co., Erie, Pa.

the machine thus being easily accessible for oiling. If it becomes necessary to take off the bracket, it can be removed by unscrewing four bolts, and the entire mechanism can then be taken to a bench for cleaning or repairs. The wheel spindle is made of tool steel, is hardened, ground and lapped, and runs in phosphor-bronze bearings provided with means for taking up the wear the same as the head-stock spindle.

The table travels automatically, as usual, and is reversed in the common manner, by dogs. The power to the table is transmitted by worm gearing imparting a steady movement, free from jars. The reverse lever is so arranged that the table can be run past the point of reverse without disturbing the adjustment of the table dogs. An automatic cross feed is provided which gives a range of feed from 0.00025 to 0.001 of an inch. The feed can be thrown out automatically when the work has been ground to size. A simple attachment is also provided for fine hand feeds. There is no removable front plate, and the machine is so designed that the mechanism inside the grinder can be removed and replaced if required, without disturbing the alignment of the ways. A diamond tool holder is furnished for truing the wheel.

The machine is made in two sizes, Nos. 2 and 3, respectively. The No. 2 machine swings 9 inches in diameter and takes 26 inches between centers. The table is graduated up to 3½ degrees and 1½ inch taper per foot. This machine takes emery wheels up to 9 inches in diameter and ⅝ inch face. The

weight of the machine is 2,300 pounds, and the floor space required 36 x 94 inches. The No. 3 machine swings 13 inches in diameter and takes 32 inches between centers. The table is graduated up to 5 degrees and 2-inch taper per foot. This machine will take emery wheels 12 inches in diameter, 3/4-inch face, and 9 inches in diameter, 1/2-inch face. The weight of the machine is 4,000 pounds and the floor space required 50 × 125 inches.

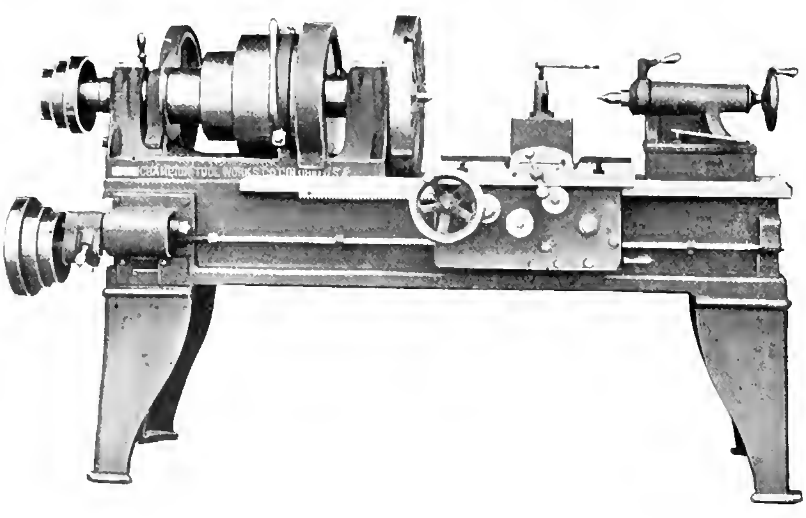
CHAMPION 18-INCH FRICTION BACK-GEARED MANUFACTURING LATHE

The heavy 18-inch lathe shown herewith was built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O., to meet the requirements of the large automobile manufacturers. As may be seen, both drive and feed are belt operated, and the mechanism has been reduced to few but strong parts. No lead-screw for threading is needed or provided. The design has been found particularly successful in heavy manufacturing, requiring rapid reductions.

The spindle is driven by a three-step cone, whose large diameter is 14 inches for a 4-inch belt. The back gears are friction operated, the clutches being of the expansion ring type, operated by a toggle mechanism controlled by the lever shown at the front of the head-stock. This provision allows heavy roughing cuts to be taken at a slow speed, while a reversal of the lever gives the change to high speed for the finishing cut, without stopping the machine. The back gear ratio is 12 to 1. A 1 5/8-inch hole is provided through the spindle.

The feed cones carry a 1 1/2-inch belt. The lower cone is journalled in a swinging frame for tightening the belt, being clamped in position by a screw shown on the under side. An automatic throw-out clutch is provided on the feed rod inside the gear box. It is operative when feeding in either direction, and is controlled by the collars shown on the feed rod, which may be set at any desired point in its length. The feed can be reversed by the handle shown in the lower right-hand corner of the apron.

The lathe is equipped with a heavy plain tool block having power cross-feed. The tool used has a section of 5/8 inch by 1 1/4 inch. The machine swings 19 1/4 inches over the bed, and 13 1/4 inches over the carriage. With a 6-foot bed, it takes 24 inches between centers. The countershaft is driven by 5-inch belts running over 12-inch pulleys, provided with full 12-inch diameter rim frictions. The net weight of the machine with the 6-foot bed is 2,500 pounds.



A Heavy, Simplified 18-inch Lathe, adapted to Rapid Reduction Work

KERN 15-INCH DRILLING AND TAPPING MACHINE

The attractive looking tool shown herewith is a new product of the Kern Machine Tool Co., 4657-4659 Spring Grove Ave., Cincinnati, O. It is especially designed to handle light drilling and tapping in an expeditious manner, being so proportioned and contrived as to combine strength, ease of manipulation and accuracy.

As a drill press, it combines the features expected in a machine of the sensitive type. By a very ingenious provision six spindle speeds are obtained with very little complication.

An Ingenious and Effective Combination of Sensitive Drill and Tapping Machine

The provision for doing this makes use of the tapping attachment, as will be understood from a study of the engravings. The counter-shaft mounted on the rear of the machine carries a three-step cone pulley belted to a mating pulley on the jack-shaft at the top of the machine. A double quarter-turn belt connects this with a large and small pulley, either of which may be engaged with the drill spindle by the operation of a friction clutch controlled by the vertical lever shown hanging down at the front of the machine. Owing to the difference of diameter of these two pulleys, it is evident that the three speeds obtained by the cones can be doubled, giving six, by connecting either the slow forward or fast reverse pulley with the spindle. The fast reverse speeds, however, would run the drills backward. To obviate this difficulty, a positive clutch is provided on the jack-shaft, by which it may be connected to either one of the quarter turn pulleys, making either of them the driver, while the other revolves idly. By this means the spindle may be reversed independently of the regular tapping attachment handle, so as to make the three fast reverse speeds available for drilling.

As a tapping machine, the tool would seem to have unusual advantages. The spindle pulleys are driven by a continuous belt, insuring a steady drive. The frictions are self-adjusting, allowing any tension to be put on that the operator may desire. The driving of the spindle by friction clutches minimizes the danger of breaking taps, since they may be so set as to permit the friction to slip, well within the breaking strength of the tap. The arrangement also permits a rapid starting, stopping and reversal of the spindle without shock or jar, whether in drilling or tapping work. An adjustable screw for the specially made endless belt is provided to increase or lessen its tension as required.

The drill has a total height of 79 inches, or of 99 inches

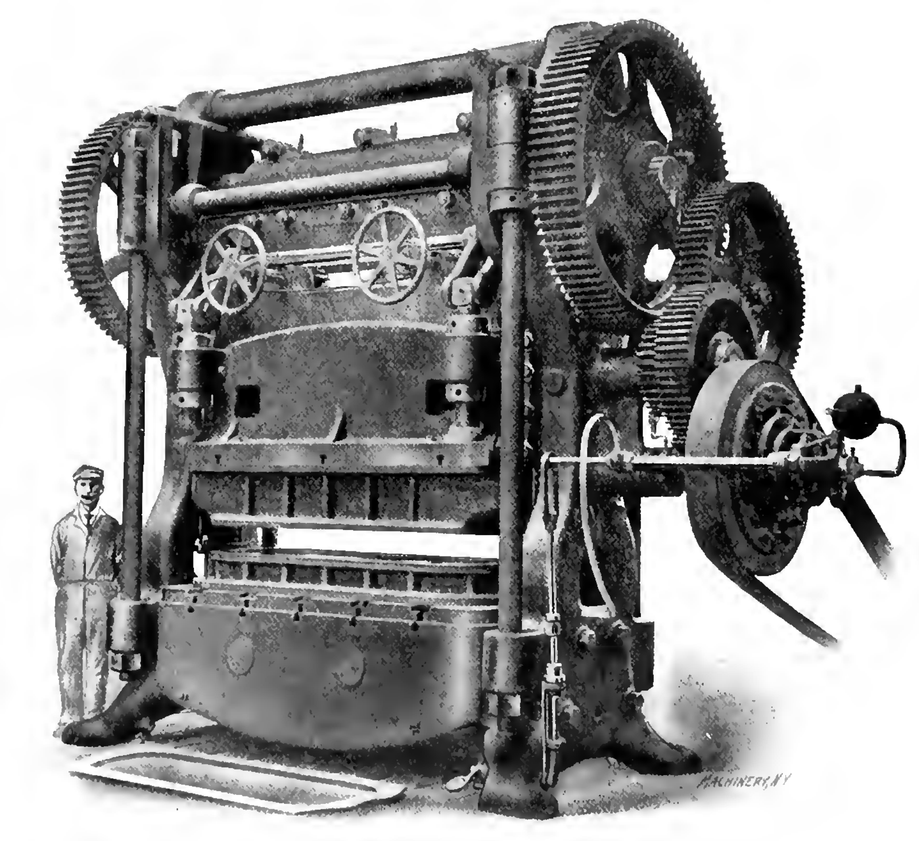
with the spindle extended. The spindle, which is counterbalanced, has a movement of 5½ inches. A driving socket for No. 2 Morse taper is provided. The table is 12½ by 14 inches, and is of the square type with a surrounding oil groove. The machine is also provided with a cup center and V-block. Both table and head are vertically adjustable on the column of the machine. The machine drills to the center of a 15-inch circle. Its net weight is 425 pounds.

FERRACUTE DOUBLE-CRANK TOGGLE-JOINT DRAWING PRESS

Presses for drawing seamless sheet metal shells are commonly designed with an outer ram or blank-holder, and an inner ram or plunger, thus making a double-acting press, as distinguished from the single-acting press which has but one ram. The outer ram may be held in position after having been moved down by various mechanical devices. The method most commonly used is to employ cams on the main shaft, and for certain shapes and sizes heavy springs are employed. A better and more modern device, however, is the use of a toggle- or knee-joint, which enables the pressure between the blank-holding surfaces of the dies to be taken more directly by the frame. This obviates the loss of power resulting from friction when the pressure is sustained by the crank-shaft. The press shown in the accompanying illustration is built on the toggle-joint principle, and has recently been placed on the market by the Ferracute Machine Co. of Bridgeton, N. J. It was designed by Mr. Oberlin Smith, president and mechanical engineer of the company.

The frame of the press is massive. The trussed bed, rests on shelves in the columns, to which it is securely bolted; each column is reinforced with two 4½-inch steel rods as shown in the illustration.

The ram and plunger have each an adjustment of 6 inches. The ram is adjusted by means of the round nuts shown in the engraving, and the plunger by means of the hand-wheels. The crank-shaft is forged from high carbon steel, and is 10 inches in diameter. It is reinforced by the long pitman-strap which unites the shaft and the plunger, the connection being made by two pitman stems. The latter are threaded and made to revolve simultaneously when adjusted by means of a shaft provided with two bevel gears. A link-belt joins the hand wheels, so that both revolve in the same direction when one is turned.



Double-crank Toggle-joint Drawing Press of Large Dimensions, built by the Ferracute Machine Co.

Two yokes, one on each side of the press, are attached to the plunger. These yokes have a vertical motion of 15 inches, the same as the stroke of the plunger. On the extensions of the middle toggle pins, rollers are provided, guided in slots in the yokes, the toggles being thereby straightened out at each stroke. The upper ends of the toggles are attached to the columns, and the lower ends to the outer ram.

The stroke of the outer ram is 6 inches, the plunger, as already mentioned, having a 15-inch stroke. The distance between the two columns is 100 inches, and the depth of the bed from front to back is 48 inches. The size of the hole in the bed is 60 inches by 18 inches. The distance from the bed to the outer ram at the top of the stroke, and in its extreme adjustment, is 32 inches, and to the inner ram or plunger, 35 inches.

The press is provided with triple gearing, the total ratio of which is 75 to 1; all gears are machine cut. The back-shaft is of unusually large diameter, and the large gears mounted on the main shaft are of the same size at each end, which relieves the shaft from torsional stresses. These gears are 5 feet in diameter and have a face 10 inches wide. The fly-wheel is 40 inches in diameter and has a face 7 inches wide, and runs at an average speed of 500 revolutions per minute. This gives a speed of from 6 to 7 strokes per minute to the press. A friction clutch is provided by means of which the ram may be stopped at any given point of its stroke. In the illustration the press is shown equipped with a positive knock-out.

The weight of the press is 91,000 pounds, the height being 13 feet, the width 16 feet and the length or depth 7 feet. The pressure exerted is 500 tons. It is designated by the makers as "Press SA175."

LE BLOND HEAVY-DUTY LATHE EQUIPPED FOR CRANK-SHAFT WORK

The heavy-duty lathe built by the R. K. Le Blond Machine Tool Co., of 4609 Eastern Ave., Cincinnati, O., described in the New Tools department of the September, 1909, issue of MACHINERY, was intended to produce a high output in a wide range of machine work. A modification of this design has been developed by the builders to meet the requirements of manufacturers who have large quantities of duplicate lathe work, but are unwilling or unable to invest their capital in attachments which, for them, would be useless.

The changes made in this simplified design (known as the "heavy-duty automobile lathe") relate, as may be seen from Fig. 1, principally to the spindle drive and feed mechanisms. The head-stock remains the same as on the machine previously referred to, with the exception of the back gearing. Two back gear ratios are provided as before, but the change from one to the other is made with a sliding key operated by the hand lever directly in front of the driving cone. This replaces the double friction clutch arrangement used and found necessary for quick changes on a general purpose tool.

The quick change gear box is replaced by one giving four rates of feed. The changes are obtained by sliding gears operated by the crank handle shown at the front of the box. The four changes are doubled by a reversible compound gear arrangement on the end of the bed, thus giving the operator a choice of eight geared feeds covering a wide range. As before, the apron is double walled and built of a single box section casting. The lead screw and split nut are removed, however, along with the quick change gear device.

The lathe is shown equipped with a set of tools of a type which has recently come into favor for automobile crankshaft work. The tools are best seen in Figs. 2 and 3, where a crank (in the rough, except for the two end journals) is having its four crank pins squared and turned. The device consists, as may be seen, of a special chuck, a tail-stock fixture, a double tool carriage and an automatic stop mechanism on the apron.

The crank-shaft is held in a split bearing in the chuck by one of the turned end journals, and is driven by the V-shaped jaw which is screwed down on the first crank arm. This jaw pivots at its back end, and is fitted with a spiral spring under the clamping screw to facilitate chucking. This work holding fixture is carried on a scraped slide on the face-plate, to which it is attached by a clamp and an adjustable gib. It is accurately positioned for the two crank centers by a hardened steel locking pin entering hardened steel bushings in the face-plate, after which it may be securely locked in position by the two T-bolts. A counter-weight is provided on the back of the face-plate which is fitted with stops for its two positions, thus enabling the operator to counterbalance the crank in either position practically simultaneously.

The other end of the crank-shaft is clamped at the turned journal in a split bearing in the tail-stock fixture. This fixture carries two hardened and ground bushings which are spaced the exact center distance of the crank throws; these bushings are alternately used as journals on the special tail spindle.

The tail-stock carries immediately in front of the main spindle, an auxiliary spindle, which is spaced the same distance apart as the journals in the fixture. This auxiliary spindle may be readily withdrawn by the lever shown on the tail-stock and serves a double purpose. In addition to affording a convenient means for changing the tail-spindle from one bearing to the other, it provides a means for accurately locating the tail fixture with relation to the crank throws when chucking. The alignment of the crank is accomplished by this auxiliary spindle in connection with a locking pin shown under and behind the face-plate (see Fig. 3) which enters a bushing in the head-stock.

The carriage is clearly shown in Figs. 2 and 3. The tool blocks are cast in one piece on a long slide which is mounted directly on the carriage. The rear tool block carries two tools set the proper distance apart for turning out the fillets, while the front block carries a round nose tool for removing the stock between the fillets. The movement of these tools is controlled by the stops shown on the slide, which enable the operator to duplicate diameters.

The longitudinal feed of the apron is controlled by the multiple stop-bar shown on the front of the bed in Fig. 1. The notches in this bar, which are spaced the same distance apart as the throws on the crank, engage a stop lever on the apron. In operation the carriage is, in turn, run up against each of these stops, bringing the back tools into exact position for turning out the fillets. The carriage is then returned, the front tool is run in, and the automatic feed is engaged. When the stop lever strikes the notch on the bar it operates a clutch on the feed rod and automatically throws out the feed. For crank-shaft work the stop bar is made as here shown to reduce the setting up time. When this feature is applied to a regular lathe, the stops are made independent, so that they may be set at any desired point within the range of the carriage travel.

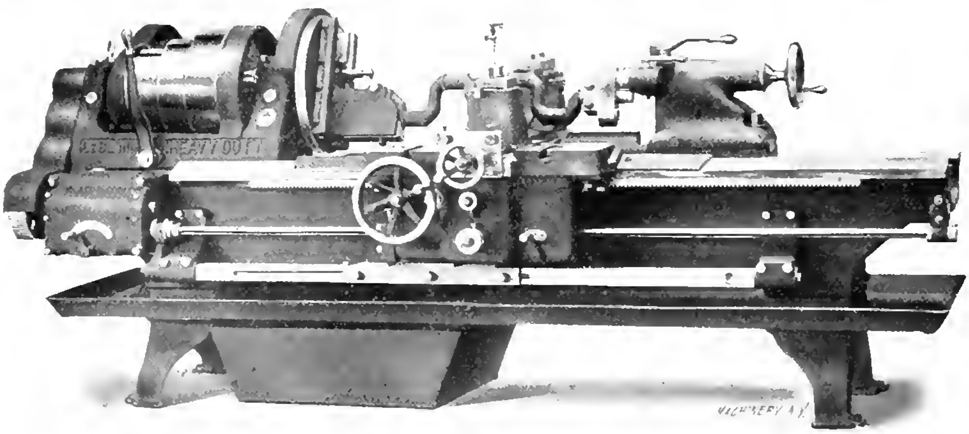


Fig. 1. Le Blond Heavy-duty Lathe arranged for Crank-shaft Work

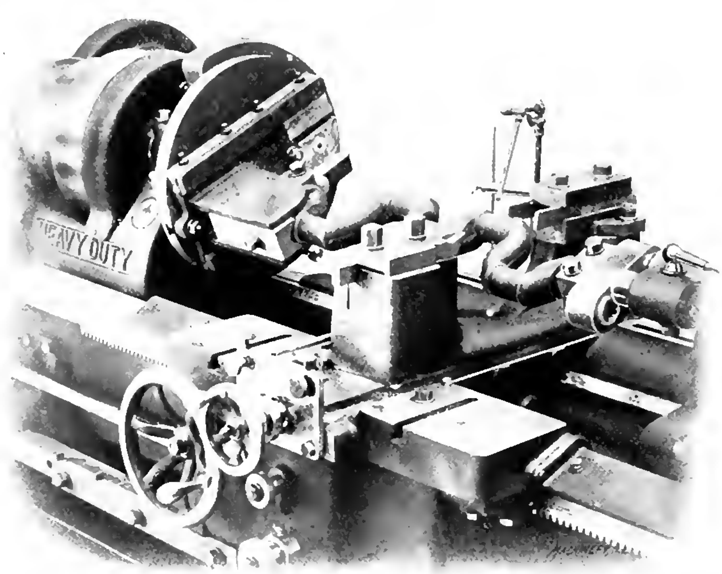


Fig. 2. Detail View, showing Special Holding Device and Tool Stops

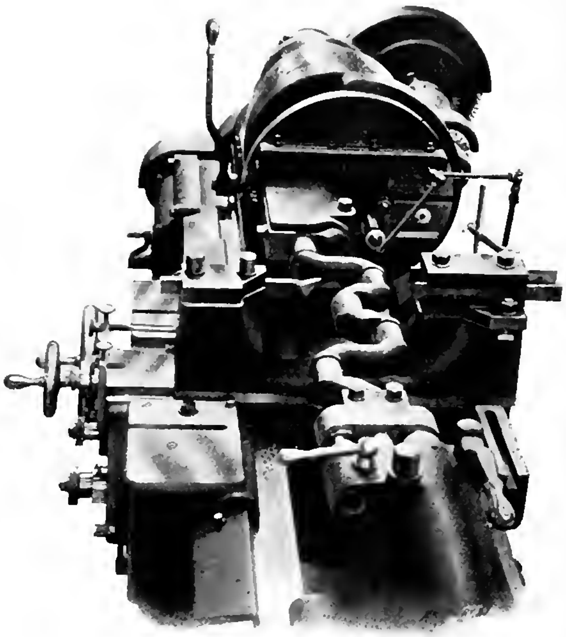


Fig. 3. The Arrangement of the Tools for Cutting the Fillets and Turning the Crank-pins

This construction affords a convenient method for turning shafts with a number of shoulders, and the manufacturers claim that on many classes of work it gives a higher production than the more complicated and expensive turret machinery, usually installed for such work.

This simplified form of heavy duty lathe is built in 16, 18 and 20-inch swings. The machine shown in the accompanying illustrations is the 20-inch size.

BERTSCH COMBINED MULTIPLE PUNCH AND SHEAR

The framework and operating mechanism for a multiple punch and for a gate shear resemble each other closely, the only difference, practically, being in the cutting tools themselves. Advantage of this fact has been taken by Bertsch & Co., Cambridge City, Ind., to develop a combined machine which has practically the efficiency of a separate tool for either of its combined functions. This combination multiple punch and shear is herewith described and illustrated.

The frame is of the gate type, having a wide cross-head operated by eccentrics at either end. The main shaft bearings are provided with adjustable split boxes; a third center bearing of patented construction is also employed, as shown. The clutch is reliable, positive, noiseless and easily operated. It has steel-faced jaws and a cast-steel switch ring, acting against a hardened steel roller on a vertical steel plunger.

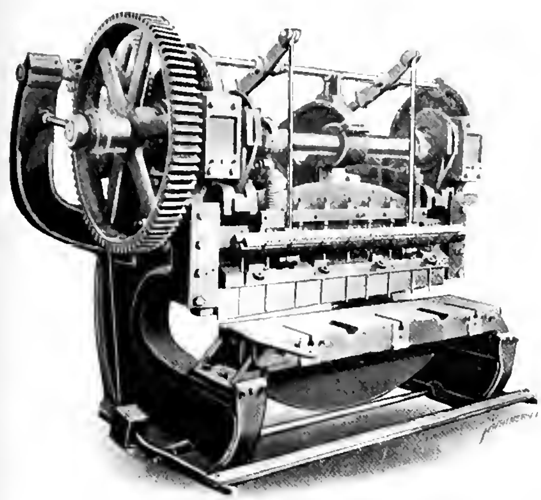


Fig. 1. Combined Punch and Shear as arranged for Plain Shearing

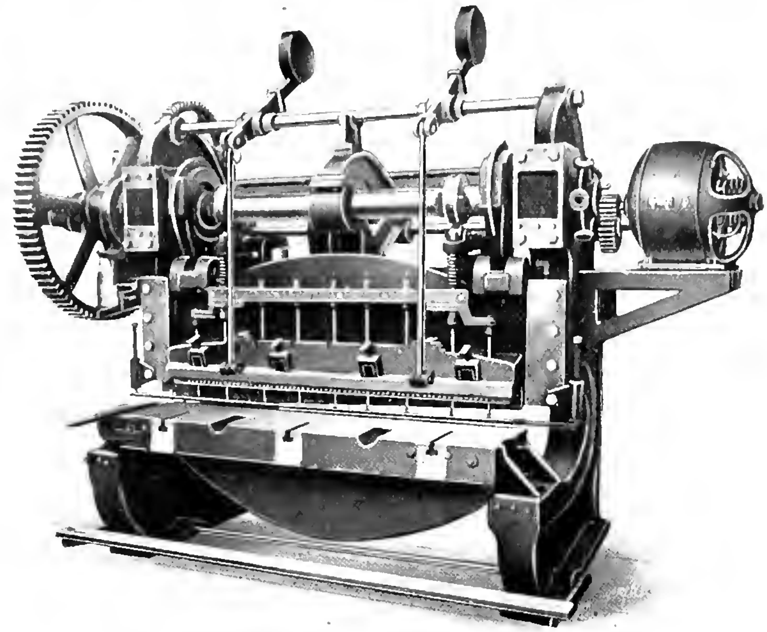


Fig. 2. Combined Machine with Cross-head swung down into Position

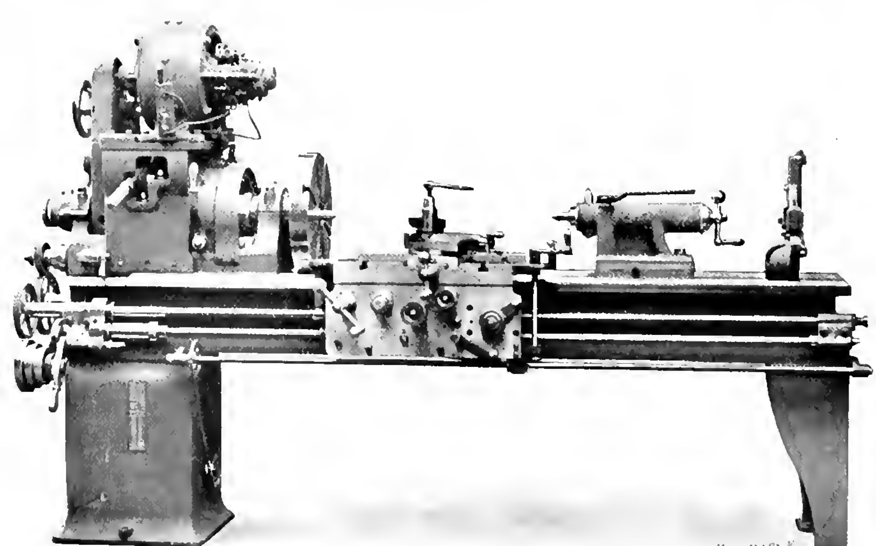
The machine is shown in Fig. 1 set up for use as a shear, and in Fig. 2 with the multiple punches in position. The latter, it will be seen, are mounted on a supplementary cross-head, hinged to the main cross-head, allowing them to be swung down into position or raised at will. Counterbalance weights are provided to facilitate this change. When engaged, this supplementary or punch cross-head is securely locked, and has a square shoulder fit along the entire length of the main cross-head which takes all the strain, none being transmitted to the hinge pins. End bearings are also provided for locating it longitudinally. The punches have either independent or universal adjustment. In the latter case they are set in an adjustable dove-tailed, steel punch-holder bar, so that the entire lot can be removed or replaced together. The punch and shear may be used together for piercing holes and trimming at one operation. The tool may be used as a simple shear as shown in Fig. 2, or as a punch only, with the upper shear blade removed.

A mechanism is provided which operates as a stripper when punching, and as a positive hold-down when shearing. This mechanism is operated by two cams mounted on the main shaft near the eccentrics. These bear down on rollers mounted on rock-shafts connected through the springs and rods shown, with a frame carrying a number of vertical rods. These latter serve as hold-downs for plain shearing work, and are of such construction as not to obscure the vision of the operator. They are of material assistance in safeguarding him when working on narrow strips. These rods also serve to support the stripper bar, as shown in Fig. 2, when punching is being performed.

This machine is made in a variety of sizes ranging from 3 feet to 12 feet in length, and with maximum capacities of 11 gage to ½-inch plate. It will be furnished for either belt or motor drive.

BRADFORD 16-INCH MOTOR-DRIVEN ENGINE LATHE

The accompanying illustration shows a regular 16-inch by 8-foot Bradford engine lathe as built by the Bradford Machine Tool Co., Cincinnati, Ohio, provided with individual motor drive. In applying the motor drive, the head-stock has been practically re-designed and adapted for the special requirements presented. The motor is placed on a frame which encloses the head-stock gearing. This arrangement is of special advantage as it puts the motor in a place where it is out of the way, makes it part of the machine, and at the same time makes it easily accessible to the operator. The connection between the motor and the lathe head-stock is through spur gears. The motor is of the 2 to 1 variable speed type, and as three speeds can be obtained by means of the gearing in the head-stock when the back-gearing is not thrown in, and three speeds with the back-gearing in operation, twelve speeds in all can be obtained. By using a rheostat, any intermediate speed from the lowest to the highest is also obtainable. The lathe is provided with a friction drive for the direct gear speeds, and a positive clutch for the back-gear speeds, and



Sixteen-inch Motor-driven Engine Lathe built by the Bradford Machine Tool Co., Cincinnati, Ohio

either can be thrown in while the lathe is in motion without danger of breakage. The motor speeds are operated by means of the smal lever at the right-hand end of the apron. The controller is inclosed in the cabinet leg of the lathe and is connected through sprockets, a splined shaft and bevel gearing with the lever which is operated over a graduated dial attached to the apron, as shown in the illustration. This arrangement makes all the controlling parts easy of access; at the same time, means are provided for stopping the lathe mechanically if required, independently of the electric equipment.

The lathe is in all other respects the same as the regular type of the Bradford lathes. The swing over the bed is 16¼ inches, the swing over the rest being 9 inches, and over the carriage 10¾ inches. The lathe with an 8-foot bed illustrated herewith takes 4 feet 1 inch between centers. A 1 11/16-inch hole is provided through the spindle. The spindle speeds obtainable vary from 5 to 340 revolutions per minute. The motor is 2 horse-power, but any style or make of motor can be fitted, if required; the speed of the motor can be varied from 600 to 1,200 revolutions per minute. The lead-screw has four threads per inch, and the lathe cuts threads from 2 to 40 per inch, including 11½ threads per inch. The weight of the lathe having an 8-foot bed, as illustrated, without motor, is 2,600 pounds net.

WELLS MOTOR-DRIVEN AUTOMATIC SCREW MACHINE

The accompanying illustrations, Figs. 1 and 2, show an automatic screw machine with individual motor drive, placed on the market by the F. E. Wells & Son Co., Greenfield, Mass. This machine is, in general, of the same design as the regular automatic screw machine built by the company, including the patented method of camming, and independent cross slides. In addition, however, this machine is provided with the advantage of direct motor drive, the power being transmitted through a speed changing device, involving the use of sliding gears, by means of which three changes of speed for the spindle are obtainable. The change gearing is shown in the rear view, Fig. 2. This speed changing device can, of course, also be used for driving the machine directly from a pulley on the main line-shaft by belting directly to the pulley which is now driven from the motor; the same number of speed changes are then obtainable. The advantage of being able to easily change the speed enables greatly increased production on an automatic machine.

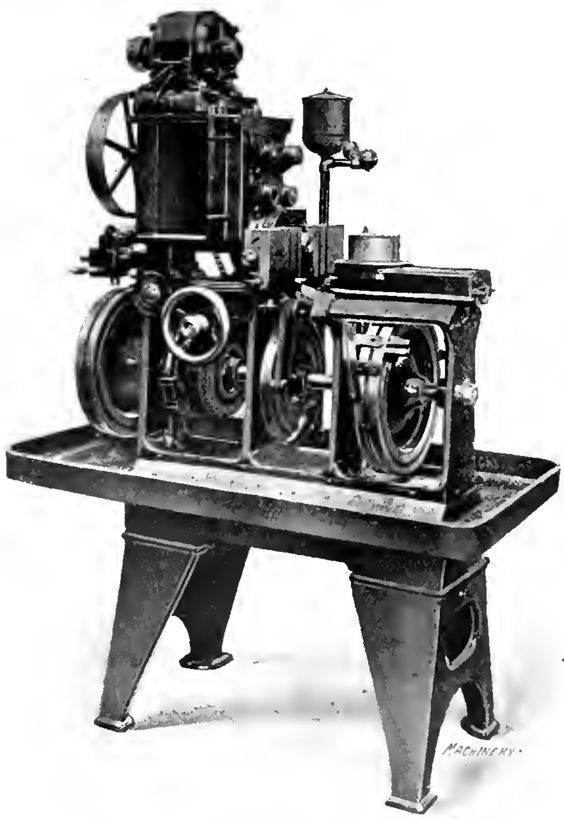


Fig. 1. Front View of Motor-driven Automatic Screw Machine, built by the F. E. Wells & Son Co., Greenfield, Mass.

Another novel feature is the method of transmitting the power from the motor to the main driving pulley without appreciable loss through the slipping of the belt. This method has been used for some years past on some classes of woodworking machinery, but has not been in vogue on metal working machines. Pins are set into the small driving pulley on the motor and the driving belt is provided with small corresponding holes. This prevents the belt from slipping when running over the small pulley, although the center distance between the two pulleys is small and the difference between their diameters marked.

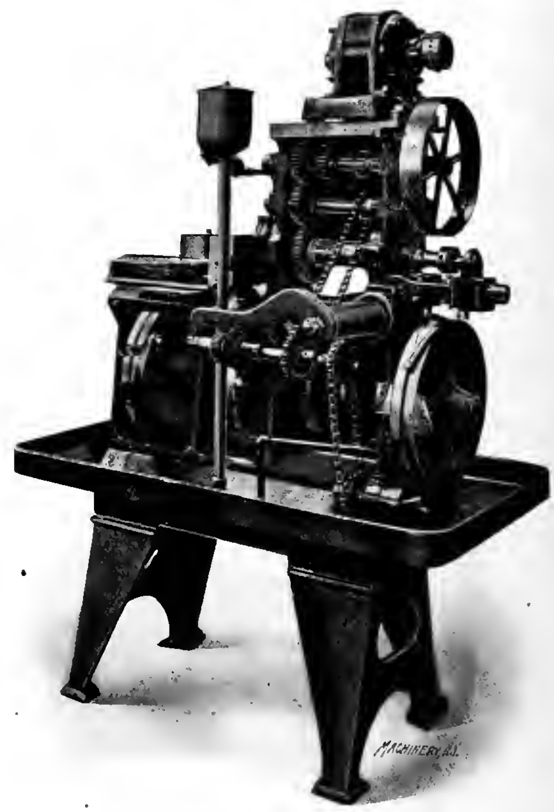


Fig. 2. Rear View of Wells Automatic Screw Machine, showing Driving Mechanism

AMERICAN TWO-FOOT AND THREE-FOOT RADIAL DRILLS

In the April, 1909, issue of MACHINERY, a 2-foot sensitive radial drill, built by the American Tool Works Co., 300-350 Culvert St., Cincinnati, O., was illustrated and described. This machine has proved very popular, and the firm has been forced, on account of the large demand, to bring out special designs of this drill in addition to the original design previously described. In Fig. 1 is shown one of these special designs, illustrating the 2-foot radial drill provided with motor drive and tapping attachment. As will be seen from the illustration, a Lincoln variable speed 3 to 1 motor is mounted beneath the box table. The speeds of the motor vary from 525 to 1,575 revolutions per minute, and the motor is under perfect control of the operator by a hand-wheel shown conveniently placed under the table in front of the motor. The tapping attachment is directly connected with the main belt drive and is controlled by the lever shown at the base of the column. The arrangement of the belting from the driving pulley in the rear at the left-hand side of the machine, to the vertical driving shaft is of particular interest, providing as it does on the one hand a convenient drive in a case where short center distances and the angularity of the drive make the arrangement rather difficult, and on the other a simple drive for the tapping attachment. It will be noted that there are no gears in this drive, either at the base or at the top of the machine, the power being transmitted throughout by belts. Means are provided for regulating the tension of the belts both overhead and below. The frictions in the tapping at-

tachment are of the American Tool Works patented type, and cannot become disengaged accidentally after they have once been thrown in. They are of ample proportions to transmit the maximum power the machine is intended for. The machine has a capacity for high-speed twist drills up to 1-inch diameter, and 1-inch standard taps. It may be fitted with a tapping chuck, making it particularly adapted for tapping small holes. The general design of the machine in all other details is identical with that described in the April, 1909, issue.

In Fig. 2 is illustrated the 3-foot American radial drill mounted on a pedestal base and not equipped with a box table. This type of machine is particularly convenient for drilling a great number of holes in work which can be conveniently moved on a truck, or otherwise, beneath the spindle of the machine. This arrangement eliminates to a considerable extent the handling of the work, and permits of its being moved from the drilling department to the next department with the least possible delay. The machine will be found of particular advantage in automobile and gas-engine manufacturing plants, and it is due to the requirements of manufacturers of this class of machinery that this type has been designed. When drilling with a jig the work can be carried out very rapidly, as the arm is easily swung to any position desired and the head rapidly moved to any point along the arm. A spindle speed as high as 900 revolutions is available, but this may be increased or diminished to suit special requirements. The bearings are all of the ball-bearing type, and the drill will run up to a speed of 2,000 revolutions per minute without signs of distress, but of course no twist drill would hold its edge long at such a speed.

In its general details the design of this machine is identical with the 2-foot drill, excepting, of course, that the dimensions are proportionately larger. The two machines illustrated show interesting examples of the possibility of adapting standard machine tools, built on the unit plan system, to different requirements by simply changing some of the details.

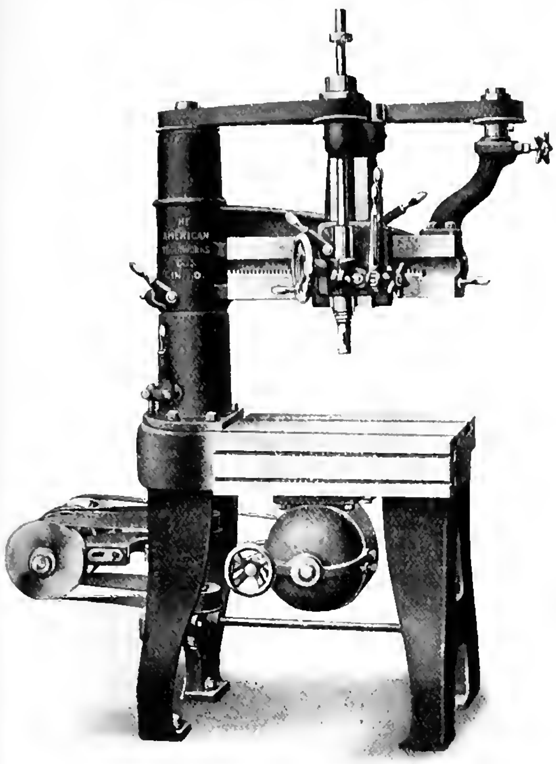


Fig. 1. American Tool Works Co.'s 2-foot Radial Drill with Motor Drive

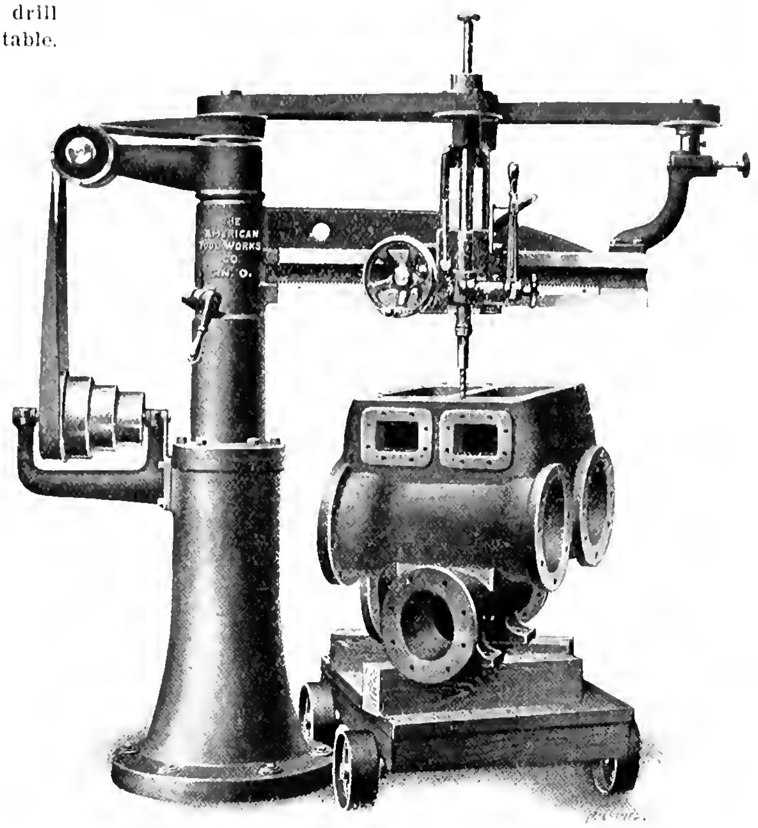


Fig. 2. Sensitive 3-foot Radial Drill, especially adapted for Automobile and Gas Engine Manufacture

DRILLING TEST—AMERICAN SENSITIVE RADIAL DRILL

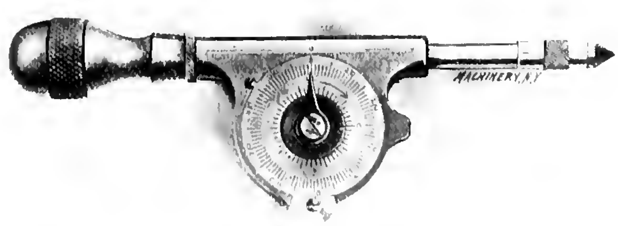
Diam. of Drill, inches	Speeds		Feeds		Net Horse Power	Remarks
	Revs. per min.	Feet per min.	Approx per Rev.	Inches per min.		
¼ C.	900	59	....	......	0.15	Cast iron 1" thick
¼ H.S.	900	137.2	0.022	20	1.50	Cast iron 1" thick
⅝ H.S.	900	147.2	0.013	12	3.0	Cast iron 1" thick
¾ H.S.	900	177	0.013	12	3.7	Cast iron 1" thick
1 H.S.	455	119	0.0066	3	2.6	Cast iron 1" thick
1 H.S.	785	207	0.0076	6	3.2	Cast iron 1" thick
½ H.S.	900	137.2	0.037	16.8	1.2	Aluminum engine frames*
1 19/64 H.S.	745	248	......	......	0.9	Aluminum case†

* ½" thick. Drilled 14 holes in 25 seconds
† Drilled from the solid. Bosses drilled and faced in one operation

The accompanying table gives some results obtained in drill tests undertaken with this machine. The table gives the diameter of drill, the revolutions per minute, the cutting speed, and the feeds per revolution and per minute, stating as well the horse-power required for driving.

BROWN & SHARPE SPEED INDICATOR

A new speed indicator has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. The new indicator is provided with two features which, in particular, will make it valuable. In the first place the indicator is equipped with a dial for registering the speed, on either side of the case. One side is used for ascertaining the velocity of shafts and spindles running in the right-hand direction, and the other side for determining the speeds of shafts running in the left-hand direction. The confusion and errors which are not uncommon when all readings are taken from one dial are thus avoided. The indicator registers revolutions in units, tens



Improved Brown & Sharpe Speed Indicator, with Dials on Both Sides of the Case

and hundreds. The second feature of importance is a small knurled wheel on the side of the case which provides a means for quickly readjusting the device after the reading has been taken. This wheel when turned revolves the disk indexing hundreds back to the starting point. This feature is of value when a series of readings is to be taken, as it saves a considerable amount of time and makes rapid and exact readings possible.

The indicator is small and light and provided with a polished wooden handle. The working mechanism is encased, and protected from dirt and injury by a heavily nickel-plated cover having a dull finish. The point is of hardened steel, and can easily be removed when worn, and replaced if required.

GORTON HEAVY-DUTY CUTTING-OFF MACHINE

A heavy-duty cutting-off machine has recently been placed on the market by the George Gorton Machine Co., of Racine, Wis. As may be seen by referring to the illustration of the machine, Fig. 2, it is exceedingly stocky and rigid in its design, and the aim of the builders has been to produce a tool capable of feeds and speeds heretofore unattainable. The bed and cutter head are both exceptionally massive, and chatter and vibration, which are inevitable in improperly designed machines of this type, have been eliminated. In addition to the rigidity, the large diameter of the main driving gear and the directness of the drive add largely to the efficiency of the tool.

The bed is a one-piece casting, heavily ribbed internally, which has its entire bottom cast solid, thus forming a reservoir for the cutter lubricant. Mounted upon this bed is a heavy cutter slide which contains the large driving gear, shown in Fig. 1, to which is attached the cutter blades and cutters. The cap which forms the upper half of the large drum bearings for this main driving gear, is bolted to the slide as shown. Cast integral with this cap are the brackets for the motor, and at the left are located the bearings for the main driving pinion which meshes with the main driving gear. The pitch diameter of the main gear is 60 inches and its face width $3\frac{1}{2}$ inches, while the pitch diameter of the driving pinion is 5 inches and the face width 4 inches. The driving pinion is forged integral with its 3-inch crucible steel shaft, and the angle of the drive is such that comparatively little pressure is placed on the cutter drum bearings. Attached directly to this cutter drum, which is made of fine-grained metal (25 per cent steel), is the cutter blade of 0.60 carbon steel. This cutter blade fits accurately over ten hardened and ground steel studs which are driven into the drum, and it is additionally secured by ten $\frac{7}{8}$-inch special screws as shown. For belt-driven machines, the driving clutch pulley is mounted directly upon the main pinion shaft. The lever which operates this clutch is seen at the front side of the machine directly over the stock vise. It is connected with the cone which expands the clutch by a rod passing through the pinion shaft, which is hollow. When the machines are electrically driven this clutch pulley is replaced by a clutch gear. The lever by which the clutch is operated is used to start and stop the machine.

This machine is designed for cutting off round stock from $1\frac{1}{2}$ to 6 inches in diameter, and square bars with widths from $1\frac{1}{2}$ to $5\frac{1}{2}$ inches. If necessary, round stock up to 8 inches in diameter may be severed by back feeding 2 inches by hand. The bars are held in the powerful clamping vise shown, which is equipped with hardened tool steel jaws. In addition to this vise there is a trolley for supporting the outer end of the bar. This trolley runs on a track, consisting of two 7-inch channels, which on a standard machine is 22 feet long. If required, special tracks 32 or 42 feet in length will be furnished. The trolley is provided with a positive measuring arrangement which permits the stock to be cut off to the required lengths. When a piece is severed it is forced through a trough at the rear into a truck, onto the floor, with little effort on the part of the operator.

The feeding mechanism on the standard machine is driven by 7-step cone pulleys, and a change of feeds is available which ranges from $1\frac{1}{2}$ to 6 inches per minute. It has been the experience of the makers that this method of driving is preferable to the all-geared drive. The lower cone pulley is connected with a gear-box containing forward and quick return feed clutches which are operated either by hand, or automatically with a positive knock-out at the extremes of the stroke, adjustment being provided for various diameters of stock.

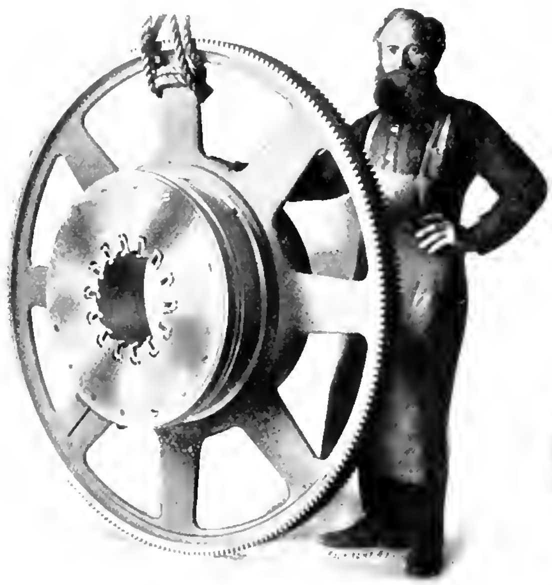


Fig. 1. Main Driving Gear of the Gorton Cutting-off Machine

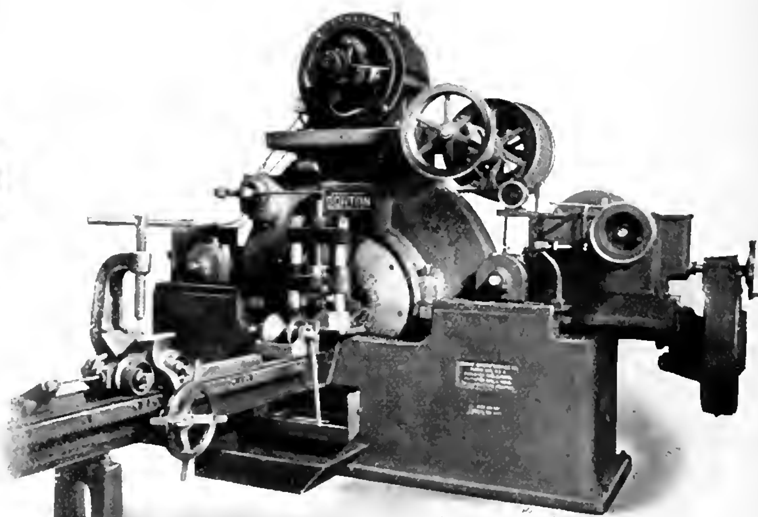


Fig. 2. Heavy-duty Cutting-off Machine, built by the George Gorton Machine Co.

Particular attention has been given to all lubrication details throughout the machine. The large cutter drum bearings which are of lumen bronze and interchangeable are flooded with oil, which is delivered into cored ways on the inside of the upper drum cap. The box-shaped extension for this oil may be seen just above the cutter blade, and in it there is a removable felt pad through which all oil entering the bearings must filter. This provision insures a lubricant which is free from grit. The main pinion bearings are equipped with a ring-oiling device, and are also flooded from the main driving gear. All the mechanism in the upper front gear case operates entirely below the surface of the oil.

Three standard cutter blades of different thicknesses are carried in stock, all of which are interchangeable. One of these blades is 7/16 inch thick, contains twelve 7/16 inch high-speed cutters, and is adapted for work ranging from 4 to 6 or even 8 inches in diameter. For cutting off stock ranging from 2 to 6 inches, a blade $\frac{3}{8}$ inch thick is recommended; this contains fourteen $\frac{3}{8}$ inch high-speed cutters and is the blade furnished with the machine unless otherwise specified. For smaller stock than that mentioned, a blade $\frac{1}{4}$ inch thick is provided

which contains sixteen ¼ inch high-speed cutters. If necessary, even this light blade can be used for severing stock up to 8 inches in diameter, but it will not stand the heavy feeds possible with the heavier blades. With each size of blade a cutter-setting gage is furnished for setting the re-ground cutters uniformly. It requires less than one minute to remove a broken cutter from the blade and replace it with a new one, and the breaking of a cutter while the machine is in use does not injure the blade.

The lubricant for the cutters is delivered by means of a geared pump, shown on top of the upper gear case. As a copious supply of lubricant should be used, the machine is equipped with a nozzle which will deliver a stream about four inches wide and one-quarter inch thick directly onto the saw cut. The chips fall on suitable screens which are contained in the chip pans shown in the side openings of the base. These screens effect the separation of the cutter lubricant from the chips which are raked from them into pans on the floor. All the collars, levers, hand-wheels, yokes, etc., on this machine are of steel, and all the nuts and screws are finished and case-hardened. The parts are all interchangeable, and the makers guarantee the workmanship and finish equal to that of the best machine tools built.

MECHANICS' MACHINE CO.'S 20- AND 26-INCH UPRIGHT GANG DRILLS

The accompanying illustrations show two sizes of upright gang drills brought out by the Mechanics' Machine Co., Rockford, Ill. In Fig. 1 is shown what is known as the 20-inch gang drill. In this, the individual drill heads with their frames, cone pulleys and gearing are mounted on a box column as indicated, the drills being built in gangs of 2, 3, 4, 5 or 6 spindles. Each drill is independent and can be stopped, started, or its speed changed, without interfering with the other drills, each having its own individual counter-shaft, operated through a foot lever, shown in the front of the machine. The work table slides on ways on the main column, and is supported on its edge by adjusting screws as indicated.

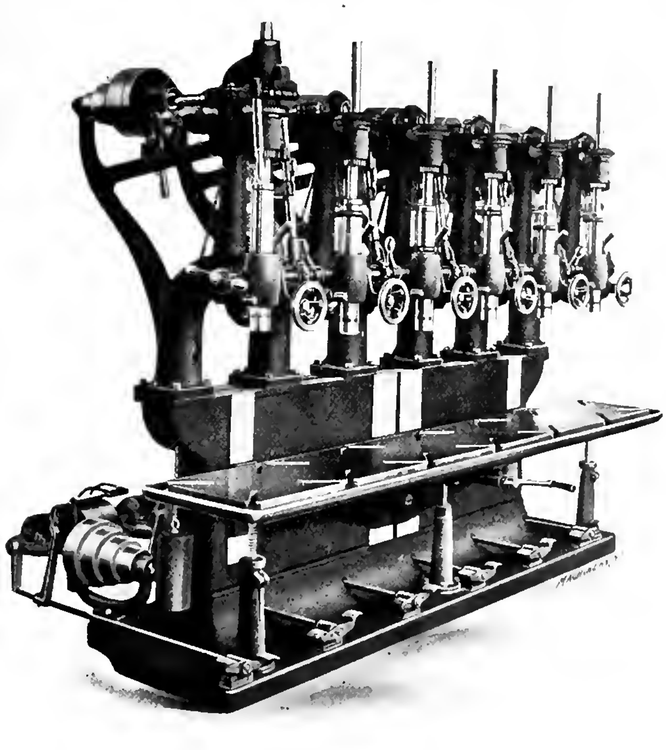


Fig. 1. Twenty-inch Six-spindle Gang Drill, built by the Mechanics' Machine Co., Rockford, Ill.

The maximum height of the drill with the spindle in its highest position is 84 inches, and the minimum height 75 inches. The distance from center to center of the spindles is 16½ inches, and the distance from the center of the spindle to the column is 10½ inches. The spindle, which is provided with a No. 3 Morse taper, has a diameter of 1⅜ inch and a vertical travel of 11 inches, and the spindle speeds are 0.005, 0.008, 0.011 and 0.014 inch per revolution of spindle. The size of the planed surface of the table for a 2-spindle machine is 11½ by 32½ inches, with an additional 16½ inches in length for each spindle added. The vertical travel of the table is 13 inches, and the maximum distance from the spindle to the table is 26½ inches, the minimum distance being 4 inches. The floor space required for the 2-spindle drill is 55 x 34 inches, for a 3-spindle drill 55 x 51 inches, an additional 17 inches in length being required for each spindle added. The weight of the 2-spindle machine is 1,900 pounds net, with an approximate addition of 800 pounds for each spindle added.

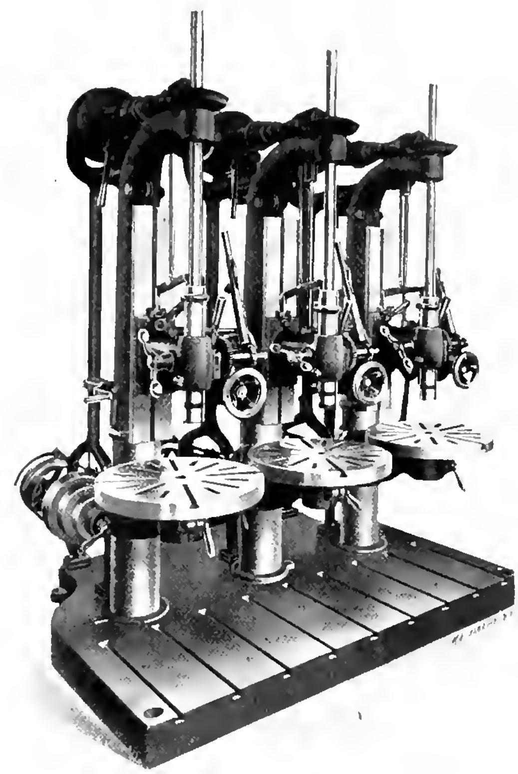


Fig. 2. Twenty-six inch, Three-spindle Gang Drill

The 26-inch gang drill in Fig. 2 is, as shown, of different design, it consisting of several practically complete upright drills mounted on a common base-plate. The design of the individual drills is also different from the design of the smaller drills shown in Fig. 1, these drill presses having sliding heads as indicated in the illustration. The 26-inch drill is supplied in gangs with 2, 3 or 4 spindles on the same base, and is furnished either with the ordinary round tables shown in the illustration, or with square tables having an oil groove or receptacle around the edges. These drills are furnished with back-gearing and positive feed; a geared tapping attachment or friction clutch tapping attachment can be furnished with one or more spindles, as required.

The maximum height of the 26-inch drill press with the drill spindle in its highest position is 87 inches; the maximum distance from the spindle to the base is 50 inches and the minimum distance 17 inches. The maximum distance from the spindle to the individual round table is 37 inches, the spindle being capable of reaching completely down to the table when in its lowest position. The distance from the column to the center of the spindle is 13 3/16 inches, the vertical feed of the spindle is 11½ inches, and the movement of the sliding head is 23 inches. The distance from center to center of the spindles is 24 inches. The floor space required for a drill press with two spindles is 48 by 67 inches, for three spindles 72 by 67 inches and for four spindles 96 by 67 inches. The net weight of the two-spindle 26-inch gang drill is 3,400 pounds, with approximately 1,700 pounds added for each additional spindle. A 24-inch and a 32-inch drill are also made in gangs, the same as the 26-inch drill. The general design of these two sizes is the same as that of the 26-inch drill.

"PEERLESS" PORTABLE ELECTRIC CHIPPING HAMMER

The electric hammer herewith illustrated and described is made by the Cincinnati Electrical Tool Co., 650 Evans St., Cincinnati, O. So far as we know, this is the first strictly electric hammer to be put on the market, there being in this tool no interposition of mechanical or pneumatic mechanism between the ram of the hammer and the source of the current.

The tool receives its current supply from an attachment connected with an ordinary direct current lamp socket. From

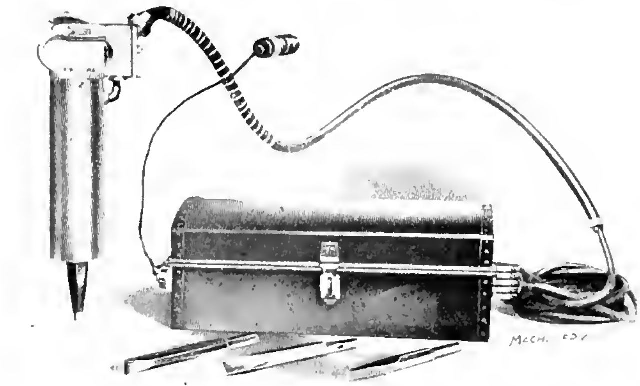


Fig. 1. An Electrically-operated Chipping Hammer, arranged with Lamp Socket Connection

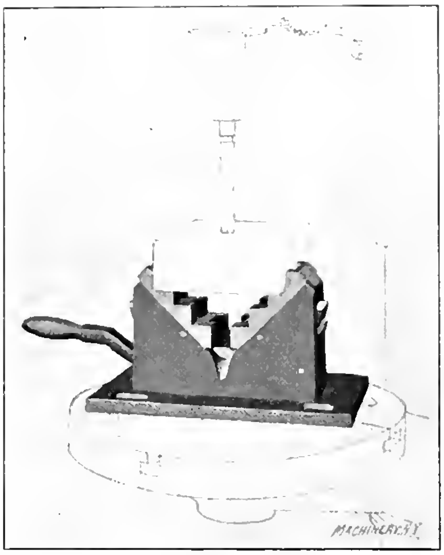
here it is led to the box shown, which contains an automatic switch mechanism for controlling the current movement throught the triple cable leading to a pair of solenoids contained within the hammer casing. When one of these solenoids is energized, the ram is raised; the energizing of the other draws the ram down again. The action of the ram or plunger on the chisel is identical with that in a pneumatic hammer. The same general appearance, and the same style of grip is retained, a switch being provided in the handle of the tool for controlling it in the usual manner.

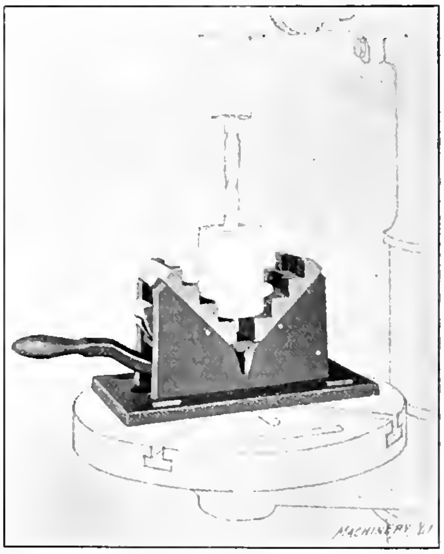
The device is light enough so that it can be carried around the shop by a boy. The box containing the switch weighs 38 pounds, and the hammer 19. The former takes a space of $7\frac{1}{2}$ by 20 inches. The hammer itself is $14\frac{3}{4}$ inches long by $3\frac{1}{2}$ inches in diameter. It will cut armor-plate up to $\frac{1}{2}$ inch thickness.

MITCHELL-PARKS DRILL PRESS VISE

The accompanying illustrations, Figs. 1 and 2, show the general design and action of a new drill press vise brought out by the Mitchell-Parks Manufacturing Co., 612 So. 6th St., St. Louis, Mo., and known as the "Gravity" vise. The device has been designed with a view of producing a drill press vise which would be extremely simple and rapid in its operation and that would, at the same time, hold the work being drilled firmly, and which could be used on work of any size or shape. The whole vise consists of only five parts and is not provided with springs of any kind, nor does it require any special parts for special work. When the handle shown in the illustrations is raised, it brings the jaws resting on the angle guides to which they are fitted, apart. A maximum opening between the upper steps of the jaws of 8 inches and between the lowest steps of the jaws of $2\frac{1}{2}$ inches can be obtained. When the work is placed in position between the jaws, its weight forces them downward along the guides, so that a firm hold is obtained on the work. When the drill enters the work, the pressure of the drill forces the jaws still further downward, and the work is gripped tighter the greater the pressure exerted on it by the drill. The jaws can therefore be said to automatically clamp the work as soon as it is placed in position. At the moment when the drill passes through the work, and the pressure of the drill on the work thus is decreased, a slight pressure on the handle will hold the work tightly so as to prevent turning at this time. Raising the handle will release the work between the jaws.

The vise may be placed loose on the drill press table except in extreme cases. When required, however, it can be easily bolted to the drill press table by means of the slots provided in the base plate of the device. The vise will hold round work from $\frac{1}{2}$ inch up to 8 inches in diameter, and work of other shapes in the same proportion. The size of the base plate of the device is $7\frac{1}{2}$ by 14 inches.





Figs. 1 and 2. The Gravity Vise, made by the Mitchell-Parks Mfg. Co., St. Louis, Mo.

MILWAUKEE SIXTEEN-INCH LATHE

In the June, 1908, issue of MACHINERY a lathe built by the Milwaukee Machine Tool Co., Milwaukee, Wis., was illustrated and described. The accompanying half-tones and line engraving show an improved design of the company's 16-inch lathe, recently placed on the market. In designing this lathe particular attention was given to provide an even distribution of metal, and an effort has been made to place the metal wherever it will do most good. Careful attention has also been given to produce a high-grade lathe as far as materials and workmanship are concerned. The lathe is especially adapted for general manufacturing purposes, it having the strength and power necessary for heavy work, and at the same time provision is made for convenience and adaptability for lighter jobs. The bed is heavier than in the previous designs, and is reinforced throughout with heavy cross ribs. The V's, which are planed at an angle of 45 degrees, have large wearing surfaces. The alignment of lead-screw and feed-rod has been taken care of when planing the bed, the bearing pads for these parts being planed and grooved to templets, the bearings being carefully fitted to the bed.

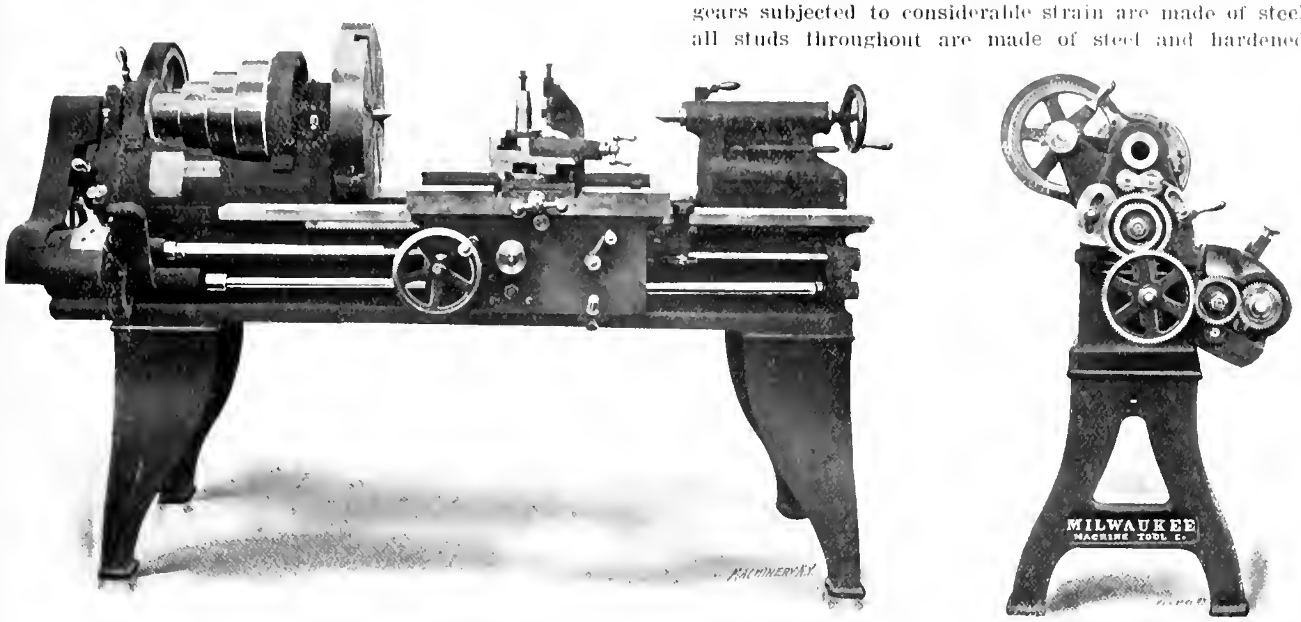
The Head- and Tail-stock

The design of the head-stock has been improved, it being more massive. The cone pulley has four steps instead of five as in the previous design, the width of each of the steps of the pulley having been correspondingly increased in order to permit a sufficient amount of power to be easily transmitted to the machine. The back-gearing is also made correspondingly heavy and of higher ratio. A patented spring cone stop is located in the face-gear and makes it very convenient for the operator when changing from the open belt speed to the back-gear drive. The spindle is provided with a 1 9/16-inch hole through its entire length and is drilled from the solid. It is made from crucible steel containing 0.60 per cent carbon, and is accurately ground. The bearings for the spindle are large, and are made of phosphor bronze and scraped to a bearing by hand. Two large oil reservoirs are located directly beneath each bearing, and the oil is carried to the spindle by means of a wick, which, on the one hand, keeps the spindle constantly wiped free from grit and dirt, and on the other hand affords ample lubrication regardless of speed.

The tail-stock is of correspondingly heavy design and has a long bearing surface on the bed. It is designed so as to permit the compound rest to be turned at an angle of 90 degrees, even when turning the smallest diameters. Screws are provided for setting it over sideways for taper turning, if required. The diameter of the tail-stock spindle is two inches, and the centers are provided with a No. 4 Morse taper.

and both slides are provided with taper gibs for adjustment, thereby avoiding the necessity of manipulating more than one screw when adjusting the gib. Graduated feed collars are provided for the feed screws for both the cross-slide and the compound rest.

The apron is carefully brazed and is tongued-and-grooved into the carriage and securely bolted to it. All pinions and gears subjected to considerable strain are made of steel, and all studs throughout are made of steel and hardened and



Figs. 1 and 2. Side Elevation and End View of Milwaukee Machine Tool Co.'s Improved 16-inch Lathe

ground, except in such cases where bronze bushings are provided. The rack is of steel, and cut in one piece. A safety locking device for the half-nuts is one of the features of the lathe.

The lathe is also furnished with a thread chasing dial, a feature which should be greatly appreciated. The dial is

The Carriage and Apron

The carriage has a bearing of 23½ inches on the ways, and is gibbed to the bed for its entire length. The bearing surface on the bed is not recessed, but is in full contact from end to end with the entire depth of the V's. This eliminates to a great extent the difficulty met with in regard to vibrations or "chattering." Instead of an inside V on the front of the lathe a flat surface is used. This shortens the bridge of the carriage, and affords a solid bearing directly under the tool-post. Large T-slots are provided for clamping work to the carriage. The cross-slide and compound rest have been made heavy in proportion to the remainder of the machine,

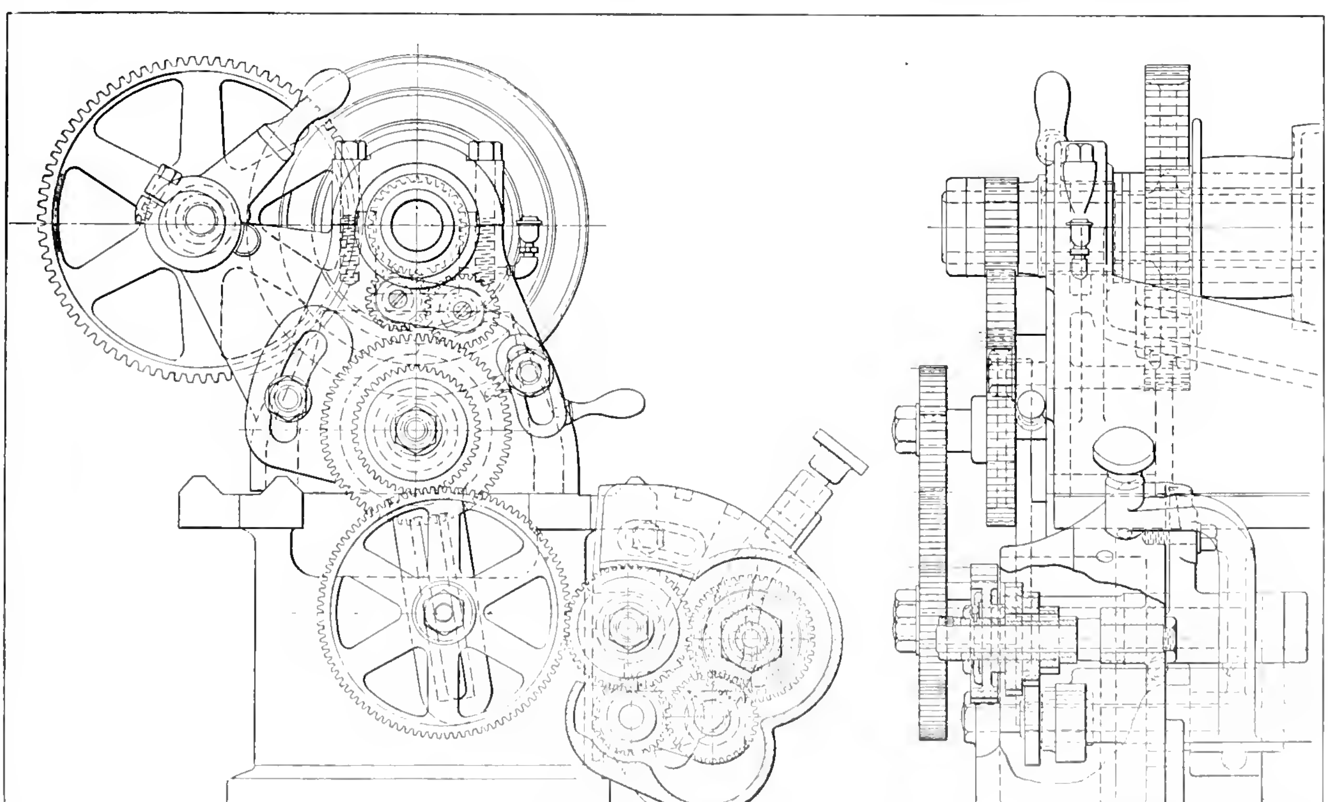


Fig. 3. Design of Feed Box and Gearing, Milwaukee Machine Tool Co.'s 16-inch Lathe

graduated to indicate the rotation of the lead-screw, and enable the operator, when cutting screw threads, to return the carriage quickly by hand, and throw in the nut at the proper moment. This feature alone saves a considerable amount of time when cutting long screw threads, as anyone having used such an attachment will appreciate.

The Change Gear Box

The lathe is provided with a change gear box which gives four practically instantaneous changes of feed through the operation of one lever, as shown in Fig. 1. The drive to the gear box and its general arrangement are shown in the line engraving, Fig. 3. Through the use of change gears supplied with the machine and this gear box, a practically unlimited range of feeds and threads per inch, within the capacity of the machine, can be obtained. The construction of the gear box is very simple, it consisting merely of a cone of gears and a sliding gear which can be brought into mesh with either of the gears in the cone. A friction disk is applied to the gear drive. It is adjustable, and can give any amount of tension desired. It will eliminate to a great extent the breaking of apron parts, etc., due in many instances to carelessness on the part of the operator.

Special attention has been given to the question of gear guards, all gears in any way exposed having been properly covered with guards. In the end view, Fig. 2, some of these guards have been removed merely in order to show the gearing, but they are well in evidence in Fig. 1. Considering the increasing requirements of the law, and the realization of the necessity of protecting the operator from possible injury, this feature is of considerable importance.

A double friction counter-shaft is supplied with the machine in which all the wearing surfaces on the clutch are accurately ground. The bearings are of the ring-oiling type, and are made of pressed steel. The hangers are made of the same material, which adds to a great extent to the strength and lightness of the construction.

The net weight of the machine with the six-foot bed is 2,200 pounds, and the approximate weight of the bed per each additional foot in length is 120 pounds.

PEERLESS AIR-COOLED PORTABLE ELECTRIC DRILLS AND GRINDERS

The tool shown in Fig. 1 (made by the Cincinnati Electric Tool Co., 650 Evans St., Cincinnati, O.) is exceptional for its lightness of weight, as compared with the size of drill it will use. Its actual weight (including the chuck) is only 4½ pounds, and it will drill holes up to 3/16 inch in steel. The style shown is made for direct current, but a similar tool is made for use with various voltages of alternating current.

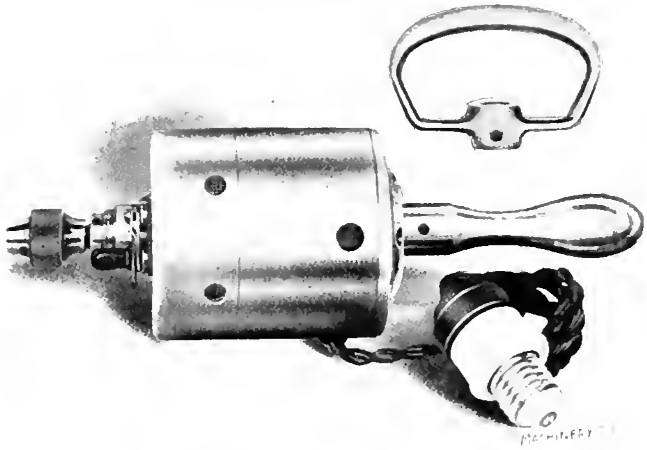


Fig. 1. "Midget" Air-cooled, Electric Drill

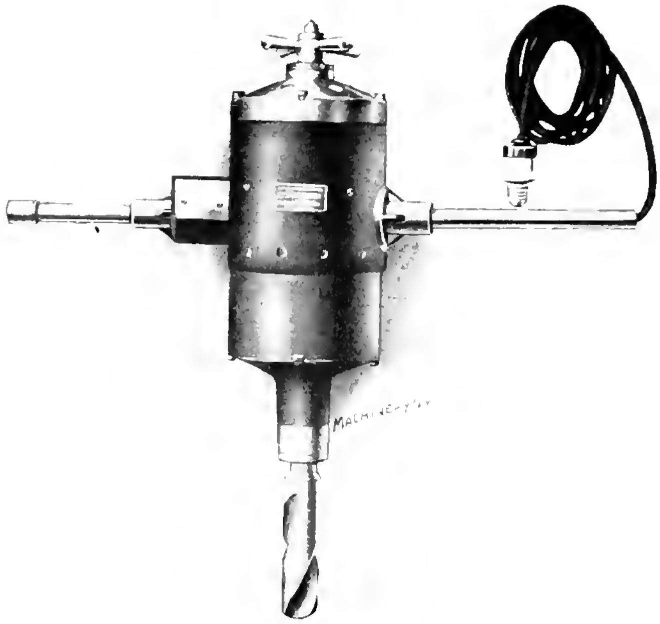


Fig. 2. Heavy Portable Drilling and Reaming Machine

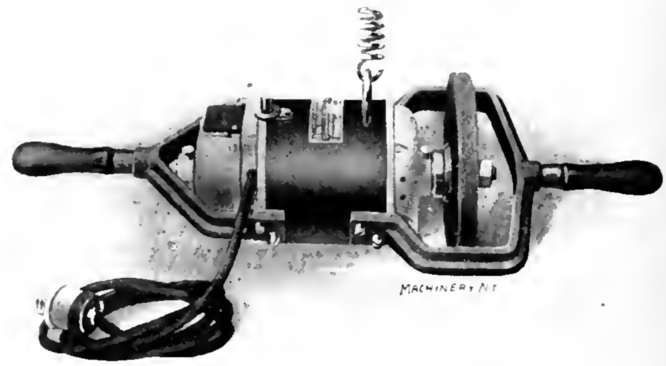


Fig. 3. A Suspended or "Aerial" Grinder for Heavy Duty

The largest size of portable drilling and reaming machines made by this firm is shown in Fig. 2. This machine is designed to drill holes in steel up to 1½, 2 or 2¼ inches, depending on which of three sizes is furnished. These three tools are fitted with Nos. 3, 4 and 4 Morse taper sockets, respectively. The smallest one weighs 63 pounds and the largest 86. Twenty feet of cable are provided, the leads entering one of the handles. A quarter turn of the latter starts and stops the machine. The motor, in common with all others in this line of portable tools, is air-cooled, and can be kept under heavy duty all day without getting heated. A fan mounted directly on the armature shaft provides the circulation for this.

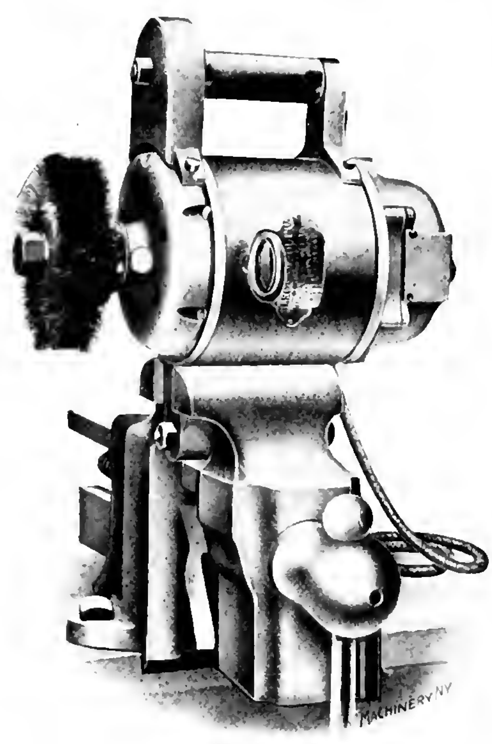


Fig. 4. A Light Aerial Grinder held in the Vise and used for Buffing and Polishing

The grinder shown in Fig. 3 is particularly adapted for smoothing off heavy castings. It is known as an "aerial" grinder, being hung on a spring suspension from the ceiling. The two handles hold it on the line of the center of gravity, and make manipulation of the tool easy. This direct current grinder is made in two sizes, for wheels 8 by ¾ inch and 10 by 1 inch respectively; it is furnished for alternating as well as for direct current.

Fig. 4 shows another type of aerial or portable grinder for lighter work than that done by the tool shown in Fig. 3. Here, however, the grinder has been caught in the vise, so as to make of itself a convenient bench buffing or polishing lathe. The starting switch is controlled by the knurled handle, a quarter turn of which serves to start or stop the machine.

One of the various lathe grinding attachments is shown in Fig. 5, where it is provided with an extension support and

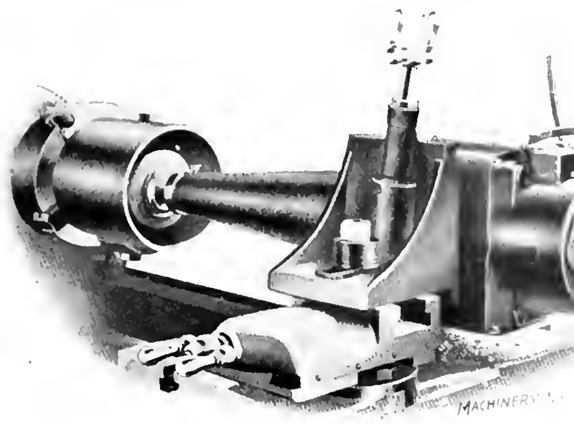


Fig. 5. Lathe Grinding Attachment, with Extended Spindle for Internal Work

spindle, particularly adapted to internal grinding. The use of such a device will bring the ordinary engine lathe into strong competition with the special grinding machine for toolroom and similar occasional work.

The various motor-driven tools just described are wound, as mentioned, for either direct or alternating current, and will be furnished for special voltages and cycles as may be required by the purchaser.

JARVIS DRAW-IN ECCENTRIC COLLET CHUCK

The accompanying half-tone shows an interesting device known as the Jarvis draw-in collet chuck, placed on the market by the Chandler & Farquhar Co., 34 to 38 Federal St., Boston, Mass. The chuck consists of a casing made in two parts, *A* and *B*, the upper part being graduated on the top surface. This casing is recessed eccentrically on the inside, and contains a cylindrical part on which worm-wheel teeth are gashed, this cylindrical part fitting in the eccentric recess of the casing, and being provided with an eccentric stem which is central with the casing when in the zero position, and into which fits

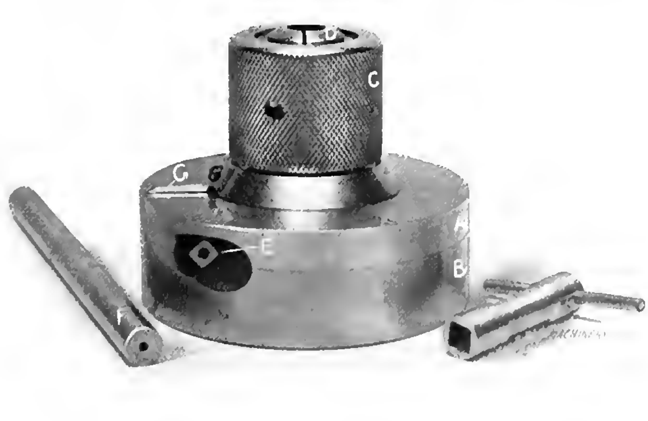


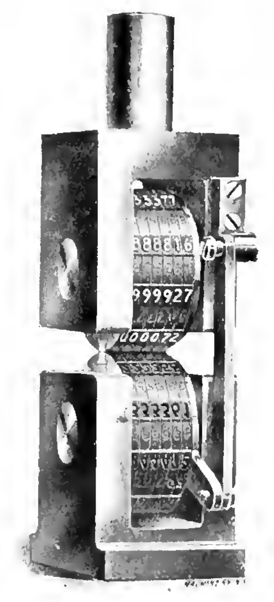
Fig. 1. Jarvis Draw-in Collet Chuck, placed on the market by Chandler & Farquhar Co., Boston, Mass.

the collet *D*. The stem is threaded on the outside, and over it fits the chuck closer *C*. The worm teeth on the eccentric disk, fitted inside the casing, mesh with a worm *E*. It is obvious that when the worm is revolved by means of a socket wrench being applied to its square head, the eccentric disk inside the casing will revolve, and will, in turn, move the collet chuck out of its true center.

The chuck will be found useful for many purposes. It can be placed either on the lathe face-plate or in a holder, and can be used for holding either the work or boring tools. It can also be used on a milling machine, grinder, or any other machine where its special features would be advantageous. It has an eccentric throw of 1/4 inch from the center, and the face is graduated to read to 0.001 inch, so that it is easy to determine how much the center of the chuck will be out of its true center when the eccentric worm-gear has been turned a certain amount. A special test bar *F* is provided to be placed in the chuck in order to test when it is running true. It should, of course, be clamped to the face-plate of the lathe so that it runs absolutely true when the pointer *G* is at the zero position. If this is the case, the test bar can be removed, the work put into the chuck, the chuck moved out of center by turning the worm, and returned to an accurately central position by merely returning the pointer to the zero position. This feature will be found useful for drilling, boring or grinding eccentric bushings, or making eccentric cams. It is also useful when boring holes to size, as the boring tool can be placed in the chuck and the amount that the boring tool is fed into the work can be read off on the graduations on the face of the casing *A*. It will be found very convenient when boring jigs and fixtures in the milling machine. The chuck collets furnished have a capacity of from 1/16 inch to 1/2 inch, varying by 64ths or 32ds, as required.

BATES METAL NUMBERING MACHINE

The accompanying illustration shows one of the many types of numbering machines made by the Bates Numbering Machine Co., 696-710 Jamaica Ave., Brooklyn, N. Y. This machine is designed for embossing numbers on soft metal tags, strips, etc. The machine is operated in a power press, the upper part of it, of course, being attached to the plunger, and the lower part to the die block. It consists, as shown, of male and female dies, and can be made with 5, 6, 7 and 8 wheels, according to the number of figures required. When at work, it will number the work consecutively and automatically, there being a connecting pitman or link, as shown, between the upper and lower dies, so that they will index simultaneously. The height of the figures provided can be made either 3/16, 1/4, 3/8 or 1/2 inch, and intermediate sizes between these can be furnished if desired. The machine is an interesting example of the development of automatic numbering machines for embossing numbers on metal.



Bates Numbering Machine for Embossing Numbers on Metal

BRIDGEFORD BEVEL GEAR TURNING LATHE

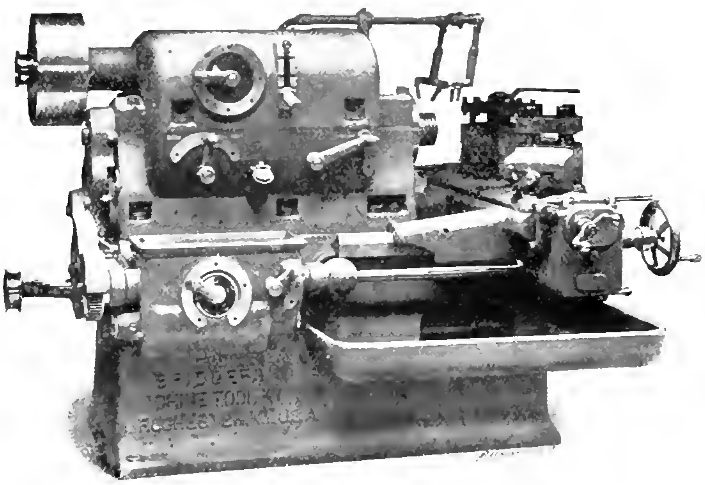
In the accompanying illustrations Figs. 1 and 2 are shown front and rear views and in Fig. 3, end view, of a lathe for turning bevel gears, which has just been placed on the market by the Bridgeford Machine Tool Works, Rochester, N. Y. This machine has been designed specifically for turning simultaneously the face, front and back angles of bevel pinions and gears up to 18 inches in diameter. Besides these turning operations, the boring and the facing of the back of the gears is also done advantageously in the machine.

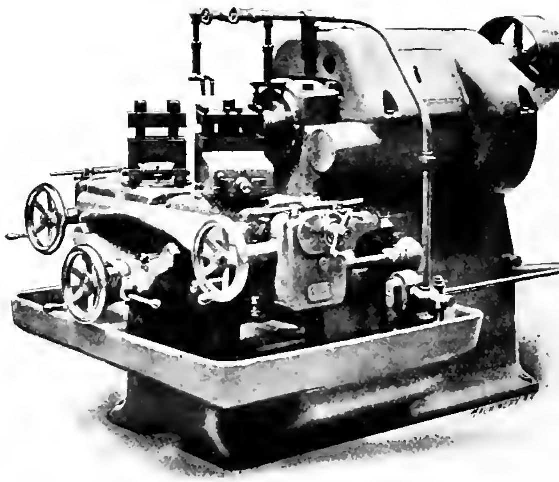
As will be seen from the illustrations, the frame, oil pan and oil reservoir are cast in one piece. The top of the frame or bed is provided with ways similar to those on engine lathes, and the head-stock of the machine is of a design similar to that used on the Bridgeford heavy duty geared head engine lathe, which was illustrated and described in the March, 1908, issue of MACHINERY, in the department of New Machinery and Tools. The drive to the geared head is through a constant speed pulley, 15 inches in diameter, as shown, with a width for a 6-inch belt and running at 140 revolu-

tions per minute. The gearing in the head provides for twelve spindle speeds ranging from 5.8 to 214 revolutions per minute. The design gives sufficient pulling power to enable three cutting tools to be used simultaneously, all cutting up to their full capacity. All the gears within the head are made of steel and run in oil. The bearings are self-oiling to prevent accidental heating and frictional losses.

The carriage is similar to that provided on a lathe, but is of a duplex construction, having an apron both in the front and in the rear of the machine, and is provided with two cross-slides carrying the angle turning rests, the right-hand cross-slide having a turret tool-holder. The carriage cross-slides and angle rests have power feed and automatic stops. The required hand-wheels are arranged within easy reach of the operator when in a working position. The machine is provided with a feed box as shown in Fig. 1, which gives ten feeds ranging from 0.005 to 0.190 inch per revolution of the spindle. The gears in this feed box are also made of steel and run in oil. From the feed box the power is transmitted by splined shafts to the aprons, the same as in a lathe, the power being carried to the rear of the machine by means of bevel gearing and a shaft which passes through the frame or bed. The machine is provided with an oil pump as shown in Fig. 2, and with properly arranged piping for carrying lubricant to the cutting tools. The oil pump is driven by a belt from a pulley on the end of the main driving shaft, as shown. All gearing has been carefully covered by suitable guards, and the machine offers a pleasing appearance on account of its well proportioned and uniform lines. The total net weight of the machine is 7,300 pounds.

The operation of the machine will undoubtedly be of interest. The first operation consists of boring the hole and facing the back of the gear. During this operation the blank is held in a universal chuck and the hole is bored out with the tool held in the left-hand rest, while the facing is done with tools held in the turret of the right-hand cross-slide. The second operation, consisting of turning the face, front and back angles, is the one where the prominent features of the machine come more particularly into play. During this operation the blank is either held on a special hub or on an arbor in the taper hole in the spindle, which is provided with a split bushing. The left-hand turning rest carries a roughing and a finishing tool for the face angle, and the turret on the right-hand cross-slide a set of roughing and finishing tools for the front and back angles. As these tools work simultaneously, bevel gears can be finished very rapidly. Two of the machines are already in operation in a gear manufacturing plant, and have made it possible to save considerable time over that required when turning the gears with ordinary engine lathe and turret lathe methods. At the same time, more accurate work can be produced than can be done with forming tools.





Figs. 1 and 2. Front and Rear Views of Bevel Gear Turning Lathe, built by the Bridgeford Machine Tool Works

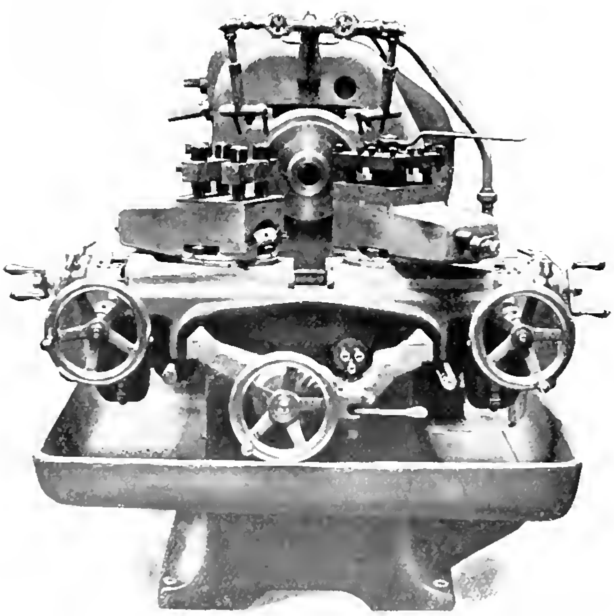


Fig. 3. End View of Bevel Gear Turning Machine

DECIMAL EQUIVALENTS ON THIMBLE OF MICROMETER CALIPER

The accompanying illustration shows an improved thimble of the micrometer caliper manufactured by the J. F. Slocomb Co., Providence, R. I. The improvement consists of a complete table of decimal equivalents of eighths, sixteenths and thirty-seconds of an inch, rolled on the thimble. It should prove very handy to the machinist to have the decimal equivalents directly on the thimble, it being possible to make the figures large and distinct and easy to find and read.

Thimble of Slocomb Micrometer, with Decimal Equivalents

* * *

The seventy-fifth meeting of the British Association for the Advancement of Science was opened August 25 in Winnipeg, Canada, with 600 delegates present from the United Kingdom, the United States and Canada. The twelve sections of the association remained in session for a week. One of the principal addresses, dealing with a variety of matter of interest to scientists and scientific educators, was delivered by Sir J. J. Thompson, the president of the association.

NEW MACHINERY AND TOOLS NOTES

Adjustable Work Clamp: Howell & Murray, Waverly, N. Y. This is a convenient tool of simple construction for holding work on the drilling machine table. The clamp jaw is adjusted and held in position by notches on an upright which is held down to the work and table by a bolt and nut, the bolt having a square head fitting in the T-slot of the table.

High-Speed Steel Twist Drill: New Process Twist Drill Co., Taunton, Mass. This drill, known as the Reliance high-speed twist drill, is made from flat bar stock twisted while hot. The twisted blade is then inserted into the tool shank, and brazed to the shank, so that the drill when finished is practically as strong as if made from one piece of steel.

Automatic Screw Machine: L. Wollstein & Co., 16 John St., New York City. This machine is adapted for making small screws and other parts commonly made in automatic screw machines. Instead of a turret, however, it carries a sliding spindle for holding a drill or other tool. When external threading is to be done the spindle can be removed and an opening die of special construction put in its place.

Small Gear Hobbing Machine: Schuchardt & Schütte, 90 West St., New York City. This machine has been designed in response to the demand for a machine to cut small gears for water meters, clocks, etc. It has a capacity for hobbing gears up to 24 diametral pitch, with an outside diameter of 4 inches and a face of 6 inches. The cutter spindle runs at 600 revolutions per minute. The machine is entirely automatic, but hand feed can be used if desired when cutting small worm gears.

Ring Oiling Bushing: Brown Engineering Co., 123 North 3rd St., Reading, Pa. This ring oiling bushing for loose pulleys and clutches is particularly adapted for use in machine shops. It will run from four to six weeks without having its oil supply replenished, and it is claimed that the bushing will save over 75 per cent of the oil ordinarily required. It can be operated at speeds as high as 2,000 revolutions per minute. The bushings are made with all the standard bores from 1 3/16 inch to 2 15/16 inches.

Oil Cup: United States Metallic Packing Co., Philadelphia, Pa. This accessory has been designed with a view of making an oil cup of maximum strength. The shank of the oil cup is of machine steel, and the cover is of pressed steel, attached to the body of the oil cup by a steel chain so as to prevent losing it. It is furnished either with a needle or wick feed, and with shanks of any desired diameter and number of threads. The standard cup, however, has a ¾-inch diameter shank and 14 threads per inch.

Universal Ball Bearings for Shafting: United Bearings Co., Bradford, Pa. These ball bearings are adapted for heavy loads and allow an end movement of the bearing. They consist of an outer casing proportioned to fit any standard hanger and containing a hardened and ground steel case at each end for receiving the ball bearings. The inner ball race is of hardened steel provided with a lining of good anti-friction metal fitting over the shaft. Thus the bearing is in fact a combination plain and ball bearing, so that if the ball bearing should be subjected to injury the bearing still is serviceable as a plain bearing.

Bench Cutting-Off Saw: Taylor-Shantz Co., Rochester, N. Y. This machine is intended to be placed on a bench or stand, and to do the work, generally, of a power hack-saw. It is designed particularly for tool-room use. Due to the fact that a blade with a thickness of only 3/64 inch is used, considerable material is saved, which is important when cutting up high-speed steel or other expensive stock. On large work a saw 5/64-inch thick may be used. The machine weighs 160 pounds and occupies a space of 14 by 14 inches. It has a capacity for cutting off 2½ inches square, 2¾ inches round, and 4 by 2 or 4½ by 1 inch flat stock.

Heavy Swaging Machine: Langelier Mfg. Co., Providence, R. I. This machine is adapted for tapering heavy work. It swages solid stock up to 2 inches in diameter and tubing up to 3 inches, and is especially intended to meet the requirements of manufacturers of heavy tubing for the automobile trade. The machine takes dies from 4 to 8 inches long; the spindle is of large proportions, its head being 10⅝ inches in diameter by 10⅝ inches long and the bearing part 6 inches in diameter by 23 inches long. The machine should run at a speed of 240 revolutions per minute and be connected to the counter-shaft by a 7-inch belt. The floor space required is 42 by 48 inches.

Saw Table: Silver Mfg. Co., 317 Broadway, Cleveland, O. This machine is adapted for small pattern shops or woodworking shops on account of being inexpensive and simple. It is equipped with a safety guard and pivoted auxiliary frame for vertical adjustment of the saw, and while adapted for fine accurate work, it is amply strong enough for rough and heavy work as well. The saw is 12 inches in diameter, and when raised projects three inches above the table. Saws up to 14 inches in diameter can be used. The ripping fence tilts to any angle up to 45 degrees. The floor space of the machine is 44 by 66 inches, the size of the table 31 by 38 inches, and the height 32 inches.

Under-Belted Disk Grinder: Gardner Machine Co., Beloit, Wis. The improvement in this grinder over the Gardner grinder illustrated and described in the July, 1908, issue of Machinery, consists mainly in the drive and a slight modification of the frame, so that the belt can be passed over the machine spindle pulley, down through the base of the machine, and through the floor to a motor mounted in the ceiling below or in the pedestal of the machine. The spindle pulley and belt are entirely enclosed so that the whole machine offers a compact substitute for the direct motor-driven disk grinder, which presents the difficulty that grinding dust is liable to get into the working parts of the motor.

Double Crank Press: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for heavy cold bending, drawing and forming operations in thick sheet steel manufacture. It is particularly intended for work of large dimensions, such as automobile engine crank cases, frame members, channels, etc., and for heavy cutting and perforating. The machine is capable of exerting a safe working pressure of 800 tons. The width between the frame columns is 74 inches, and between the gibs 67 inches. The stroke of the slide is 14 inches and the distance from the bed to the slide, the stroke down and the adjustment up, 20 inches. The adjustment of the slide is 6 inches.

Hardening Furnaces for High-Speed Steel Tools: American Gas Furnace Co., 24 John St., New York City. These furnaces are the results of a series of experiments undertaken to determine the best means for hardening different kinds of high-speed steel tools in gas blast furnaces. Different types of furnaces have been adopted for various kinds of tools, each type being, of course, used for a considerable variety. For instance, a special furnace is made for heating reamers, drills, taps and other tools of considerable length but small diameter. Small cylindrical work is suspended by the shanks in the heating space and is removed after heating without coming in contact with the lining of the furnace or the supports, thus preventing injury to the fine cutting edges.

Electric Pyrometer: Bristol Co., Waterbury, Conn. This pyrometer is intended for high temperatures and is designed to permit quick readings. An advantage of the instrument is that its construction substitutes an inexpensive metal for the expensive platinum-rhodium for the larger part of the couple. The tips of the couple, however, are of platinum-rhodium, and may be exposed to a temperature of 3,000 degrees F. without danger of the temperature at the junctions between the tips and the remainder of the couple exceeding a safe limit. The complete instrument is portable and temperatures up to 2,500 degrees F. can be obtained in a few seconds. By using a special form of tip, the instrument can be used for measuring the temperature of hot metal surfaces.

Forty-Ton Duplex Chain Block: Yale & Towne Mfg. Co., 9 Murray St., New York City. This chain block has been brought out to meet the demands of the trade for a dependable hand hoist for handling very heavy loads in cases where the installation of an electric crane or steam hoist would be out of the question. It is composed of two 20-ton units with equalizing bars at top and bottom, thus providing for a single point of suspension and a single point of attachment of the load. Provision is made for swiveling each unit at top and bottom. The hand chains are arranged to permit two, four or eight men to work effectively. When the load is larger than 40 tons, it can generally be handled by two of these hoists working together, giving a double capacity of 80 tons.

Motor-Driven Sensitive Drill: Willey Machine Co., Jeffersonville, Ind. This drill press has been built heavier than former designs, and has a square table instead of a round one as previously used. The motor is connected to the spindle by a belt and cone pulley, and three changes of speed are provided. The motor is adjustably mounted for tightening the belt, and the starting switch is placed within the motor frame, eliminating connections outside of the motor. The distance from the center of spindle to the column is 12 inches, the maximum distance between the spindle and table 38 inches, the vertical motion of the spindle 3 inches, and the size of the table 11½ inches square. The total height of the drill is 67 inches, and the weight of the machine 200 pounds. It requires a 1/3 H. P. motor.

Vertical Keyseat Milling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This machine is adapted particularly for keyseating, and is built along the lines of a vertical milling machine. The spindle is mounted in a vertically adjustable saddle, so that a minimum distance of 6 inches and a maximum distance of 18 inches between the end of the spindle and the top of the table is obtainable. The spindle speeds vary from 142 to 395 revolutions per minute with the back-gears in, and from 430 to 1,194 revolutions per minute when driving direct with the back-gears thrown out. The work-table is 11 inches wide and 40 inches long, surrounded by an oil pan. It has an automatic power feed motion of 36 inches in either direction. The feed motion is obtained by a feed box giving nine changes. The machine occupies a floor space of about 4 by 5 feet.

Three Head Reaming and Tapping Machine: Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is adapted for work on cast iron T- and L-shaped pieces up to

18 inches, and steel T's and L's up to 12 inches. It is provided with three heads mounted on a T-shaped bed, and has a stationary table to which the cradles for holding the work are clamped. Each of the three heads has independent hand adjustment and drive, as well as independent power feeds suitable for reaming and tapping, the feeds obtainable being 1/32, 1/16 and 1/8 inch per revolution. The maximum distance from the center of the machine to the ends of the spindles is 26½ inches; the distance the centers of the spindles are above the work-table is 15 inches. The spindle speeds are from 3¼ to 14 revolutions per minute. The power for each head consists of a 12½ H.P. variable speed motor.

Inclinable Rotary Furnace: Rockwell Furnace Co., 26 Cortlandt St., New York City. This furnace, intended for smooth round work, has a rotating cylinder or drum lined with a standard hard refractory brick with a smooth internal surface. The furnace is capable of being inclined, and the gradual incline causes the material to feed forward. The degree of pitch may be adjusted through a hand-wheel so as to regulate the progress of the material through the furnace to the required time of heating. This automatic continuous heating provides for a uniform heat in all the pieces, none of them being likely to be overheated or not sufficiently heated, as is the case in stationary furnaces. These furnaces can be built to suit different requirements, and in sizes to handle up to 2,000 pounds of stock per hour.

Universal Boring Tool-Holder: The Robinson Tool Works, Waterbury, Conn. This tool-holder differs from other holders intended for the same purpose particularly in that it passes over the lathe tool-post instead of passing through the tool-post slot. It is clamped by means of the regular tool-post wedge and screw, the tool supporting ring or washer being removed from the tool-post. The advantages claimed in connection with this tool-holder are that it elevates the boring tool horizontally, that tools of any diameter and of any kind of round stock can be used, and that it is always possible to have the tool projecting the right length from the holder. It is made in five sizes, the smallest size adapted to a No. 1 watchmaker's lathe, and the largest to lathes having 20 to 36 inches swing and taking boring bars to 1¼ inch in diameter.

Variable Speed Counter-shaft: Hawkeye Mfg. Co., Cedar Rapids, Ia. This device depends for the variations of speed on the greater or less amount of slipping in the frictional contact between the constant speed driving pulley and the shoes of a spider carrying the driven pulley. It is claimed that uniform speeds are obtained, due to the fact that the principle of the centrifugal governor is introduced in the mechanism. The essential parts of the device are driven pulley and a friction clutch of the drum and brakeshoe type, having an adjustable contact controlled by a lever, or a sheave with drop chain, with which the pressure of the shoes on the wheel face can be regulated. Not only the cone pulley, but also the tight and loose pulleys, are eliminated from the drive. A continuous range of speeds from the maximum to the minimum is obtainable.

Surface and Tool Grinder: Robinson Tool Works, Waterbury, Conn. This grinder has been designed for grinding the faces of small dies and punches and for surface grinding of other small parts occurring in tool work. It can also be used as a regular tool grinder, and is provided with holders for grinding twist drills and milling cutters. It consists of a head carrying two wheels, one at each end. A table or platen is provided under one of the wheels. The other wheel is provided with an adjustable tool-rest and a fixture for holding twist drills, this latter having a capacity for drills from ⅛ inch up to 1½ inch diameter. The machine is either adjustably mounted on a column or furnished as a bench grinder. The diameter of the surface grinding wheel is 5 inches and of the drill grinding wheel 6 inches. The net weight of the machine, including counter-shaft, is 180 pounds.

Rivet Spinning Machines: Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. Three new riveting machines have been brought out by this company, two being riveters of the noiseless type equipped with flat and horn tables, and designed for work requiring a great depth of throat; work 11½ inches from the edge can be riveted. On the riveter provided with a flat table, fixtures can be mounted for different classes of work. The machine with the horn table is especially adapted for the manufacture of railroad lamps, signal lamps, metallic doors, etc. A small double spindle riveting machine for rivets ⅛ inch in diameter and less and adapted for light work such as small hinges, jewelry novelties, etc., has also been brought out. It heads simultaneously both ends of a plain wire passing through the work. This machine may be mounted on a bench or pedestal and is operated by a treadle attached to the floor. The maximum capacity between the spindles is 1½ inch.

High-Speed Drilling and Tapping Machine: Cincinnati-Bickford Tool Co., Cincinnati, O. This machine has been designed to meet the requirements of a high-speed and high-powered machine, particularly adapted for high-speed steel twist drills. It is also provided with a slow speed for tapping and with a quick return for withdrawing the tap. It is of the upright type, motor or belt driven as required, and provided with special bracing in the back of the column to provide additional strength. The head is vertically adjustable on the column; the spindle is provided with ball bearings, and jam nuts for adjustment, and an automatic stop so that a number of holes may be drilled to a given depth. A geared feed box is located on the sliding head and provides for six feeds varying from 0.006 to 0.039 inch per revolution of the spindle. The lever for manipulating the back gear when placed in a neutral position will stop the spindle. The machine is provided with gear box drive when belt driven, but in the variable speed motor driven machine the motor takes the place of the gear box. The gear box provides for 18 different speeds, giving, in connection with the back-gears, 36 spindle speeds varying from 38 to 534 revolutions per minute. The machine is provided with the company's patented geared tapping attachment, and a high-speed attachment, desirable for drilling small holes, may also be used in connection with this drill. The machine is built in sizes from 24 to 42 inches.

* * *

THE SALE OF THE IRON AGE

The sale of the *Iron Age*, the formal transfer of which was made the latter part of September, transfers to new owners the oldest and best-known trade publication in this country. The publication will be continued by the David Williams Company, with Charles T. Root, President, Charles Kirchhoff, Vice-President, and W. H. Taylor, Secretary and Treasurer.

In his valedictory, which is given the leading editorial place in the last number, Mr. Williams says:

The conductors of *The Iron Age* have always felt their responsibility as publishers of an organ of important information to which the trade looked for impartiality and fairness. Its reputation (even in other hands) is dear to us, and on no account would we have entertained a proposition to allow the paper to get into the hands of men whose ideals of journalism were not high. Fortunately this is not the case here. The purchasers are men of standing and eminently qualified for the task they have undertaken. I have known Mr. Root for many years, and entertain for him a profound respect and regard, not only as a peculiarly able publisher, but as a charming and high-minded man. His associates are publishers of character, experience and skill. I feel that *The Iron Age* is safe in their hands and wish them all possible prosperity and success.

The opinion Mr. Williams holds of the gentlemen who now control the *Iron Age* is shared by all who know them, and especially by trade paper publishers whose knowledge is more intimate and personal. Under their management the *Iron Age* will undoubtedly advance along new and aggressive lines, to even greater prosperity than it attained under its former owners.

* * *

WORCESTER TRADE SCHOOL

Plans for the proposed Worcester trade school have been prepared by the architects, and submitted for consideration. The academic building has a frontage on Grove St. of 200 feet and runs south on Concord St. to Prescott St. It is to be built of brick with limestone trimmings and the estimated cost is $275,000. Fronting on Grove St., is the academic section of the wing, 57 feet by 52 feet, three stories and basement. Attached to the academic section and fronting on Concord St. is the shop, 214 feet long and 42 feet wide, two stories and basement. The first and second floors of the academic section will be occupied as class rooms, and on the third floor is a large drafting room. The basement and first story of the shop section will be given up to the machine shop and the second floor will be devoted to the wood-working department. At the south end of the shop, fronting on Prescott St., will be the power plant in the basement and on the opposite side is the blacksmith shop. The moulding room will be on the first floor under these departments. A department for bookkeeping and cost accounting is provided for, where the pupils will be taught the cost of production. The wing about to be constructed will accommodate about 300 boys, and the estimated cost is from $50,000 to $60,000.

* * *

The central idea that the boy gets at college is training, training of the mind, storing the mind full of things. Now I say, without the slightest hesitation, that for success in life, intellectual training comes second or third. Without question, character comes first; good sense, second; and intellectual training, third.—*F. W. Taylor.*

THE VERNAZ CIRCULAR CUT FILE*

The Vernaz file has been previously illustrated and a general description presented in the March, 1907, and the September, 1908, issues of MACHINERY. In the latter of these issues it was referred to as the "Vixen" file, this name being the American trade name. The file is the result of an effort on the part of Mr. Alexis Vernaz of Yverdon, Switzerland, to save from the scrap heap a large number of accidentally hard castings. Proving itself successful, it was patented in nearly all industrial countries. The most prominent feature of the file, apparent to the casual observer, is that the teeth of the file are cut circular as shown in Fig. 1.

The essential feature of the Vernaz file, outside of the circular cut, is the form of the tooth itself, the section of the teeth being similar to that of the teeth in a milling cutter. The included angle of the teeth is 60 degrees, with a front rake of 1½ degree. The number of teeth per inch varies from 6 2/3 to 16, according to the purpose for which the file is intended. The teeth are cut one at a time with an end mill made in the shape of a hollow cylinder, having a diameter of from 2½ to 3 inches, and the edge beveled off to an angle of 60 degrees. This end mill is set at an angle of 1½ degree with a line at right angles to the plane of the file. In the manufacture of the files, automatic machines rotate the cutters, feed them into the file blanks to the proper depth, withdraw them, index or move the file the length of the pitch, and then repeat the same action for the next tooth.

At first it would seem that the inclination of the axis of the cutter would produce a cutting edge on the file which would not be flat, but concave. This, of course, is true of the bottom of the cut, but the shape of the top or edge, being produced by the intersection of the conical (beveled) face of the cutter with the cylindrical surface made by the preceding cut, is rather doubtful at first sight. In Fig. 2 the true shape of the edge has been determined by drawing it in a scale several times the true size. In this illustration lines *C* and *D* are corresponding elements of the cylindrical and conical surfaces of the tooth at the edge of the file, and determine the corner *A* of the tooth. The point *A* at the outer edge of the file falls distinctly below the surface of the blank. The top of the file, consequently, is very slightly convex, which is probably an advantage. The convexity is very slight, amounting to only about 0.002 inch on a file 1¼ inch wide.

It has been found that the circular cutting edges cut properly whether the file is pushed straight or at an angle, and also that the relatively large pitch and depth of teeth prevent clogging and the necessity of cleaning, and produce exceptionally smooth surfaces. The surface produced on steel is smoother than that from an ordinary second-cut file, due to the fact that the latter has a tendency to retain small chips between the teeth which scratch the surface filed. On fibrous and tenacious materials, such as wrought iron, mild steel, brass and aluminum, the improvement over ordinary files is very marked. That the action is a cutting one and not an abrading or grinding action, is shown by the chips, which under the magnifying glass are curled up and look as if they were made by a lathe or planer tool.

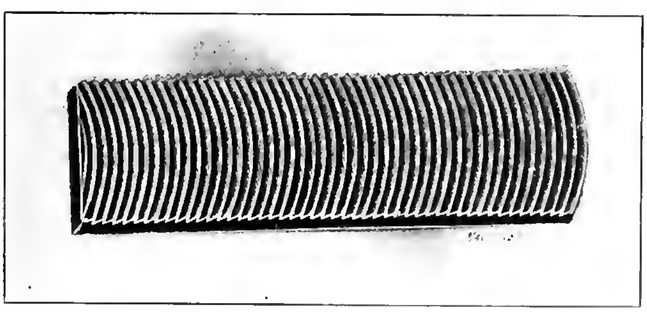


Fig. 1. A Section of the Vernaz File, known in the United States as the "Vixen" File

Tests have been undertaken on these files at the works of Wm. Sellers & Co., Inc., and by Tinius Olsen & Co., Philadelphia, Pa., using a file-testing machine built by Edward G. Herbert, Ltd., of Manchester, England. (This machine was described in the December, 1907, issue of MACHINERY, engineering edition, and also referred to in the September, 1909, issue of MACHINERY, engineering edition, in an article entitled "The Testing of Files and Tool Steel.") In making comparative tests of twenty-nine files from eleven different makers, it was found that twenty-eight out of the twenty-nine regular commercial files, when tested on cast iron, removed from 0.7 to 20.6 cubic inches, while only one file removed 73 cubic inches. These tests also bore out the results of experiments made by Edward G. Herbert himself, showing that the two sides of a file often show extreme variation in cutting capacity. In the tests referred to, the worst case of this kind was a file which removed 20.6 cubic inches by one side and 0.4 cubic inch by the other. Four Vernaz files have been tested on cast iron. The poorest one removed a total of 48.2 cubic inches, using both sides, and the best 143.75 cubic inches, the variations between the two sides being very slight, the worst case being a file removing 49.1 cubic inches by the one side and 34.9 by the other. On high carbon steel the minimum and maximum figures for ordinary commercial files were 3.6 and 6.4 cubic inches, and for the Vernaz files 9 and 25.8 cubic inches. In this case, however, two out of three Vernaz files showed a marked difference on the two sides.

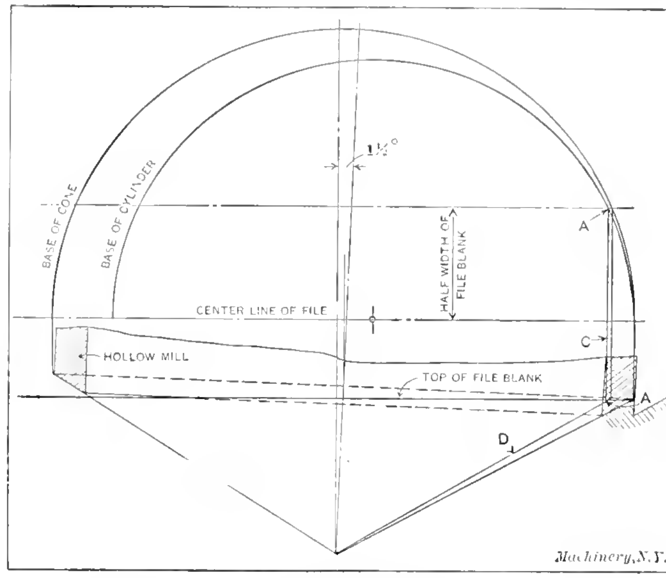


Fig. 2. Diagram used for showing that the Top Surface of the Vernaz File is Convex

The committee of the Franklin Institute reporting on the Vernaz file considers that this invention is the first radical improvement in files for generations, and that the inventor has done the industrial world a marked service, not only in presenting a new and efficient cutting tool for metals, but also in the impetus which the introduction of the tool will give to improvement in cutting capacity and endurance of the regular type of files. The committee, therefore, recommended that the inventor be awarded the Elliott Cresson medal as an appreciation of his achievement.

* * *

Santos-Dumont, the Brazilian aviator who attracted the attention of the world to himself some years ago by his dirigible balloon experiments and exploits, lately built an aeroplane of diminutive size that flew at a speed of fifty-five miles an hour near Paris, September 11. It weighs together with pilot only 260 pounds, and has only nine square yards of wing surface as against twenty-two square yards in the Curtiss aeroplane, twenty-six square yards in the Bleriot machine and fifty-three square yards in the Wright machine. The motor is a two-cylinder gas engine developing 30 horsepower at 1,800 R. P. M. The machine, which is of the butterfly type, is so constructed that it can be used both as an aeroplane and a motor car, rising at will from the road, and descending again to run on the ground. Santos-Dumont expects to reduce the distance required to rise to about forty or fifty yards. The trials at St. Cyr required only seventy to eighty yards to start.

* Abstract of a report of the Franklin Institute, through its Committee on Science and the Arts, published in the *Journal of the Franklin Institute*, September, 1909.

PERSONAL

Charles S. McCarthy has taken the position of superintendent with the Warner Mfg. Co., Toledo, O.

O. J. Sundstrand has been elected secretary and treasurer of the newly-organized National Machine & Tool Works, Rockford, Ill.

William M. Grove has been given full charge of the Cleveland territory for the product of the Ingersoll Milling Machine Co., Rockford, Ill.

T. F. Meek, for twenty-one years with the Detroit Steel Casting Co., is now vice-president and general manager of the Toledo Steel Casting Co., Toledo, O.

C. C. Wais of the C. C. Wais Machine Co., Cincinnati, Ohio, has sold his business, and is now connected with the Covington Machine Co., Covington, Va.

F. G. Kernan, formerly Eastern sales agent for the Fox Machine Co., Grand Rapids, Mich., has been made general sales manager of the company, with headquarters at Grand Rapids.

M. T. Lanse has been made secretary and treasurer of the Foglesong Machine Co., Dayton, Ohio, succeeding A. C. Jackson, who is now cashier of the North Dayton Savings Bank.

Henry Bowman, formerly with the Detroit Steel Casting Company, has taken the position of superintendent of the Toledo Steel Casting Co., which firm succeeds the C. E. Sutton Company.

Perley E. Harvey, who recently resigned from the position of assistant superintendent at the Chapman Valve Mfg. Co., Springfield, Mass., has taken a position with the Fore River Ship Building Co., Quincy, Mass.

W. S. Chase, sales manager of the National-Acme Mfg. Co., Cleveland, Ohio, sailed September 11 for a two months' business trip in Great Britain and on the Continent. He was accompanied by his wife.

Frank Salomon, representative of the engineering staff of Alfred Schütte, Cologne, Germany, is on a visit to America in the interests of his house. His American address is Alfred H. Schütte, 90 West St., New York.

The name of the heating and ventilating engineer of New York, referred to in the article by Mr. C. M. Ripley, "Pure Air Law for Workmen" in the September number, engineering edition, is Percival Robert Moses.

Edwin Cedarleaf, formerly superintendent of the Rockford Machine & Shuttle Co., is now general manager of the National Machine & Tool Works, a concern which succeeds to the old Dalin Bros.' shop and business in Rockford, Ill.

Adolph W. Gilbert has been elected president and general manager of the Chapman Valve Mfg. Co., Springfield, Mass. Mr. Gilbert recently resigned from the position of general manager with the Pratt & Cady Co., Hartford, Conn.

Charles M. Robertson, superintendent of the Colburn Machine Tool Co., Franklin, Pa., resigned his position September 1 to become a salesman with the E. L. Essley Machinery Co., of Chicago and Milwaukee, agent for the Colburn boring mill.

T. W. Warner has been elected president and general manager, and E. S. Janney, secretary-treasurer of the newly organized Warner Mfg. Co., maker of automobile gears and transmissions, which occupies a part of the old Pope plant in Toledo, Ohio.

Frank H. Hill, formerly in the sales and engineering departments of the New York office of the Sprague Electric Co., has been made manager of the Atlanta, Ga., branch office, and assumed his new duties September 1. Mr. Hill succeeds Mr. F. V. L. Smith, resigned.

P. P. H. Conover, secretary and treasurer of the Miami Valley Machine Tool Co., Dayton, Ohio, returned in September from a two months' trip in Europe. He visited England, France, Germany, Italy and Switzerland. The trip was partly on business and partly for pleasure.

P. T. Wingo, for twenty-two years with the Brown & Sharpe Mfg. Co., Providence, R. I., on work relating to gearing and special machinery, has resigned and is now connected with the Cadillac Motor Car Co., Detroit, Mich., in a general mechanical engineering capacity.

A. W. Lewin was advanced September 1 to the position of manager of the New Orleans office of the Sprague Electric Co., New York. Mr. Lewin is a member of the American Institute of Electrical Engineers, and has had extensive commercial and engineering experience in the electrical business in both North and South America.

James H. Norris, for the past nine years business manager of the John F. Allen Riveting Machine Co., 370-372 Gerard Avenue, New York City, resigned his position, his resignation having taken effect September 1. It was Mr. Norris' intention to take a rest of about two months, part of which time was to be spent on an extended trip.

P. J. Hoenschied, for several years vice-president and mechanical manager of the National Twist Drill & Tool Co., Detroit, Mich., has disposed of his interests in that concern and expects to start a new company for the manufacture of automobile parts. The Hoenschied stock was purchased by members of the National Twist Drill & Tool Co.

C. E. Wust, of C. E. Wust & Co., Seebach, Zurich, Switzerland, is in America to establish licensees for making the Wust herringbone gearing (see MACHINERY, engineering edition, April, 1908, page 515) and to make a contract with some maker of American machine tools to build the Wust herringbone gear-cutting machine. The Grand Union Hotel, New York, is his headquarters.

M. M. Shepherd has just been appointed shop instructor at the James Millikin University, Decatur, Illinois. Mr. Shepherd has had wide experience both as a mechanic and as an instructor in designing, drafting, pattern-making, forging, foundry and shop work. He was for three years teacher of manual training in the city schools of Providence, R. I., and four years in similar work in the high schools of Milwaukee, Wis.

F. H. Banbury, engineer of the Acheson-Oildag Co., Niagara Falls, N. Y., sailed for Europe on the steamship *St. Louis*, September 25. Mr. Banbury is an Englishman by birth; he came to America about five years ago and became connected with the Acheson-Oildag Co. over a year ago. His European trip is taken in the interest of the company to introduce deflocculated graphite, the discovery of Edward G. Acheson, president of the company.

W. E. Wickenden has been appointed assistant professor of electrical engineering of the Massachusetts Institute of Technology, Boston, Mass., and will assume the duties vacated by Prof. G. E. Shaad, who has gone to the University of Kansas to take charge of the electrical engineering department there. Mr. Wickenden is a graduate of Dennison University, and is a member of the electrical engineering staff of the University of Wisconsin. He is the author of a book on photometry and illumination.

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OBITUARIES.

James Denver, formerly master car builder of the N. Y., N. H. & H. R. R., died August 19, and was buried in Springfield, Mass.

Walter E. Andrews, president of the Williams Typewriter Co., died at his home in Shelton, Conn., September 7 of arterial trouble, aged fifty-nine years. Mr. Andrews was a native of Vermont, and, when a young man, went West and resided in Des Moines, Iowa, for many years, where he became president of the Western Newspaper Union. He came East to Brooklyn and about nine years ago removed to Shelton.

Russell Markham died at the home of his son, E. R. Markham, Cambridge, Mass., August 24. Mr. Markham, during war times, worked on rifles for the United States government at the old Jones & Lamson shop, Windsor, Vt., and the Massachusetts Arms Co., Chicopee Falls, Mass. After the close of the civil war the Lamb Knitting Machine Co. bought the Massachusetts Arms Co. plant and Mr. Markham entered its employ as foreman, which position he held for nearly forty years, retiring only four years ago on account of advanced age.

Robert Hoe, 3rd, head of R. Hoe & Co., printing press builders, New York and London, died in London, September 22, aged seventy years. Mr. Hoe was the third in line of printing press builders. His grandfather, Robert Hoe, came to America from Leicestershire, England, in 1784, and in 1803 started a printing press plant with his brothers-in-law, Matthew and Peter Smith. Mr. Hoe was succeeded by his two sons, Col. Richard M. Hoe and Robert Hoe, 2nd. Robert Hoe, 3rd, was a son of the latter, and succeeded to the management in 1884. At the time that Robert Hoe, 3rd, entered the business, the cylinder press invented by his uncle, Richard M. Hoe, had a capacity of only 9,000 sheets of four pages each per hour, which had afterwards to be folded by separate machinery or by hand. Hoe presses are now built that are fed with eight rolls of paper at once, and produce 166,000 16-page newspapers per hour, folded ready for delivery. While Mr. Hoe was remarkable for his inventive capability, it is said he never took out a patent in his own name. He was an organizer of ability and systematized his factory thoroughly in all departments. Mr. Hoe also had some reputation as an author, having written several books on book-binding, evolution of printing presses, etc. He gave a great deal of attention to the education of apprentices, and every boy apprentice to R. Hoe & Co. was compelled to attend school, one hour of his working time and one hour of his own time being devoted to this purpose every week day evening. The Grand Street factory, New York, employs about 2,500 men, and the London factory about 800 men.

* * *

The Zeppelin airship has found a serious rival in the Schütte airship, which will undergo thorough trials within a few months. This navigable balloon will have a lifting capacity of five tons, and its chief interest centers in the fact that the inventor has devised means for storing the gas forced out of the balloon by the ascent into high altitudes, or by the expansion due to the heat of the sun's rays. This fact

will enormously extend the possibilities of remaining in the air, as the gas can again be supplied to the balloon as required. The plans have been submitted to leading aeronautic experts and are said to have met with their encouragement. Prof. Schütte retains the rigid frame of the Zeppelin airship but employs wood instead of aluminum, and the cover has a lining of gold-beater's skin. From these new features important advantages are anticipated. The airship will be lighter and more elastic, the loss of gas will be reduced to a minimum, and the absence of metal in the framework will render ignition from lightning less probable. At the same time, the absence of metal enables a wireless telegraphy outfit to be carried in the car without danger.

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COMING EVENTS

October 3-9.—St. Louis Centennial Week, St. Louis, Mo. Balloon, airship and aeroplane races will be arranged under the auspices of the Aero Club of St. Louis.

October 4-8.—Annual joint convention of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants' Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12.—Monthly evening meeting American Society of Mechanical Engineers at the Engineering Societies Building 29 West 39th St., New York. Calvin W. Rice, secretary, 29 West 39th St., New York.

October 12-13.—Semi-annual convention of the National Machine Tool Builders' Association at the Hotel Astor, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY's seventh annual outing.

October 19-21.—Annual convention of the American Railway Bridge and Building Association, Jacksonville, Fla. S. F. Patterson, secretary, Boston & Maine R. R., Concord N. H.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

December 1-13.—Annual convention of National Association for the Promotion of Industrial Education, Milwaukee, Wis. J. C. Monagham, secretary, 20 West 44th St., New York.

NEW BOOKS AND PAMPHLETS

INVENTIONS, PATENTS AND DESIGNS. By G. Croyden Marks. 116 pages, 4¾ by 7 inches. D. Van Nostrand Co., New York. Price $1.

This work contains the full text of the British patent and designs act of 1907 and will for this reason be particularly valuable to Americans who are interested in British patents. The general text treats of fostering industries, the meaning of patents, what is patentable, surrender and revocation of patents, licensing of inventions, infringement of patents, patent working in America, legal proceedings, applying for an injunction, how to work patents, designs, etc.

POCKET MANUAL OF ENGINEER'S SOLAR TRANSIT. 53 pages, 4½ by 6½ inches, 9 illustrations. Published by Keuffel & Esser Co., 127 Fulton St., New York, and Hoboken, N. J.

The manual describes the Keuffel & Esser engineer's solar transit, its adjustments and method of use. A table of mean refractions is included, also rules for taking the sun at any latitude or longitude, determining the meridian by direct observation on the sun and determining the meridian by observation on Polaris. While the manual is designed for engineers and others fully familiar with the use of the transit, it will also be found of considerable interest to amateurs and others who would like to know how the polar explorers Cook and Peary located the pole or how navigators verify their position in mid-ocean.

MACHINE SHOP DRAWING. By Fred H. Colvin. 139 pages, 4½ by 6¾ inches, 91 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $1 net.

This book is intended to help those who do not understand the reading of drawings rather than to teach drawing itself. It is a fact that many good mechanics are "shy" on reading blue-prints, and this treatment of the subject has been with a view of explaining to this class the principles of mechanical drawing, illustrating the same with examples of common objects found in machine shop practice. The contents by chapters are: Reading Drawings, Drawing of a Monkey Wrench, Some Examples of Drawings, Laying Out Spur Gears, Laying Out Bevel Gears, The Worm and Worm-wheel, and Sketching.

HENDRICKS COMMERCIAL REGISTER OF THE UNITED STATES FOR BUYERS AND SELLERS. 1,220 pages, 7½ by 10 inches. Published by S. E. Hendricks & Co., 74 Lafayette St., New York. Price $10, express charges prepaid.

This well-known directory of the architectural, mechanical, engineering, electrical, construction, railroad, iron, steel, mining, mill, quarrying, exporting and kindred industries has passed into the eighteenth edition. It contains over 350,000 names and addresses and has 35,774 classifications, fully listing manufacturers and dealers in the industries mentioned. The comprehensiveness of the directory may be inferred from the statement made by the publishers that it lists for railroads everything from a track bolt to a locomotive; for mining, everything from a miner's lamp to a stamp mill of steel tipple; for the machine shop, everything from a tool-holder to a boring and turning mill or traveling crane; for foundries, everything from a molder's flask to a cupola; for contractors, everything from a pick or shovel to a hoisting engine or steam shovel; for the drafting room, everything from a drawing pencil to a blue-printing machine; for power transmission, everything from a belt fastener to a complete system including the latest specialties in right angle transmission and variable speed countershafts. The directory is one that we heartily recommend to all who desire comprehensive lists of concerns in the various industries. The lists are conveniently arranged for circularization, etc.

CATALOGUES AND CIRCULARS

FREDERICK O. DRAKE & CO., Fisher Building, Chicago, Ill. Catalogue of mechanical books for home study.

MODERN TOOL CO., Erie, Pa. Leaflet of universal grinding machines made in two sizes, 9 x 26 inches and 13 x 32 inches capacity, respectively.

AMERICAN RAILWAY STEEL TIE CO., Harrisburg, Pa. Circular describing the composite steel and asphalt filling tie made under the John G. Snyder patents.

PHILLIPS PRESSED STEEL PULLEY WORKS, 4th St. and Glenwood Ave., Philadelphia, Pa. Leaflet illustrating the Elliott Cresson medal awarded to Ferdinand Phillips, October 2, 1907, for his machinery for manufacturing pressed steel pulleys.

WELLS BROS. CO., Greenfield, Mass. Circular of machine screw taps and dies of the American Society of Mechanical Engineers standard. The A. S. M. E. sizes are being adopted by many manufacturers, and it is probably only a matter of a few years when the V thread machine screws will become obsolete.

FRANK MOSSBERG CO., Attleboro, Mass. Five full size illustrations of Mossberg screw wrenches, namely: Midget, Sterling No. 2, Sterling No. 3, Sterling No. 14, and Sterling No. 50. The half tones reproduce the beautiful mottled effect of case-hardening and are very attractive examples of half-tone illustrations.

ELECTRICAL ALLOY CO., Morristown, N. J. Catalogue No. 2 of resistance materials in every variety of wire, sheet and ribbon, nickel steel alloy, nickel copper alloy, ferro nickel alloy, nickel-chromium alloy, German silver alloy, for use in the manufacture of arc lamps, resistance controllers, car heaters, measuring instruments, rheostats, etc.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Leaflet on drill grinding, reproducing MACHINERY's shop operation sheets Nos. 100 and 101 on grinding flat and twist drills. The company supplies a model drill point in die-cast metal which is intended to serve as a guide to the proper grinding of drills. This will be found valuable by all users of twist drills. The price is $1.

NEW ERA GAS ENGINE CO., Dayton, Ohio. Catalogue of New Era auto-cycle which is designated as a two-wheeled automobile, and is operated similarly to an automobile. It has no pedals and is driven by an air-cooled 3½ horse-power single-cylinder motor through a two-speed gear that enables the rider to ascend the steepest hills found on the ordinary highways.

KEUFFEL & ESSER CO., 127 Fulton St., New York, and Hoboken, N. J. Price list of blue-print papers which are supplied in three grades as regards time: regular, requiring from four to eight minutes' exposure in bright sunlight; quick, for work required on short notice and where no good light is available, and electric quick, for use with electric light and electric printing machines.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletin of tungsten miniature low voltage incandescent lamps, 1.5 to 20 volts. These lamps vary in efficiency from 0.9 watt per candle power to 1.33 watts per candle power, and are desirable for use on automobiles, flash-lights, signs, dental, optical and surgical instruments, etc., and in fact in any place where small low-voltage power lamps are used.

MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio. Catalogue F of Miami Valley engine lathes made in 13-inch and 16-inch sizes, 13-inch stud lathes, sensitive drills, plain cutter and reamer grinders, No. 2 universal grinder with automatic feed, No. 2 universal surface grinder, No. 1 universal cutter and tool grinder. The operations of grinding a form cutter, gear cutter, blanking punch, spiral cutter, T-slot cutter, side milling cutter, etc., are illustrated.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin No. 4009 of Temple Ingersoll "electric air" rock drills. The Temple Ingersoll "electric air" rock drill apparatus comprises an electric motor and a two-cylinder air pump and the rock drill proper. The air pump is connected with the rock drill by two hose and the pulsations of the pump work the drill in unison, using the same air continuously.

CHAPMAN ENGINEERING CO., 917 Land Title Building, Philadelphia, Pa. Catalogue of casehardened, corrugated copper flange gaskets, adapted to all kinds of steam service, working equally efficiently under superheated steam, high pressures or low pressures. These gaskets are guaranteed not to burn or blow out, to stand 500 pounds steam pressure and superheated steam of any practicable working temperature and to make an absolutely tight joint on a rough or pitted surface.

NORTON CO., Worcester, Mass. Booklet entitled "Facts Worth Knowing about Grinding Wheels," containing valuable information for users. The Norton grinding wheels are made by three processes—vitrified, silicate or semi-vitrified, and elastic, and in grades suitable to all classes of work. Suggestions for ordering are given which will be found valuable by those who are not fully aware of all the factors that enter into the selection of grinding wheels necessary to secure the highest efficiency.

NEWMAN-ANDREW CO., 107 West St., New York. Circular of "Toledo" high-speed steel manufactured by Jno. Hy. Andrew, Ltd., Toledo Steel Works, Sheffield, England. The circular gives directions for treating "Toledo" high-speed steel, ordering steel suitable for various purposes, such as cold chisels, boiler snaps, mint dies, rock drills, lathe tools, milling cutters, etc., and lists the various brands manufactured. A comparison of thermometric scales, and tables of weights of bar stock per lineal foot are appropriately included.

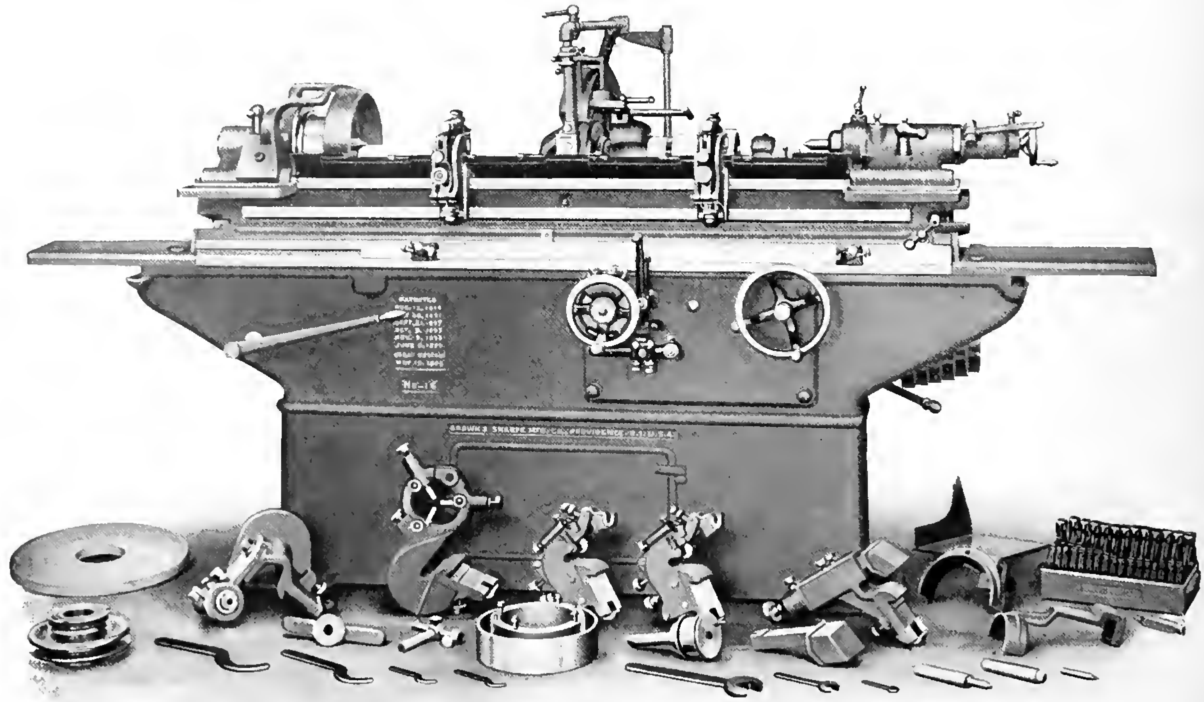
ELECTRO DYNAMIC CO., Bayonne, N. J. Circulars No. 29, 32, 34 and 35, illustrating the electro-dynamic interpole variable speed motors which have the following characteristics: 1. Constant speed at any controller position regardless of load. 2. Wide speed range by field control. 3. Freedom from sparking. 4. Compactness. 5. Reversibility. 6. Operation on any single voltage—110, 210, or 500 volts. The circulars describe the theory of magnetic action and illustrate the construction of the motors, and their application to machine tools, elevators, printing presses, crane trolleys, vacuum cleaning pumps, centrifugal pumps, etc.

W. S. ROCKWELL CO., 50 Church St., New York. Circular of Rockwell annealing and hardening furnaces, giving dimensions, fuel consumption of oil and gas, and other data required by purchasers. The furnaces are made in 13 sizes, the smallest having chamber dimensions of 10 by 13½ inches, and entrance to chamber, 9 by 5 inches. The largest furnace listed has a chamber 39 by 54 inches with entrance 36 by 18 inches. These furnaces are suitable for annealing, hardening, tempering and casehardening, but are not adapted for hardening high-speed steel.

NATIONAL FILE & TOOL CO., 2110 Allegheny Ave., Philadelphia, Pa. Catalogue of the "Vixen" patent hand milling tool. The Vixen file and milling tool was described in the May, 1909, number of MACHINERY. It differs from the ordinary file in the shape of the cut, the teeth being formed on the arc of a circle and so shaped as to give a smooth shearing action. It is claimed that the Vixen file and milling tools will cut from three to five times as fast as an ordinary file tool, and last from four to six times as long. They are particularly efficient on soft metals and alloys such as babbitt, lead, aluminum, etc., cutting rapidly and being self cleaning.

W. F. & JOHN BARNES CO., 231 Ruby St., Rockford, Ill. Catalogue No. 69 of upright drills and other machine tools, comprising bench friction disk drill, floor friction disk drill and regular upright drills of various patterns and designs from 15 inches swing to 50 inches swing, inclusive. These drills are provided with special attachments according to requirements, including gear tapping attachment, compound table, oil feeding device, multiple spindle head, etc. The Barnes horizontal radial drill is illustrated, and also the Barnes water emery grinder, adjustable screw press, universal sliding chuck attachment, and various features of design and construction of the upright drills

BROWN & SHARPE MFG. CO.,



B. & S. Grinding Machine Accuracy is Permanent

When a machine is new its perfect working condition and ability to produce accurate work are naturally expected. **The real test, however, is that of long continued service** and it is here that is manifested the **excellent design** and **high quality** of **workmanship** which characterize

B. & S. Grinding Machines.

In construction a sufficient amount of metal is correctly distributed in all parts to secure rigidity—a factor of utmost importance. The working parts are easily accessible and all levers and hand wheels are conveniently located so that the operator may have full control from the front of the machine. This, together with the employment of a special cross feeding mechanism that causes work to be ground automatically to within .00025 of an inch of a required size, enables **one operator** to **easily run two machines.**

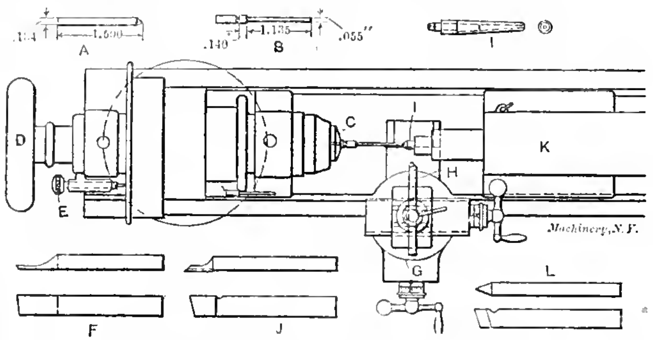
Another feature of great importance consists in the fact that the work speeds and table feeds are completely separated, permitting the correct table feed for any work speed to be obtained.

Supplement to MACHINERY, November, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Jig and Die Work in the Bench Lathe—I"

SHOP OPERATION SHEET NO. 115.

A. L. Monrad. MACHINERY, November, 1909.



Accurate Turning in a Bench Lathe.

1. As the pin is to be turned to the dimensions given at *B*, secure a piece of say 0.134-inch wire which is the size of Stub's gage number 29. Insert split chuck *C* for this size wire in the lathe spindle, being careful that the tapering part of both chuck and spindle are clean. Push the wire through the chuck until it projects about 1⅝ inch, and tighten the chuck by turning the hand-wheel *D*.

NOTE.—Never use the indexing pin *E* in the holes of the pulley to prevent the latter from turning while tightening the chuck (unless a special index plate is used for that purpose) as by so doing the indexing holes will become worn.

2. If the wire extends far beyond the hand-wheel *D*, place a horse beneath the end of the wire to keep it from flying about when turning, or saw it off close to the lathe spindle.

3. Fasten a cutting-off tool *F* in the tool-post with the point as close as possible to the latter to prevent chattering. Set the tool so that it will cut off 1½ inch of stock, and with the belt on the smallest pulley and the foot on the treadle giving the slowest speed, cut the wire, using lard oil as a lubricant.

NOTE.—If a number of pieces are to be cut off, the tail center can be used as a stop for the stock by locating it 1½ inch from the cutting edge of the tool.

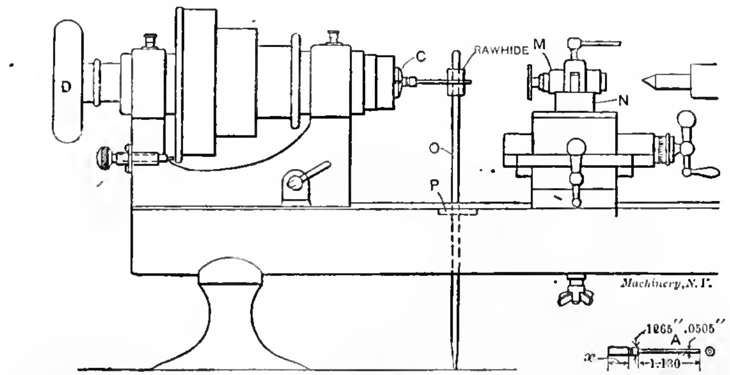
4. Set the slide rest *G* to an angel of 30 degrees, and fasten the piece of wire, previously cut off, into the chuck so that its end projects about ¼ inch. Set the cutting edge of a diamond pointed tool *H* to the height of the center of the work and turn the latter to a conical point as shown at *A*. Allow the wire to project about 1 5/16 inch beyond the face of the chuck and support it by a special female center *I* in the tail-stock *K*.

5. Rough turn the pin, using the diamond point tool *H*. Take a finishing cut with a side tool *J*, forming the pin as shown at *B*, and making it 0.055 inch in diameter and 1.135 inch long to the shoulder. When turning, shift the belt to the largest pulley and press down with the foot on the fast treadle. Cut a groove 0.140 inch from the shoulder with a sharp thread tool *L*.

6. After the pin has been hardened, polish it in the lathe, using a medium grade of emery cloth, and then draw the temper to a light straw color. Again polish the pin ready for the grinding operation.

SHOP OPERATION SHEET NO. 116.

A. L. Monrad. MACHINERY, November, 1909.



Grinding in a Bench Lathe

1. After the pin is turned and hardened as described in the preceding sheet, grind off the conical point by hand on an emery wheel making the distance from the end to the shoulder 0.130 inch as shown at *A*. Insert a chuck the proper size for the small diameter of the pin in the head-stock spindle.

2. Insert the small end of the pin in the chuck within 1/16 inch of the shoulder and tighten the chuck slightly by turning the handle *D*. If the work is gripped too tightly, it is liable to run out of true.

3. Fasten the grinding attachment *M* in the tool-post so that the axis of the wheel spindle is parallel with the axis of the work, and also so that the two axes are in the same horizontal plane. Adjustments for height may be obtained by inserting a ring *N* beneath the attachment. Dress the face of the wheel, which should be of fine carborundum, to an angle of about 5 degrees. Cover the slide rest with a piece of cloth to protect the bearings from the abrasive when grinding, and grind the part x of the pin perfectly true.

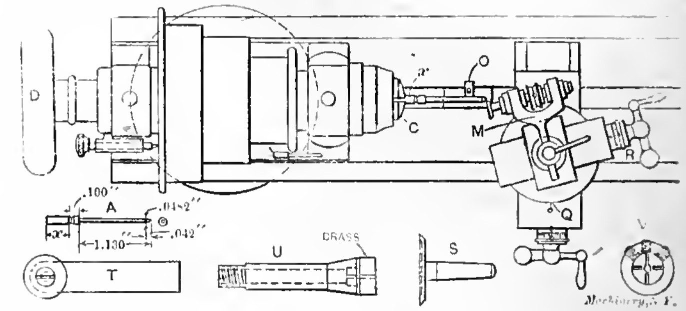
4. Place a larger chuck *C* in the spindle and reverse the pin, gripping it by the part just ground. If the outer end of the pin runs out it may be trued by inserting a narrow strip of tissue paper between the taper of the chuck and the spindle.

5. The steady-rest *O* is next adjusted to the work. This must be done very carefully so as not to spring the pin when grinding. First move the brass plate *P*, up between the ways of the lathe bed, and then adjust the rawhide support until it is in line with the work. Next stick the wire point into the bench, as shown in the illustration, so that the rawhide just barely touches the pin.

6. Grind the pin up to the shoulder to a diameter of 0.0505 inch, allowing 0.0005 for lapping. Be sure that the work is parallel before taking the finishing cut. Keep the wheel sharp and run with the belt on the second pulley and the foot on the fast treadle. Feed moderately, grinding off 0.001 inch at a time. Grind the head to a diameter of 0.1265 inch. Allow the steady rest to remain in position for the succeeding operation.

SHOP OPERATION SHEET NO. 117.

A. L. Monrad. MACHINERY, November, 1909.



Grinding with a Diamond Wheel

1. Loosen the screws in the slide rest and swing it around to an angle of 4 degrees, using the graduations at *Q*.

2. Grind the end of the pin true, and then set the feed-screw thimble *R* to zero. Next grind a taper on the end 0.042 inch long and 0.049 inch diameter.

3. Remove the emery wheel from the tool-post grinder, drive a diamond wheel *S* in the grinder collet and screw it into the spindle. The spindle should be driven direct from the main shaft, using the smallest pulley, to obtain the slowest speed. Distribute some number 2 diamond dust mixed with sperm oil over the face and side of the wheel and then charge the latter by holding a hardened roller *T* against its face and side for say five minutes.

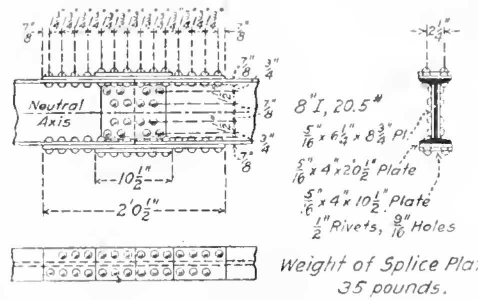
4. Change the belts so that the grinder runs at the fastest speed while the pin revolves very slowly, and finish grind the end of the pin. Set the thimble *R* on the feed-screw to zero, and grind the taper end to 0.0482 inch diameter at the largest part, as shown at *A*, leaving a sharp corner and a shoulder which is to be 0.001 inch on a side after the work is finished by lapping.

5. Move the slide rest and the steady rest *O* to one side, and with a lap *V*, lap the two diameters of the pin to 0.050 and 0.126 inch, respectively, using the finest emery and sperm oil. To lap the pin round and straight, do not move the lap slowly, but draw it back and forth moderately fast, for by so doing a perfectly straight and round surface is obtained. Finish with a clean lap and use machinery oil for draw-lapping to obtain a very brilliant and shining surface. Move the slide rest back in position, and with the hand resting on the slide rest, draw-lap the taper of the pin, using a flat copper lap and fine emery, or white oil-stone dust and sperm oil until it is reduced to 0.048 inch at the largest part.

6. Reverse the pin in the chuck so that the end x projects, and break off this end. Insert a chuck *U*, to which a brass piece has been soldered, in the spindle. Drill and bore a hole, in which the small part of the pin will be a push fit, in this brass piece, and push the pin through the plate. Solder the pin to the plate. Replace the diamond wheel with an emery wheel and adjust the latter until its axis is in the same plane and at right angles with that of the work. Face the head of the pin to a length of 0.100. With a side tool remove the solder and withdraw the pin.

I.—SPLICES FOR I-BEAMS

Splice for 8 inch, $20\frac{1}{2}$ pound I-beam.



Weight of Splice Plates 35 pounds.

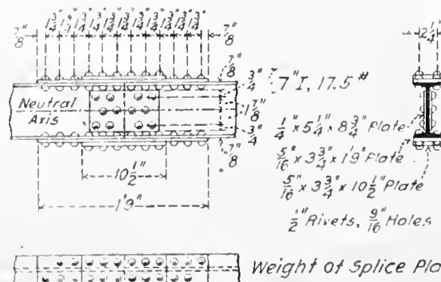
Bending efficiency of splice:

Rivets,	81%
Net section of beam,	82.6%

Efficiency of splice for direct tension:

Rivets,	82.2%
Net section of beam,	88.8%
Net section of splice plates,	100%

Splice for 7 inch, 17.5 pound I-beam.



Weight of Splice Plates 26 pounds.

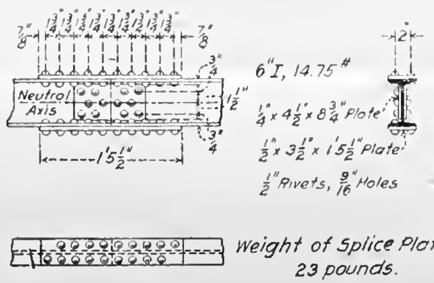
Bending efficiency of splice:

Rivets,	92.3%
Net section of beam.	82.8%

Efficiency of splice for direct tension:

Rivets,	78%
Net section of beam,	88.4%
Net section of splice plates,	89.7%

Splice for 6 inch, $14\frac{3}{4}$ pound I-beam.



Weight of Splice Plates 23 pounds.

Bending efficiency of splice:

Rivets,	83.3%
Net section of beam,	89%

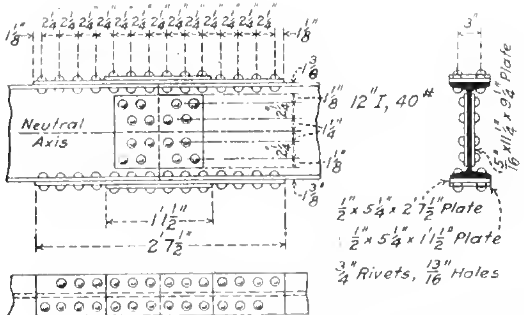
Efficiency of splice for direct tension.

Rivets,	81.3%
Net section of beam,	87.8%
Net section of splice plates,	91.5%

Contributed by A. L. Campbell

II.—SPLICES FOR I-BEAMS

Splice for 12 inch - 40 pound I beam.



Weight of Splice Plates 85 pounds.

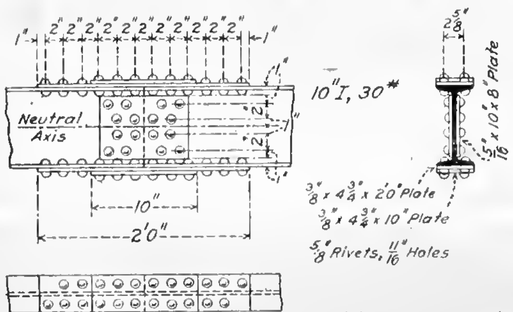
Bending efficiency of splice:

Rivets,	104%
Net section of beam,	80.7%

Efficiency of splice for direct tension:

Rivets,	89.7%
Net section of beam,	86.7%
Net section of splice plates.	95.4%

Splice for 10 inch - 30 pound I-beam.



Weight of Splice Plates 50 pounds.

Bending efficiency of splice:

Rivets,	89.1%
Net section of beam,	84.5%

Efficiency of splice for direct tension:

Rivets,	79.2%
Net section of beam,	89.8%
Net section of splice plates	96.4%

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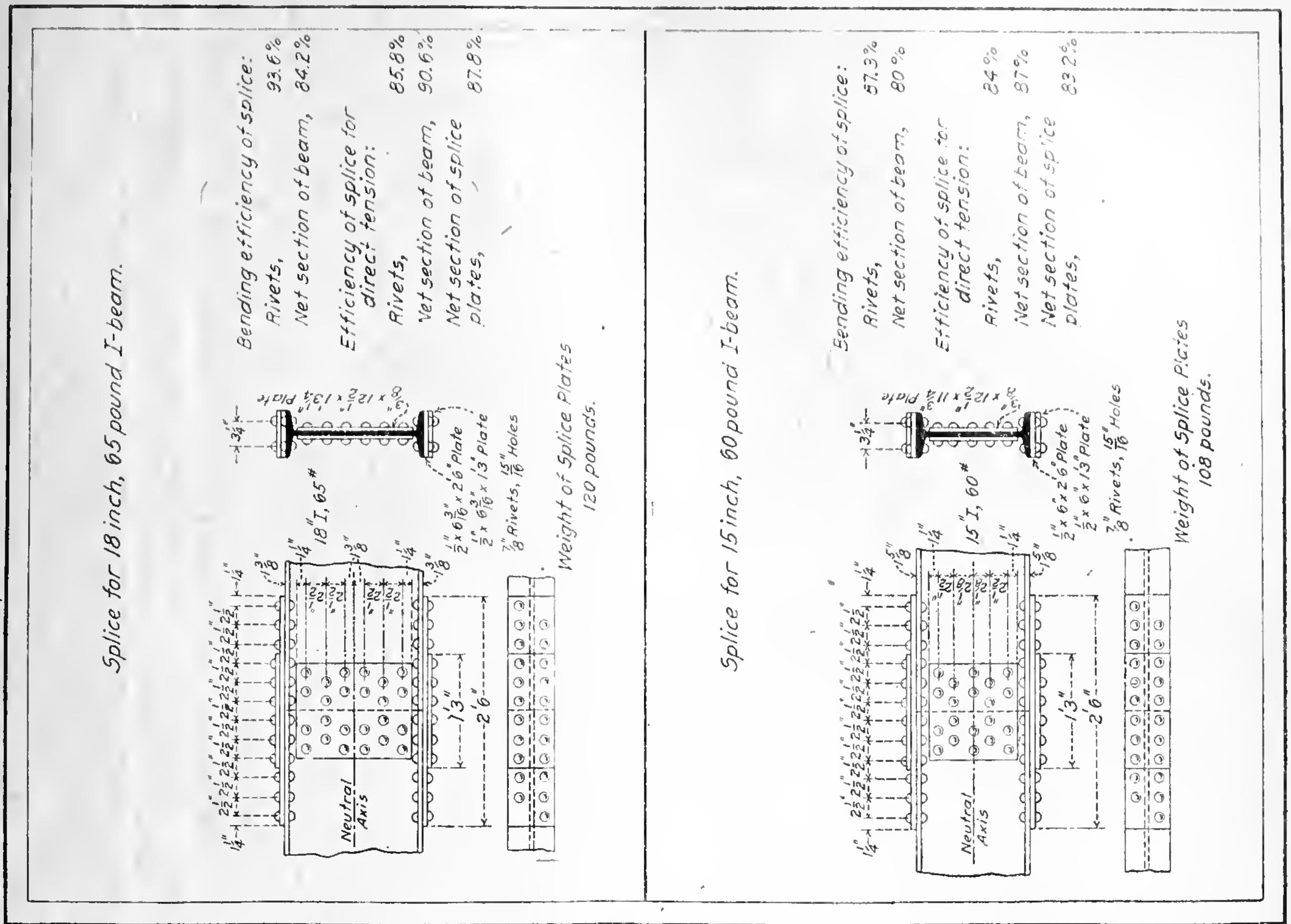
III.—SPLICES FOR I-BEAMS



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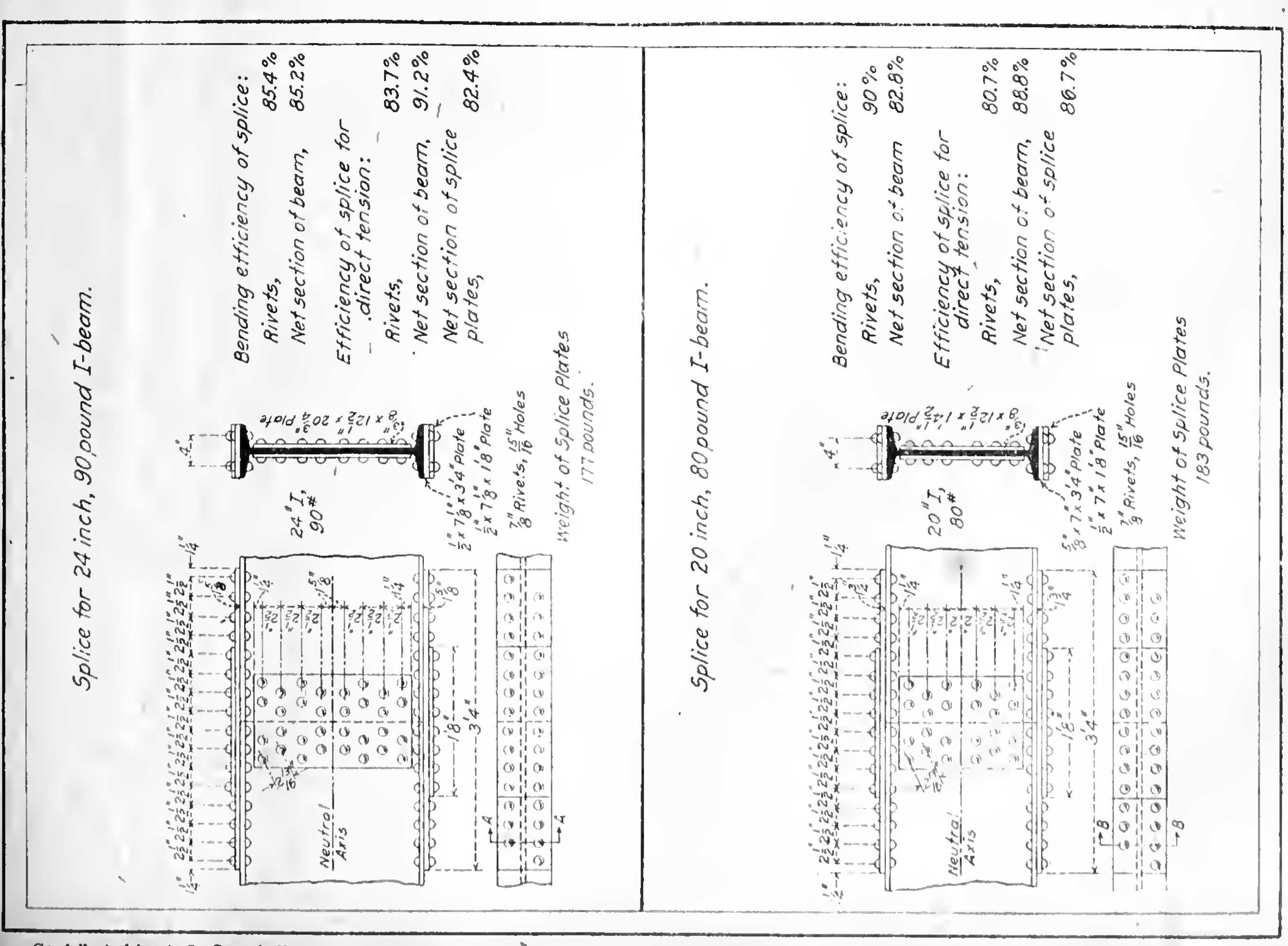
IV.—SPLICES FOR I-BEAMS



Contributed by A. L. Campbell

MACHINERY

November, 1909

CHAIN-MAKING EXTRAORDINARY IN A SCRAPLESS PRESS-ROOM

CHESTER L. LUCAS*

TWENTY-FIVE thousand links of steel sprocket chain, automatically punched, formed and assembled complete in one day of 10 hours! This is the remarkable, though everyday performance of each of the many automatic chain presses in the factory of the Locke Steel Belt Co., of Bridgeport, Conn., manufacturers of steel belt or sprocket chain.

This chain is made primarily for two classes of work: agricultural machinery, such as planters, mowing machines, harvesters, etc., and for conveying and elevating machinery in the mining, grain and other similar industries. The chain is made to meet all requirements, being made in varying sizes from ½ to 3 inches in width, and in thicknesses from 0.045 to 0.250 inch. During the making of this chain not an ounce of the stock is wasted in scrap, excepting a small "scallop" at the beginning and another at the end of each coil of steel. The part of the link which is punched to form the opening in the center is curled around and serves to connect the link with the one following. Thus, 100 feet of steel ribbon enters the press from one side and emerges on the other side as 95 feet of completed chain—the slight shrinkage being due to the bending of the steel in forming the link. The steel used is of low carbon, and comes in large coils ready for the press, having been rolled to the right width for the size chain into which it is to be made; therefore all sharp edges that would result from sheared stock are eliminated. The chain is easily parted at any desired point by simply bending a link backwards as far as possible and slipping it out edgewise.

* Address: Saugus Station, Lynn, Mass.

The Automatic Chain Press

The principal feature of the making of this chain is the automatic chain press shown in Fig. 1. This type of machine was specially designed and built for the work, and as the results will testify, it has been highly satisfactory. In general, it resembles and in fact is, a heavy, powerfully-geared, triple-action press. At the right of the illustration may be seen a roll of stock being fed to the press, and just outside of the housings of the press is located the feeding device which is patterned after the familiar grip feed. The main point of this feed is its positive action, which is absolutely necessary on account of the construction of the dies themselves. If, for example, the stock and partly completed links should, through failure of the feed, be advanced but half the required distance, the dies would be badly damaged at the next stroke of the press. Fig. 2 shows the feed in cross-section, and its operation is as follows: As the connecting-rod *A* descends (actuated by a crank on the driving wheel) it causes link *B* to recede, carrying with it part *C*, which upon reaching lug *D*, pulls back the feed finger *E* in conjunction with slide *F*, of which it is a part. When the end of the stroke is reached, the forward motion throws the feed finger *E* with its jaw, into the stock, forcing it hard against the corresponding jaw in the slide beneath the stock. Between these two jaws the stock, with the whole slide, is carried forward the distance required to form one link. To prevent the slide *F* from moving forward before finger *E* has gripped the stock, a spring pressure plate *G* is provided which bears against the slide. Before the steel ribbon enters the feed, it

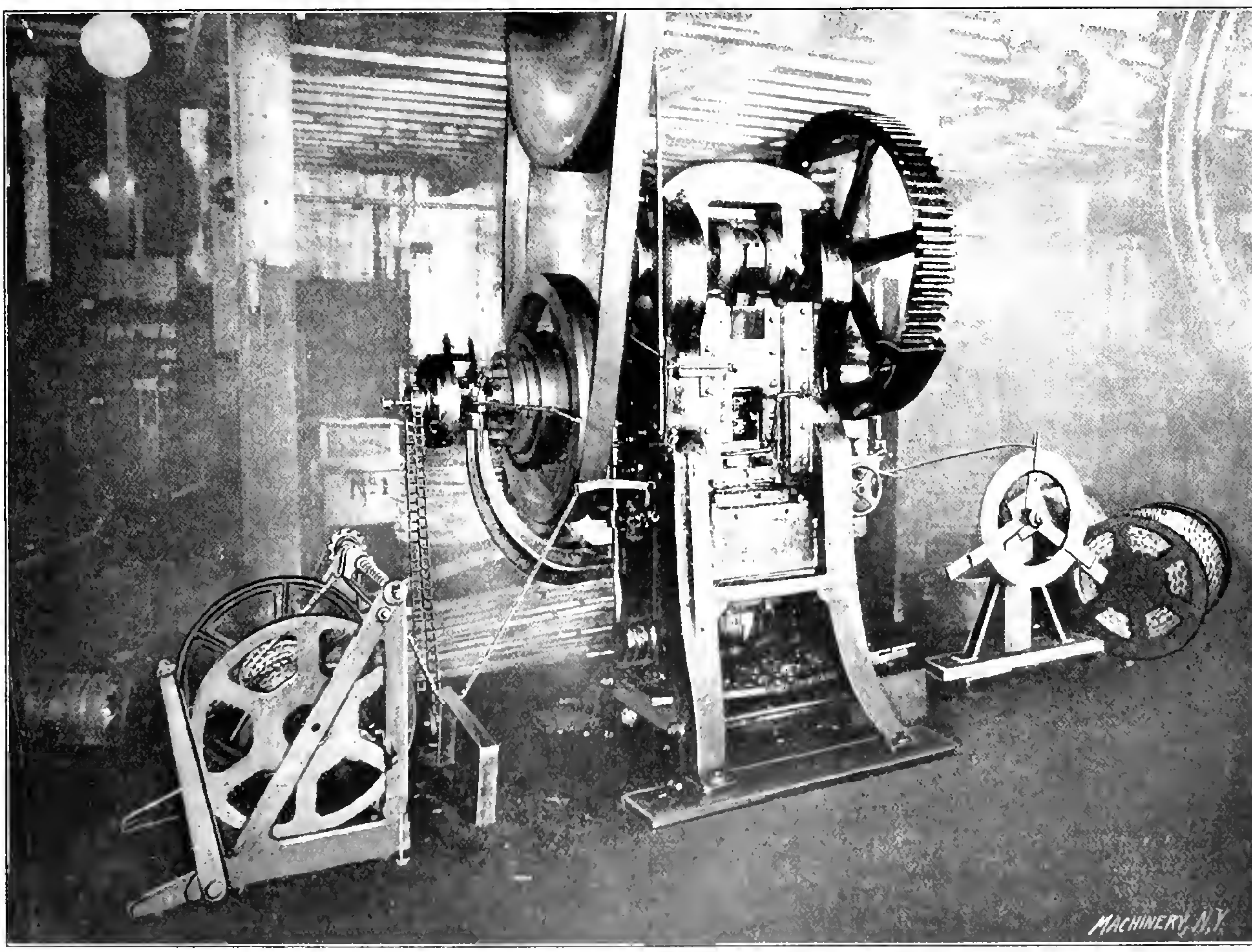


Fig. 1. Automatic Chain Press and Reel upon which Finished Chain is wound

passes between a set of straightening rolls that effectively removes any kinks or dents that would interfere with the action of feed or dies.

The Dies

The dies used in this chain press are very interesting. Although of a modified design, they are after the style of the ordinary follower die; several operations of the chain making being performed upon as many different sections of the stock at each stroke of the press. Another noticeable feature is that all wearing parts, such as punches, scoring chisels, etc., are so arranged in the dies that they may be easily removed without interfering with the rest of the dies, thus facilitating adjustment and renewal. The bodies of the first chain dies were made of tool steel; later machine steel was used, and at the present time machine steel case-hardened to a depth of 1/16 of an inch, is giving better satisfaction than either the unhardened machine steel or the tool steel.

The press tools for the making of the chain are shown in Figs. 3 and 4; these may properly be divided into four parts: the punch *A*, which is held and operated by the main ram of the press; the plate (or stripper) *B*, which is held and operated by the cam-slide; the principal die *C* (also shown in plan view in Fig. 4) fastened to the bed of the press; and the finishing die *D* held and operated by the triple-action mechanism beneath the bed of the press. The function of plate *B* is to hold the body of the chain while punch *A* with its sections *b*, *c*, *e*, *h* and *j* are performing their work on the links and also while finishing die *D* is at work on the under

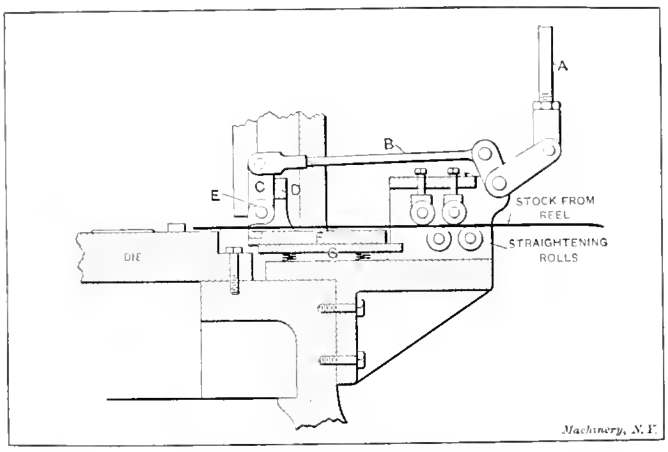


Fig. 2. Positive Feeding Mechanism which advances the Stock the Length of a Link at each Stroke

side of the stock, connecting the links. Just before punch *A* does its work, plate *B* is clamped upon the stock by means of a cam-slide, and held there until the upward stroke releases it.

After leaving the straightening rolls, the stock enters the feeding mechanism already described, and by it is advanced the length of one link under the dies. The first stroke of the press forms the stock over the rounding projection *a* in the die; at the same time, on the under side of the stock, scoring chisels b_1 in the die meet scoring chisels *b* in the punch, on the top side of the stock. While the hump is being formed over *a*, the scoring chisel *c*, located at the top of the hump in the punch, does its work, making a cut clear across and half way through the stock, to facilitate the separation of the links in a succeeding operation. The result of this stroke of the press is indicated by the letters *A* in the illustration, Fig. 5, which shows the appearance of the top and bottom of the stock. While the upward return of the press is under way, the feed is advancing the stock another link's length forward, bringing the hump just formed into position over projection *d* in the die. When the press comes down on the second stroke, scoring chisel e_1 in the die and *e* in the punch make opposite cuts that connect the first two cuts made, near their rear ends, thus outlining three sides of what is to be the open space at the center of the link. With this stroke, figure punch *f*, located in plate *B*, stamps the size of chain into each side of the face of the link. This stroke leaves the stock in the condition shown at *B*, Fig. 5.

The semi-completed links are again forwarded one length, bringing the first hump over shearing knife *g* in the die. On the third down-stroke section *h* in the punch separates the stock on the short scored cross line and pushes it in either direction into the die cavity *i*. This step is plainly shown at *C*. The stock is advanced again for the final operation of completing and connecting the links. As the punch descends, section *j* separates and pushes well down into the die, the center of the link, which operation takes but little pressure, as it has already been deeply scored on both sides. Simultaneously, section *k* of plate *B* severs the link where it has been previously scored. At this point, inverted punch *D*,

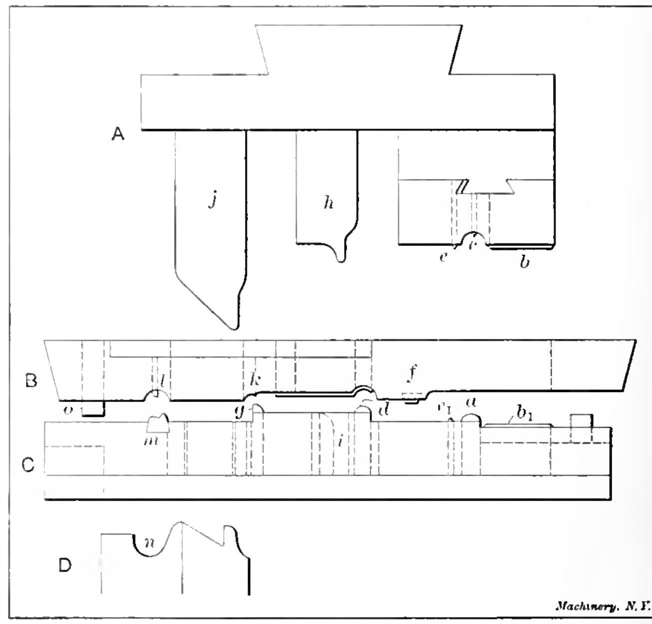


Fig. 3. The Dies used in the Chain Press

operated by the triple-action mechanism beneath the press bed, receives the link tongue in the section *n* and then rises, pushing the link tongue upward and through the center of the link ahead. At the end of its upward journey the tongue strikes the depression in plate *B*, which rounds it nicely into shape, thus connecting it with the forward link and completing the operation of making the chain. A projection *l* is placed in this recess to prevent the link from entirely closing, which would make separation of the completed links

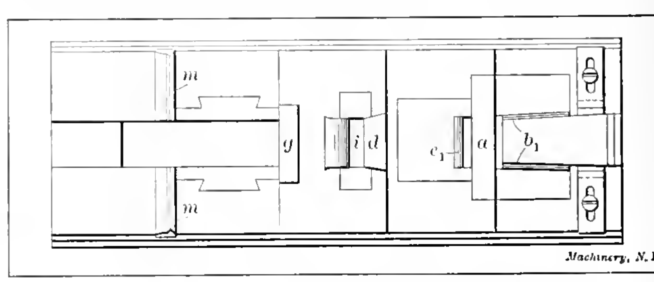


Fig. 4. Plan View of the Die shown in Fig. 3

impossible. During the linking operation, the balance of the stock, outside of the opening, is held by plate *B* against projection *m* and the rest of the die. Stop *o* is added to the dies to insure that the finished chain is pulled from the dies but one link at each stroke of the press. As the link nearest completion is severed from the balance of the stock, it is plain that it would be pulled too far by the winding mechanism if stop *o* did not drop into the opening of the preceding link and hold the link following in position for the linking operation.

While the operations just described have been taking place on the first link other links have of course been started, so that at each stroke of the press four different links are undergoing the various operations and one link is completed and connected with the finished chain that is being wound on the reel at the left of the press.

The Reel

As the completed chain leaves the press it passes under a cam-lever and thence to the reel at the left of the press, as shown in Fig. 1. The solving of the winding problem was not as simple a matter as it would at first appear. To begin

with, the reel weighs over 100 pounds empty and wound with chain, over 500 pounds; therefore the mechanism must be strong and simple, especially as the weight is constantly changing. Secondly, at the starting of the empty reel only about two feet of the chain is wound in one revolution, but when the reel is nearly filled, from eight to ten feet are wound in one revolution, consequently the reel winding must be intermittent. Thirdly, adequate means had to be provided for winding the chain in even layers in order that it might be easily unreeled in subsequent handling.

The reel is about three feet in diameter and made of heavy iron with the sides perforated to reduce the weight as well as to allow the oil better circulation in the tempering bath, which will be described later on. In use, the reel is supported on four small rollers at the base of its support; the rear set acts as driver and transmits the power for turning the reel. When the lever at the side of the reel is thrown down, the rear set of rollers drops back and allows the reel to roll out of the frame. The scheme for obtaining the intermittent motion to the reel-winding is simple. To the driving mechanism (which by the way is operated by power conveyed from the press by a Locke steel chain) is added a friction clutch, controlled by the cam-lever under which the chain passes on its way to the reel. When the chain is being wound too fast, it pulls up against the cam-lever, which by this upward motion disengages the friction clutch and stops the reel. After enough chain accumulates to allow the lever to drop and thus engage the clutch, the reel starts again. The chain is wound in even layers by the screw at the top of the reel which is made with a double (forward and reverse) thread. The carriage over which the chain passes is thus guided slowly backward and forward as the reel is wound, thereby producing a regular and evenly wound reel.

The Hardening Furnace

In many respects the most interesting part of this chain-making plant is the hardening room. To this department the reels of completed chain are brought, and by means of hardening furnaces like those shown in Fig. 6, the soft steel links are automatically hardened. As each link receives the same heat for the same length of time and is quenched in a bath of never-varying temperature, it is obvious that each link of the chain must be thoroughly and evenly hardened.

The illustration Fig. 7 shows a sectional view of the furnace and tank. The incline is lined with firebrick and the heat is supplied through four burners *B* which burn crude petroleum. The chain leaves the reel at the base of the furnace and passing over the sprocket wheel *A* enters the incline, through which it passes at the rate of from 6 to 10 feet a minute, entering the hardening tank shown at the foot of the incline in a bright cherry red heat. After dropping deep into the tank the chain is brought up and over sprocket wheel *C* and thence to the reel where it is wound in the manner already described. By referring to the illustration, it will be noticed that from the time the chain leaves the sprocket wheel *A* at the top of the furnace, until it reaches the sprocket wheel *C* at the end of the hardening tank, it comes in contact with nothing except the red-hot firebrick and water. In this way it is plain that there can be no danger of the hot links being stretched and thereby affecting the pitch of the chain. Provision is made for adjusting the heat in the furnace to suit large or small chain, and the machine is fitted with cone pulleys to regulate the speed at which the chain passes through.

With a line of red hot chain constantly entering the hardening tank, it does not take long to heat the water. To keep the water cool, a large supply pipe is steadily emptying cold water into the tank and at the side is an overflow pipe to carry away the warm water. One little kink on this machine deserves mention, and that is the utilizing of the exhaust heat to dry the chain as it comes out of the tank, dripping wet. As in the other reel drives, the power for this machine and its reel is transmitted by chain similar to that under process of making.

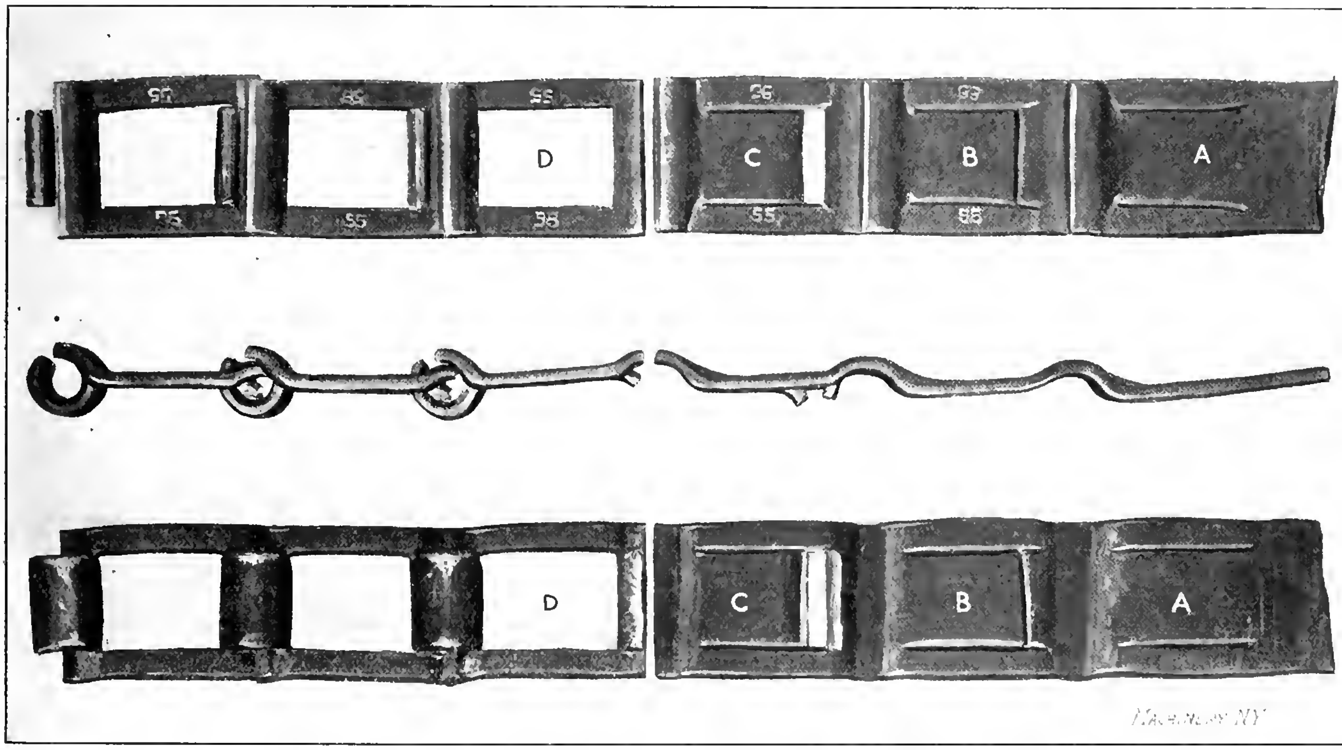


Fig. 5. The Four Successive Steps in making the Chain, and the Completed Links

Tempering

The hardened chain which is of course very brittle in its extreme hardness, now undergoes the tempering process. Great vats of neatsfoot oil are heated to a temperature of 620 degrees F. and into these the full reels of chain are lowered by means of cranes. In this hot oil the reels are left for half an hour, which reduces the temper to a point where the steel has its maximum toughness. Next, the reels of chain are placed on an iron plate which is kept continuously hot, and upon this plate they are left until the adhering oil is baked hard upon the surface of the chain.

Inspection

The tempering operation really completes the chain, yet it is put through a very rigid test which precludes the chance of a single defective link escaping. Fig. 8 shows a view of the testing department and testing apparatus. Here the chain is separated into 10-foot lengths or, if required, into special lengths, as may be seen in the background. Each of these lengths is stretched out upon the testing bench and compared with a standard 10-foot length of the same pitch. If it agrees within the required limits, one end is held by a hook

at the end of the bench and the other end attached to the testing apparatus shown. The main lever of this device is studded with pin holes, and by means of a pin and different weights the required testing pressures can be applied to the various sizes of chain. It is then again compared with the standard to detect stretching. As the chain is drawn from the reels, it is pulled through a series of sprockets to discover any stiff or otherwise faulty links that may be in it.

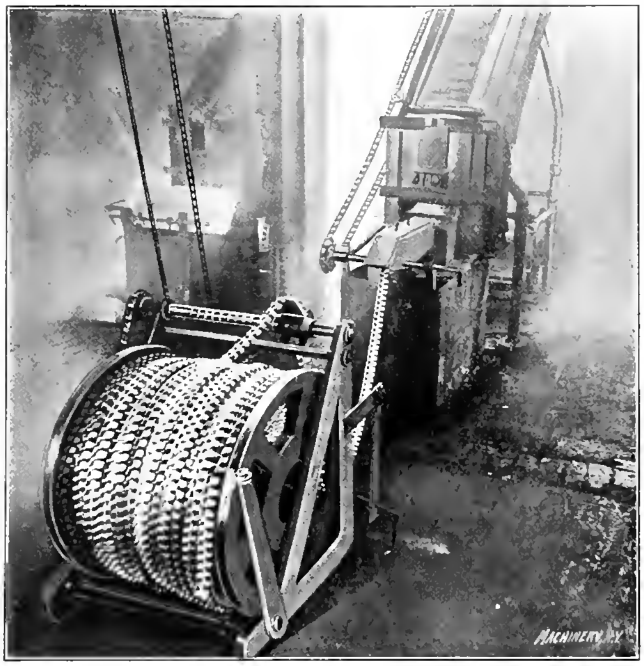


Fig. 6. Chain passing from the Reel into the Hardening Furnace

Each and every link undergoes this exacting examination, and, as two men will put 20,000 feet of the chain through the various tests in one day, the process is not as slow as it would at first seem.

It is not necessary to apply oil to the chain prior to shipment, as the oil tempering operation leaves the chain with a film of oil, baked on, which not only protects the steel from

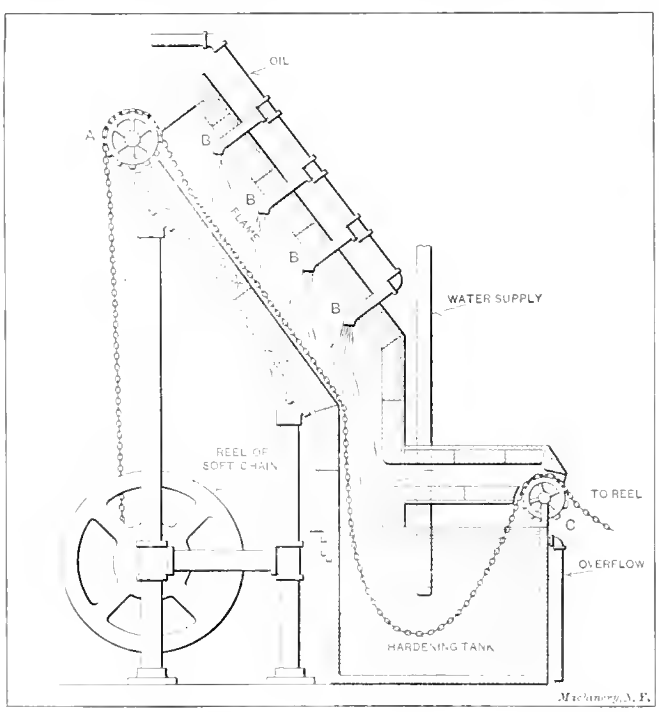


Fig. 7. Sectional View of the Automatic Hardening Furnace

the action of air and water, but gives the chain a durable glossy black finish that satisfactorily completes the manufacture of a superior sprocket chain.

* * *

A new aviation prize, offered by the French paper *Matin*, consists of a sum of $20,000 which will be paid for the first flight with an aeroplane from "city to city" before Aug. 1, 1910.

APPLICATION OF ELECTRICITY FOR PURIFYING AIR

New applications of electricity are being discovered daily but not every new application is of as much interest or importance as one recently developed for purifying the air of reading rooms, theaters, and other close places where large numbers congregate. The apparatus referred to is the ozone generator made by the National Air Filter Co., Chicago, a large installation of which was recently made in the Chicago Public Library to purify or ozonize the 10,000 cubic feet of air per minute that is forced into the main reading room. Dr. W. A. Evans, health commissioner of Chicago, declared that the air in the library building prior to the installation of the apparatus was entirely unfit for use, being foul and dangerous, and probably no other building in the city has been subjected to more condemnation because of its defective ventilating system than it. After the installation of the ozonizing apparatus it was found that the main reading room was completely deodorized, the air being freed of that disagreeable and deleterious odor which for years had so thoroughly permeated all papers, books, furnishings, etc., in this large room. The fresh sterilized "mountain" air in the room reduced the humidity during the hot, oppressive days of summer, and greatly increased the comfort of the readers and employes. The installation renders the disinfecting of all books, periodicals, papers, etc., on the shelves, racks, tables, etc., an automatic process, keeping them constantly in a hygienic condition.

Fig. 8. Department where the Chain is tested

The ozone generator is installed in the large air duct and measures 6 feet high, 11 inches thick and 1 foot wide; it consumes 6.5 amperes of current per hour while ozonizing 15,000 cubic feet of air per minute. A connection is made with a feed wire of 110 volts to a step-up transformer which discharges a current at a potential of 7,000 volts. The high-tension current feeds into a series of electrodes made in the form of ordinary hairbrushes. A static electrical discharge is maintained playing against a series of glass plates. Through this blue electrical discharge of 7,000 volts, air is forced, the result being that all bacteria, germs, etc., are electrocuted. When the filtering electrodes become dirty or clogged they are simply rubbed together and cleaned as one would clean an ordinary hair brush. The generator is placed between the fan and the spray of water used in washing the air, to prevent losing the ozone which the water would otherwise naturally take up.

The low consumption of current and consequent low maintenance cost makes the ozone generator feasible for purifying the air of shops, mills and factories where difficulty is experienced in supplying air in large volume free from odors. It is of commercial importance for preserving and restoring food and other products affected by odors or quickly tainted by decay. Ozone has been found to completely deodorize stale milk, cream, butter and other creamery products, and other uses for the process are constantly being discovered. It is being used for aging wine, curing tobacco, tanning hides, purifying water, etc.

CALCULATING THE SIZE OF BLANK FOR ROLLING SCREW THREADS

J. F. SPRINGER*

There are some interesting problems connected with screw threads which come into prominence when we take up the question of forming them, not by a cutting operation, but by a rolling process. In the process of thread rolling there is no cutting of the groove; the whole procedure depends upon pressing the metal down at one point and permitting it to protrude at another. There are no chips. The amount of metal with which one begins is the amount with which one ends. When cutting a thread in the lathe, the gage of the thread is the same as the gage of the blank; but this is not the case in thread rolling. The thread here projects out beyond the original surface, so that to make a screw thread of a particular gage, it is necessary to use a blank of less diameter. But how much less? To answer this question, it is necssary to determine just how much material is contained in a screw thread.

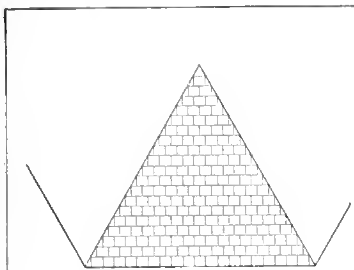


Fig. 1

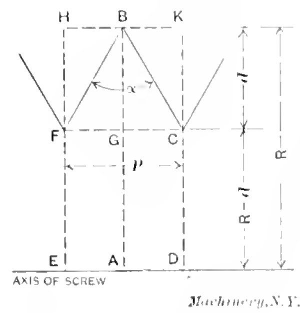


Fig. 2

Before taking up this question in a mathematical way, it may be well to point out how it might be solved experimentally. Suppose we wish to ascertain the exact volume of a sharp 60-degree V-thread ¾ inch in diameter, 10 threads per inch. Taking a ¾-inch rod of some homogeneous material, we first weigh it accurately. We next cut the required thread in the lathe, and measure the length of rod thus threaded. We may now weigh the rod again. The difference between this weight and the former one is evidently the weight of material removed in forming the groove. To get the weight of the thread itself, we may now turn off the threads and weigh the rod after the threads have been turned off. Still another method of getting the volume of the thread depends upon the fact that the groove and thread combined form a cylindrical shell whose volume may easily be calculated (by subtracting the volume of the cylindrical core from that of the blank before threading). Therefore, when once we have ascertained the volume of groove or thread, the volume of the other may readily be obtained from the combined volume by subtraction. All methods of cutting and weighing, however, require very delicate scales and careful experimentation; besides, they have to be repeated for every size.

It is important, then, to consider how we may approach this subject mathematically. The simplest thread to calculate is the square thread. In this thread the amount of metal removed is exactly the same as that left in the thread. Consequently, to get the volume of either thread or groove, we calculate the volume of the cylindrical shell, between the core of the bolt and the original cylinder of the blank, and then divide by 2. Suppose the diameter of the blank is 2 inches and the depth of thread is 0.2 inch. Then the radius of the blank is 1 inch, and that of the core 0.8 inch. If the length of the threaded portion is 3 inches, we have for the shell:

$\pi \times 1^2 \times 3 - \pi \times 0.8^2 \times 3 = 3.393$ cubic inches.

As thread or groove is one-half the shell, we have, for either, the value 1.697 cubic inch.

If there are eight threads to the inch, then there are altogether in the three inches of length a total of 24 threads. Consequently, the volume of a single thread passing once around the screw is $\frac{1.697}{24} = 0.071$ cubic inch.

Now let us consider the case when square grooves and square ridges run around the bolts in planes perpendicular to the axis. Just as before, the volume of the ridges is just equal to that of the grooves, provided that ridges and grooves are the same in section. We must, however, have an equal number of grooves and ridges in order to calculate correctly. In three inches we should have 24 ridges and 24 grooves. Consequently, as before, we find that a single ridge or groove has a volume at 0.071 cubic inch. Consider now what this means. Provided the cross-section is the same in both cases, a square thread has the same volume whether the thread is a ridge in a plane at right angles to the axis or whether it winds as in a screw. This is a very important conclusion, as upon it depends our method for the calculation of other styles of threads. It does not matter, then, how much or how little a square screw thread is inclined, its volume is ever the same, provided no change in the axial section is made. To determine its volume, accordingly, we take it in its easiest position—that is, when it is a plain annular band. We can easily calculate this, by finding the volume of a cylinder whose base has the same diameter as the thread and whose height is one-half the pitch. From this we subtract the volume of the cylinder whose height is one-half the pitch and whose diameter is that of the thread less twice the depth of the thread. The difference between these two volumes will be the volume of one thread passing once aronnd the screw. Let $2R$ be the diameter of the original blank, p the pitch, and d the depth of thread. If we denote the volume of one convolution of square thread by V, we may write

$$V = \frac{1}{2}\left[\pi R^2 p - \pi (R - d)^2 p\right] = \frac{1}{2}\pi p\,(2Rd - d^2) \quad (1)$$

Let us now inquire whether this principle that the volume of a convolution is independent of the inclination of the thread is true for the ordinary V-thread. In Fig. 1 is represented in axial section a 60-degree V-thread. We may divide this triangle by a series of lines all parallel to the base and equally distant from one another. We further divide the several bands into which the triangle is thus divided by vertical lines

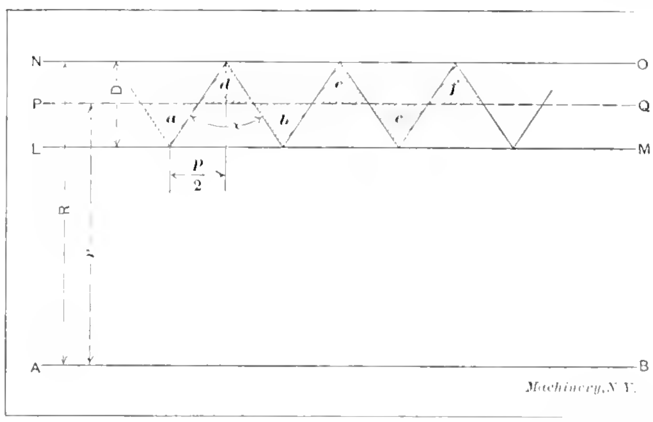


Fig. 3

into small squares all equal to each other. We have as the result a multitude of square screw threads. With the exception of the helical strips, one at the summit and one at each end of a row of squares, the cluster of little square threads will make up the large V-thread.

We now proceed to reduce the size of the section of the little square threads. Each one is made smaller, but each is kept square and all are kept equal. To do this, all we have to do is to draw all the lines closer together. The sum of the squares is now more nearly equal to the V-section, and the cluster of the small square threads becomes more nearly equal to the V-thread. If we continue to make the squares smaller, we get closer and closer to the V-section, and the cluster of square threads gets closer and closer to the V-thread. As there is no limit to our process of reducing the squares and, therefore, no limit to the closeness with which the resulting cluster of square threads approximates the V-thread, we conclude that the rule for square threads holds

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for the full V-section and the full V-thread. That is to say—we conclude that the volume of a V-shaped convolution may be found by ascertaining that of an annular ring having the same V-section. This is a very important conclusion.

A little consideration will soon convince one that precisely the same rule applies to any style of thread. For, by the same system of approximation, we may reach the same result.

Let us now derive the formula for the volume of a sharp V-thread. In Fig. 2, let a be the angle of the thread, p the pitch, d the depth, and R one-half the outside diameter. We must calculate the volume of an annular ring having the triangle BCF as its axial section. The volume of the annular ring may be determined by adding together the two conical frustums generated by rotating $ABCD$ and $ABFE$ on ED as axis and then subtracting the cylinder generated by rotating $FCDE$ on the same axis. We may write:

Frustum $ABCD =$

$$1/3 \times 1/2\, p\, [\pi R^2 + \pi (R-d)^2 + \pi R (R-d)].$$

Frustum $ABFE =$

$$1/3 \times 1/2\, p\, [\pi R^2 + \pi (R-d)^2 + \pi R (R-d)].$$

Cylinder $FCDE = p\,\pi\,(R-d)^2$.

Consequently, denoting the volume of the convolution of the screw thread by W, we have

$$W = \frac{p\,\pi}{6}[R^2 + (R-d)^2 + R(R-d)] + \frac{p\,\pi}{6}[R^2 + (R-d)^2 + R(R-d)] - p\,\pi\,(R-d)^2$$

$$= \frac{p\,\pi}{6}[2R^2 + 2(R-d)^2 + 2R(R-d) - 6(R-d)^2]$$

$$= \frac{p\,\pi}{6}[2R^2 + 2R^2 - 4Rd + 2d^2 + 2R^2 - 2Rd - 6R^2 + 12Rd - 6d^2]$$

$$= \frac{p\,\pi}{6}[6Rd - 4d^2],\quad W = \frac{p\,\pi}{3}[3Rd - 2d^2)$$

$$= \frac{p\,d\,\pi}{3}[3R - 2d] \qquad (2)$$

We may put this formula in a different form. By referring to Fig. 2, we may write

$$\tan\frac{a}{2} = \frac{GC}{BG} = \frac{\tfrac{1}{2}p}{d} = \frac{p}{2d},\ \text{or}\ p = 2\,d\tan\frac{a}{2}.$$

Substituting this in equation (2), we get

$$W = \frac{2\,d^2\,\pi\tan\frac{a}{2}}{3}[3R - 2d] \qquad (3)$$

Since $\tan 30° = \frac{\sqrt{3}}{3}$, we have for the sharp 60-degree thread:

$$W_1 = \frac{2\,d^2\,\pi\,1/3\sqrt{3}}{3}[3R - 2d]$$

$$= \frac{2\sqrt{3}}{9}d^2\,\pi\,[3R - 2d] \qquad (4)$$

Now, just as we found the volume of a convolution of the thread by adding two frustums and then subtracting a cylinder, so we may proceed with the calculation of the volume of a convolution of the thread groove. But we may take a different course; we observe that a thread convolution plus one of its adjacent groove convolutions has a volume equal to that of an annular ring whose axial section is the sum of those of thread and groove. By taking one-half of one adjacent groove and one-half of the other, we may reduce the annular ring to a cylindrical ring whose axial section is $FCKH$ (Fig. 2). The volume of this ring is obtained by subtracting the cylinder formed by rotating $EFCD$ from that formed by rotating $EHKD$. That is, the volume of the ring is $p\,\pi\,R^2 - p\,\pi\,(R-d)^2 = p\,\pi\,(2\,R\,d - d^2) = p\,d\,\pi\,(2\,R - d)$. If we subtract from this the volume of the thread (equation 2), we get for the volume X of a convolution of the V-shaped thread groove.

$$X = p\,d\,\pi\,(2R - d) - \frac{p\,d\,\pi}{3}(3R - 2d)$$

$$= \frac{p\,d\,\pi}{3}(3R - d) \qquad (5)$$

Since $p = 2\,d\tan\frac{a}{2}$

we have

$$X = \frac{2\,d^2\,\pi\tan\frac{a}{2}}{3}(3R - d) \qquad (6)$$

For the sharp 60-degree thread, we have

$$X_1 = \frac{2\sqrt{3}}{9}d^2\,\pi\,(3R - d) \qquad (7)$$

It is interesting to note that with V-shaped threads, where the grooves have equal but inverted sections, the volume of a groove convolution is greater than that of a thread convolution. Thus the groove convolution is (formula (5))

$$\frac{p\,d\,\pi}{3}[3R - d]$$

and the thread convolution (formula (2))

$$\frac{p\,d\,\pi}{3}(3R - 2d)$$

The first value is greater than the second. By subtracting, we ascertain that the excess of groove over thread is $\frac{p\,d^2\,\pi}{3}$.

In rolling a screw thread, a sharp ridge is pressed into the blank. As the metal being operated upon is not easily compressible, particles move away from the advancing tool, penetrating, under the pressure applied, into the body of the blank; but they cannot coalesce with the particles against which they press; nor can they sensibly find room through compression. Thus it comes about that a sharp ridge pressed into a steel blank accomplishes two results. First, it makes an indentation or groove. Second, it forms, indirectly, two adjoining ridges with a groove between them. Without going further into the process of thread rolling, enough has been said to make it clear that in threading a blank, the lower part of the groove is made by pressing suitable tool edges into the blank, and the upper part of the thread is due to material forced up out of the blank. Disregarding minute quantities, this bottom portion of the groove must equal in volume the extruded material. In Fig. 3, AB is the axis of the blank, PQ represents its original surface, LM marks the depth to which there is actual penetration of the forming dies, and NO defines the height to which there is extrusion of material. The problem that has to be solved is to determine $2r$, the diameter of the blank, when $2R$, the diameter of the desired screw, is given. The volume, then, of the grooves a, b, c, etc. must just equal the volume of the threads d, e, f, etc. By formula (3) we may express the volume of a convolution of the thread def. We replace d in this formula by its equivalent $R - r$, and obtain volume of thread convolution e (see Fig. 3).

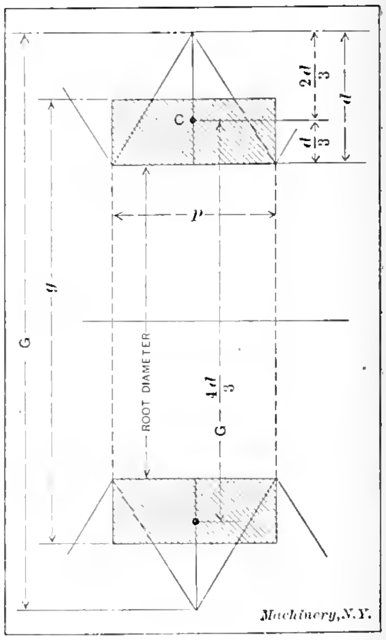

Fig. 4

$$e = \frac{2\,(R - r)^2\pi\tan\frac{a}{2}}{3}(R + 2r)$$

Similarly, by formula (6) we may express the volume of a convolution of the groove b; we must, however, replace R in this formula by r, and d by $D + r - R$ (see Fig. 3). We then have:

Volume of groove convolution

$$b = \frac{2\,(D+r-R)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(2r - D + R)$$

Now thread convolution c must be equal to groove convolution b.

$$\frac{2\,(R-r)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(R + 2r) = \frac{2(D + r - R)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(2r - D + R)$$

or $(R-r)^2\,(R+2r) = (D+r-R)^2\,(2r - D + R)$.

From this we get, after performing the operations indicated and collecting

$$3\,Dr^2 = D^3 - 3\,D^2R + 3\,D\,R^2.$$

Dividing by $3\,D$,

$$r^2 = \frac{D^2 - 3\,D\,R + 3\,R^2}{3}$$

$$r = 1/3\,\sqrt{3\,(D^2 - 3\,D\,R + 3\,R^2)}. \qquad (8)$$

It will, perhaps, be more convenient to have this formula in terms of R and p instead of in terms of R and D. Referring to Fig. 3, we see at once that

$$D = \frac{p}{2}\cot\frac{\alpha}{2}$$

Replacing, by means of this value, the quantity D in formula (8), we get,

$$r = 1/3\,\sqrt{3\left(\frac{p^2}{4}\cot^2\frac{\alpha}{2} - 3/2\,Rp\cot\frac{\alpha}{2} + 3\,R^2\right)}$$

$$r = 1/6\,\sqrt{3\left(p^2\cot^2\frac{\alpha}{2} - 6\,Rp\cot\frac{\alpha}{2} + 12\,R^2\right)}$$

If $\alpha = 60$ degrees, then $\cot\frac{\alpha}{2} = \sqrt{3}$,

and we get,

$$r = 1/6\,\sqrt{3\,(3\,p^2 - 6\,\sqrt{3}\,R\,p + 12\,R^2)}$$

$$r = 1/2\,\sqrt{p^2 - 2\sqrt{3}\,R\,p + 4\,R^2} \qquad (10)$$

Formula (10) applies to the ordinary sharp V-thread of 60 degrees. The value $2r$ would be the diameter of wire that should be used on a thread rolling machine to produce a screw thread of an external diameter equal to $2R$. Let g be the diameter of blank wire and G the diameter of the finished screw thread. Then we may write,

$$g = \sqrt{p^2 - G\,p\,\sqrt{3} + G^2}. \qquad (11)$$

[The final formula above may be obtained in a simpler manner as follows: In Fig. 4, let

G = the outside diameter of thread,
g = diameter of blank,
d = depth of thread, and
p = pitch of thread.

The volume of one thread convolution equals the area of its section multiplied by the length of the path of the center of gravity of the section, if the section be rotated once about the axis of the screw. The center of gravity of a triangle is located one-third of its altitude from the base. Hence, C is the center of gravity, and the path of C when the thread section is rotated is a circle with the diameter $(G - \frac{4\,d}{3})$

The volume of the thread convolution then is

$$(G - \frac{4\,d}{3})\,\pi \times \frac{pd}{2}.$$

This volume must equal the volume of a hollow cylinder having an outside diameter equal to the diameter g of the blank, an inside diameter equal to the root diameter $(G - 2\,d)$ of the thread, and a height p (see Fig. 4).

Thus

$$\left(G - \frac{4d}{3}\right)\pi \times \frac{pd}{2} = [g^2 - (G - 2d)^2]\,\frac{\pi p}{4}$$

Solving for g^2 in this equation gives us

$$g^2 = \frac{4\,d^2}{3} - 2\,G\,d + G^2$$

or

$$g = \sqrt{\frac{4\,d^2}{3} - 2\,G\,d + G^2}$$

But for a 60-degree thread $d = p \times \cos 30° = \frac{p\,\sqrt{3}}{2}$.

Therefore, for a 60-degree thread

$$g = \sqrt{p^2 - G\,p\,\sqrt{3} + G^2}$$

This formula is the same as the one already found by the author's method.

While this formula is theoretically correct, it should be remembered that in thread rolling a great many factors enter which cannot be determined with absolute exactitude. Minute inaccuracies in the thread rolling tools, for instance, lack of homogeneity in the material, etc., would influence the size of blank required. The formula, however, will furnish a guide for selecting the approximate size of stock for thread rolling, although the final determination may have to be left to practical experiments.—EDITOR.]

* * *

HINDERING RECLAMATION WORK IN THE WEST

The reclamation work of the United States government in the arid regions of the West is done under the provision of the Reclamation Act which provides that the land benefited by the water provided shall be assessed for the cost of the work. The payment is made, not into the general fund of the United States Treasury, but into a special fund for reclamation work, and it again becomes available for further reclamation work in other sections.

The reclaiming of the arid regions was begun extensively under ex-President Roosevelt and his Secretary of the Interior, James Garfield. During the Roosevelt regimé settlers were permitted to work on the irrigation projects and the payment for the work was applied to offset assessments on their claims. This practice obviously was mutually beneficial to the settlers and the government. The settlers were able to employ their time profitably while waiting for the life-giving water and the government benefited inasmuch as it received payment on the assessments in advance, thus enabling other irrigation work to be begun long before it would have been possible had the settlers been obliged to wait for the returns received from the irrigated land before making payments.

Under the Taft-Ballinger regimé, the practice of applying the payments for work done by the settlers on future assessments has been stopped, because of an interpretation of the practice placing the government in the light of a debtor to the settlers for the work done on the projects. The *Engineering News* published a long editorial in its September 30 issue calling attention to the misrepresentation of an editorial in the *New York Times* accusing the Roosevelt Secretary of the Interior of being a socialist, etc. The *Engineering News* points out that the irrigation work, which is of enormous extent, has been done most efficiently and without the suspicion of graft, and it hints that this hindrance of further irrigation work is not in the interest of the general public. It is a pity that governmental red tape unwinding should be permitted to slow down one of the greatest projects ever undertaken for the common good.

* * *

The Department of the Interior of Canada has recently been estimating the available water power of the Dominion, and it is stated that there is 26,000,000 horse-power available in accessible localities, of which only 500,000 has hitherto been developed.

COMPRESSOR DESIGNING—THE DISTRIBUTION OF THE LOAD

FRANK RICHARDS*

The air compressor shown in Figs. 1 and 2 may be regarded as a standard machine for the special line of work for which it is adapted. There is that which is picturesque for the engineer as well as for the landscape gardener, and this is a picturesque and interesting machine, embodying a number

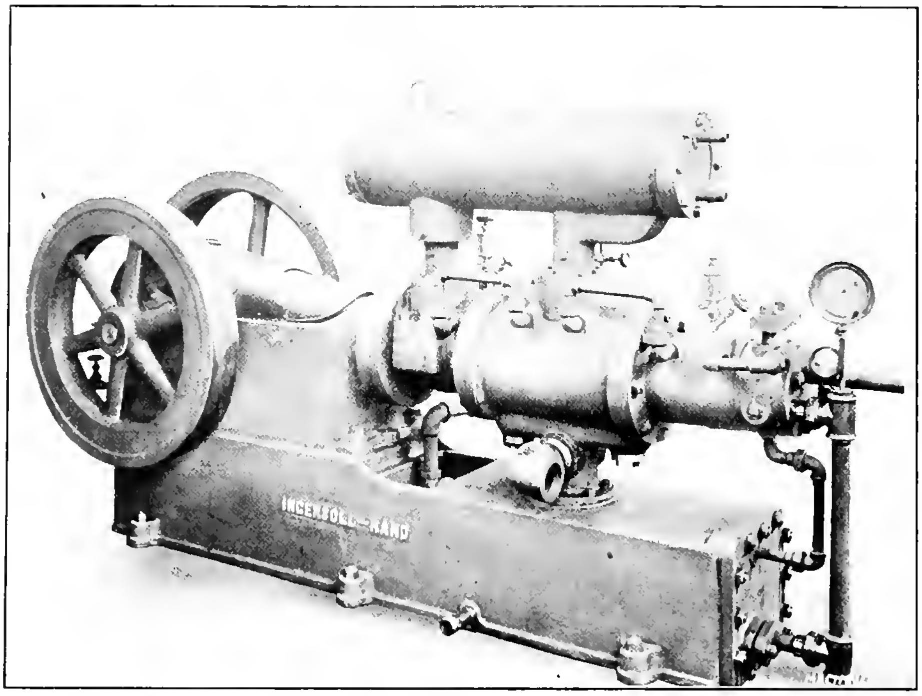

Fig. 1. Ingersoll-Rand Three-stage Air Compressor, designed to compress to 1000 pounds per square inch

of details of ingenious design which are well worth considering. The compressing of air is not in any case as simple an operation as the pumping of water, and when high pressures are required, involving, as in this case, multiple stage compression, the problem of equitably apportioning the work and the effect for each step of the operation, the providing for the easy flow and the efficient cooling of the air between the stages, the reduction of machine friction to a minimum, the providing for the proper lubricating of all the working parts, the arranging of all for ready accessibility when wear or accident makes it necessary, constitute in all an intricate problem, the solution of which is well worth looking into. Nothing, of course, is final, and everything achieved is a challenge to surpass it, so that doubtless later there may be a better machine than this, or than any we now know of, and we must note its points of excellence while we may.

This is a three-stage air compressor designed to work to 1,000 pounds gage pressure, with a free air capacity of about 50 cubic feet per minute. It is a power-driven machine, the type of power application being according to circumstances. As here shown it has a pulley for a belt drive, but it may also be driven by a chain, gearing, a Pelton wheel on an extension of the shaft, or by a direct-connected electric motor.

The dimensions of the cylinders are: 8-, 5- and 2¾-inch diameter, respectively, by 8-inch stroke, and the normal speed is 150 revolutions per minute, giving a piston speed of 200 feet. The low-pressure, or intake, cylinder is double-acting and the other two are single-acting. The three cylinders are in a straight axial line, one piston-rod extending from the crosshead through all the pistons. The low-pressure cylinder is between the other two, the intermediate cylinder being in front, or toward the crank, and the high-pressure cylinder at the back. The pistons of the intermediate and of the high-pressure cylinder are, in fact, plungers on each side of the low-pressure piston. The working area of the low-pressure piston on each side is, therefore, only that portion of the piston which surrounds the plungers, and these areas are quite different on the two sides of the piston on account of the different plunger diameters. This arrangement gets rid of all cylinder heads or partitions and stuffing-boxes between the cylinders. The only stuffing-box for the entire machine is that in the head next to the crosshead and opposed to the working pressure of the intermediate cylinder. The piston rings are the only packings required besides this one stuffing-box. The packing rings for the low-pressure and the inter-

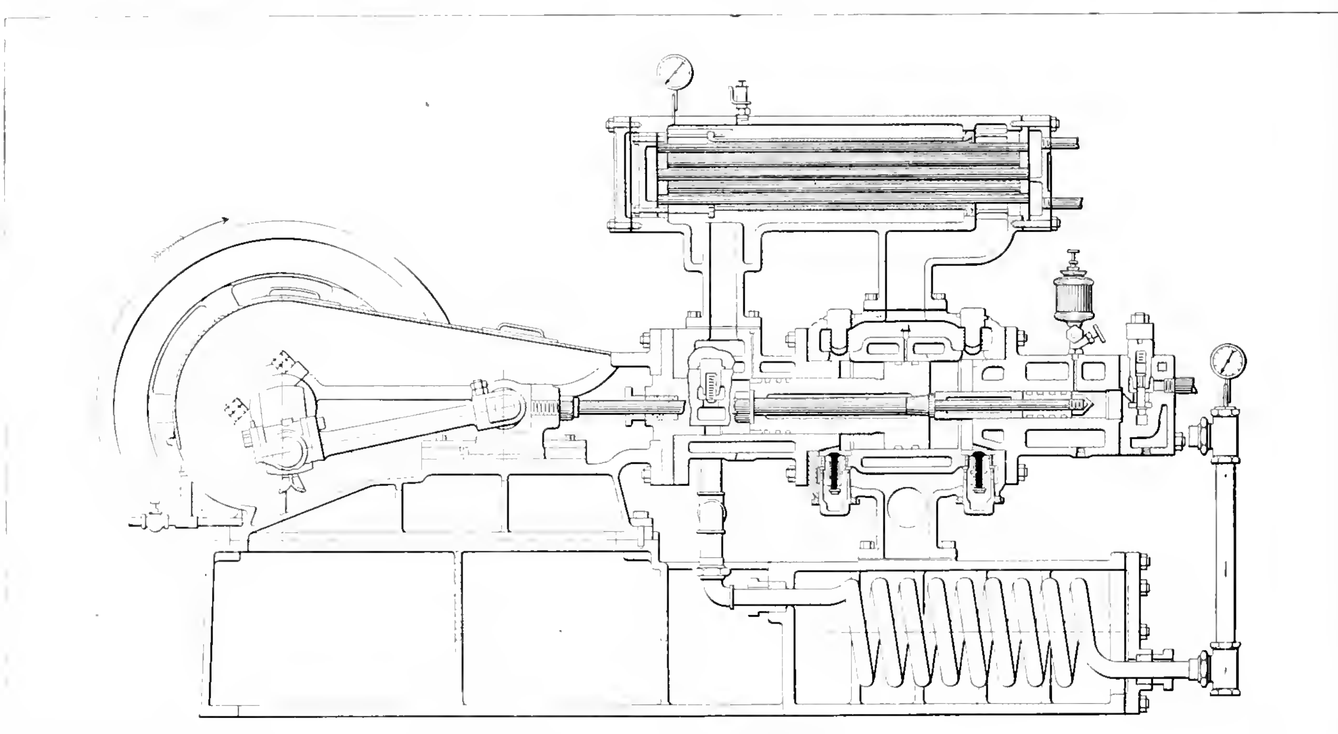

Fig. 2. Sectional View of the Three-stage Air Compressor

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mediate pistons are sprung into grooves turned in the solid metal. In the high-pressure piston or plunger the grooves are not turned in the solid but are formed by removable sections which fit the piston-rod and also the cylinder bore, and which are cut away at the outer corner to form the grooves for the rings. When the main portion of this piston is in place in the cylinder, a packing ring is slipped in to fit against it; one of the movable sections of the piston is then slipped in against this, then another ring, then another piston section with a washer and nut outside, which secures all. The middle or low-pressure pisten has a taper fit on the rod, and is secured by a nut outside the intermediate plunger, which thus locates it precisely and holds it securely.

The actual working clearances of one of these compressors, as determined by the inspector, were: for the low-pressure cylinder, 3/32 inch and 3/32 inch; intermediate cylinder, 1/8 inch; high pressure, 1/8 inch. The distribution of the pressures and the apportionment of the work of compression throughout the cycle of operations of this compressor are such as to make the work for each stroke nearly the same.

On the forward stroke, or with the pistons moving toward the crank, the low-pressure piston and the intermediate piston are both compressing to their respective pressures, and the receiver pressure against the high-pressure plunger is assisting; that is, its thrust at practically constant pressure is to be deducted from the total work done by the other two pistons. On the backward stroke, the low- and the high-pressure pistons are compressing, and the receiver pressure against the intermediate piston is assisting in the work. By calculation based on the assumption that the compression is adiabatic, it is found that the horse-power required for the forward compression stroke of the low-pressure cylinder is 2.79, and for the same stroke of the intermediate cylinder, 8.52 H.P. The total horse-power resistance for the forward stroke is $8.52 + 2.79 = 11.31$ H.P. The intake pressure against the high-pressure plunger which is approximately constant, is sufficient to develop 3.13 H.P. which is to be deducted from the working horse-power of the other two cylinders, giving us as the net horse-power for the forward stroke $11.31 - 3.13 = 8.18$ H.P. For the back stroke of the low-pressure piston the horse-power resistance equals 4.17 H.P., which is, of course, greater than for the forward stroke, because of the increased piston area. The resistance for the working stroke of the high-pressure cylinder equals 8.93 H.P., giving a total for both the low- and high-pressure cylinders of $4.17 + 8.93 = 13.10$ H.P. From this it is necessary to deduct the power due to the intake pressure against the intermediate piston, which is found to be 3.13 H.P. The net power for the back stroke then will be $13.10 - 3.13 + 9.97$ H.P.

While the work of the two strokes is so nearly equal, that of the back stroke is the larger, which is at it should be, as this occurs on the thrust of the connecting-rod instead of on the pull. A sufficient reduction of the terminal delivery pressure would equalize the work for the alternate strokes.

As before stated, adiabatic compression is assumed in each cylinder, with efficient intercooling between the stages. The cylinders are all very completely water jacketed, so that the temperatures of the working surfaces are kept down, and satisfactory lubrication is maintained, but there is little cooling effect upon the body of air in the cylinders during the operation of compression. The circulation of the cooling water is accomplished by a single continuous flow through both intercoolers and all the water-jackets, there being no places where the water can remain without change. The efficiency of the intercooling is sufficiently indicated by the fact that the temperature of the air leaving the second intercooler and entering the last compressing cylinder was found upon a prolonged test to be the same as that of the initial intake or 70 degrees, and the temperature of the air as finally delivered, there being no after cooler, was 188 degrees. The final temperature for perfect adiabatic, single stage compression to 1,000 pounds would be above 1,250 degrees, which would be prohibitive in practice.

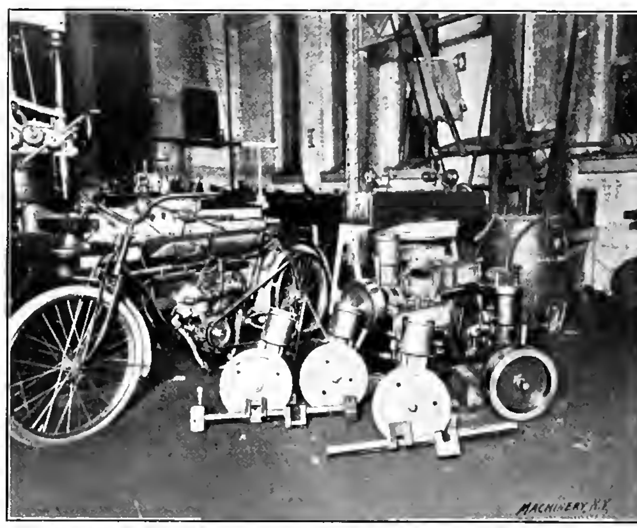
In a test which was made of one of these machines, in which the number of strokes of the compressor required to fill a receiver of known capacity was ascertained, the volumetric efficiency of the compressor, or the ratio of the volume actually delivered to the total piston displacement of the low pressure cylinder, was determined to be 0.927.

This compressor considered in detail will be found to be an extremely simple one when the complication of function is allowed for. The main frame combines in itself all the particulars upon which perfect and maintained alignment depends. The first cylinder has a true seat against the frame and the other cylinders successively locate themselves by their seating, all the joints being scraped and the faces going together without packing. Every valve is independently accessible by the removal of its cap. Taking off the high-pressure cylinder (which is no more work than the removal of a cylinder head) makes all the pistons easily removable, and gives complete access to all the cylinder interiors.

* * *

SHOP WORK AT THE UNIVERSITY OF WISCONSIN

As a rule, students graduate from engineering colleges with but a faint idea of modern machine-shop practice. They are often hastened through their required shop work by incapable instructors, who are only too willing to get them off their hands. To offer the students an interesting and instructive class of work, Mr. Paul Sladky, instructor in mechanical practice at the University of Wisconsin, designed last year a small, two-cycle gasoline launch motor. The accompanying engraving shows several of these engines. One of them is mounted on a testing rack, which consists of a propeller working in a barrel of water, enabling the engine to be tried out under almost actual working conditions. Fifteen of these engines were built the last school year by students who had no shop experience, except the work required by their respective courses. Three single and two double engines are now in almost daily service on Lake Mendota, Madison, Wis., giving excellent satisfaction. The cylinder is $3\frac{1}{2}$ inches in diameter with a 4-inch stroke. The cylinder and head are integral, the crank case and side plates separate. The crank-shafts are forged at the university shop from machine steel billets and are machined with a special lathe fixture. By means of a distance piece, two cylinders may be connected to make a double engine.



Gasoline Engines built by the Students at the University of Wisconsin

To give the students instruction in the use, value and manufacture of interchangeable parts, jigs and fixtures are used wherever possible. In designing this engine, Mr. Sladky endeavored to make it as simple and durable as possible, and yet require neat and accurate work on all the different machine tools. So much interest has been taken in this class of work that Mr. Sladky is now designing a four-cycle engine to offer the students a choice of a number of sizes and types. The student buys the castings at cost and owns the engine when it is finished. He is obliged to test his engine himself, thus gaining by actual experience a knowledge of some of the gas engine troubles he is likely to meet in his future work.

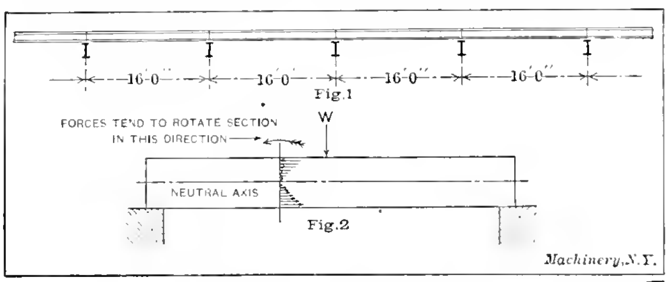
The engraving also shows a motor cycle, the engine of which was made by a junior mechanical engineer.

SPLICES FOR I-BEAMS AND CHANNELS*†

A. L. CAMPBELL‡

It often happens, in the use of rolled shapes for structural purposes, that the material could be spliced together conveniently and with economy, provided an efficient and reliable form of splice were available.

For example, Fig. 1 shows a side elevation of a long row of floor beams, supported every sixteen feet. In such a case the row of beams is usually made up of sixteen-foot lengths, supported on the cross beams, and with little or no connection between their ends. If the floor load is uniformly distributed, the maximum bending moment in the floor beams will be $\frac{WL}{8}$ at mid-span, where W is the total load on the beam per panel, and L is the panel length. Now, assume that the row of floor beams is shifted bodily eight feet to the left or the right, so that the beams will be continuous over the supports, with the ends butting together at mid-span; then, if the ends were efficiently spliced together, we would have a continuous floor beam, with maximum bending moments of $\frac{WL}{12}$ at the supports, and $\frac{WL}{24}$ at the splices. Thus, the bending moment in the floor beams is a maximum where their gross section is available to resist it, while the bending efficiency of the splice at mid-span need be only 50 per cent of the maximum.



Figs. 1 and 2. Diagrams for Calculations of Splices for I-beams

With the second arrangement the floor will safely carry a load 50 per cent greater than it would with the first, or for the same load only two-thirds as much material need be used in the floor beams. Long ties, etc., might also be made up of two or more pieces, with splices, thus saving double freight charges for shipping long pieces.

Splices for I-beams and channels have been calculated in the following, and the splices for the I-beams are also shown in the accompanying Supplement. The sections are taken from Carnegie's Hand-book, and a medium section of each size has been chosen. The calculations may, however, be readily applied to any desired section. In every case the splices for I-beams and channels consist of a top and bottom plate, or plates, riveted to the flanges, and two side plates riveted to the web.

The reason why medium-sized sections have been selected for the calculations, rather than the so-called standard sections, is that the medium-sized section more nearly fulfills the average requirements in design, and as the steel mills constantly roll other than the standard sections, they can be obtained without difficulty. An inspection of a table of steel shapes reveals the fact that the standard section is usually the lightest section rolled of any one size, and has a very thin web. If a short standard section be used as a beam, the load, which will produce a fiber stress of 16,000 pounds per square inch in a beam, will greatly overload the web of the beam over the supports, when it acts as a compression member. If one or more of these light sections be used as columns or struts their strength is limited to the crippling strength of their webs. For these reasons the engineering department of the firm where the writer is employed has adopted the medium weights of I-beams and channels as standard sections for average designs.

* See also article entitled "Beam Formulas," MACHINERY, September, 1905, engineering edition, and MACHINERY'S Data Sheet No. 48, Stresses and Deflections in Beams, Shafts, etc.

† With Data Sheet Supplement.

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Having assumed a section to be spliced, it is first necessary to find what proportion of the total area of the section exists in the flanges, and what is contained in the web. Then the splice is so proportioned that the strength of the beam will be, at that point, as nearly as possible equal to what it would be if no splice existed in it. The method of procedure when designing the splice will be illustrated in the following computations, in which the working stresses are assumed as follows:

Tension and compression, 16,000 pounds per square inch.
Shear, 10,000 pounds per square inch.
Bearing, 20,000 pounds per square inch.
Double shear is equivalent to 1.8 single shear.

Splice for 24-inch 90-pound I-beam (See Supplement)

Area of section, 26.47 square inches.
Thickness of web, 0.631 inch.
Width of flange, 7.131 inches.
Tangent of web, 20.75 inches (depth of flat portion of web).
Grip of rivet, 27/32 inch (depth of rivet holes in flanges measured on center line of holes).
Sectional modulus of section, 186.6 (neutral axis perpendicular to web).

As shown in the Supplement, the rows of rivets in the web are 2½ inches apart; thus each row may be regarded as carrying a load equal to the stress in a strip of the web extending 1¼ inch above and below its center line. Since the distance from the top row to the bottom row of rivets is 18¼ inches, the portion of the web upon which the web rivets of the splice will be effective is 18¼ + 1¼ + 1¼, or 20¾ inches, and the sectional area of this portion is 20¾ × 0.631, or 13.09 square inches. The area of the section to be cared for by the rivets in each flange, or the sectional flange area, is then $\frac{26.47 - 13.09}{2}$ or 6.69 square inches.

Having now found the flange and web areas of the above section, it is only necessary to so proportion the rivets in the splice that the existing fiber stresses in the beam may be transferred into the splice plates, and to provide ample metal in these plates to prevent excessive fiber stresses in them.

The net section of a strip of the web 2½ inches wide (one 15/16-inch hole deducted) is (2½ — 15/16) × 0.631 = 0.99 square inch, and the allowable tension on this strip will be 0.99 × 16,000 = 15,840 pounds. Allowable double shear of a ⅞-inch rivet = 1.8 × 6,010 = 10,818 pounds, while its bearing value in the web is ⅞ × 0.631 × 20,000 = 11,060 pounds. The number of rivets required in the web plates for each strip is therefore 2.

The net section of the flanges will be 6.69 — 2 × 27/32 × 15/16 = 5.11 square inches, and the allowable stress on this area will be 5.11 × 16,000 = 81,760 pounds. The number of ⅞-inch rivets in single shear required to transmit this stress to the flange plates is 14. The web plates should have a combined thickness greater than the thickness of the web, so two ⅜-inch plates are used. In like manner two ½ × 7⅛-inch plates will have a combined net area of 5.25 square inches, and may be used on both flanges.

The sectional modulus being 186.6, the maximum allowable bending moment in a beam of this section is 186.6 × 16,000 = 2,985,600 inch-pounds. At first, 14 rivets only are calculated for on each side of the center of the splice, in the flanges. Taking moments about the neutral axis of the beam and splice, for the rivets above or below this axis, we obtain the resisting moment for this portion of the rivets as follows:

$$14 \times 6{,}010 \times 12 = 1{,}009{,}680 \text{ inch-pounds.}$$

$$2 \times \frac{73}{96} \times 10{,}818 \times 9\tfrac{1}{8} = 150{,}128 \text{ inch-pounds.}$$

$$2 \times \frac{53}{96} \times 10{,}818 \times 6\tfrac{5}{8} = 79{,}130 \text{ inch-pounds.}$$

$$2 \times \frac{33}{96} \times 10{,}818 \times 4\tfrac{1}{8} = 30{,}679 \text{ inch-pounds.}$$

$$2 \times \frac{13}{96} \times 10{,}818 \times 1\tfrac{5}{8} = 4{,}758 \text{ inch-pounds.}$$

Total resisting moment 1,274,375 inch-pounds.

The fractions whose denominators are 96 represent the ratios of the distances from the neutral axis, of the different rows of web rivets, and the product of this fraction multiplied by 10,818 is the actual working load of any one web rivet, when the flange rivets have assumed their maximum allowable load.

Since the forces producing tension and compression in the beam below and above the neutral axis tend to cause rotation in the same direction (see Fig. 2), the resisting moment of all the rivets on one side of the splice is twice the above amount, or 2,548,750 inch-pounds. The resisting moment being always equal to the bending moment, the bending efficiency of the above splice with respect to the rivets is

$$\frac{2,548,750}{2,985,600} = 85.4 \text{ per cent.}$$

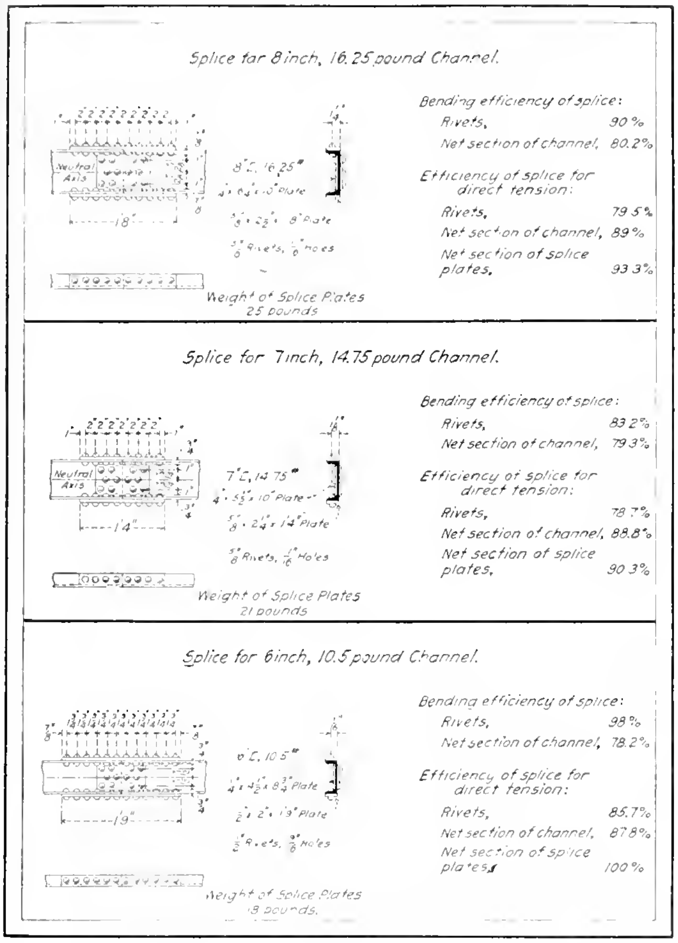

Fig. 3. Splices for 6-, 7- and 8-inch Channels

The point of minimum bending efficiency of the beam at the splice will be found at section AA, two rivet holes being here deducted from each flange. The transverse sectional area of these two rivet holes is 1.58 square inch, and the distance from the center of gravity of this area to the neutral axis of the beam is about $11\frac{5}{8}$ inches. The bending efficiency of the beam at section AA is therefore

$$\frac{2,985,600 - 2 \times 1.58 \times 16,000 \times 11\frac{5}{8}}{2,985,600} = 80.4 \text{ per cent.}$$

Since the minimum efficiency of the splice is the effective one, it is desirable to increase the strength of the beam by a rearrangement of the flange rivets. If one rivet is omitted from each flange at section AA, the bending efficiency of the beam will be increased, but that of the rivets in the splice will be reduced to 80.6 per cent. It therefore becomes necessary to leave two rivets in each flange at this point and add one extra rivet, as shown. Fifteen rivets are now effective in each flange, and the rivet efficiency for bending is 90 per cent. The least bending efficiency of the beam will still be found at section AA, and amounts to

$$\frac{2,985,600 - 2 \times 1.58 \times 16,000 \times 11\frac{5}{8} + 2 \times 6,010 \times 12}{2,985,600} = 85.2$$

per cent.

If the above spliced beam is placed upon supports at the ends in such a manner that the splice does not come exactly in the center between the supports, but so that the section AA comes between the center of the splice and the middle of the beam and yet is not more than 85.2 per cent of half the span from one of the supports, then, if loaded in the middle, this beam will be able to carry the same load as it would carry if the beam were in one piece. It is easily seen that for most, if not all, conditions of loading the above beam, the splice may be so located that the beam will be as strong as though no splice existed in it.

This splice is excellent for direct tension also. The point of minimum efficiency for a net section of the beam will be found at section AA, and will be

$$\frac{26.47 \times 16,000 - 2 \times 1.58 \times 16,000 + 2 \times 6,010}{26.47 \times 16,000} = 91.2 \text{ per cent.}$$

The efficiency of the rivets will be, with fifteen $\frac{7}{8}$-inch rivets in single shear in each flange, and sixteen $\frac{7}{8}$-inch rivets in double shear in the web,

$$\frac{30 \times 6,010 + 16 \times 10,818}{26.47 \times 16,000}, \text{ or } 83.7 \text{ per cent.}$$

The net section of the splice plates will have an efficiency, along the innermost row of rivets, equal to

$$\frac{2 \times \frac{3}{8}\,[6(2\,13/16 - 15/16) + (3\frac{1}{4} - 15/16) + (2 \times 1\frac{1}{4} - 15/16)] + 2[7\frac{1}{4} - 2 \times 15/16]}{26.47} = 82.4 \text{ per cent.}$$

In the design of this splice it has been assumed that the ends of the spliced beam do not butt tightly together. If these ends were fitted together perfectly no splice plates would be needed on the compression half of the beam. Since a perfect bearing is impossible, at least the two web plates should extend to the top of the beam. The top flange plates may, however, be safely omitted when the ends are well butted together and a floor plate is riveted to the top flange.

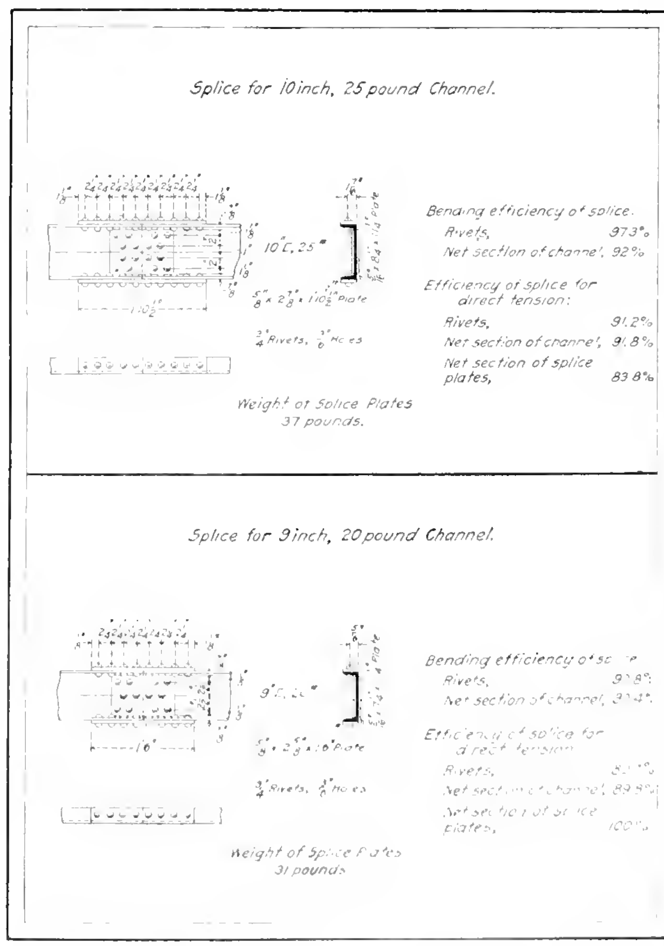

Fig. 4. Splices for 9- and 10-inch Channels

Splice for a 20-inch 80-pound I-beam (See Supplement)

Area of section, 23.73 square inches,
Thickness of web, 0.6 inch,
Width of flange, 7.0 inches,
Tangent of web, 16.5 inches,
Grip of rivets, 29/32 inch,
Sectional modulus of section, 146.7.
Gross web area $= 16.5 \times 0.6 = 9.9$ square inches.

$$\text{Gross flange area} = \frac{23.73 - 9.9}{2} = 6.92 \text{ square inches.}$$

The net flange area $= 6.92 - 2 \times 15/16 \times 29/32 = 5.22$ square inches, and the allowable tension on this area is $5.22 \times 16{,}000 = 83{,}520$ pounds. The number of rivets required is fourteen, but from the computations already made for the 24-inch I-beam it is seen that this number actually ought to be fifteen. Use one $\frac{5}{8} \times 7$-inch plate, and one $\frac{1}{2} \times 7$-inch plate, for each flange, and two $\frac{3}{8}$-inch web plates. As in the preceding case, each row of web rivets should contain two rivets.

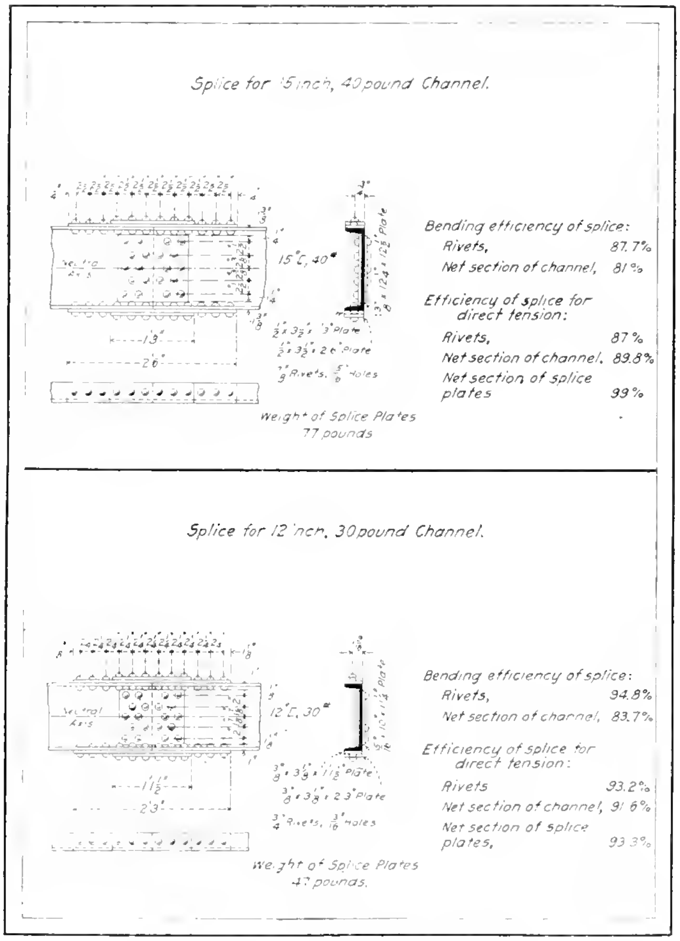

Fig. 5. Splices for 12- and 15-inch Channels

The total resisting moment (twice the moment of the rivets above or below the neutral axis) of the rivets on one side of the splice is

$$\begin{aligned}
2 \times 15 \times 6{,}010 \times 10 &= 1{,}803{,}000 \text{ inch-pounds,}\\
2 \times 2 \times 7/10 \times 10{,}500 \times 7 &= 205{,}800 \text{ inch-pounds,}\\
2 \times 2 \times 9/20 \times 10{,}500 \times 4\tfrac{1}{2} &= 85{,}050 \text{ inch-pounds,}\\
2 \times 2 \times 1/5 \times 10{,}500 \times 2 &= 16{,}800 \text{ inch-pounds,}\\
\text{Total resisting moment.} &\ \ 2{,}110{,}650 \text{ inch-pounds.}
\end{aligned}$$

Note.—10,500 pounds is the bearing value of a $\frac{3}{4}$-inch rivet in the web. This amount is less than that of double shear.

$$\text{The bending efficiency of the rivets is } \frac{2{,}110{,}650}{146.7 \times 16{,}000} = 90$$
per cent.

The minimum bending efficiency of the net section of the beam will be found at section *BB*, two rivet holes being here deducted from each flange. The efficiency will be

$$\frac{2{,}347{,}200 - 2 \times 1.7 \times 9\tfrac{1}{2} \times 16{,}000 + 2 \times 10 \times 6{,}010}{2{,}347{,}200} = 82.8 \text{ per cent.}$$

When this splice is used in a tension member, the weakest part of the beam is at section *BB*, and the efficiency is

$$\frac{23.73 \times 16{,}000 - 2 \times 1.7 \times 16{,}000 + 2 \times 6{,}010}{23.73 \times 16{,}000} = 88.8 \text{ per cent.}$$

The rivet efficiency will be

$$\frac{30 \times 6{,}010 + 12 \times 10{,}500}{23.73 \times 16{,}000} = 80.7 \text{ per cent.}$$

The efficiency of the net section of the splice plates will be

$$\frac{2 \times \frac{3}{8}[4(2\,13/16 - 15/16) + (4 - 15/16) + (2 \times 1\tfrac{1}{4} - 15/16)] + 2\,[(7 - 2 \times 15/16) \times 1\tfrac{1}{8}]}{23.73} = 86.7 \text{ per cent.}$$

Splices for channels are designed in exactly the same manner as those for I-beams, so an explanation of details is unnecessary. It will be noticed, however, in the accompanying engravings, that the flange rivets are not located on the regular gage lines of the channel flanges, but as nearly as possible in the middle of the flange plates. This was done to avoid eccentric loads in these plates.

In the accompanying Data Sheet Supplement are shown splices for I-beams of various sizes, and in the accompanying illustrations are shown the splices for channels. The efficiency of the riveting, net section of the beam, etc., are also given in percentages.

Splices are not shown for I-beams and channels smaller than the 6-inch sections, because it is not often necessary to splice such small pieces; also, the efficiency of the splice would probably be low. The efficiencies of the above splices may be increased by modifying their details. For instance, it will be noticed that usually the least efficiencies are for the net section of the beam for bending, and for direct tension; and the rivet efficiency for direct tension. These values may be increased by using smaller flange rivets, and more of them. In general it may be said that the minimum efficiency of any of the above splices may be made as high as 85 per cent. Only one size of rivet is here used, however, since it is desired to make the details of these splices conform to standard practice as much as possible.

The writer has been unable to find any published data concerning the splicing of structural shapes; he has devised the above method of analysis and furnished designs of splices, with the hope that it may be of some use to others.

In conclusion, it is regretted that none of the above splices have ever been tested to destruction, so that no experimental data are available to confirm or disprove the correctness of the above analyses. However, a set of splices very similar to these was designed by the writer, for a large manufacturing firm in the middle West. These splices have been used continuously for the past two years on all classes of work. In no case have they given trouble, or showed signs of weakness, though often loaded to the full capacity of the pieces in which they occur. One of the most prominent examples is a 15-inch 60-pound I-beam, of 27-foot span, supported at the ends and uniformly loaded with about 500 pounds per lineal foot. This beam is spliced in the middle, and has deflected about one-fourth of an inch under the above load. The beam has deflected in a long smooth curve, showing that the bending efficiency of the splice is really high. If the splice were weak in proportion to the rest of the beam, the tension and compression on the bottom and top of the beam would localize at the splice; and the two halves of the beam would deflect as chords intersecting at the splice, instead of as an arc. Another good illustration is a tension member 116 feet long, composed of two 15-inch, 55-pound channels, and a 1 x 12-inch plate, carrying a load of 544,000 pounds at the middle. It contains six splices, all designed by the above methods, and has borne this load for about fifteen months, with no signs of weakness.

* * *

THE BENEFICENT TARIFF

Every family using iron ore, pig iron, scrap iron, steel rails, cash registers, linotypes, typewriters, steam engines, and wood pulp will now be able to buy them for less, and the cost of living will be reduced.—*New York Times.*

CHAPTERS IN THE EARLY HISTORY OF MACHINE TOOLS—3

JOSEPH G. HORNER*

In continuing the discussion of early types of machine tools, we shall take up in the present article the development of drilling and boring machines, the steam hammer, screw-cutting machinery and the primitive forms of gear-cutting and milling machines.

Slot Drilling Machines

Richard Roberts of Manchester is said to have invented the slot drilling machine as well as the slotting machine, but in 1847 Nasmyth designed a slot drilling machine to avoid the labor of cutting grooves by drilling, chipping and filing. The drill was, as now, flat ended with a notch at the center. The machine was provided with a work table having self-acting traverse, the length of which was adjusted by a crank and rod, and a down-feed put on automatically at the end of the stroke. The gain was stated to be ten to one, and a boy or laborer was given the task of attending to it. Nasmyth did not patent it, but "always had an abundance of orders, as it was its own best advertisement."

A Whitworth slot drilling machine of date 1867 is shown in Fig. 18, driven by a cone pulley and shaft at the back of the bed, through miter gears, and sliding horizontal and vertical shafts to the spur gear seen on the top of the spindle. This spindle runs in hardened conical bushings in a sliding octagonal ram. The spindle head is adjustable along the bed by hand to suit the position of the slot or cotter hole in the work. The reciprocating movement of the drill spindle is operated from the small three-speed cone pulleys seen on the bottom slide of the head. The front pulley is keyed to a worm shaft, rotating a worm wheel with a slotted disk, to which is attached a connecting rod, adjustable for length of stroke, the other end of which is fixed to the middle slide. The octagonal ram slide has a cross adjustment by hand, and the octagonal ram itself has a variable automatic and down feed at both ends of the stroke.

Drilling Machines

The drilling machine was early developed into essentially present designs, both fixed and radial. Back geared cone spindles, self-acting and counterbalanced drilling spindles, rack elevated tables and compound movements to tables, may

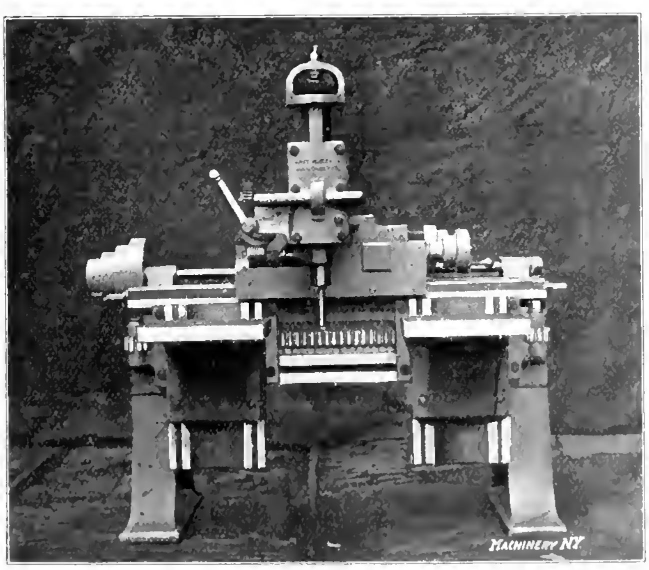

Fig 18. Slot Drilling Machine, Joseph Whitworth & Co. (1867)

be noted in examples dating from 60 to 70 years back. The framings have a strangely skeleton like appearance, for the box framing had not then come into use.

There were radial drilling machines at Soho, the radial arm being capable of vertical adjustment on a round pillar, by means of a screw. The brackets which carried the pillar were bolted to the wall.

A boring and drilling machine at Soho was double back geared and provided with power and hand feed. It stood 25 feet high, its brackets being bolted to the wall, and the floor plate being movable along a bed 36 feet in length on the floor. It was used largely for boring the beams of the early engines.

In drilling machines made by Whitworth 60 or 70 years ago (Fig. 19) the worm-wheel feed was applied to the drilling spindles. The portion of the spindle above the splined driving bevel wheel and between it and the top bearing was threaded. Two worm wheels located on opposite sides engaged with the screw threads. The worm wheel journals worked in bearings, and the ends were prolonged to be embraced by divided friction clips, Fig. 20, tightened or slackened by a vertical screw. When the clips were tightened so that the worm wheels could not revolve, the spindle screw was fed positively. If the clips were slackened to permit the wheels to slip moderately, the amount of feed was lessened. Probably this graduated feed was too uncertain in its action, but it seems to have been used frequently on radial as well as on fixed machines made by Whitworth.

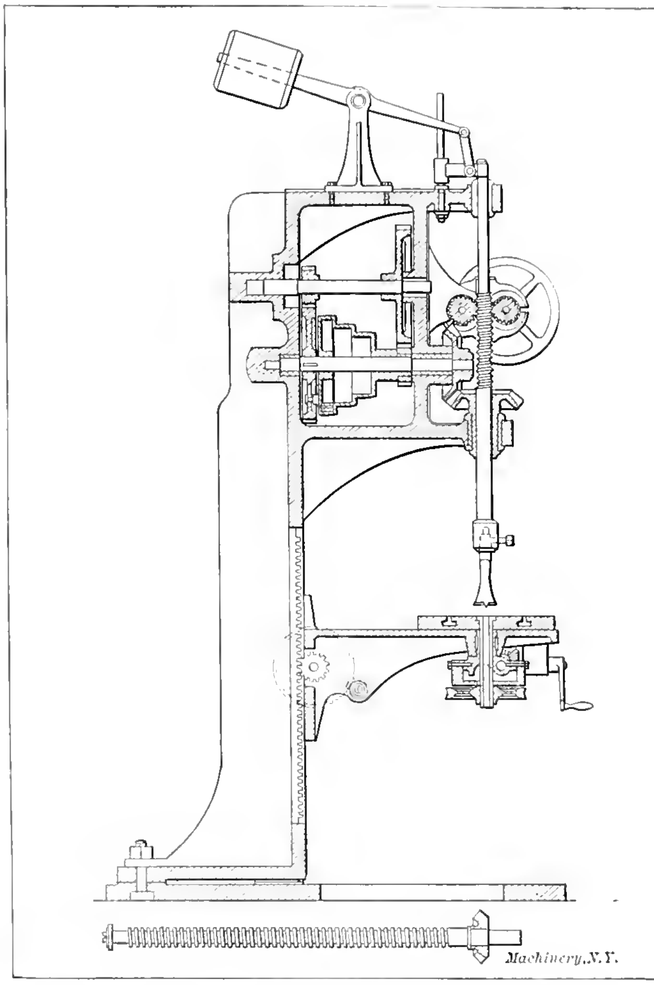

Fig. 19. Vertical Drilling Machine with Screw Feed and Worms Joseph Whitworth & Co. (About 1846)

In the forties we find drilling machines in which the spindle feed is imparted by a treadle and a lever at the top, counterbalanced, pressing the spindle downward by the movement of a bracket sliding on the face of the framing, in which bracket the end thrust was taken.

In the same period the self-acting feed motion through spur gears had been applied by a Mr. Lewis of Manchester to a wall drill. On the spindle above the lower bearing a spur pinion was keyed engaging with a wheel on a feed shaft parallel with the spindle, the driven wheel being engaged or disengaged by a sliding clutch. At the top of the feed shaft a spur pinion engaged with a wheel having its boss threaded to fit a square threaded screw cut on the upper part of the spindle, thus feeding the latter. Hand feed could be substituted for that of power by means of a handwheel on the feed spindle.

Boring Machines

The vertical lathe dates back to the early part of the nineteenth century. It was in use before Bodmer improved it, crystallizing it practically into its present form. The foundation or base carried the spindle on which the circular table

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or faceplate was keyed. The tool-box with down-feed motion was carried on a horizontal cross-slide with vertical adjustments on uprights flanking the table. The advantages claimed for it were precisely those claimed to-day.

There were many boring machines both vertical and horizontal in the forties to meet the requirements of the marine engine builders. There were big cylinders in those days, necessary because of the very low pressures adopted, and they were generally bored in vertical machines.

In one of Maudslay's early lathes may be traced the beginnings of the milling and boring machines. The headstock was

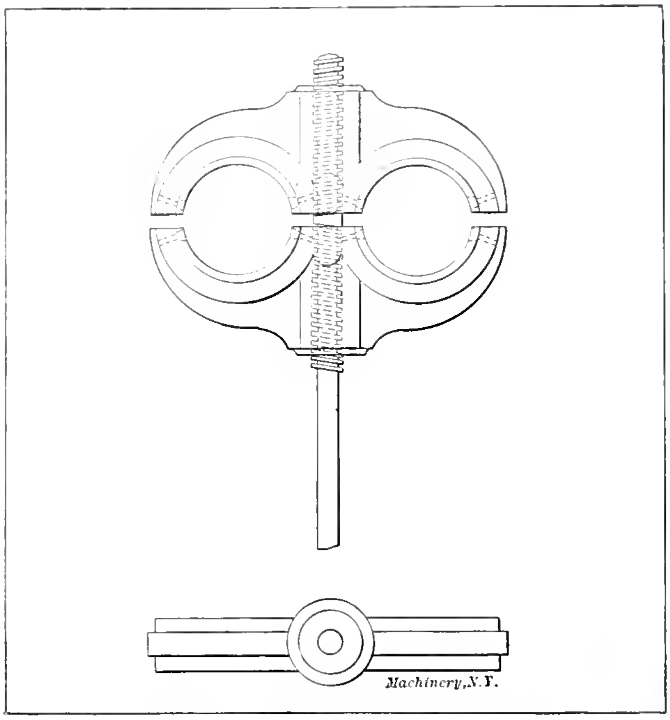

Fig. 20. Friction Collars of Screw Feed Wheel, Whitworth Drilling Machine

provided with a side or lateral traverse by hand or power on a rather long base which would qualify it for milling. Work to be bored was clamped on a table on a bed slide or carriage of large area, the table being raised or lowered on the slide by means of four screws.

A boring machine by Maudslay was already differentiated from the lathe used for boring. The table possessed transverse motion by a screw for boring holes in parallel. The boring bar was capable of vertical adjustment by that movement of its bearings in guides actuated by screws, both driven simultaneously through bevel wheels from a horizontal shaft at the top, just as the cross slide of a planing machine is elevated. The bar was rotated by a five-stepped pulley, grooved for gut band, thence through spur gear to the bar. A screw at the left provided for the horizontal feed of the bar. The feed was put on by power by means of cord-driven pulleys from the bar itself.

Horizontal and vertical boring bars were in existence at Soho. The first was 12 inches diameter, hollow, and having space enough to bore a length of 14 feet 4 inches, and diameter of 4 feet 6 inches. The traversing screw was hand-cut. It was worm-driven, the gear on the end of the bar being a mortise worm-wheel. Differential gears were fitted for feeding the boring head. This machine was made in the period when Murdoch was there, of coal gas fame. There were several boring bars dismantled a few years ago. As Murdoch died in 1839 they must have been built a good while prior to that.

A vertical boring bar 14 inches diameter was the one which bored the cylinders for the screw engines of the *Great Eastern*. This was worm-driven, the gears being below the floor and protected by a plate. The traversing or feed gear was carried on a beam above, built into the wall. These tools were built into the walls and floors as integral portions of the works, and were the precursors of modern tools. Among these ancient machines the dates of which are unrecorded, but which must lie about the period of Waterloo, were lathes, boring machines, wall planers, and others.

After the opening of the Liverpool and Manchester Railway in 1830 there came a great boom in machine tool making. Railways were being constructed all over England between 1830 and 1840, and locomotives and trucks could not be built fast enough. Anything that saved labor was in great demand. The makers of self-acting tools were full of orders. During this period very many great improvements were effected, and the machine tools assumed in several instances nearly their present forms.

Ocean steam navigation was also a potent cause of development, for the marine engines of that time were of massive proportions requiring big boring and planing tools.

Nasmyth Steam Hammer

To this cause the invention of the steam hammer was due. A wrought iron paddle shaft 30 inches diameter was required for the *Great Eastern*, and no firm in England or Scotland would undertake to forge it. Nasmyth was appealed to, and designed his hammer on the essential lines which have survived to the present, except that it fell by gravity only. This was in 1839. The crankshaft was never made, a screw being substituted, and the hammer was allowed to be shelved. In 1842 Nasmyth when on a visit to Creusot saw his hammer at work froging a crank, and learned that the idea had been taken away by a visitor to Patricroft. Then he patented it, and orders came in quickly. Fig. 21 illustrates the first hammer, from a model now in South Kensington Museum.

An offspring of the steam hammer was the steam pile driver, the first two of which were used for the construction of the Keyham Docks, an extension of the Devonport Royal Naval Docks. They were termed steam hammer pile drivers, and were a grand success. A four ton falling weight making eighty blows a minute drove in piles 18 inches square and 70 feet long in $4\frac{1}{2}$ minutes. Previously the same work done by a hand machine had occupied 12 hours.

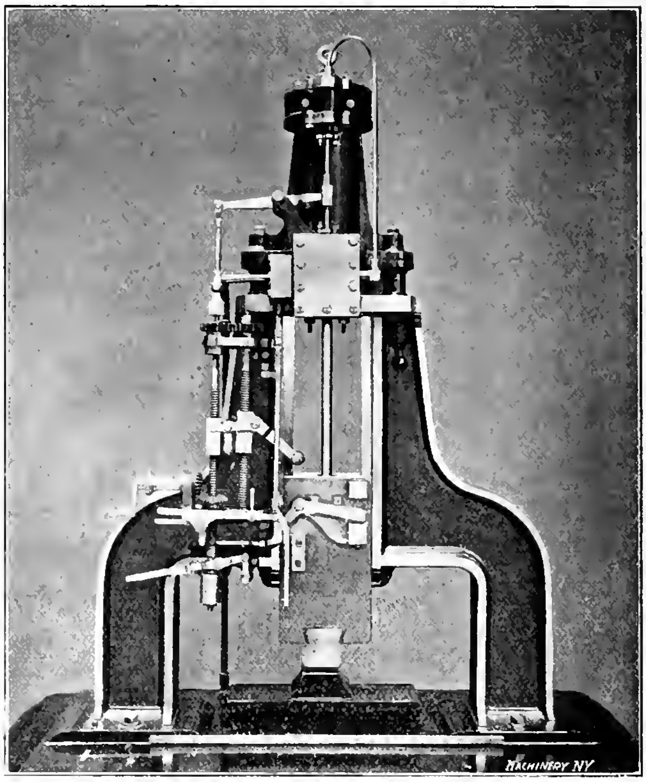

Fig. 21. Model of Nasmyth First Steam Hammer, in South Kensington Museum

When Maudslay began his labors there were no standard screws. Each bolt had its own nut, the two being marked to match. The subsequent work of Whitworth has somewhat eclipsed that of his old master, but he carried on and completed the labors which had engaged the attention of Maudslay from about 1800 to 1835, the time of his death.

Screw-cutting Machinery

One of Maudslay's early devices for originating screws, Fig. 22 (about 1800), and now preserved in South Kensington Mu-

seum, embodied an endless screw and tangent wheel as the essential element. The wheel was mounted with its axis vertical on a table to be slid along a lathe bed. Through a hole in the table frame the bar to be threaded was passed. A tool-holder was secured to the top of the disk, through which a concave chisel edge was projected downwards to come in contact with the bar to be threaded, being set by the tangent screw to the inclination of rake which corresponded with the pitch of the screw to be cut. A chasing tool for the same pitch was carried in a slide rest with screw adjustment, and

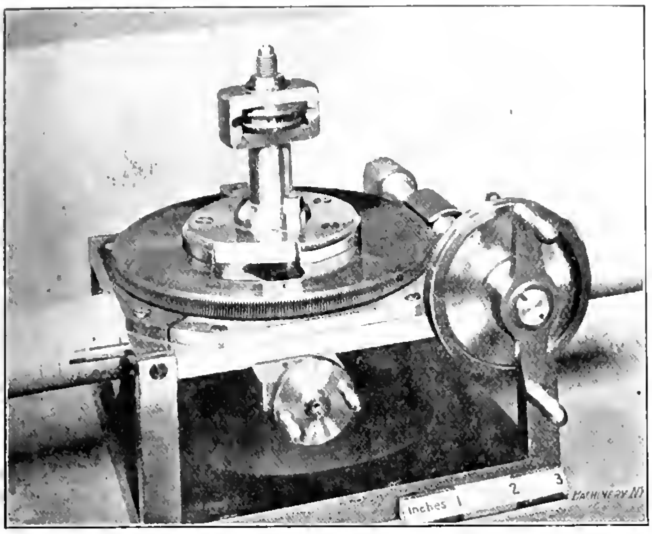

Fig. 22. Maudslay's Machine for Originating Screws (About 1800)

entered a hole at the side. On the bar being rotated, the chisel edge compelled the device to travel longitudinally, while the chaser following, cut the thread. The bar was of soft metal or of hard wood, and from this bar copies were made in steel. In the screw generating machine the essential was the setting of the generating instrument to the precise angle of a given screw. Everything depended on the accuracy of this setting. Maudslay produced a guide screw in the generating machine which he used afterwards in the screw-cutting lathe. In the latter he produced a screw 5 feet in length by 2 inches diameter with fifty threads to the inch. Its nut was 12 inches long with 600 threads.

The screwing machines for threading and tapping were made between 60 and 70 years ago in nearly the same designs as many are at present. They were of horizontal type with

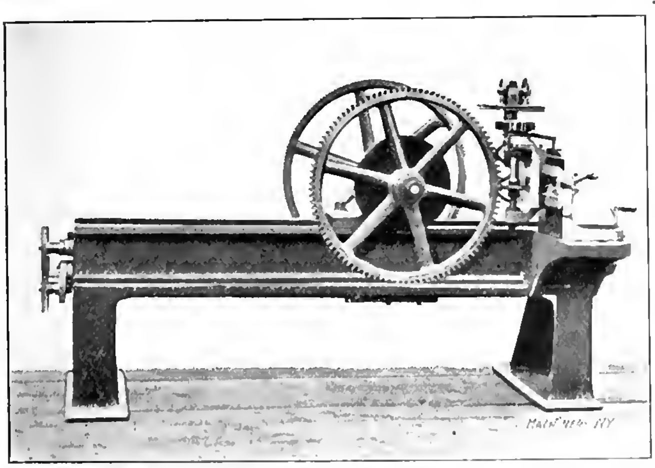

Fig. 23. Gear-cutting Machine, Joseph Whitworth & Co. (1868)

either one or two spindles revolving the bolts, and a cross bar carrying the dies. After cutting, the reversal of the spindles ran the nuts off. A dark fish oil was used for lubrication. Apart from the slowness of their operation they gave practically as good results as those of to-day.

There was a nut tapping machine in the Maudslay shops, and also a bolt screwing machine with a long lead screw in front of the bed having a buttress thread of coarse pitch, and a swing plate with change gears. The clasp nut was a half nut occupying the front portion of the screw, with which it was held in contact by a massive pear weight, much as the pawls of some hand cranes are now. On lifting this at the completion of a traverse, a suspended weight at the right-hand end of the bed pulled the carriage back ready for another cut.

Gear Cutters and Milling Machines

Maudslay made form bevel gear cutters of a peculiar kind, supported on flat topped lathe type of beds. The headstock, comprising two bearings and a mandrel, carried a dividing wheel at the rear end of the mandrel, and the wheel blank at the front end. On a small shaper arm standing out from the bed the tool holder was reciprocated by a crank motion. The inner end of the bar was pivoted on a point in the axis of the mandrel, while the other was fitted with a finger which was retained in contact with the form; a hollow templet larger than the tooth shape held in an adjustable bracket.

Fig. 23 illustrates a Whitworth spur gear cutting machine of date 1868, having a capacity up to 4 feet 6 inches. It is of a design that was very popular a few years ago. The dividing wheel is seen on the farther side of the bed. Its large diameter is noticeable. The cutter spindle is cord-driven, power being gained through spur gears. The change-gears for pitching are seen at the left-hand end of the long bed, and the index handle for operating it at the right-hand end. The cutter slide has a self-acting feed across the tooth faces, and is arranged to swivel in the horizontal and vertical planes for dealing with bevel and worm gears.

A small cutter forming machine by Whitworth & Co., date 1868, is seen in Fig. 24. It is based on the principle of some gear cutters of the period, using a dividing head with circles of holes and an index peg. Its cutter spindle was cord-driven, the cord running over small guide pulleys, and the cutter

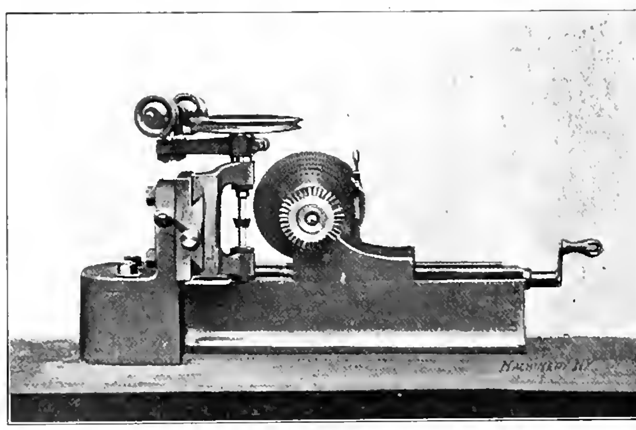

Fig. 24. Cutter Forming Machine, Joseph Whitworth & Co. (1868)

slide was traversed by hand. The cutter was mounted on the spindle of the dividing head, and the slide which carries the latter was adjustable along the bed by hand to suit cutters of different diameters. The cutter head is arranged to swivel in horizontal and vertical planes to suit angular and other cutters. Formed cutters are produced by hand profiling by means of the two handles shown.

The employment of rotary cutters in place of single-edged tools was an epoch the full development of which has been reserved for quite recent years. The first note of this was sounded more than a century ago when one Vaucasson, a Frenchman, invented the milling cutter. It was a very imperfect milling tool, with the teeth of much finer pitch than modern practice allows. The cutter was inefficient in its first form, and nothing but the lathe was available for its operation, and thus the single tools continued to hold their own until the demands made by governments for interchangeability in the parts of small arms brought the opportunity to the circular cutter. Eli Whitney was the man who first recognized, or at least actually developed, its capabilities, and he invented and developed the earlier type of machine for its operation.

There was a nut milling machine in Maudslay's shop in 1829, having been devised as an attachment to the lathe by Nasmyth, who had recently commenced working there. Maudslay wanted a model of a 200 H. P. marine engine made, and entrusted the work to Nasmyth. There were about 300 cast steel nuts to be made, and Nasmyth rigged up a dividing

plate and nut spindle on the slide rest of a lathe and shaped the faces with a milling cutter or "circular file" held in the headstock spindle. Subsequently a special machine was built for nut cutting for use in the factory, and when Nasmyth went into business for himself he built numbers of them for engineers.

Nuts were commonly shaped with a milling cutter in England more than 60 years ago. There was a machine by Archibald Milne of Glasgow in which an end mill shaped the faces. The nuts were mounted on a vertical mandrel projecting from a circular table, having 6 equidistant notches, locked with a spring catch and lever. A self-acting feed was provided for moving the nut up to the cutter. It was cord-driven from four-speed pulleys through a worm and wheel, pinion and rack on the under side of the table. The cutter spindle was driven slowly through spur gears from fast and loose belt pulleys.

A nut milling machine of 1866 by Whitworth is seen in Fig. 25. The nut mandrel was rotated by a worm gear and locked with a pin passing through holes in a division plate. The mandrel head was traversed along the bed past the cutter by a screw, and knocked out by a self-acting clutch arrangement. The cutter drive was by belt and worm gear enclosed. The nut mandrel is firmly held by a self-centering

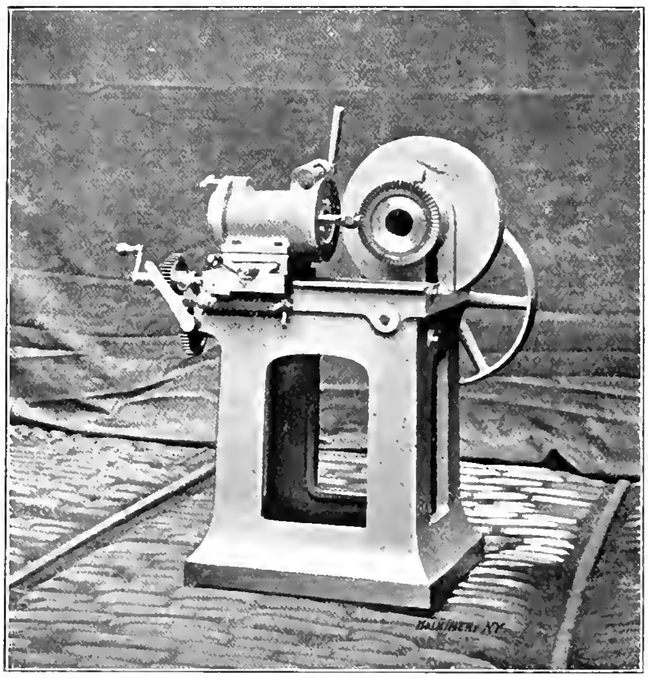

Fig. 25. Nut Milling Machine, Joseph Whitworth & Co. (1866)

three-jaw chuck, actuated by the worm and worm wheel. The chuck is formed with a sleeve which takes its bearing in the head and has keyed to it at the left-hand end a division plate. The chuck and nut mandrel are rotated by hand, and the position defined by a taper pin passing through holes in the division plate. The mandrel head is fed automatically along the bed past the cutter and tripped at any desired point. The cutter drive is by belt and spur gear enclosed.

Mr. Bodmer of Manchester had made a milling machine about 1824. But that was not strictly the first, which was one the late Mr. Parkhurst had seen, and was informed that it was at work in 1818 at a gun factory at Mill Hollow, Middletown, Conn. It was a hand machine. The cutter was driven by a belted headstock, with a three-stepped wooden cone removed from a lathe. The work was traversed under the cutter by a hand crank turning a pinion which slid a rack under the work table. If a second cut was required it was packed up. The idea was there but few improvements occurred until about 1850 when the Howe machine was introduced resembling in several respects the Lincoln miller designed by Mr. Pratt in 1854, in which for the first time a screw feed was substituted for that of the rack. The period of the American Civil War was prolific in milling machines used in the manufacture of small arms. All were of horizontal spindle design, and all were modeled essentially on the Lincoln type. The first universal machine was built about 1865 after the design of Joseph R. Brown, one of the founders of Brown & Sharpe Mfg. Co. The machine, Fig. 26, is still in existence in the works. Essentially it comprises the features of present-day machines, but the latter embody many features which add to their convenience and fulfill the requirements now demanded of a machine.

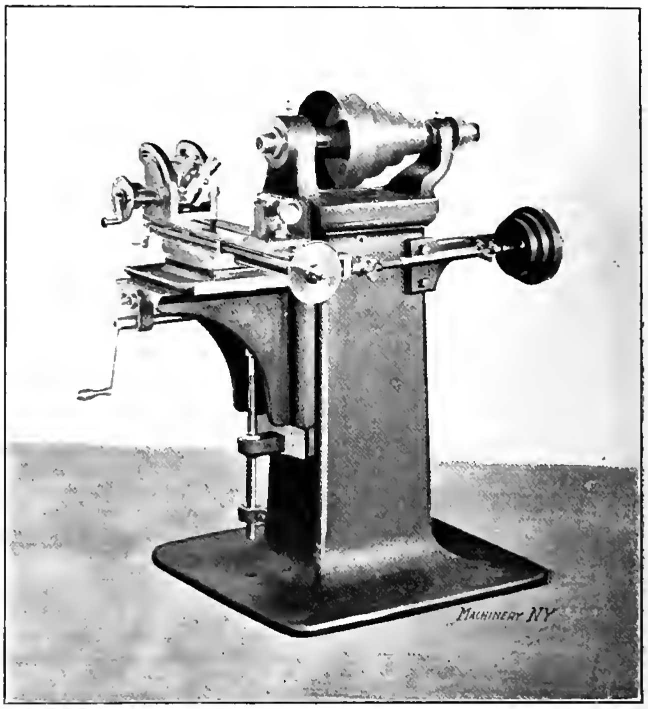

Fig. 26. First Universal Milling Machine. Built about 1865 by Joseph R. Brown, of Brown & Sharpe Mfg. Co.

Fig. 27 illustrates a very massive milling machine with inserted tooth cutters by Whitworth & Co. in 1867. It was designed for tooling the flat faces of marine cylinders and work of similar character. It was driven by a steam engine through worm gear. The work was attached to the table in front, which slides on a bed in front of the main upright, and is provided with cross adjustment by hand. The automatic feed of the table along the bed is operated from the

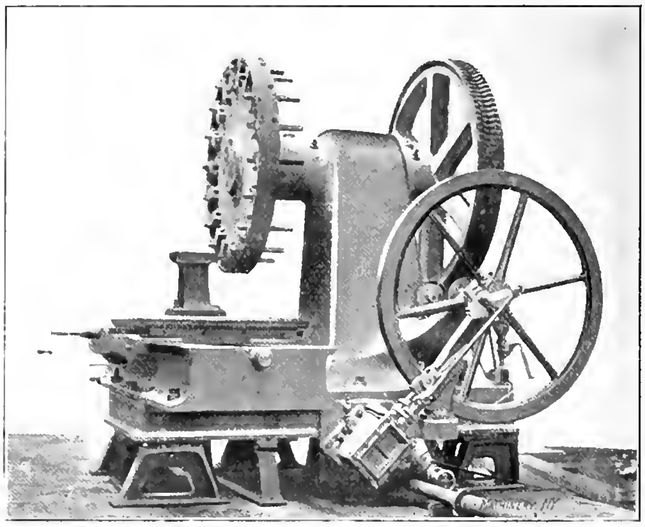

Fig. 27. Very Large Type of Milling Machine, driven by Steam Engine. Joseph Whitworth & Co. (About 1867)

worm shaft through change gears, and worm wheel on the screw, disconnected by hand-operated clutch at the left-hand end of the bed. The cutters are ordinary tools, each fixed by a clamp plate and two bolts, and may be placed with their cutting edges either on the edge or on the face of the disk as desired.

Nasmyth was the first to build the independent machine tool driven by its own small engine, abandoning the shafting, pulleys, belting, and laying down steam pipes instead. This arrangement has met with great favor in boiler making and plating shops where the machines are mostly heavy and scattered. Such machines are still made and used, though the electric motor drive is rapidly displacing them.

THE MAKING OF TOOL STEEL

ERIK OBERG*

Few mechanical processes have, during the general progress of engineering, undergone so little change as the methods and processes employed in the making of tool steel. With the exception of a more direct method for introducing the carbon into the steel, it may be said that, in general, the same methods are still used as were employed centuries ago. Improved methods for heating the furnaces and for handling and working the steel at various stages of the manufacture have, of course, been introduced but there has been no new principle applied in the actual production of the steel.

Before describing in detail the various processes and operations involved in the making of tool steel, the general procedure may be briefly reviewed as follows: Tool steel is made by using low phosphorus and sulphur wrought iron and adding carbon to it. Two methods have been in use, the older one being the so-called cementation process, in which the wrought-iron bars are packed in air-tight retorts with powdered charcoal placed between the bars. When the retorts are thus filled, they are put into a furnace, called the cementation furnace, where they are heated to a red heat and permitted to remain at that temperature for several days. During this time the iron will absorb carbon from the charcoal up to about 1½ per cent of its own weight. The process, in fact, is similar to the ordinary case-hardening process for giving parts made of low-carbon machine steel a hard high-carbon surface. The carbonized bars, called "blister" steel, are then cut up into small pieces and are re-melted in a crucible, and from that poured into molds. The billets thus formed are afterwards hammered or rolled into the desired shapes.

The newer method, largely employed at the present time, consists of putting small pieces of wrought iron directly into a crucible together with the proper amount of powdered charcoal. This charge is then melted and permitted to remain in the molten state for some time before being poured into molds. While in the molten state the iron will absorb the carbon much quicker than when only red hot, as in the cementation process. When the carbon is added directly in the crucible it is also possible to more accurately determine the carbon content of the final product and for this reason the newer method is far superior to the cementation process, which, however, is still considerably in use in the old steel manufacturing districts in Europe. The newer method is more commonly in use in America, and is the method employed in the steel-making plant of the Heller Brothers Co. of Newark, N. J. It is the object of the present article to briefly describe the making of tool steel as this process is carried on in the works of this firm.

* Associate Editor of MACHINERY.

History of the Heller Brothers Company

The original business of which the present plant of the Heller Brothers Co. is an outgrowth was established in 1836 by Mr. Elias Heller, the grandfather of the present officers in charge of the company's business. Mr. Heller at that time engaged in the making of files and horse rasps in a small shop in what is now the central part of Newark, N. J. Up to that time English files had been used exclusively in the United States and Mr. Heller was one of the first, if not the very first man, to make files in this country. The business gradually grew until the first buildings of the present factory were erected in 1873 at Forest Hill, a suburb of Newark, ten miles out of New York City on the Erie Railroad.

Fig. 1. Tool Steel Furnace and Charging Floor at the Heller Brothers Company's Plant, Newark, N. J.

It was found that a relatively low-carbon steel of a uniform composition, such as is required in the manufacture of horse rasps was impossible to obtain at that time in the United States at a reasonable price, and, for this reason, in 1881, the firm built a small plant for the manufacture of high-grade tool steel primarily for its own use. Since then, however, this department of the plant has been considerably increased so that at the present time the firm manufactures a considerable quantity of steel for the market, specializing particularly in high grade brands of carbon tool steel and high-speed alloy steels. The plant now includes a melting furnace having a capacity of thirty crucibles at a time, a number of steam hammers and a small rolling mill, besides the required heating and annealing furnaces. In 1899 the firm was incorporated under the name of Heller Brothers Company.

Material Used for Making Tool Steel

The raw material used by the Heller Brothers Co. for the making of tool steel is Swedish (Dannemora) wrought iron having a carbon content of from 0.10 to 0.20 per cent. This

Fig. 2. The Charge of Swedish Iron, Bag of Charcoal, and the Clay Crucible in which the Charge is melted

iron comes in flat bars, $1\frac{1}{2}$ by 2 inches, and is cut up into small pieces about one inch wide. The reason why Swedish iron is used in preference to other kinds is that it has proved itself superior in the making of high-grade tool steels. It is possible to obtain American iron having by chemical analysis practically the same composition as the Dannemora iron, and being as free from phosphorus, but nevertheless, when transformed into tool steel, the final product will not be of the same quality as that made from the Swedish iron. Metallurgists are at a loss to explain the reason for this. Steel makers say that the Swedish iron has more "body"; but, of course,

Fig. 3 Pouring the Molten Steel. The Photographic Plate shows the Intense Light and Heat and Fireworks Effect

this in itself does not mean anything except that it produces better results. One cause may be that the Swedish iron ore originally contains less impurities, and that for this reason wrought iron of a given quality can be produced without having passed through, in the same degree, the processes necessary for removing the impurities from the iron ore. These processes possibly change somewhat the crystalline structure of the iron, although its chemical composition remains exactly the same. This is mere theory, however, and should not be accepted as the demonstrated cause of the superiority of the Swedish wrought iron for the making of tool steel.

The Melting Furnace

The furnace in which the crucibles containing the metal are heated, which, as already mentioned, has a capacity of thirty crucibles at a time, is gas heated, the gas being obtained from a gas producer in the company's plant. The furnace is of the Siemens type, the gas entering it alternately from either side through checker plates. The action of the furnace is as follows: When the gas enters on one side, the exhaust gases pass out through the checker plates on the other side; these exhaust gases, being of a very high temperature, heat the checker plates rapidly to a red heat; at this time the entering gas is automatically shut off, and gas is admitted from the opposite side. This gas, then, passing through the heated checker plates, is thoroughly preheated, and when combustion takes place a much higher degree of total heat is obtained. The combustion gases from this side now heat the checker plates on the other side, and the process of pre-heating the gas as it enters alternately from the two sides of the furnace is thus automatically taken care of.

The charging floor, or the floor on which the men work who insert the crucibles in and remove them from the furnace, is level with the top of the furnace and iron-braced fire-brick covers, as shown in Fig. 1, are provided, which are kept over the openings of the furnace at all times except when a crucible is put in place or removed. The furnace, of course, is built up of fire brick, and is covered on top with steel plates. It is kept running continuously day and night, as it would

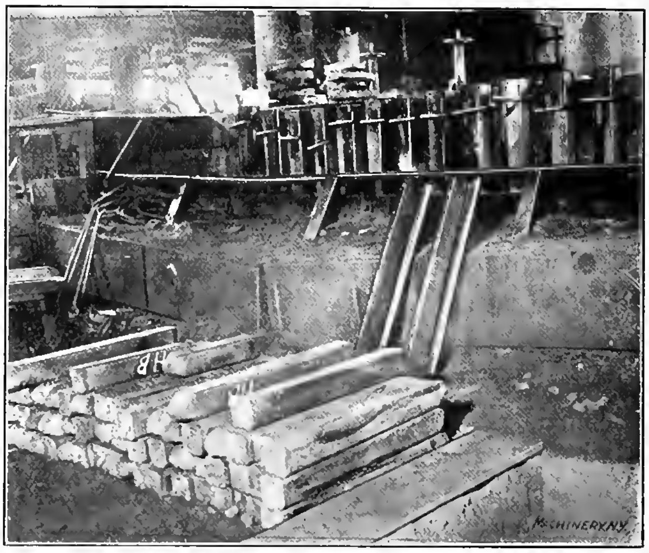

Fig 4 A Row of Molds ready for the Metal to be poured, an Open Mold, and a Pile of Ingots

crack and be destroyed by the severe internal stresses due to sudden cooling if the fire were permitted to go out. The life of the furnace is from six months to a year, after which time it must be rebuilt.

Crucibles

One of the crucibles used for the melting of the iron is shown in Fig. 2. The height of the crucible is about 20 inches and it is one foot in diameter at the central part.

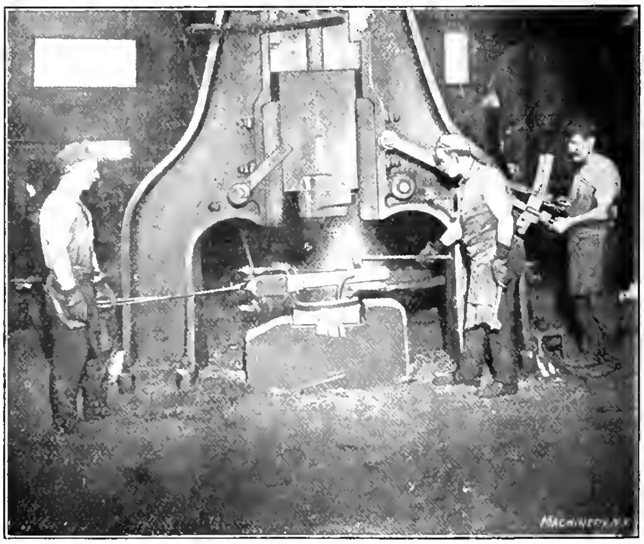

Fig. 5. First Stage in Hammering the Ingot to Size under a 2500-pound Bement Hammer

When placed in the furnace it is provided with a fire-clay cover not shown in the illustration. The crucible has a capacity of seventy-five to eighty pounds of iron. It is made from a mixture consisting of several foreign and domestic clays of

proper proportions. The crucibles are manufactured in the plant of the company, and are made in a manner similar to that used for making clay pots. A form is used to give the outside shape, and a revolving former is employed to shape the inside. When the crucible has been thus formed it is permitted to dry at ordinary room temperature, a storage room being provided where the crucibles are lined up on shelves for the purpose of drying. When properly dried, they

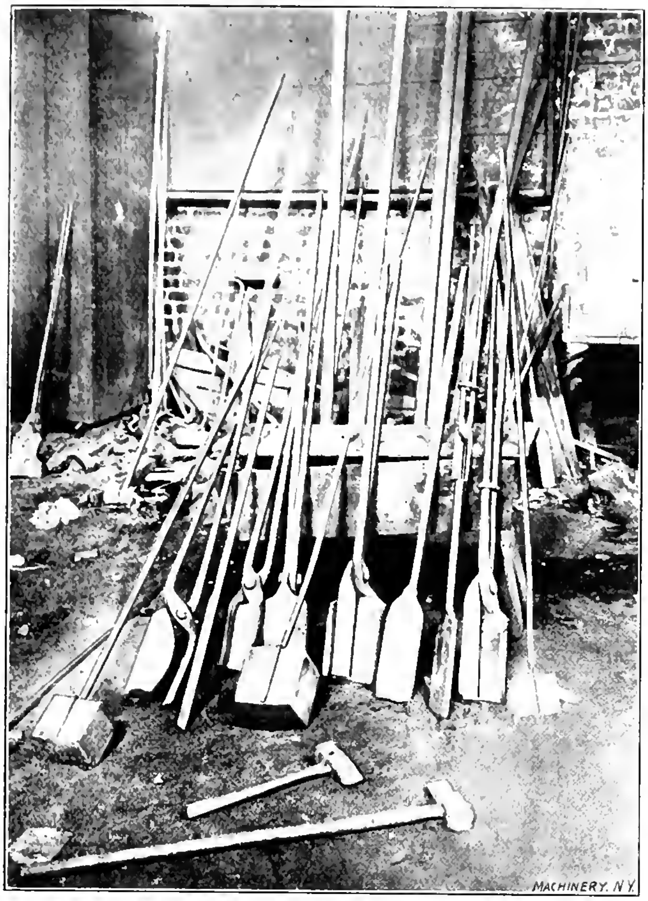

Fig. 6. A Collection of Tools used when handling the Ingots and hammering them to Size

are put into an annealing furnace where they are slowly heated to a high temperature. They must then be taken directly from the annealing furnace while hot, charged with the iron and charcoal, and put into the melting furnace. After this the clay crucible is not permitted to cool off until its usefulness is past. The heat of the crucible and the charge while in the furnace is from 2,500 to 2,800 degrees F.

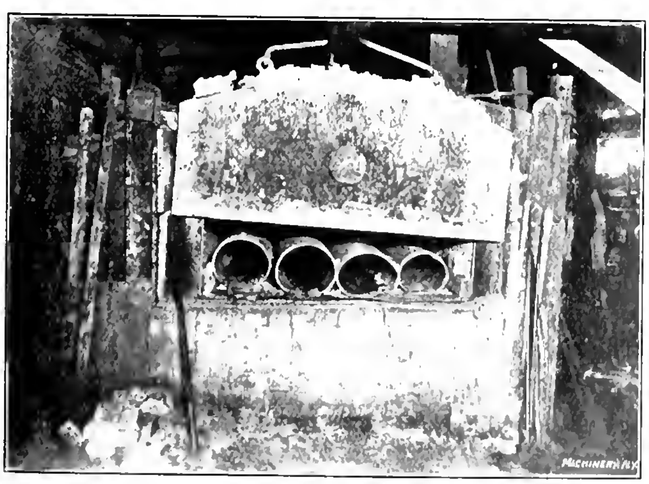

Fig. 8. One of the Annealing Furnaces, showing the Pipes into which the Tool-steel Bars are placed while being heated for annealing

Comparison between Clay and Graphite Crucibles

The use of clay crucibles in preference to crucibles of graphite is important in the making of high-grade tool steel, and is in accordance with the practice employed by the best English steel makers at Sheffield, where the clay crucible has been used for this purpose for centuries past. When the clay crucible is used, there is absolutely no possibility of any extraneous matter mixing with the charge, and the carbon content can be very closely predetermined. When a graphite crucible is used, small particles of graphite will flake off from the inside of the crucible and these particles will mix with the charge. They will, however, not enter into chemical composition with the steel, but will merely mix with it mechanically, so that, in the steel, there will be small particles of graphite imbedded, thus producing small holes and flaws in

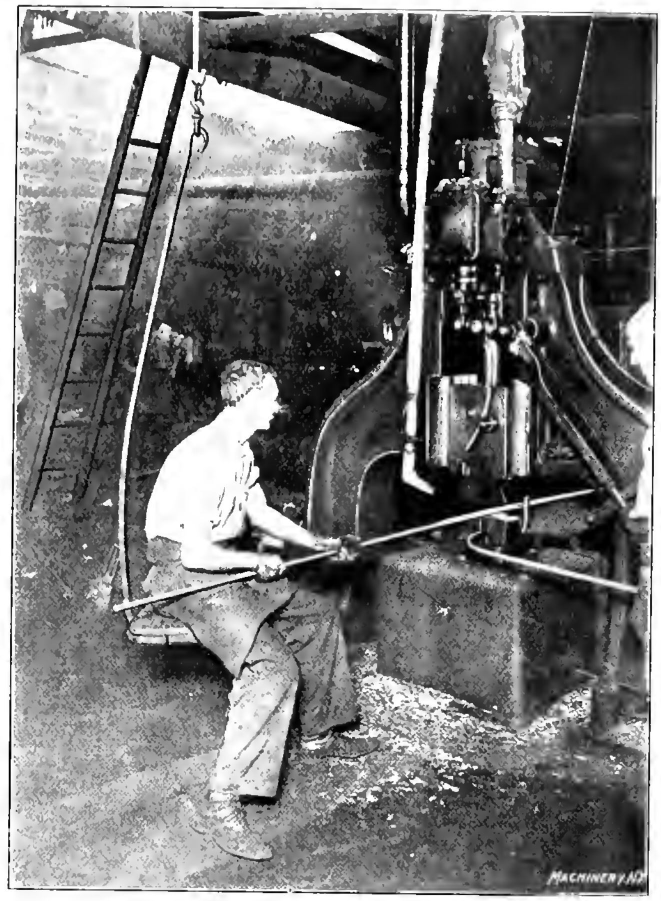

Fig. 7. Hammering a Round Bar to size under a Small Bement Hammer

the finished material. The graphite crucible, however, will last longer, and is therefore cheaper to use, but when a high-grade tool steel is to be produced the clay crucible is the only one which will give entirely satisfactory results.

Melting and Pouring the Steel

The work of charging or filling the crucibles and pouring the molten metal into the molds is carried out on the charg-

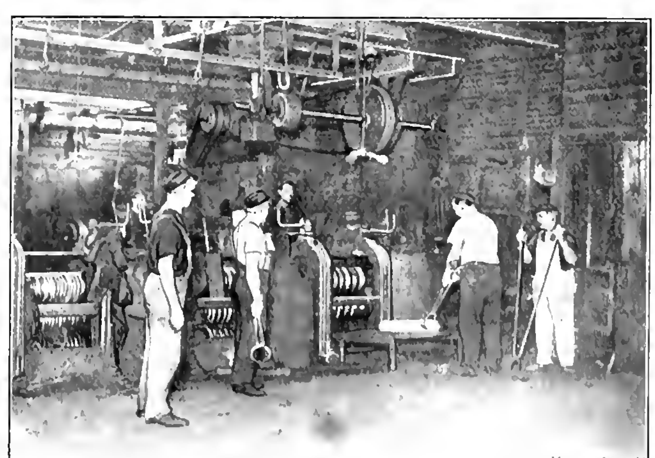

Fig. 9. The Rolling Mill, showing the Ingot just before it passes between the First Set of Rolls

ing floor, shown in Fig. 1. The crucibles are charged with about seventy-five pounds of wrought iron cut up into pieces, as has already been mentioned, a pile of wrought iron ready for the crucible being shown in Fig. 2. About half of the iron is first put into the crucible, then a bag containing the powdered hardwood charcoal, shown on the top of the pile of iron pieces in Fig. 2, is put in, and finally the remainder of

the iron charge is placed on top of this. When high-speed steel is made, other ingredients, such as chromium, tungsten, molybdenum, etc., are placed in the crucible together with the charcoal and iron.

The carbon content in the tool steel is determined by the amount of charcoal in the charge; some carbon, of course, is contained in the wrought iron, so that it is not possible to calculate directly the proportions of charcoal necessary for a certain weight of iron to produce a given percentage. Some of the charcoal is also lost in the slag. The common method of determining the amount of charcoal required, however, is to consider that each ounce of charcoal will give about 0.07 per cent carbon to the steel, or, as the steel maker would express it, one ounce charcoal gives seven "points" carbon. This proportion is approximately correct for ordinary carbon contents, but when steel of a high carbon content is required it is necessary to add charcoal in a greater proportion, partly on account of the fact that the original amount of carbon in the wrought iron is then of relatively less importance, and partly because more of the carbon is lost or wasted. The charge for high-speed steel of standard quality is proportioned so as to give 5 to 6 per cent chromium, 19 to 20 per cent tungsten, and 0.55 to 0.75 per cent carbon.

The crucibles are placed into and lifted up out of the furnace by means of large tongs, the men doing the work standing partly over the furnace while removing the crucible. In Fig. 1 a crucible had just been removed from the furnace from where it was immediately moved across the floor to the molds, which stand vertically, and into which the molten metal is poured to form the ingot. Before pouring, however, but after the crucible has been removed from the furnace, the slag collecting on the surface of the metal is first removed by a long iron bar, and then a small amount of manganese is put into the crucible. This prevents the oxidizing of the metal while being poured, and tends to insure freedom from blow holes or flaws in the ingots. A number of molds ready to have the metal poured into them are shown in Fig. 4, the photograph being taken from the level of the floor of the shop, which is several feet below the level of the charging floor. One of the molds which are made in halves, is shown opened up in this illustration. The molds are made of cast iron and the standard inside dimensions of the molds, and, of course, also the dimensions of the ingots, are four inches square, by about three feet long, the ingots containing about 150 pounds of iron, or the contents of two crucibles with a capacity of seventy-five pounds each. In Fig. 1, one crucible has just been poured into the mold and is now being recharged, while the other crucible stands on the side of the mold ready to be poured. Fig. 3 is a photograph taken at the moment of pouring the molten metal into the mold. The intense heat and the fire-works effect produced is well exhibited in the illustration.

As soon as the metal has been poured, the crucible, which is not permitted to cool off on account of the fact that in such a case it would be destroyed by cracking, is put back into the furnace to be heated up again before recharging. In some cases, when it has not cooled off too much during the pouring, it will be immediately re-charged without re-heating. When re-heated, however, it is removed from the furnace after a few minutes, and the charge put into it as already described. It is then immediately put back into the furnace where it is permitted to remain from four to six hours when it is again removed, and the metal poured, and the same process repeated. As the furnace is in operation day and night, about five heats are obtained in the course of twenty-four hours. A crucible will only last for about four to six heats.

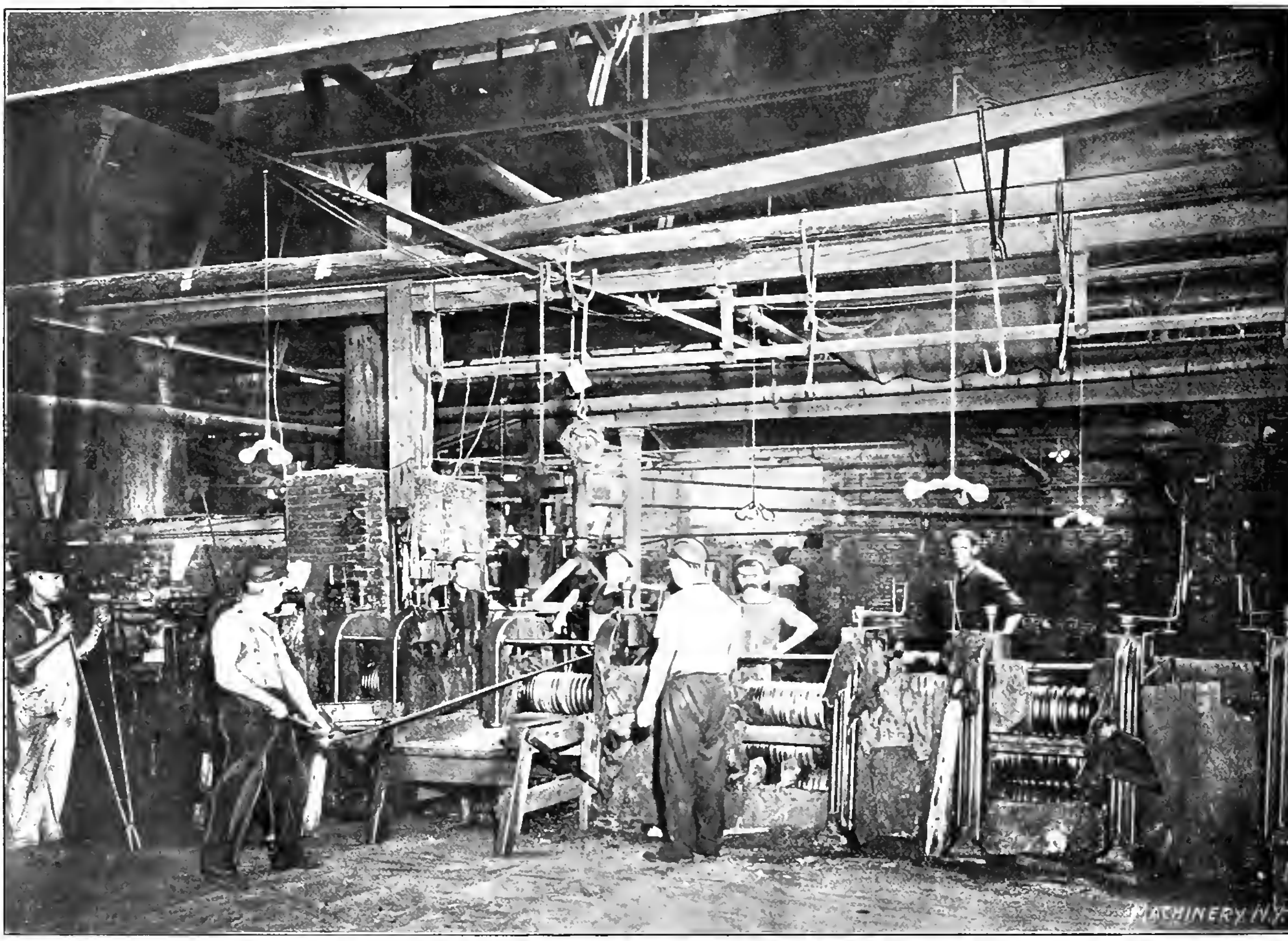

Fig. 10 The Rolling Mill, showing the Ingot after it has been rolled down into a Long Bar of Small Diameter

In order to prevent the steel from sticking to the molds, these latter are "smoked" by burning rosin underneath them which leaves a thick black coat of smoke or soot on the face of the mold. The ingots are permitted to cool off in the molds and are then removed and stored in piles on the floor, as shown in Fig. 4.

The Welding Process

The next operation performed is the heating of the ingots in a heating furnace to a welding or white heat, after which

they are put through what is termed the welding process. This consists in placing the white hot ingot under the steam hammer and lightly tapping it with gentle blows on the surface, so as to close up or weld all minute cracks or flaws that may be present on the outside of the ingot. This insures a homogeneous structure and freedom from flaws and cracks in the finished material.

Hammering to Size

After having been welded, the ingot is either again permitted to cool down and it is then re-heated to a red heat, or it may be immediately taken and placed under the steam hammer and hammered down to the required size. In Fig. 5 an ingot is shown where the hammering to size has just com-

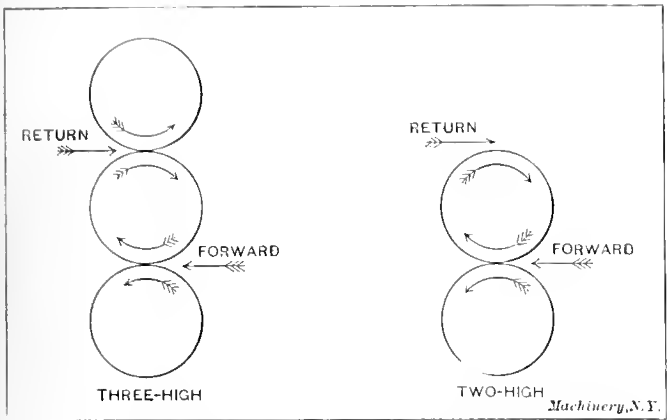

Fig. 11. A Diagrammatical Sketch showing the Difference between the Action of Two- and Three-high Rolling Mills

menced. The hammering adds to the firmness and quality of the steel and insures homogeneity of the material. In order to insure the correct size being obtained, tools similar to those employed by regular blacksmiths are used as stops or gages. A square block provided with a long shank, called a peg, of which a number are shown among the tools in Fig. 6, is placed on the anvil of the hammer and acts as a stop. This block is of the required thickness of the bar. When the steam hammer has hammered down the bar to this size, it will strike this block and is thus prevented from making the bar undersize. Two thin or flat blocks are also shown in Fig. 6, these being used to give the right thickness to the smaller sizes of flat bar stock. After the bar has been thus hammered down to a given size by using the pegs as stops, it is gaged by sheet iron snap gages at various places, in order to ascertain if it has the correct size uniformly along its whole length.

Round bars are made in a similar manner, swages similar to those used by the ordinary blacksmith being employed to obtain a round and smooth surface. In Fig. 7 is shown a smaller steam hammer under which the bars are hammered down to their exact dimensions, this being in a sense a continuation of the operation of hammering down the ingot, shown in Fig. 5.

When the bars have been thus hammered down to the correct size, it is necessary to anneal them in order that they may be soft enough for working. The bars are therefore placed in an annealing furnace. This furnace contains a number of long large pipes, the ends of some of which are shown in Fig. 8. They are regular cast iron water or gas pipes. The bars are placed in these pipes and the ends of the pipes are carefully sealed with fire clay. After this the front of the furnace is closed by the door or cover shown in the illustration, and the furnace is heated for about twenty-four hours; then the fire is deadened and the bars are permitted to slowly cool down for about two days. When the bars are taken out of the annealing furnace they are ready for shipment.

The Rolling Mill

All the ingots, however, are not hammered into shape; smaller sizes of square and round stock are rolled to the required size. Two illustrations of the rolling mill are given in Figs. 9 and 10. The ingot is first heated to a high heat and is then placed between the first set of rolls illustrated in Fig. 9, where the ingot is shown ready to pass for the first time between the rolls. It is here passed between the rolls from one side to the other, becoming smaller in cross section and of greater length at each successive pass. It is of interest to note how the mechanical operation of rolling keeps the heat in the bar, so that a great number of "passes" can be made without losing any of the original heat; as a matter of fact, the bar shows even a higher degree of heat at successive stages, the work performed on the iron in the rolling process being partly transformed into heat.

In Fig. 10 the ingot is shown rolled down into a long bar of small size. This illustration also shows to the left the heating furnace, and the general arrangement of the rolls and the rolling mill. When the ingots are to be rolled down to very small sizes it is necessary to divide the rolling operation into two stages, owing to the great length of the bar when it has been rolled down to a comparatively small size. In such cases the bar, after having first been rolled down to a certain size, is cut up under shears into shorter pieces of equal length, immediately after coming from the rolls. These pieces are re-heated in the furnace and are again passed between the rolls to produce the smaller sizes.

The rolling mill shown in Figs. 9 and 10 is what is called "three-high," that is, it consists of three rolls over each other, of which the bottom and top rolls run in the same direction, while the middle or center roll runs in a direction opposite to both. From the diagrammatical sketch, Fig. 11, it will be seen that by this arrangement it is possible to pass the bar first through the two lower rolls over to one side and then back again through the two upper rolls to the first side. In this way the bar is reduced in size a certain amount each time it passes back and forth. When rolling mills are provided with one set of two rolls only ("two-high") and are not made reversing, as is the case with the set of rolls shown in use in Fig. 10, it is evident that it is possible to pass the bar between the rolls only in one direction, and the bar must be passed back over the top roll to the front side "idle," as

Fig. 12. A Corner of the Stock Room

is plainly shown in the engraving. When the bar has been rolled down to the required size it is annealed in the same manner as described for the hammered bars, and is then ready for shipment.

In Fig. 12 is shown an illustration of a part of the stockroom, showing the finished bars in the racks.

* * *

The freedom from corrosion of tantalum, says the *Scientific American*, has suggested the employment of this metal as a material for writing pens, but tantalum pens have failed to pass a test for durability that is applied in France to steel pens. This test consists in loading the pen with a weight of 180 grammes (6 1/3 ounces) and moving a band of paper beneath and in contact with the pen at the ordinary speed of writing until 10 kilometers (6¼ miles) of paper have passed. The loss in weight of the pen should not exceed 0.7 milligram (0.0108 grain). The tantalum pens were found to lose more than twice this amount, but the loss has been reduced to 0.8 milligram (0.0123 grain) by slightly oxidizing the tantalum.

POWER TESTS OF A STOCKBRIDGE SHAPER

H. P. FAIRFIELD*

The following tests were made on an 18-inch shaper built by the Stockbridge Machine Co., Worcester, Mass., to obtain data relative to the size motor best adapted for driving the machine under normal conditions of roughing cast-iron. No attempt was made to learn what it was possible to accomplish by heavy feeding or abnormal depths of cut, but simply to go somewhat beyond the common shop usage in cuts and feeds. The few data shown in Table IV, for example, were taken merely as a check on those shown in the previous tables, as it was considered improbable that a shaper of this size would ever be used for roughing a cut so deep as one-half inch. I may say, at this point, that each table represents the average results of a series of runs made to conform as closely as possible to uniform conditions, and were made after the machine had been tuned up by careful observation and attention to adjustments, lubrication, etc., and with the cutting tool ground to a gage and kept sharpened to the original gage throughout the runs. A high-speed steel cutting tool was used on account of retaining its keenness for a longer interval of time than a carbon tool would do. The cutting speed selected (25 feet) for runs I to IV, inclusive, was decided on as that which would allow the use of either a carbon or high-speed steel cutting tool, and could be said to fairly represent average shop practice. The material cut was an average grade of cast iron such as is used in ordinary machine tool parts, and the block was cast into such a form as to preclude all springing of the work itself.

TABLE I

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/8	17	0.0147	25	1.20
1/8	17	0.0294	25	1.68
1/8	17	0.0441	25	2.14
1/8	17	0.0588	25	2.68
1/8	17	0.0735	25	3.49
1/8	17	0.0882	25	4.02

TABLE II

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/4	17	0.0147	25	1.73
1/4	17	0.0294	25	2.68
1/4	17	0.0441	25	3.22
1/4	17	0.0588	25	3.90
1/4	17	0.0735	25	4.40

TABLE III

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	17	0.0147	25	2.55
3/8	17	0.0294	25	4.29
3/8	17	0.0441	25	6.00
3/8	17	0.0588	25	7.67

Tables I to IV give the average of repeated runs where all conditions of length of cut, depth of cut, and cutting speed were made as uniform as possible for each series, the feed only being varied. The runs were made cutting the full stroke of the machine, a rather unusual condition; but, as it was desirable to know what, if any, additional power might be necessary, if full stroke was to be used, the tests were run as shown.

The additional runs tabulated in Tables V and VI were made to show the effect in power consumption of a change in cutting speed, also as a means of comparing the Stockbridge two-piece crank mechanisms with the ordinary type of crank-shaper. Table V is the average of a series of runs made with the machine in its normal condition as a two-piece crank-shaper, and Table VI is compiled from the same number of runs, but made with the mechanism blocked in such a manner as to convert the machine into an ordinary crank-shaper of the usual type. In making the tests V and VI, the length of the cut was shortened to 12 inches, which conforms very well to the average length of work likely to be done on a machine of this size.

While the cost of power consumed in the average machine shop is not a large percentage of the manufacturing cost, the up-to-date manager is giving this item consideration when he purchases machinery, and when a machine is shown to consume less power and at the same time is adapted to produce the maximum output, he considers it worth while. A glance at Tables V and VI shows that the two-piece crank is a considerable power saver as compared with the regular type of crank-shaper, and while the saving in an hour's time may not appeal to the casual reader, it most certainly will if he uses his pencil and considers the savings effected in a year's time.

These tables are also quite interesting as showing how speeding up in a shop increases the power consumed. While it is a common enough saying among machine users: "It takes power to do work," some cases that have come under the writer's notice lead him to conclude that not all machine men fully realize its full significance. At a recent exposition of manufacturers, a machine tool firm exhibited a line of machines designed to work the modern high-speed cutting tools to their limit. When asked by the exposition management what power it was likely to use, the company's figures were for less than one-half what it actually used. There was no restriction on the power and the company could have been supplied with ample power by merely asking for it, as it was only a question of the wiring and fusing which the management desired to settle. As it transpired, it was necessary for this firm to shut off all but a single machine, changing from one to the other as the show was on.

TABLE IV

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/2	17	0.0147	25	3.20
1/2	17	0.0294	25	5.43

TABLE V

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	2.10
3/8	12	0.0294	17	2.68
3/8	12	0.0294	25	3.22
3/8	12	0.0294	30	4.02

TABLE VI

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	3.08
3/8	12	0.0294	17	3.35
3/8	12	0.0294	25	3.62
3/8	12	0.0294	30	4.16

In conclusion, the writer desires to again emphasize the fact that the tests were made primarily to establish the size or power of motor to be used as a driver on the above shaper.

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* * *

In the report of the committee on fuel economies, at the American Railway Master Mechanics' Association convention at Atlantic City in June, W. C. Hayes, chairman, made the statement that the investigation of the committee has shown that less than three per cent of all the locomotives on all of the North American continent use anthracite, liquid and other than bituminous fuel. Hence, the problem of locomotive boiler design as regards fuel is mainly concerned with bituminous fuel.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS

THE R. K. LE BLOND MACHINE TOOL CO

ETHAN VIALL*

Many interesting things are to be seen in the machine tool building shops of Cincinnati; some possibly that are not new, others undoubtedly old but nevertheless of the nature of "shop kinks" to many mechanics who have not been fortunate enough to run across anything like them, and in the line of interesting tools and methods the R. K. LeBlond Machine Tool Co., certainly holds its own.

In Fig. 1 is shown the way nine grooves are milled at once, on the outside of the cylinders used on the LeBlond lathes to cover the quick change gears. These grooves are not very long, so the feeding is done by means of the large hand-wheel shown, which operates a worm and gear set into the head of the fixture.

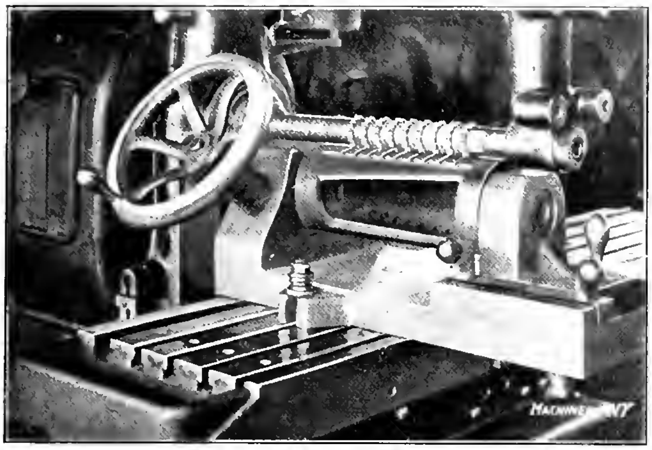

Fig. 1. Milling Nine Grooves simultaneously in a Quick-change Gear Cover

A jig for holding apron half-nuts while milling the dovetail bevel is shown in Fig. 2. Two of the half-nuts are placed in the jig and the bevel on one side is milled; the jig-head is then indexed half a turn and the job finished. Four different sizes of half-nuts are milled in this jig, which accounts for the four grooves to be seen in the head on each side of the dove-tail.

The slots in the bottom of milling machine vises are milled while the vises are clamped onto a cast-iron block, Fig. 3, the base of which is so made as to be bolted to the milling machine table with the block either parallel or at right angles to the line of feed, so that slots may be milled at right angles to each other, with the same jig.

Short shafts are milled for Woodruff keys, while held in the upright V-vise shown in Fig. 4. This vise is also very

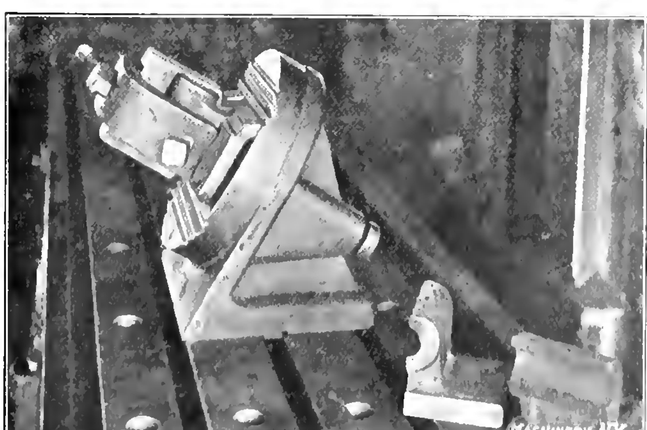

Fig. 2. Fixture for Milling Dove-tail Bevel on Apron Half nuts

handy for many other jobs where it is necessary to hold round stock.

All sizes of plain cast-iron pulleys are faced and crowned in the special milling machine shown in Fig. 5, and a quicker or neater job could hardly be imagined, as with two mills working on opposite sides, simultaneously, only a half revolution of the pulley is necessary to finish the rim. By referring to the engraving, it will be seen that the pulley arbor and chuck, is driven from underneath by a worm and gear, and the big cutter heads are equipped with both cross and

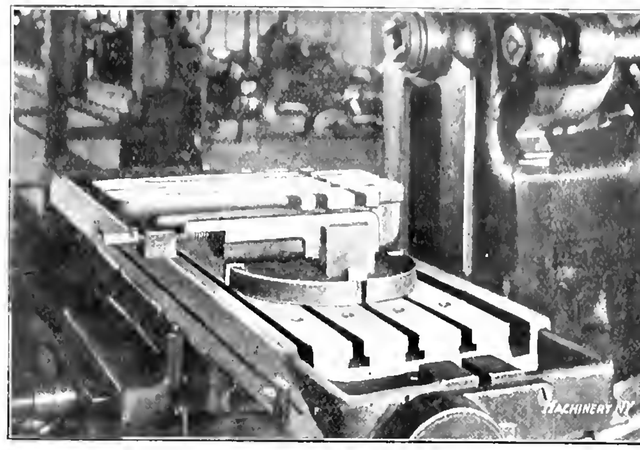

Fig. 3. Fixture for Holding Milling Machine Vises while slotting them

parallel hand feed, making it easy to set the machine for any size pulley within its capacity or to vary the amount of crown wanted on the face. The spindles carrying the milling cutters are back geared and the whole machine is made heavy and powerful in order to do good work.

A neat little jig used for holding the graduated sleeves used on the feed-screws of both lathes and milling machines, while drilling the set-screw hole, is shown in Fig. 6. In order to always have the set-screw hole in the same position relative to the numbers of the graduations, a little pointer for the zero mark on the sleeve is set into the face of the jig. Spacing collars are also used to bring the short sleeves properly under the drill bushing.

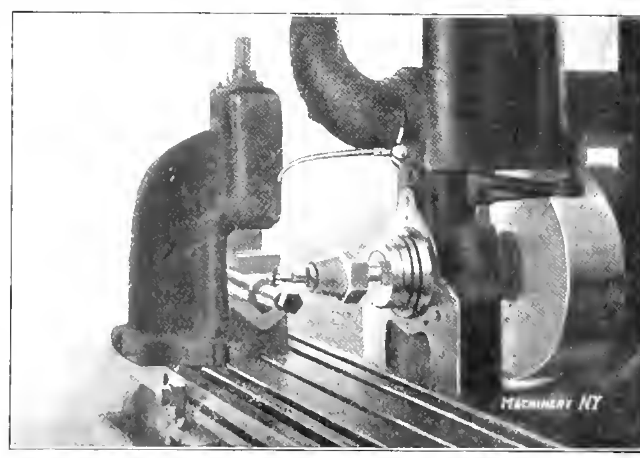

Fig. 4 Upright V-vise for Holding Shafts which are being milled for Woodruff Keys

At *A*, Fig. 7, is a special mandrel on which the large front box nut, for the No. 4 milling machine, is placed and turned after the threads have been cut in it. This mandrel is made to screw directly onto the lathe spindle, the square hole in the center being used for a wrench hold.

After the nut is screwed onto the mandrel, it is locked in place by a slight turn of the handled locking-collar *B*, which has a stop pin *C* set into the back and intended as a guide for setting the locking collar in the same position for each nut, by backing it up against the stop-screw *D*. The width of the nut is gaged by setting the point of the cutting tool against the hardened screw *E*. Another type of mandrel, known in most shops as a friction nose-chuck, is shown at *F* in this engraving. This mandrel screws onto the lathe spindle the same as the one just described, and it is used to hold large bored-out rings or collars, while turning the outside. A ring *G* is shown in place on the mandrel and the way it is locked by the pin *H* rolling and wedging in the beveled notch, is plainly apparent.

Fig. 8 illustrates a little tapping kink which is sometimes very useful when doing special work in the lathe. When

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tapping by this method, the tail-stock spindle is disconnected so as to be free to move out or in; the chuck holding the tap is connected to the lathe carriage by a short piece of rod as shown, the lathe is geared to cut the same thread as that on the tap and with the tap close to the work the feed is thrown in. If in backing out the tap, it is not desirable to use the feed on account of the backlash, the rod is easily backed out of the hole in the chuck, the key in the tail-stock of course keeping the spindle from turning with the chuck and tap, when the lathe spindle motion is reversed. Lead-

finished. Many shops leave a center hole on each end, that on the pointed end being all but cut off; the center is then hardened on this end, which often distorts the end which has been left on for the center hole. Next the piece is placed between centers and the body ground, and finally the center is placed in a split chuck and pointed.

Fig. 12 shows a magnetic chuck which was made by the foreman of the grinding room for special work.

In Figs. 13 and 14 are shown two views of a box jig for holding lathe aprons while machining the holes, and in Fig.

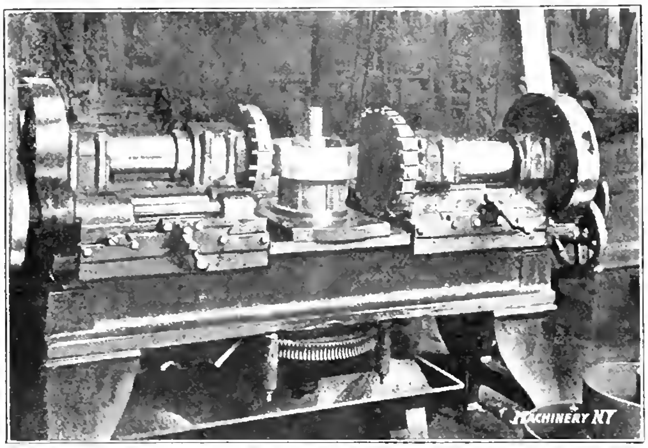

Fig 5. Pulley Turning and Crowning Machine

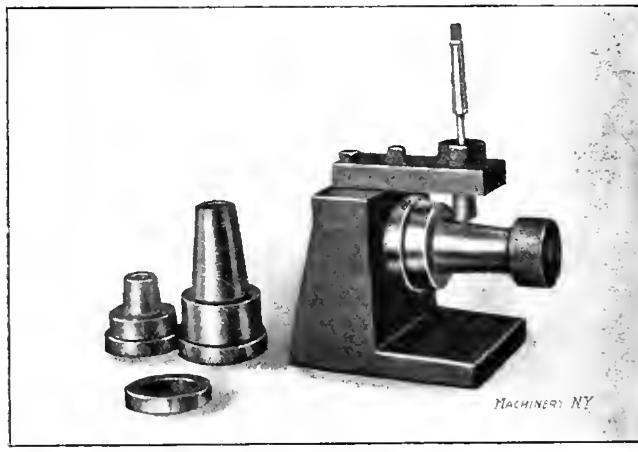

Fig. 6. Drilling Jig for Dial Sleeves

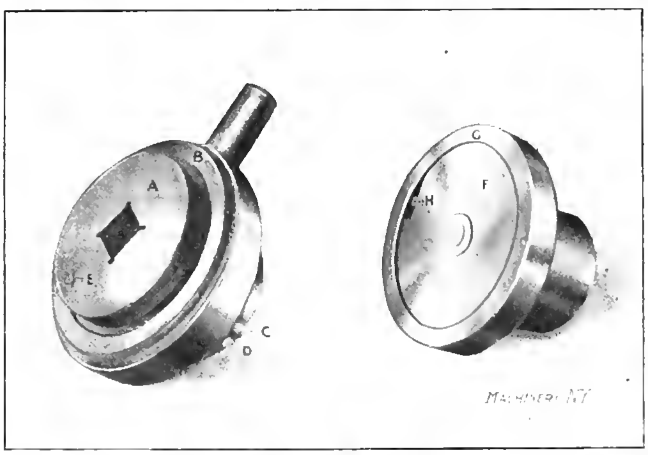

Fig 7. A Nut Mandrel and Friction Nose Chuck

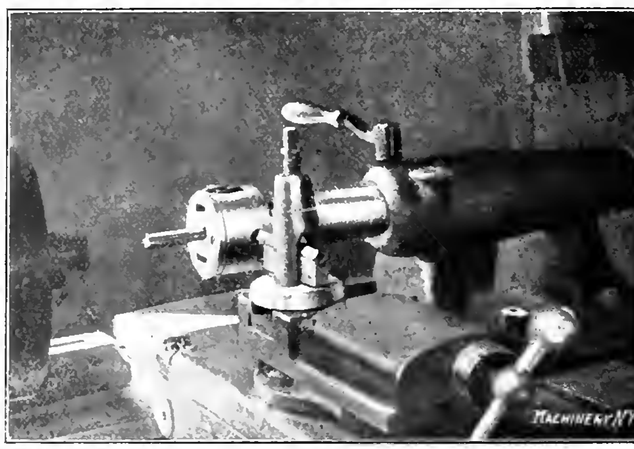

Fig. 8. Lathe arranged for Tapping with the Aid of the Lead-screw

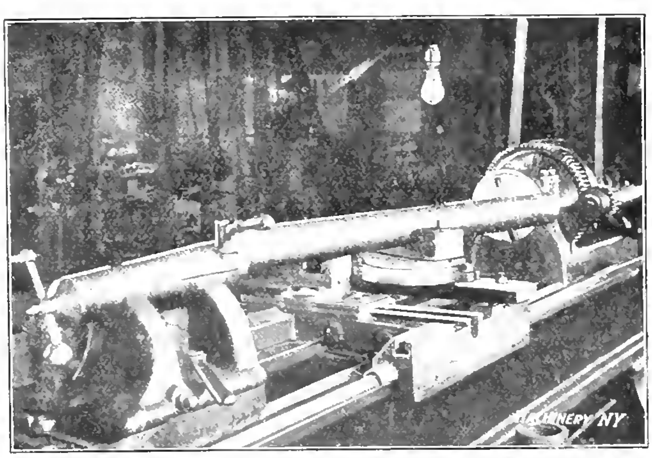

Fig 9. Turntable for Reversing Heavy Work in the Lathe

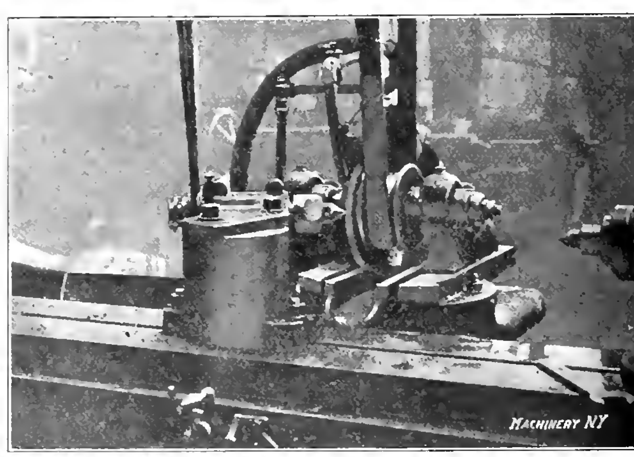

Fig 10. Grinding the Point of a Foot-stock Center—First Operation

ing the tap in in this way, is not always possible or desirable, but as was said before, it is sometimes an exceedingly useful kink.

Where heavy work has to be turned end for end in a lathe, a turntable similar to the one shown in Fig. 9 is sometimes used. This kind of turntable is quite common in railroad shops, but it is seldom seen in other shops, even where it could be used to advantage.

The method of grinding the hardened foot-stock centers may be of interest, as it is done differently in some shops. Here the center is held as in Fig. 10, and the point ground; then using a male and female center, as in Fig. 11, the body is

16 is shown the complete set of tools used. By closely examining these engravings, several interesting things may be noted. In the first place, all tools are driven from the drill-press spindle by the universal-jointed shank and socket shown. Then it will be seen that each tool whether drill, cutter or reamer, has its individual bushing which is kept from turning in the permanent jig-bushing, by a pin set in below the shoulder which fits into a notch in the latter; then, too, the long boring-bars *B*, *C*, *D* and *E*, have keyways running the full length of the pilots for the purpose of engaging keys set into the pilot guide bushings in the jig. These bushings are flanged, and set into another bushing in the jig, in such

a way as to be free to revolve with the boring-bar, instead of having the pilot revolve in it which prevents chips or dirt getting in and scoring the pilot, as usual. The flanges on the inner or guide-bushing keep all dirt from between it and the outer or bearing-bushing, and give long life to both bushings and boring-bars.

in Fig. 15. This jig is made to slide back and forth, in order to bring the work in the proper position under the tool, by means of the hand lever A. This lever is made long so as to project through an opening in a sheet iron drum that is placed on the drill press table, around the jig, to keep the soap water that is used from spattering all over the shop.

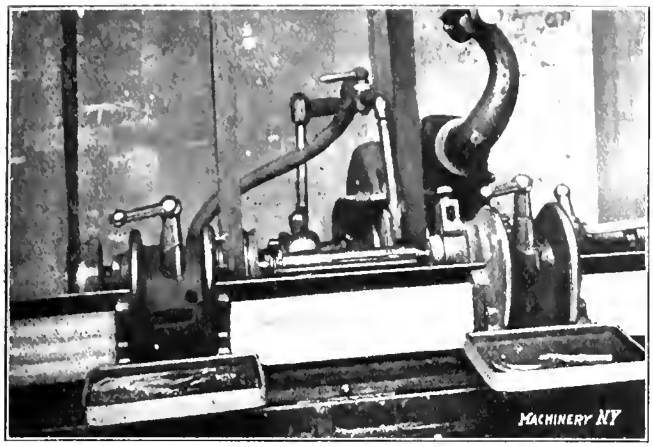

Fig. 11 Grinding the Body of a Foot-stock Center—Second Operation

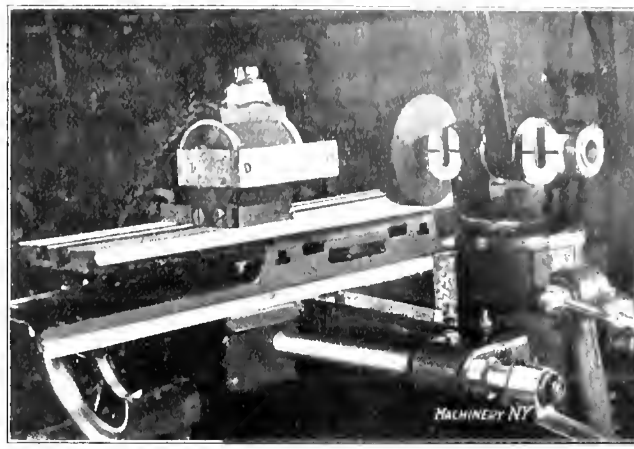

Fig. 12. Home-made Magnetic Chuck

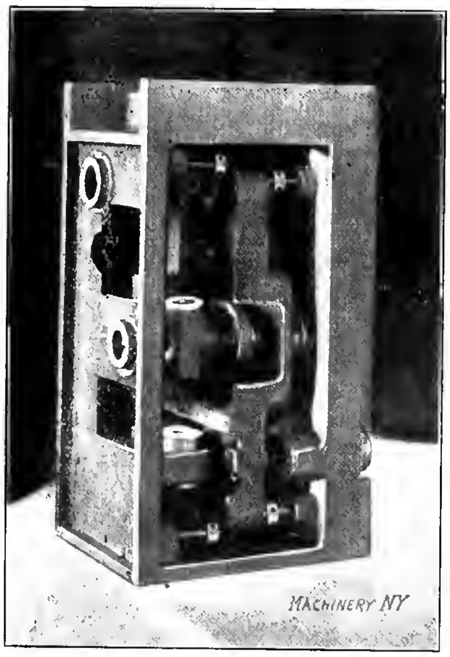

Fig. 13 Box Jig for Machining Lathe Aprons

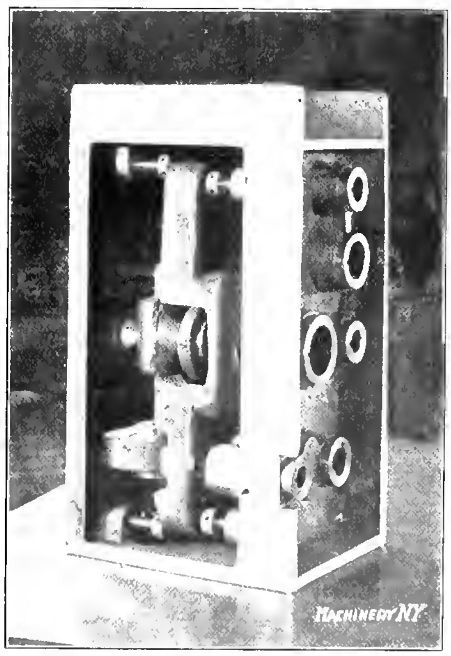

Fig. 14. Another View of the Lathe Apron Box Jig

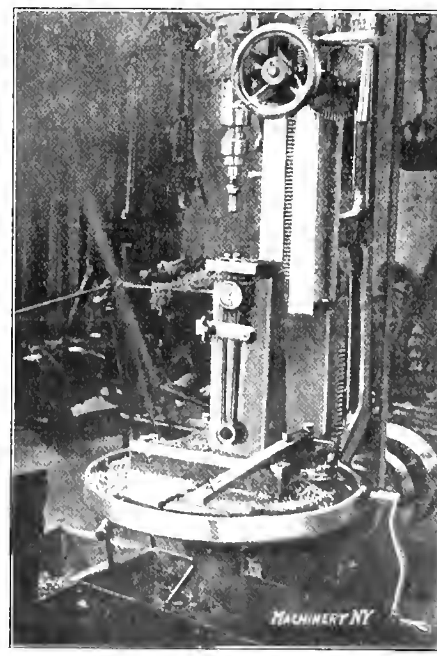

Fig. 15. Jig for Holding Connecting-rods

Fig. 16 Tools used for Machining Lathe Aprons

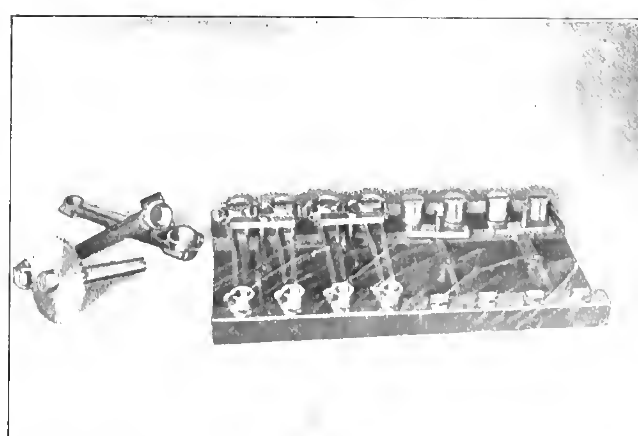
Fig. 17 Fixture in which Connecting-rod Bearings are cut off

During the recent dull season, in order to keep their regular force at work, a contract was taken for the machining of a large number of automobile engine parts, and two of the jigs used for some of the work on connecting-rods are worth describing. These rods and bearing-boxes are cast in one piece, and after the bearings are bored out, the work is put in a jig and the holes in the large end for the oil hole and cap screws, are drilled, counterbored, and tapped as shown

After the holes are finished, the connecting-rods are placed eight at a time in the jig shown in Fig. 17, and the bearing caps sawed off in a milling machine, using the saw shown

In Fig. 18 is a front view of a small hand-operated graduating machine, with the part A of a compound rest in place, and the tool B just finishing a cut, and in Fig. 19 is a rear view, showing the way the machine is geared and operated. The indexing or dividing ratchet wheel and dog is shown

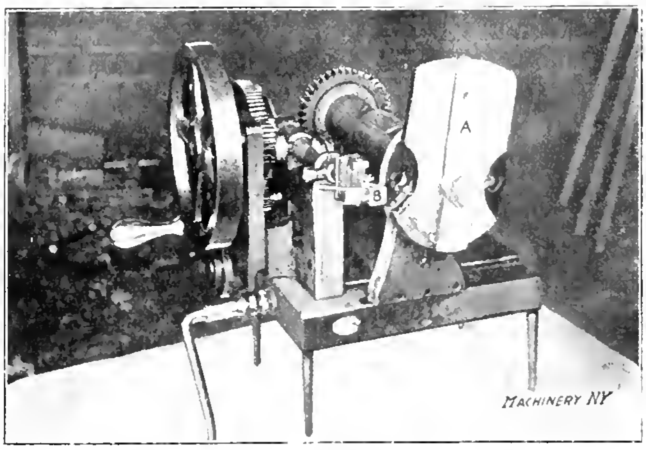

Fig 18. Graduating Machine Front View

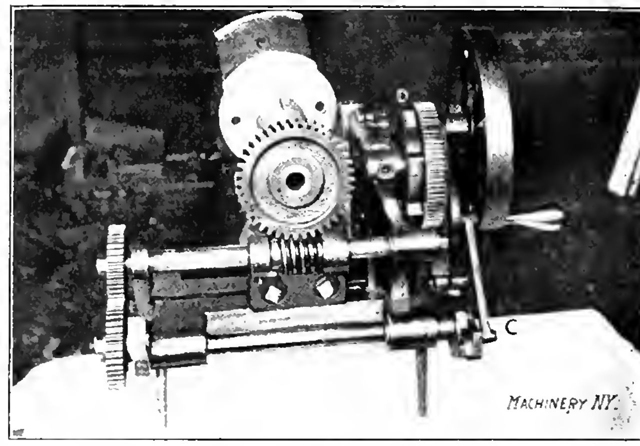

Fig. 19 Graduating Machine—Rear View

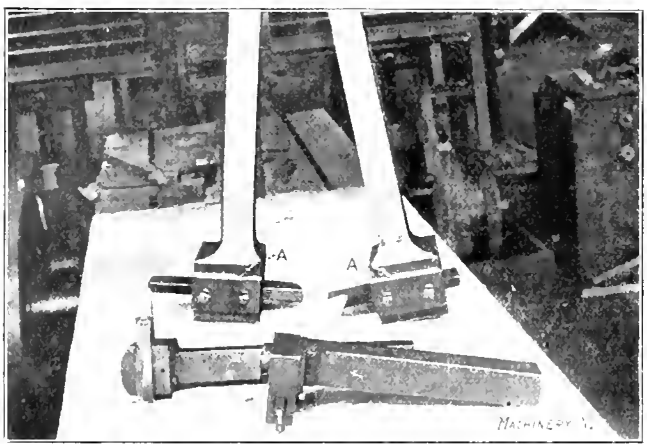

Fig 20. Clapper-box Planer Tools for Side Facing

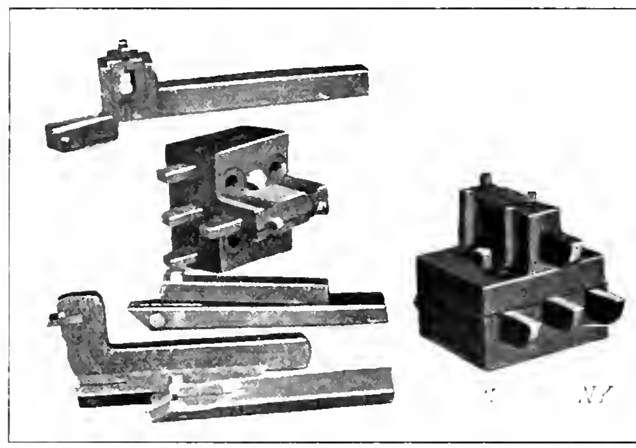

Fig. 21 Miscellaneous Inserted Cutter, Planer Tools

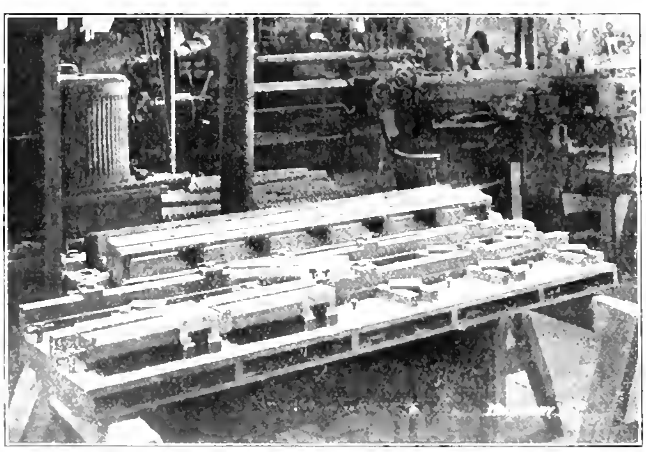

Fig 22 Fixture for Holding Lathe Carriage Slides while planing them

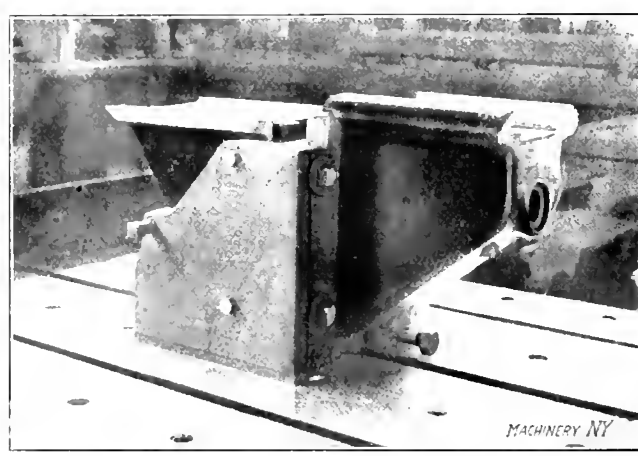

Fig 23 Combination Fixture for Holding Grinder Knees while planing Male and Female Dove-tail Slides

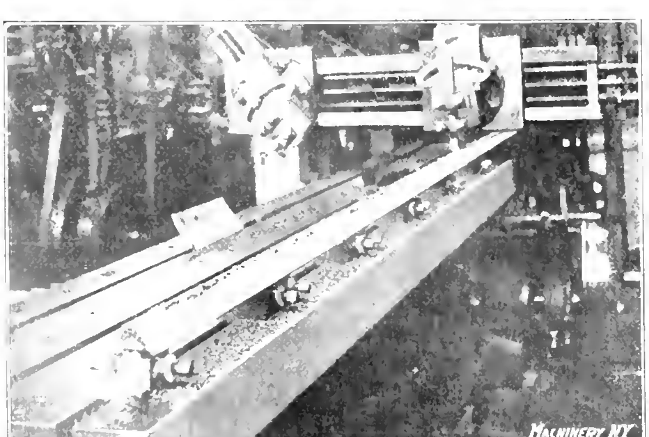

Fig 24 Simple Form of Fixture for Holding Gibs on the Planer

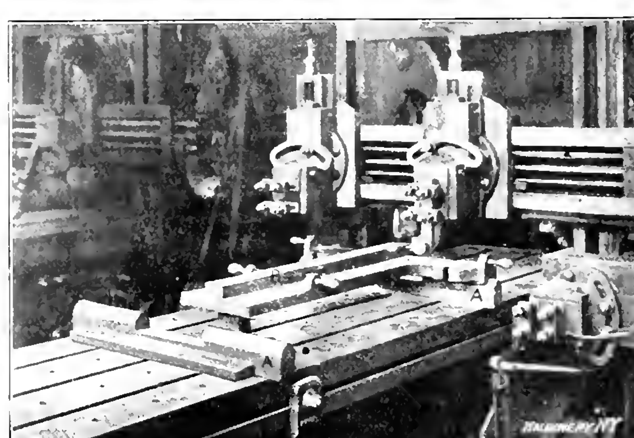

Fig. 25. Gage for Setting False V's for Lathe Carriages

at C, and a cam-wheel with four even and one high rise at D. This cam-wheel gives the tool its four short strokes and one long one, which is the usual motion.

In the planing department, there are a number of "clapper-box" tools such as shown in Fig. 20, used for side cutting on the planer. The two large ones, made right and left, have a little plunger and spring with a crosspiece A, which may be turned lengthwise of the clapper to allow the tool to be drawn back out of the way if necessary, but it is turned crosswise when the tool is in use, in order to draw the clapper and tool back into position at the end of the reverse stroke. Several other forms of tool holders, which need no explanation, are shown in Fig. 21.

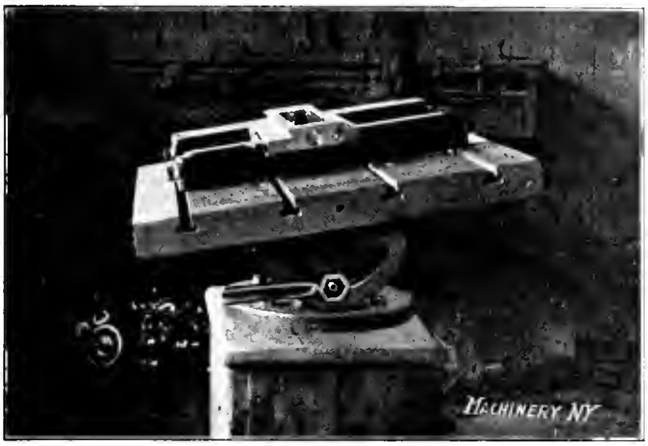

Fig. 26. Adjustable Table for Holding Lathe Carriages or Other Parts while Scraping and Fitting

A jig for holding ten top-slides for lathe compound rests, while planing the bottoms, is shown in Fig. 22, and in Fig. 23, is a combination-jig for holding grinder knees. The illustration shows two in position, but this is only done to show how they are held for the two planing operations, only one, of course, being planed at a time. Fig. 24 shows how gibs are planed, seven at a time, being held by pins inserted in holes drilled in the ends. Lathe carriages are lined up for the planing of the cross-ways, by being laid on the pieces A shown in Fig. 25. In order to get these pieces absolutely at right-angles to the travel of the planer table, the device B is used. This is simply laid on one of the pieces A as shown, and then tested by a dial indicator placed in the tool-holder. When the indicator reads the same for the entire length of B, the cross-piece A is tightened down, and the next one tested. A very handy iron table used to hold carriages or other parts while scraping and fitting is shown in Fig. 26.

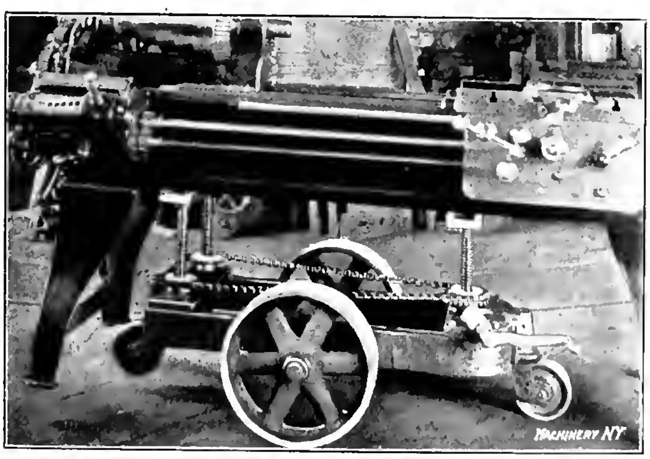

Fig. 27. An Elevating Truck for Raising and Moving Lathes

Every shop foreman knows what a nuisance the starting and stopping of an emery wheel is and how apt a man is to leave it running when he is through with it. The LeBlond shop had the usual trouble and so the arrangement shown in Fig. 28 was put on. As the man steps on platform A, the belt is shifted over and the wheel starts, and as soon as he steps off, the weight B pulls the belt over onto the loose pulley and stops the wheel.

Fig. 27 shows the ingenious truck used to move lathes around, the construction of which can be seen at a glance.

BIG GUN MAKING IN A NUT SHELL

This is how big guns are built at Elswick according to a clipping from *Pearson's Weekly*, a popular British journal, sent to us by a valued contributor. The account is graphic, but, though somewhat lacking in detail, it probably passes muster as the "real thing" with the class of readers to whom such "fluffy" literature appeals:

"Red hot steel ingots are forced into a rough cylindrical shape, either by the pounding of steam-hammers (some of them can give a blow of 700 tons), or by hydraulic presses. The largest of the latter gives a pressure of nearly 6,000 tons.

"Now that the rough forging has been made it has to be tested, and this is a critical part of the process: A few pieces are cut off from the main forging, heated in oil at a temperature of about 1,500 degrees F. and fixed firmly in iron jaws. Hydraulic pressure now tries to tear each lump in two, the strain sometimes rising to 46 tons on each square inch. If all the sample pieces stand the test, the forging is held good enough to make a gun. If not, another forging is made.

"If the test is satisfactory the rough pillar of steel is now 'rough-bored' inside and 'turned' on the outside. Then it is hardened by being dipped into a bath of hot oil; then bored and turned again till smooth; then annealed, or allowed to cool slowly from a high temperature; then it is 'fine bored' and 'fine-turned.' The next process is that of testing the surface. It is tested both chemically and by mirrors.

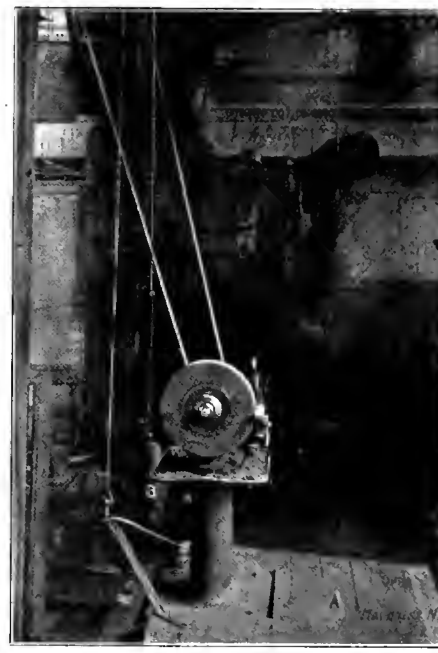
Fig. 28. Automatic Emery Wheel Belt-shifter

"The gun is now well into shape, but it needs strengthening. A deep pit is dug, and the gun set upright in it. Red-hot hoops of steel are dropped on from on top. As they cool they tighten. After each layer of hoops the gun is planed by a lathe to make it smooth for the next layer.

"Now the inside is rifled or grooved like a screw. When the powder chamber has been bored out and the breech-block fitted, the gun is nearly ready for its trials. The Elswick big guns are tested near Silloth, on the flat and lonely shores of the Solway Firth."

* * *

A remarkable high-speed run of regular passenger trains is being made by the Great Western Railway of England, in connection with transporting the passengers of the Cunard liners from Fishguard to London. The total distance from Fishguard to London is 261 miles, a distance which was covered, on August 30, in 268 minutes by the special mail train, and 276 minutes by a passenger train consisting of ten cars, and weighing 274 tons. The first part of the run is a difficult one, owing to heavy grades, including one, over a mile in length, of 1 in 50. The latter part of the run, however, presents more favorable conditions and the run from Carmarthen to London, a distance of 230 miles, was made in 228 minutes, including a stop of four minutes. At one section 75 miles were actually covered in 60 minutes, and 100 miles were covered in 83 minutes 19 seconds, a remarkable performance with so heavy a load behind the tender. The locomotive pulling the train was a four-cylinder, non-compound, six-wheel coupled engine weighing $75\frac{1}{2}$ tons, cylinders $14\frac{1}{4}$ by 26 inches, working pressure 225 pounds, and with driving wheels $80\frac{1}{2}$ inches in diameter.

AN ELECTRIC SURFACE GAGE

GEO. J. MURDOCK*

Geo. J. Murdock†

The purpose of the electric surface gage is to obtain aural as well as visual evidence of the truth of a plane surface. There are places on many classes of work, such as jigs, where it is difficult to see whether or to what extent the surface is out of truth, with the common surface gage. This is notable where there is an overhanging projection so close to the surface plate that it is impossible to look under. In dark weather it is very trying on the eyes to see whether the fine point of the needle touches the work or to what extent it does not. The electric current will communicate an audible signal when the needle comes in contact with the work, when under the most favorable circumstances such contact cannot be seen with the eye. This surface gage can also be used for many purposes for which the usual type is comparatively useless; for instance in truing up work on the face-plate or in a chuck, concentric with the axis of the lathe spindle, or for ascertaining the truth of a shaft between centers in the lathe or an arbor in the same position. When the pointer makes contact with the work, the electric current will speak to the brain through the ear where the eye cannot see.

Fig. 1 shows a side elevation of this gage. Its general design is similar to that of the gages in common use. The

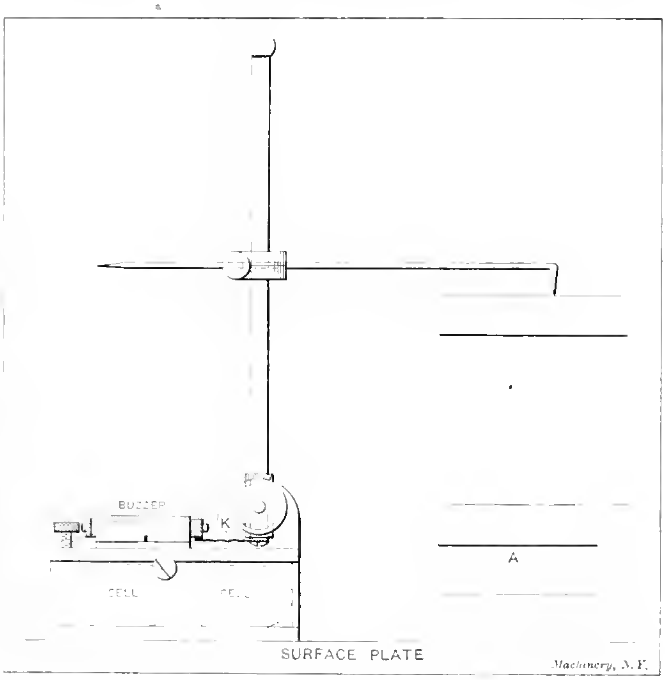

Fig. 1. Surface Gage equipped with Electrical Apparatus for Producing Sound when the Pointer is in Contact

base is cast with a recess in the bottom in which lie on their sides, two small dry cell batteries known as "Ever Ready" No. 650. This cell is 1¼ x ⅝ x 2 inches, and is especially adapted for this work. The ends of the cells are shown in Fig. 1 by dotted lines. On the top of the base is a small buzzer known as a midget, which is noisy enough for the purpose and which occupies but a small space. The positive and negative terminals of the cells are soldered together as shown in Fig. 3. The cells are then inserted in the base so that only the terminal G of the battery comes in contact with the metal of which the base is composed. The other terminal is passed up through a hard rubber bushing H (Fig. 4), and connected by a wire J to one binding post of the buzzer. The other binding post is connected to the insulated needle-bar by the wire K which is rolled up on a small wire so as to give it a coil. After it is coiled it is well to dip it in shellac varnish so that the current cannot short circuit through an accidental contact by the wire with the top of the base. It will now be seen that the circuit has two terminals, one being the base, and the other the needle point; consequently, whenever the point of the needle comes into contact with the work being tested, the current will pass through the work to the surface plate, and thence back through the base of the gage to the terminal G of the battery which is in contact with the inside of the base. Whenever the current passes through this circuit it energizes the magnets in the buzzer and causes it to

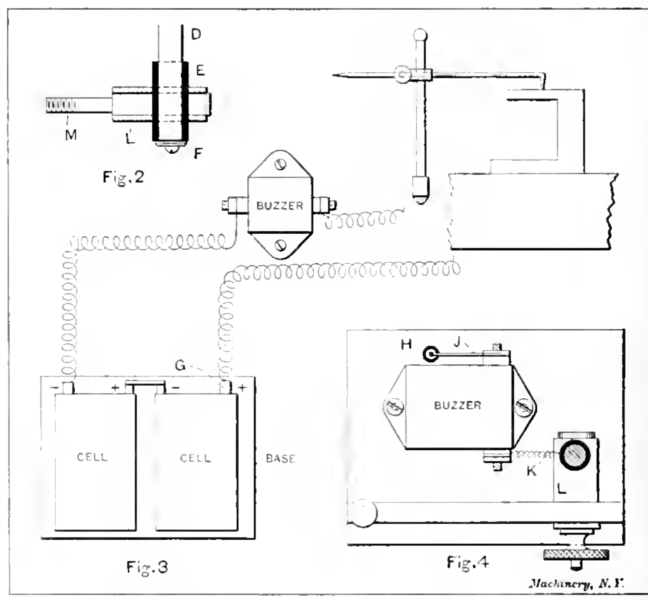

Fig. 2. Diagram showing Electrical Connections and Plan of Gage

give out a clear sound that can be heard several feet away. The moment the needle point passes to a low point on the surface of the work, the contact is electrically broken and the buzzer ceases to sound. At E, Fig. 2, is shown the hard rubber sleeve that insulates the needle-bar D from the base L. The usual form of binding device is used, of which the threaded stem M is a part. It is well to have a small shoulder on E so that the bar cannot slide down and make contact with the base of the tool, in which case it would run the battery down. It will be seen that no switch is required, as the circuit can only be closed through the needle-bar and needle.

The buzzer is secured to the top of the base by two screws, one at each end, and it does not require insulating from the base, as the binding posts are insulated at both terminals from the enclosing case. In trying the truth of a surface, as at A in Fig. 1, the foot of the work would be set up on parallels and the needle inverted with its point up; it can then be placed under this surface and indications taken in a location that would be difficult or perhaps impossible to see. For work in the lathe, the base of the gage can be set on the tool-post foot, and when the point of the gage strikes the work, no matter how lightly, the current will pass through the work in the chuck or on the face-plate to the lathe spindle, shears, and thence back through the tool-post foot and to the base of the gage, ringing the buzzer as the result, and the work can be trued accordingly. The same happens when an arbor is between the lathe centers, and no matter how fast it runs, the buzzer will sound when the point touches, when it is impossible for the eye to see it touch.

After the cells are inserted in the base, a metal bottom should be fitted so that they cannot drop out, and the work should be done so they cannot shake around in the base. It is also advisable not to leave the point of the needle long on the work as it runs the batteries down uselessly; but for all ordinary requirements they will last a very long time if a little care in this respect is taken.

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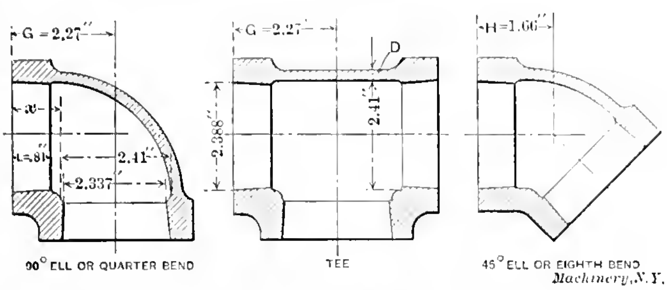
† George J. Murdock was born in New Berlin, New York, 1858, and received an academic and engineering education. He has been employed by the Hall Signal Co., New York; Western Instrument Co., Newark, N. J.; Manhattan Typewriter Co., Newark, N. J.; Sloan & Chase Mfg. Co., Newark, N. J., in the capacity of foreman, tool-maker, draftsman, foreman of instrument finishing work, etc. At present he is practicing engineering on his own account, making a specialty of instrument and precision tool work.

PIPE FITTINGS—THEORY VS. PRACTICE IN THEIR MANUFACTURE

F. W. BARROWS*

If I were asked what determines the thickness of ordinary, screwed pipe fittings, I should reply that the market price is now the final and controlling authority, all other essentials having long been dominated by this price; the weight being the conclusive test of merit. In theory the fitting should be strong enough to resist the internal pressure to which it may be subjected either by the fluid it is to convey or by the piper in "making up"; and the fittings now in the market have been proved, by numerous tests, to be not only strong enough to resist these internal strains, but have also successfully withstood the strains caused by changes of temperature, and by failure to "line up."

Using the formula $p = \frac{St}{r}$, in which p represents pressure; S, ultimate strength; t, thickness; and r, inner radius, and by substituting the values for ¾-inch gray iron fitting found in



Two inch fittings for 100 pounds pressure, proportioned according to MACHINERY's Data Sheet for June, 1905.
E (outside diameter of body) = 2.85 inches and tap diameter (outside at end) = 2.337 inches.
$E - 2D = 2.41$ inches or inside diameter of fitting, and $\frac{2.41 - 2.337}{2} = .0365$ inch clearance for tap.
$G - \frac{2.41}{2} = 1.065$ inch or X, and $X - L = .255$ inch, which is the clearance for the run of the machine or for making up. (Approximately three threads.)

Fig. 1. Sectional Views of Gray Iron Fittings illustrating Clearance for Threading and "Making Up"

the Data Sheet for June, 1905, giving dimensions for fittings to withstand 100 pounds pressure; p (bursting strain) $= \frac{20{,}000 \times 0.15}{0.55} = 5{,}454$. This product divided by 100, the pressure for which such fittings are guaranteed, gives a safety factor of 54.54. Through stress of circumstances, a line of ¾-inch piping, connecting a testing pump with its work, which was to be tested to 1,000 pounds, was made up with ordinary (100-pound pressure) gray iron fittings and brass check valves; and so well did it stand this extreme (water) pressure, that it was continued in use for some years. The pump used was a lever hand pump and the efforts to keep the pressure above 1,000 for the time considered necessary for inspection, caused the gage to show at times as high as 1,500 pounds.

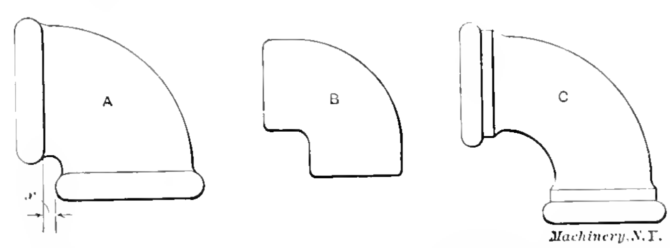
Taking t and r from the same list for 2-inch fitting, $p = \frac{20{,}000 \times 0.22}{1.205} =$ bursting strain of 3,731 (nearly), which would give, for this fitting, a safety factor of 37.34. This is without doubt a safe thickness.

Bronze (commonly called brass) fittings are usually made of yellow brass, which, strictly speaking, is not a bronze because it contains zinc, and for which the value of S may be safely taken (even for the miserable stuff used in "Rf" brass fittings) at 18,000; and t, as the patterns have an allowance for finishing, may be set down at 0.19. Substituting these values, the formula now reads: $p = \frac{18{,}000 \times 0.19}{1.205}$, which gives the bursting strain at 2,838, and a safety factor of 28.38 for this fitting, which factor, though less than that for the iron fitting, is still great enough for safety.

A line of six-inch piping, supplying steam from a boiler (gage pressure, 100) to an engine, ran along the ceiling and was connected, through a 90 degree elbow and a vertical pipe some eight feet long, to the engine. In the horizontal pipe there was an expansion joint of the ordinary, sliding type, and through somebody's oversight, this piping was used for several days without any stop for the expansion joint other than the rigidity of the elbow connecting the vertical to the horizontal piping. No accident occurred.

For 6-inch fitting, $p = \frac{20{,}000 \times 0.42}{3.41} = 2458$, giving a factor of 24.58 for safety. With the same factor as for 2-inch, this fitting would have been 50 per cent thicker and the 12-inch, with the 2-inch factor, would be nearly twice as thick as shown on the Data Sheet referred to in the foregoing. For a 6-inch bronze fitting, if designed on the theory that a 2-inch fitting is a good standard to base calculations on, the thickness of body would have been from 50 to 100 per cent (as the value of S might be varied to suit different mixtures) more than "good practice" calls for. Some exception may be taken to the stated value of S for the brass fittings, but in my opinion it is placed quite high enough when taking into consideration the large amount of poor scrap that is commonly used, and the shiftless methods of melting and pouring allowed in some foundrys, through either inefficiency or carelessness.

To go back again to the common practice, a little further consideration of what might be called the necessary attributes of a good fitting, will show that the fixing of the weight has also fixed, within very small limits, the thickness; which term as applied to fittings, means the thickness of body between thread bosses. The weight should be properly distributed in the length, and in the diameter of the ends, which must successfully resist the strain of making up. The length



A—Beaded brass ell with long ends, with clearance for tool at "x" to machine beads, and large fillets between bead and body that fitting may be readily finished all over by strapping, as is often required.
B—Malleable iron ell without bands or beads, known as a gas fitting. Because of their uniform thickness these castings are more easily made sound—a very good feature of this fitting.
C—Gray iron longturn or water fitting. This fitting, because of its long, easy curves (a prominent feature in all its different forms), is well adapted for piping intended to convey liquids.

Fig. 2. Types of Common Fittings

must be such as to permit a suitable length of thread and also room for tapping without any danger of the taps striking together at the end of the run, or of the piper's being able to screw the pipes in until they meet. The threaded ends and the tapped holes vary in size, and the piper is usually a strenuous individual who may be relied upon to accomplish this if possible. Then there remains a certain amount of metal which may be divided between the length of end bands and thickness of body, the inner diameter of which, fixed by the pipe size, is usually made slightly larger than the outside of the pipe to prevent any shoulder being formed in tapping.

One may vary the diameter of the ends, but after having become acquainted with the aforesaid piper and his trusty "Stilson," the inclination will be to increase this diameter, even at the expense of body thickness. Again, when one has once learned how easy it is to crack a cast iron tee or ell through the "corners," there will be a still greater inclination to enlarge the ends of new fittings. The beaded fitting is probably the best form for resisting this making-up strain, and most brass fittings are made in this form, but the beaded, gray iron fitting does not seem to suit the trade.

If the foundry is to produce good sound castings, at the minimum cost, the change of thickness where the tapping boss and the band join the body, must not be too abrupt, a requirement which will keep the end size down and thus limit the amount of metal which can profitably be used in strengthening the ends. Another reason for not reducing the end size—for small fittings especially—is found in the practice followed

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by nearly all manufacturers, of tapping these smaller sizes with straight taps—thus bringing the strain of making up more exactly at the end of the fitting. Some makers claim that small fittings tapped in this way are just as good as the others. The smaller sizes of pipe show up rather badly; Briggs' standard gives a good length of thread, nicely tapered, which allows for quite a variation in size of the tapped hole, but requires, for a solid die, too much thickness of stock: at least this seems to be the verdict of those who make solid dies, as they are, almost without exception, made too thin. (Can this be another question of cost?) The dies are also often made with greater taper than Briggs' standard in order that the thin die may cover as much variation in size as the standard does, and even if the fittings were tapped taper, the pipe cut with the commercial die wouldn't fit. It may be that the claim "just as good"—for straight taps—should be allowed to stand.

The thickness of the body may be increased by shortening the bands, but if carried to extremes, this would hurt the appearance of the banded fitting. The net weight may be increased by using cheaper material, but this would not *improve* the goods, and the quality, fixed by the ever-present need of keeping down the labor cost, is now about as poor as it can well be. Iron fittings must be soft, and brass fittings must be of a mixture which will cut smoothly, in order that the cost of tapping may not be increased by spoiled work. Labor cost saved by improved facilities, is frequently expended in increasing the weight, and thus causing greater sales. Some customers may demand that the material used show a certain tensile strength; this would, in most cases, mean better material, and the customer expects to, and does, pay a better price. Again he may require that they be tested up to some stated pressure, which would raise the price by causing the rejection of some pieces, not for lack of strength, but because of holes through the castings. If the test is made by water pressure, the fittings unable to stand the test at first will often be found, upon testing again after some hours, to be perfectly tight; the holes, too small to be seen until located by the test, after the first wetting, are soon closed by rust. Natural gas fittings are often tested to 1,000 pounds, and, to prevent leakage through the casting, they are boiled for hours in paraffine.

In brief, the qualities demanded by the trade have placed the ordinary fittings far above any theoretical strength, and the efforts to improve these fittings tend, not to change the weight, but rather to a better distribution of the metal, so that when the new fitting is placed on the market, the first and final question, deciding its success or failure, will be: "What does it weigh?"

* * *

The Patent Office issued 33,514 patents in 1908, and registered 6,029 trade-marks, labels and prints; 22,328 patents expired during the year. The total receipts were $1,896,848 and the expenditures $1,712,303. On January 1, 1909, the Patent Office had a balance to its credit of $6,890,726. The work on that date was current, except in five examining divisions out of 49, and those five have caught up with their work since then. Special attention is being directed to the classification of the 915,000 United States patents, the 2,000,000 foreign patents, and the 85,000 volumes in the library, which is expected to reduce the expense of examining applications by one-third, and to improve the character of the work. Commissioner Moore has requested Congress to use a part of the surplus earned by the Patent Office for the erection of a building suitable for its needs.

* * *

A sensation was created in marine circles by the announcement that the Curtiss steam turbines in the Southern Pacific liner *Creole*, built for the New York and New Orleans service, are to be taken out and reciprocating engines installed in their place. It is claimed that the vessel has not operated satisfactorily; her coal consumption is said to be excessive, 2,000 tons being required for the round trip between New York and New Orleans. The contract with the Fall River Shipbuilding & Engine Co., which built the vessel and turbines, called for a speed of sixteen knots an hour on a fixed maximum coal consumption. The vessel cost about $1,000,000.

MACHINERY'S DATA SHEETS—A WAY TO USE THEM

W. A. WARMAN*

I have preserved and used MACHINERY'S Data Sheets since their inception, and I shall offer a few suggestions from my experience concerning a method of filing them. Binding these sheets is unsatisfactory, as the index is never up-to-date. Again, few if any shops have occasion to refer to all the sheets, and dead material is undesirable, especially if it encumbers live stuff.

The most satisfactory arrangement I have found is that illustrated herewith. This is what is known as a transfer case for the open filing system. It consists of a box 5 by 8 by $10\frac{1}{4}$ inches, with a cover opening part way down each side, making it very easy and convenient to handle the sheets. The folders shown are made of heavy manila paper with a tab on one side. For convenience, these tabs are staggered. The folders can be made with three or five tabs if desired. The guide cards, with white tabs, are of heavy binder board. As shown in the illustration, the tabs are located on the guide

Filing Case for Machinery's Data Sheets

cards so that four extend across the filing case. Those on the folders are wider, being about one-third the width of the case.

The operation of the system is as follows: Divide the box into subjects with the guide cards, and subdivide the subjects with the folders. For instance, when filing the data on gears, mark a guide card *gears*. Then mark a folder *bevel*, one *miter*, one *spiral*, one *spur*, one *worm*, etc. The sub-classifications may be carried to any extent required for convenience. By this method the indexing is done once only, and the index is always up-to-date. The data pertaining to a class of any subject are in a folder convenient to handle, and fresh material is so easily added that special tables and data pertaining to one's own line may be made on standard size sheets, and inserted in the folders. Such sheets greatly increase the value of the outfit as a time saver.

MACHINE SCREW TAP AND BODY DRILL SIZES

Size	Threads per inch	Body Drill	Tap Drill	Size	Threads per inch	Body Drill	Tap Drill
2	56	43	48	8	32	18	28
3	48	38	44	10	32	9	20
4	46	32	41	12	24	I	15
5	40	30	36	14	20	c	10
6	32	28	33	14	24	c	6

I had a set of sheets shellaced for use in the shop. The shellac keeps them quite clean and they can be washed when soiled. After using the shellac, I found that celluloid lacquer was much easier to use. It may be applied directly to the sheets, while to avoid discoloration, they must be sized before shellacing.

As to the Data Sheets, most all that we have used have been very satisfactory. The only one on which I would suggest a change would be the tap drill list for machine screw taps. The list given herewith is very near for average machine shop work. It is certainly healthier for taps than the

* Address: Keller Mechanical Engraving Co., 570 West Broadway, New York.

list given on Data Sheet Number 2. To devise a tap drill list with which an amateur cannot go wrong, would be an almost impossible task; so many factors need to be considered in determining the drill size that will give the best result. I do not see how any table of sizes for small taps can be used without variation, as conditions vary. The best one can do is to compromise.

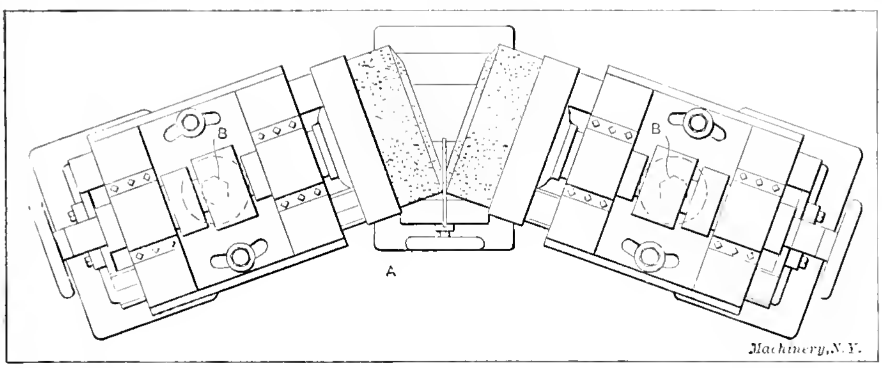
If a screw has little to do, what is the use of taking a chance of breaking a tap by forcing it to cut a full thread? The kind of materials must always cut a large figure in determining drill sizes.

* * *

GRINDING MACHINE FOR SKATES, ETC.

A machine that will grind metal bars on both sides simultaneously has been patented by Chetwood Smith of Worcester, Mass. (U. S. patent No. 930,626, Aug. 10, 1909). His machine is particularly adapted for grinding the blades of skates or in the formation of tools where the sides are to be tapered or ground on a curve.

Mr. Smith found that for successful operation, the axes of the grinding wheels should be at an angle to each other, as shown in the engraving, which is a plan view of his machine. The wheels are cup-shaped and beveled at their working edges to present frusto-conical grinding faces. The axes of the wheels are set at such an angle that the adjacent portions of the grinding faces are substantially parallel when the wheels are employed to grind the blade, the blade being supported on a rest which is made vertically adjustable by the hand-wheel *A*.



Grinding Machine for Skates and Other Parts Finished Simultaneously on Both Sides

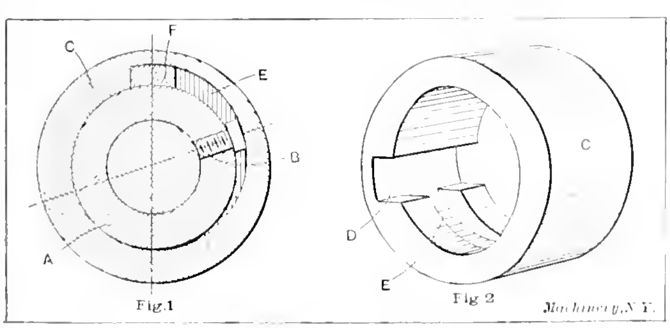
Each carriage has at its under side below the stud *B* a threaded boss and screw with a hand-wheel, which adjusts the carriage longitudinally of the base of the frame, thus adapting the grinding faces of the wheels to the thickness of the work or compensating for the wear of the grinders.

* * *

SET COLLAR FOR SHAFTS

A set collar with an effective retaining means, whereby the danger of its becoming loosened upon the shaft is eliminated, was patented by Israel W. Exley of Colville, Washington. (U. S. patent No. 930,169, Aug. 3, 1909.)

Fig. 1 is a cross-section of the assembled device and Fig. 2 is a perspective view of the locking collar.



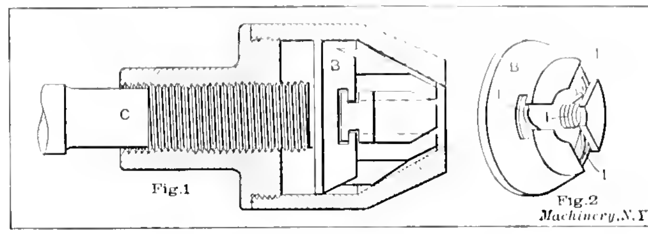
Set Collar for Shafts with Protector for Screw Head

After collar *A* is fastened upon the shaft by the retaining element *B*, collar *C* is slipped over it, the longitudinal opening *D* in the latter coming over the projecting head of *B*. The collar is rotated, bringing the head within the annular passage *E*, which has walls diminishing from its point of connection with the surface of the longitudinal passage. A wedge *F* is then inserted in *D*, and the collars *A* and *C* are thus securely locked upon each other, and the retaining element *B* effectively locked and held in position on the shaft.

* * *

DRILL CHUCK

Thomas J. Fegley and George O. Leopold in U. S. patent No. 932,259 (Aug. 24, 1909), assigned to North Bros. Mfg. Co., Philadelphia, Pa., describe a simple and cheap chuck that will readily and firmly grasp a drill or other tool. A longitudinal section is shown in Fig. 1 and a perspective view of one of the jaws in Fig. 2.



Drill Chuck with Radially-acting Jaws

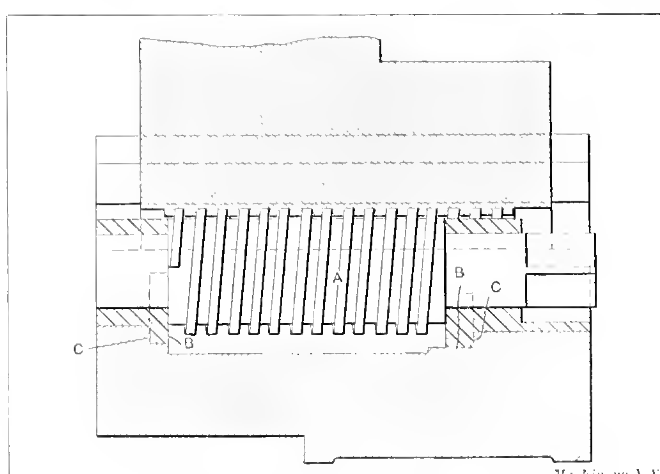
The operation of the chuck is as follows. On screwing the stem *C* into the shell, the disk *B* is forced toward the conical portion of the shell, which, in turn, forces the jaws toward each other against the pressure of the springs *I* (Fig. 2), closing the jaws upon the drill inserted in the chuck. By reversing the movement of the shell the jaws are released from pressure and the springs *I* will force them apart.

By making the disk hollow (Fig. 2) and mounting the springs on studs, the springs are held in position even when the chuck is dismantled.

* * *

CHUCK JAW SCREW MOUNTING

In U. S. patent No. 930,075 (Aug. 3, 1909) Albert P. Kern describes an improved mounting for the radially adjustable jaws of a chuck, which he has assigned to the Cincinnati Chuck Co., Cincinnati, O. The engraving is a section of one of the jaws, showing the operating screw *A*, and the sleeves Mr. Kern uses for bearings. The sleeves are of hardened steel, each having a flange *B* engaging against the shoulder *C* of the body to prevent the sleeve from being radially displaced in its seat. Preferably the outer sleeve has a portion of its periphery cut away for providing clearance for the sliding jaw. The ends of the screws are thus given a hard steel bearing in the radial slot, so the greatest possible efficiency may be derived.



Hardened Chuck Jaw Screw Mounting

* * *

The government of Western Australia is about to undertake the construction of a railway line, 114 miles in length, connecting the Pilbarre goldfields with Port Hedland.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1909

PAID CIRCULATION FOR OCTOBER, 1909, 21,196 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

INDEX FOR VOLUME XV

MACHINERY was started September, 1894, the first volume containing only 192 reading pages and about the same amount of advertising. The fifteenth volume contains 1,000 reading pages and more than double that number of advertising pages. While the growth of MACHINERY has been somewhat unusual in the history of trade publications, it measures quite accurately the growth of the machine tool and kindred industries which the publication represents.

The index for Volume XV, engineering edition, comprises over 4,000 references and fills seventeen pages, type size slightly larger than the regular MACHINERY page, set in six-point, four columns to the page. Copies of the index of the engineering, railway or shop edition will be sent to subscribers on request.

* * *

PROGRESS IN SAFEGUARDING MACHINERY

The promoters of the national movement for providing safeguards for the dangerous parts of machinery to prevent the many distressing accidents to life and limb, should be gratified by the material improvement in this detail noticeable in machine design in the past two or three years. Comparatively few builders of engine lathes, for example, now neglect to cover the back gears and other gears with guards. The appearance of the lathe is improved, and a potential danger to the fingers of the operator is removed.

Purchasers of machine tools can materially accelerate the movement by insisting that all danger points be safeguarded. There is scarcely ever a good reason why gears should not be covered. A pair of spur gears is about the wickedest combination for mutilating fingers that can be conceived of; why should they be left uncovered when so dangerous? The proper shielding of all moving parts that can be covered without interfering with the function of the machine is essentially the designer's duty, and it should never be done as an afterthought when avoidable. This costs less in the original design with which it can be made harmonious, and what is most important, the guards integral with the machine cannot be readily removed by the workmen. Many machines have been wrecked or put out of commission for several days by having clothing or tools accidentally drawn between the gears, resulting in bending the shafts and even breaking the frames. By all means provide gearing with suitable covers, harmonious with the general outline of the machine. This remark is addressed to the designer.

* * *

LEARN TO DRAW

Every machinist who aspires to advance himself in his trade should learn mechanical drawing, or its rudiments, at least, so that he can make an accurate, understandable sketch. Drawing is a universal language, and the mechanic who cannot read drawings or blue-prints is not of much account nowadays. Picture writing is the earliest known form of written language, and the easiest understood. It is so comprehensive and simple that the most intricate ideas are made clear even to a child who perhaps cannot read. A sketch tells much that cannot be imparted by word of mouth. We never lose our wonder at the miracle and mystery of the repeated line—the repetition of the straight and curved that is the substance of all delineation.

A machinist would be ashamed to acknowledge that he could not read or write, and he should consider that he is equally at fault in his mechanical training if he cannot draw and read mechanical drawings. Drawing is an exceedingly useful accomplishment to a man who has to direct the activities of his shop mates. He can save time and convey clear ideas by resorting to sketches. The record can be made permanent, and is often a convenient reference long after it was made. The man who can make an accurate sketch of a machine part or a mechanism must have an accurate mental picture of it, and that means clear thinking. One great difference in men that makes some leaders and others followers is the respective capacity for thinking. The mere act of drawing accurately will stimulate mental activity wonderfully. It will usually make the individual study to understand things that in his conceit he believed he fully understood before. Drawing in this respect is akin to writing for the press. A man never realizes how little he actually knows of a process, method, or mechanism until he tries to describe it accurately in written words.

* * *

CATALOGUE FILING FOR SMALL CONCERNS

Every concern, large or small, that receives many catalogues listing machinery and other products likely to be useful in its business, should have some systematic method of filing them for ready reference. The average proprietor of a small shop probably will say that it is all right for the big concern to provide a catalogue file but, when you are superintendent, foreman, business manager and office boy all in one, there is mighty little time left for such fol-de-rol. Doubtless there is not much time left for systematic effort in the poorly managed business, but the time wasted in looking through a heap of papers for a catalogue that is dimly remembered and badly wanted will, if rightly directed, more than suffice for properly filing catalogues and price lists so that they can be readily found.

A simple and cheap method of caring for advertising literature is in use in the editorial department of MACHINERY that is recommended to those particularly who cannot afford a more elaborate system. First, a number of ordinary letter files was provided that cost at retail 25 cents each. These files were numbered on the back, beginning with 1 and filled with the catalogues on hand. Each catalogue put in No. 1 file has the number 1 written or pasted on its cover and those put in No. 2 file are marked 2, and so on. The obvious purpose of these numbers is to facilitate replacement in the proper file when removed. The date of receipt of all circulars and other advertising literature is written on them, thus 9/28/09. A card index of 3 x 5 cards is compiled, each concern represented having a card on which is written the number of the file in which its catalogue is stored.

Catalogues are filed as received, filling the new boxes without regard to matter on hand except when new literature from concerns already indexed is received, then the new matter is put in the old box and no change in the cards is made. No attempt is made to file in alphabetical order, but a small concern could preserve the alphabetical order without great trouble, and in that case the card index would not be necessary.

Another means for avoiding the cards is a list of the concerns represented in each file pasted on the back of the files. The common letter files are 10 x 11½ inches inside, and will store the average size catalogues easily, and if a little care is taken each file can be so filled as to leave very little waste space.

* * *

LIGHT AERONAUTIC MOTORS

The aeroplane has been aptly typified as "an engine with wings," meaning that the motor is the heart and substance of the heavier-than-air flying machine. No other vehicle is so dependent on its motive power: A motor boat will still float if its engine is disabled; an automobile may be run off by the side of the road and left until the repair man can be called; a motor-cycle can be propelled by foot power; but the aeroplane must at once leave its element and negotiate the best landing place available when the engine stops. A dependable motor is so necessary to the success of the flying machine that we are forced to conclude that until it has been developed into a perfected state the aeroplane will remain little more than a dangerous toy for a few bold experimenters to risk their lives in.

In the race to develop aeronautic motors that will fly, the effort has been made to excel in lightness of construction, and some of the resulting motors have been marvels of power per unit of weight. It now appears, in the light of experience, that the sacrifice of dependability to mere lightness has defeated the object of making a motor that will certainly fly. It is not sufficient that the engine be made so light and powerful that it can easily raise itself; it is of equal or greater importance that it continue in flight and develop full power so long as the operator desires and the fuel supply holds out. One flying machine experimenter says: "Three different types of light-weight aeronautic motors experimented with have proved more than unsatisfactory. While the machine easily flies and rises with each of these motors, none can be depended on to stand the strain of continued operation. This experience forced me to consider the building of a new motive power, meeting more efficiently the requirements of the new art. The manufacturers of the present-day light motor, in an endeavor to lighten the engine, lose sight entirely of the real function of the motor. In an aeroplane, continued, ever-ready and dependable power is more important than in an automobile for a hundred and one reasons."

The experiments of the Wright brothers indicate that very light or very powerful motors are not absolutely necessary. In the official test at Fort Myer, Orville Wright lifted and carried 1,300 pounds with an engine rated at less than 24 horse-power, at a speed of about 45 miles an hour. Comparing this with the Curtiss record at Rheims, France, in August this year (see October number) the difference in weight per horse-power is marked. The Curtiss aeroplane, loaded, weighed about 700 pounds and developed 63 horse-power, the weight per horse-power being about 11 pounds, while in the Wright aeroplane it was about 55 pounds per horse-power. The greater area of wing surface in the Wright machine undoubtedly means that less power is required for sustaining the load.

The correlation of power of the engine, the size and speed of the propellers, and the area and shape of wing surfaces to secure the highest efficiency will undoubtedly require many more experiments than have been made by the Wright brothers and others, and probably some strange discoveries will be made in the realm of aerodynamics.

* * *

CHAIN MAKING WITHOUT SCRAP

Practically all manufacturing operations are accompanied with more or less waste. The turning of logs into merchantable lumber, for example, is enormously wasteful, not 50 per cent of the cubic contents in the logs appearing in the finished lumber when worked up by the machinery in general use twenty years ago. It is true that considerable improvement has been made in eliminating waste since the advent of band saws and thin resaws that convert a much smaller amount of wood into sawdust than the old circular saws of a generation ago, but even with the highly developed modern wood-working machinery the waste still is large, and in the majority of wood-working operations it must so continue except in the case of veneering. So it is in the milling industry, and all along the manufacturing line with a few notable exceptions.

Machine shop operations consist of turning, planing, drilling, boring and milling, all of which remove metal from where it is not wanted, thus making the finished product by wasting material in chips. Cutting, bending and forming is done in presses, however, with little waste, and some press work has been so highly developed as to eliminate practically all scrap. The article on another page of this number (engineering edition) "Chain Making Extraordinary in a Scrapless Press Room" is a notable example in which the elimination of scrap in an automatically formed product has been carried to the limit. While the process is typical of similar processes for the cold conversion of metals in wire or ribbon form into merchantable products, none we believe has equalled this.

To convert a coil of cold steel ribbon into perfect machinery chain, hardened against wear without a particle of scrap except a trifling scallop at each end of the coil, is a triumph of manufacture, and when it is considered that the product is turned out automatically, and the finished chain is 95 per cent of the length of the steel ribbon, we figuratively take off our hat to the man or men who have made this astonishing feat possible. Remember that the product is not the light plumbers' chain made from thin brass stock, but is machinery chain in sizes from ½ inch to 3 inches wide, and in thickness of 0.045 to 0.250 inch. The large sizes are capable of transmitting heavy power.

That man is called a public benefactor "who makes two blades of grass grow where one grew before," and equal justice requires that we acknowledge our debt to the men who have made scrapless chain, screws, nails, and other useful products possible at a labor cost so low as to be almost negligible.

* * *

THE MASSACHUSETTS PLAN FOR INDUSTRIAL INSURANCE

In the August, 1907, issue of MACHINERY, an article was published entitled "Industrial Life Insurance and the Workman." In this article the great waste incident to industrial life insurance, as conducted by the large industrial life insurance companies, was pointed out, and in a short item in the September, 1907, issue mention was made of the law enacted in Massachusetts permitting the savings banks to conduct industrial insurance. It appears that the Massachusetts plan during the two years it has been in operation has proved successful, and many firms and industrial corporations employing great numbers of men have taken active interest in the matter by way of facilitating the spread of information relating to the methods employed by the savings banks. One of the latest large Massachusetts manufacturing corporations to introduce into its plant the plan of savings bank life insurance and old age annuities is the B. F. Sturtevant Co. of Hyde Park, Mass. A savings bank agency has been established within the works, in charge of a person furnished by the savings bank insurance committee of the Boston Chamber of Commerce. As industrial insurance is practically a necessity to the majority of industrial workers, this departure is a very important one, and it is to be expected that this form of insurance will be introduced into other states as well.

Under this system of savings bank life insurance, any savings bank is authorized to establish an insurance department for issuing life insurances, limited to $500 and annuities limited to $200 per year, to residents of Massachusetts. While the amount of insurance in any one savings bank is thus limited, the same person may take out life insurance and annuities in more than one bank. The most important feature of this system of insurance is that the cost is much lower than that charged by the large life insurance companies in the past, notably the Metropolitan of New York and the Prudential of New Jersey. The savings bank industrial insurance is conducted at actual cost, and all profits are returned to the policy holders. The causes of the high cost of the industrial insurance in the large companies has been high managing expenses, which for instance, in the industrial department of the Metropolitan Life Insurance Co. in 1904 were 42.08 per cent of all the premium receipts. In the same year the percentage of managing expenses to the deposits made

during the year in the Massachusetts savings banks was 1.47 per cent. These facts were disclosed during an investigation made in Massachusetts, and as a result of this investigation the law relating to savings bank life insurance was enacted.

Although the general public has not responded as readily to the advantages of life insurance as was expected, the response of the various industrial establishments, where the managements have done considerably towards presenting the advantages of the scheme to the employes, has been satisfactory. A large amount of savings bank insurance has been obtained at the leading shoe factories in Brockton and Haverhill, and at the Fore River Ship Building Co., Quincy, and the United States Shoe Machinery Co., Beverly, Mass. The success has been greatest where the employes are well paid and of an intelligent class. To facilitate making this class of life insurance known to the employes the literature on the subject is usually first distributed in the pay envelopes. After that a trained insurance man from the Boston Chamber of Commerce interviews all the men and women who have shown interest in the subject. The success of the plan has caused considerable interest among manufacturers in other states.

An interesting comparison between the savings bank insurance and that offered by the large industrial life insurance companies is given by the Massachusetts State Actuary in a recent publication, wherein he shows that under this system an old age annuity with the life insurance feature added, costs less than what the working man now pays for his industrial life insurance alone. If a man is twenty-five years old and pays to the savings bank $1.30 each month, and his neighbor of the same age pays $1.35 each month to the insurance company, then the savings bank depositor when he reaches the age of sixty-five will have no more insurance to pay, but will begin to receive an annuity of $100; his neighbor, however, will continue to pay $1.35 each month to the insurance company until he is seventy-five years old, and yet nothing will be paid to him as annuity at any time, but his insurance merely amounts to a given sum payable at death.

Some figures relating to the actual cost of insurance under this system may prove interesting. By paying $1 a month, a man twenty-one years old may secure for himself an annuity of $200 a year, commencing at an age of sixty-five, and continuing throughout life. A man twenty-five years old by paying $1.16 monthly for twenty years may obtain a life insurance of $500. By a payment of eighty-two cents a month for life, he can purchase the same amount of insurance, his family receiving $500 at his death whenever it may occur. Including, as this system does, the annuity plan at an age of sixty or sixty-five years, it is an efficient substitute for the old age pension systems adopted in England and Germany, and instead of making the pensioner a *dependent* for life, this plan makes the man who commences to save a small amount early in life, *independent* in his old age. Under our present industrial conditions the importance of this system can hardly be overestimated.

* * *

An extensive plan for a system of airship lines to be established in France is outlined in *Page's Weekly;* where the capital for permanent structures and equipment is to be had is not explained. In view of the fact that service of this kind can hardly be expected to be financially successful, this most important consideration seems to have been given too little attention. Five airships, it is stated, capable of carrying from eight to twenty passengers besides the crew, will be built, and four lines will be immediately operated. Three stations, it is stated, are practically ready (?), and that of Rheims will be ready within two months. One line will extend northeast from Paris, another southeast to Lyons, another southwest to Orleans, Bordeaux and Pau, and a western line to Rouen. A similar company has been formed in Germany. It is stated by the *Practical Engineer* that the capital is 3,000,000 marks and that two ships are being built by the Zeppelin company, each capable of carrying the necessary crew and twenty passengers, the cost per ship being $140,000. No attempt is made, it is stated, to *estimate the profits*; this seems to be the most sensible part of the venture.

BOARD DROP-HAMMER DESIGN

H. TERHUNE*

About two years ago the writer had occasion to redesign an entire line of drop-forge machinery for a large drop-forge plant in the East, using board drops exclusively. In years past the use of these hammers has been severely (and justly) criticised because of the high cost of upkeep. For some reason the builders of these machines have neglected to keep the design up to the demands put upon the machines. Having been designed mostly for straight work, they often fail when forging four- and six-throw crank-shafts, automobile front axles, or any other kind of work requiring a lot of "break-down" (bending into shape) work.

So serious have been the repair bills on this class of work that many drop-forge plants have adopted the system of using two sets of dies, one to break down and another to finish, so that the impressions in the die blocks can be placed more central in the hammer. This not only entails extra cost for dies, but the tying up of an extra hammer as well; whereas, if the hammer had been properly designed to withstand the additional strains put upon it due to the breaking down, as well as wide enough between uprights, the work could have been done in one machine at a much less cost; the break-down being done at one side, and in the same die block as the finishing impression.

It is the side thrust that causes so much trouble with the piston rod and packing gland of the steam hammer.

Economy of Board Drops

For forgings up to say 300 pounds, the writer does not believe that a more economical way can be found to forge them than in a properly designed board drop hammer. The power consumption is extremely low. In one plant using 45 board drops varying from 400 to 3,000 pounds or a total falling weight of 50,700 pounds, even with a bad arrangement of jack-shafts, these hammers together with 23 trimming presses and kindred machinery are driven by two motors of 75 and 100 H.P., respectively, and yet there is power to spare. For convenience let us assume that 40 H.P.—a low estimate—are used on the presses and other machinery; this leaves 1 H.P. for every 375 pounds of falling weight.

Almost every builder of steam drops recommends a boiler plant of at least 0.75 H.P. for every 100 pounds of falling weight. It is true that a steam drop will do more work in a given time for the same number of pounds falling weight than a board drop, but this is not so important when we consider that the best furnace to-day will hardly keep a board drop constantly going. Besides, what would become of the average drop forger if kept constantly before his fire for a full day of nine hours?

General Construction of Board Drop Hammer

To meet the requirements of an up-to-date drop-forge shop, the hammer, of which a front and rear view are shown in Fig. 1, was designed. It is an almost indestructible machine, the capacity of which seems to be limited only by the ingenuity of the die sinker. In the design many new and commendable features have been introduced.

The bases are of cast iron and in one piece, a weight ratio of 15 to 1 between base and hammer being adopted; that is, if the hammer weighs 2,000 pounds, the base would weigh 30,000 pounds. A shoe or "sow" of 0.45 carbon steel is keyed and doweled into the base, and the die openings planed into this. The recess in the base for the uprights is planed straight through, assuring a permanent alignment, as there is a bearing the entire width of the uprights.

Fig. 4 shows the section of upright used by most builders since board drops first came into use. As work became more and more severe, and uprights failed, nothing was done, however, but to increase the cross sectional area till the center became very porous, an even section of metal being impossible. The V's too have failed, and in every case the break was perpendicular to the surfaces in contact (see Fig. 4). These failures, together with a practical and theoretical knowledge of conditions led up to the form of upright shown in Fig. 5, which has nearly an even section of metal distributed so as to

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better withstand the shocks brought to bear upon it. The V is backed up by a beam of the depth A and the thickness B, and any direct thrust that is perpendicular to the apex of the V is taken up by beams of depth C and thickness D.

Adjustments

It often happens in drop forge work that the dies do not match exactly sidewise, and some adjustment is necessary to bring them in line. The top die is generally doweled securely onto the hammer, and some drop forge plants use double keys for holding the bottom die in the shoe. One taper key is driven in from the front, and another taper key is driven in from the rear. In adjusting the location of the lower die relative to the upper one, all that is necessary is to back one key out and drive the other one in. This form of adjustment, however, is rather limited, as the taper of the keys must not be too lower part of the upright thus straddles or forks over the body of the bolt, as shown in Fig. 6. The collar-nut on the end of the bolt is shown at A in Fig. 1, this nut bearing against a boss on the upright. One bolt of this kind is provided for each upright. In adjusting, the hammer with upper die is let down until the faces of the dies come together. Then the base binding bolts are loosened, and also one of the upright adjusting bolt nuts. The other adjusting bolt nut is tightened, thus moving the entire upper structure—uprights, hammer and head—to the right or left, as the case may be, until the dies are properly matched. Then all parts are again locked into place. The moving of the entire structure is quite common in board drop hammer designs and is considered good practice, especially when the base binding bolts are at an angle, as is the case in the present hammer, as this

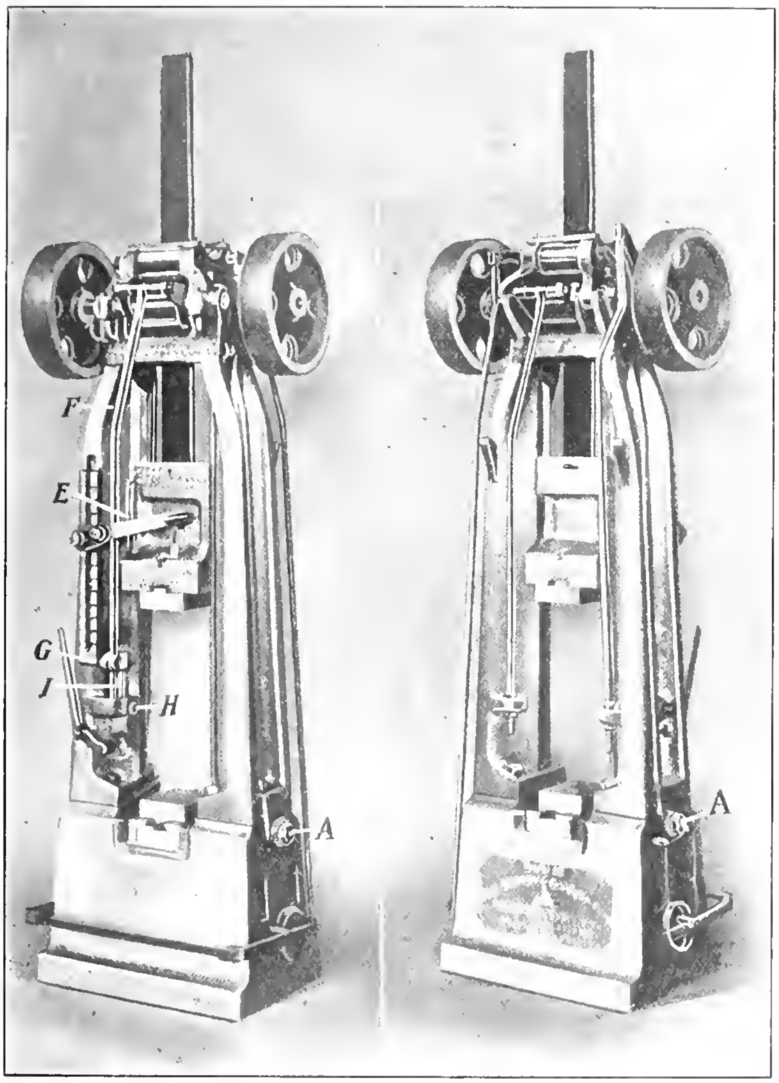


Fig. 1. Front and Rear Views of Board Drop-hammer of Rigid Design

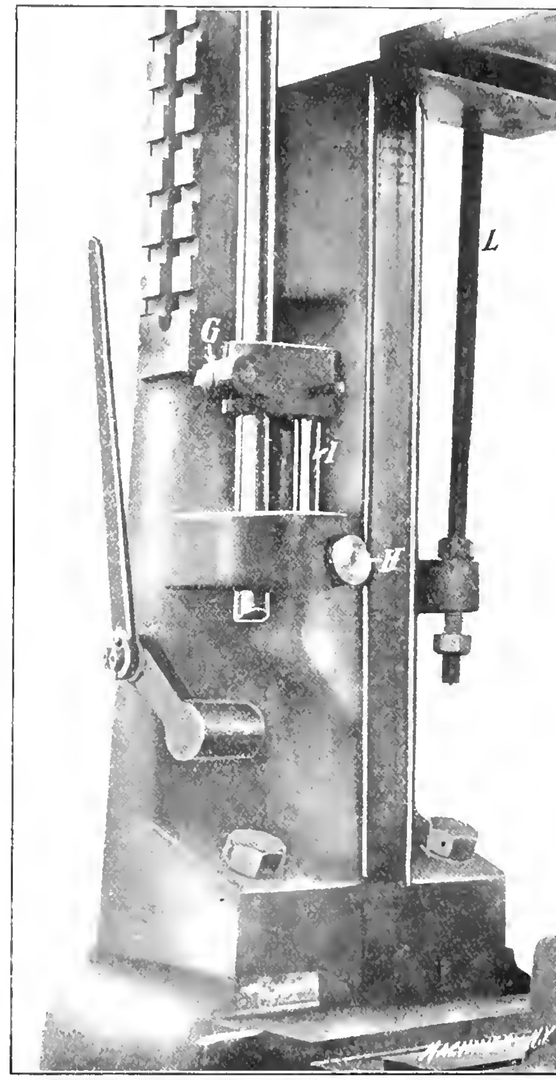


Fig. 2. Automatic Knock-off Arrangement

great, or the keys will not remain in place; it also adds an extra piece to fit and possibly jar loose.

A better method of adjustment is to move the entire upper structure sidewise on the base by means of an adjusting bolt; but this bolt has, possibly, been one of the greatest annoyances of the board drop in years past. For a long period all makers used practically the same construction, consisting of a set-screw passing through a nut inserted in and fastened to the base, the point of the screw bearing against a projection of the upright. The hammering action of the upright, however, is very severe, especially on break-down work, and the point of the adjusting screw soon becomes upset so that it can neither be removed nor used for adjusting the uprights.

In the present construction, therefore, a bolt with a T head has been laid horizontally in the recess for the upright cast in the base. The T-head is let into the base, so that the bolt cannot move relative to the base casting. The round part of the bolt rests on a finished surface in the recess, and a finished groove is provided in the upright to fit over the bolt; the draws the uprights apart and back against the adjusting bolt nuts.

Notches are cut in the collar of the nut, as shown in Fig. 3, and a flat spring is fastened to the base and brought to bear in the notches, this forming a positive lock and an easy means of adjustment. With a special thread on the bolt, an adjustment as fine as 0.0028 inch can be had.

The trouble due to constant vibration causing the uprights to creep together and pinch the hammer at the bottom is overcome by setting the base binder bolts at an angle, thus keeping the upright back against the upright adjusting bolt nut. The adjustment for different heights of fall is made by a bracket clamped to a modified form of rack in any desired position on the left-hand upright. (See Fig. 1.) The roll releasing lever E, better shown in Fig. 7, allows the friction bar F to release on the up stroke without shock or noise. The automatic knock-off H is best shown in Fig. 2.

Adjustment for different thicknesses of dies is made through the adjustable dog G, carrying a stop pin I.

the latter resting on a flattened surface of the knock-off *H*, which has an elongated hole through it. The side of the hammer is beveled to fit the beveled end of the knock-off *H*. As the hammer descends the knock-off is forced back, allowing the stop pin to fall through the elongated hole. For thick dies the stop pin is set forward, and, as shown in the line engraving Fig. 8, consequently falls earlier. In this line engraving, *C* is the elongated hole in the upright allowing adjustment for the stop pin; the pin is shown set for thick dies and it is moved back in the slot for thinner dies. The elongated hole through the knock-off is indicated at *D*. As the hammer descends it is evident that when the knock-off is forced back, the stop pin falls through the slot in the knock-off and allows the friction bar to drop, and thus the eccentrics on the lifting rolls are brought into contact with the lifting board. The hammer then rises until the hammer pin, which is made of wood in order to lessen the impact, comes in contact with the roll releasing lever, which raises the friction bar and thus releases the rolls.

As shown in Fig. 8, the stop pin rests on a surface the width of which equals *y*. Should the stop pin be moved to

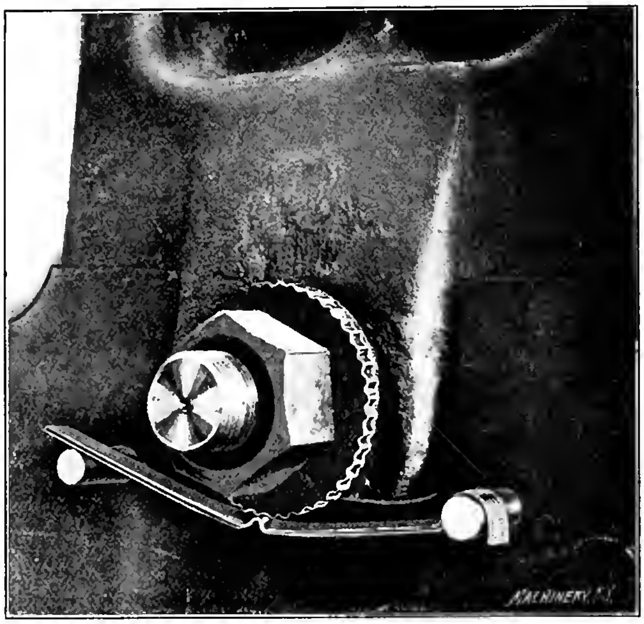
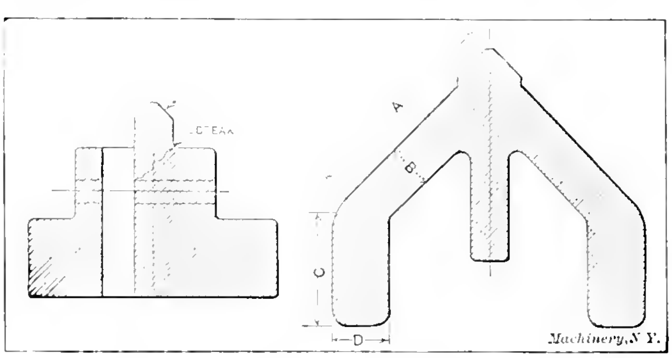


Fig. 3. Locking Arrangement for Upright Adjusting Bolt Nut

the left to the end of the slot in the upright, the knock-off evidently would have to be forced back a distance equal to *z* before the friction bar could fall. As the side of the hammer and the front of the knock-off are beveled only $5\frac{1}{2}$ degrees, the hammer must travel a considerable distance to force the knock-off back $1\frac{1}{4}$ inch, which is its extreme travel.

Even if the drop forger is not careful in setting the knock-off, little can be lost in having it act too early, unless



Figs. 4 and 5. Section of Uprights of Usual Type and of the Type used in the Hammer shown in Fig. 1

at a very short fall, because the hammer has a velocity of a free falling body, having fallen several feet, while the friction bar starts from rest when the knock-off releases it. The friction bar should be heavy enough to throw the rolls against the lifting board with force enough to lift the hammer readily. The best condition is to catch the hammer when rebounding from the dies.

It will be noticed that there is no provision made for preventing the knock-off from turning around its own axis. Provision to prevent turning was made on the first hammer built, but it was found unnecessary, as the weight of the friction bar resting on the flattened surface always keeps the knock-off

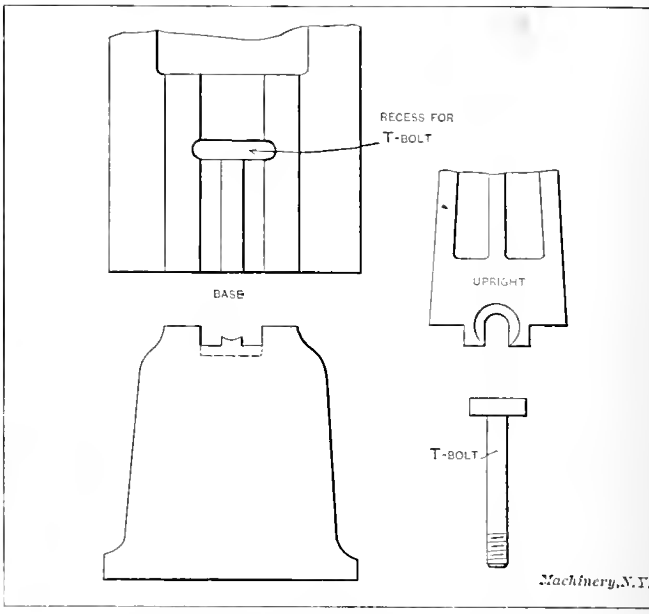


Fig. 6. Details of Sidewise Adjustment of Uprights

from turning when the bar is up, and as soon as released, the pin passes down to the slot in the knock-off, making turning impossible.

The knock-off stop is counterbored instead of being bored clear through. The reason for this is that the impact of the hammer would be likely to shear off the taper pin. With the construction shown, the pin has nothing to do but overcome the impact and pressure of the spring, and even this impact is lessened by fiber washers which act as cushions, as well as by a safety cotter pin which would act in case the taper pin should fail.

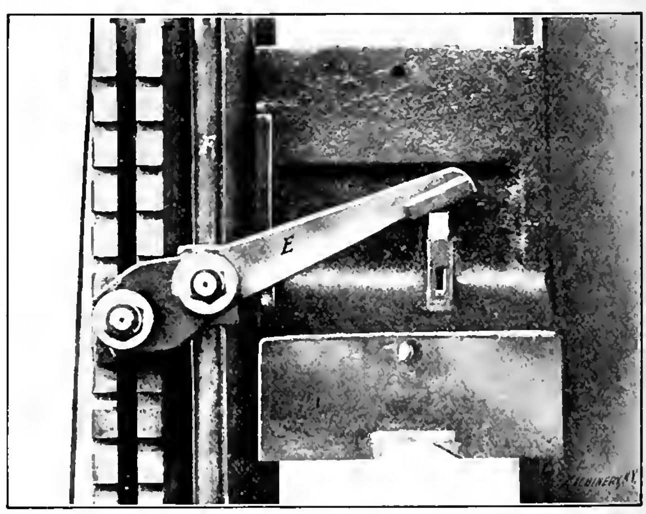


Fig. 7. Arrangement for Adjustment for Different Heights of Fall

When the hammer pin comes in contact with the roll releasing lever, as previously mentioned, thereby raising the friction bar and releasing the rolls, the hammer again falls and will continue to run automatically until the treadle is released. At this time it comes to a rest on the top of its stroke, and is held there by board-clamps *K*, Fig. 9, located above the rolls out of the way of any oil that may work out of the bearings. By a greater or less depression of the treadle, any blow may be struck regardless of the set fall. The hammer can also be stopped at any point when falling, without injury to the machine.

Head Construction

Fig. 9 gives a good idea of the head construction. Both lifting rolls, as well as the board clamps, are mounted on eccentric sleeves, the front one of each being intended for operating and the rear one for the adjustment necessary, due

to the rolling down or wear of the board. This feature is one of the most important in the whole construction as a perfect alignment of the rolls is always assured, regardless of how careless the operator may be. The adjusting bars *L* are carried down in the back of the uprights through lugs cast on them, and locked within easy reach of a person standing on the floor. (See Fig. 2.) Adjustment for the wear of the board can thus be made in a few seconds, whereas usually on all drops offered to the trade a ladder is necessary for reaching the set-screws located behind each end of the rear roll bearing. It is then a mechanical impossibility to ever get the rolls and clamps parallel, with the proper amount of friction, while the drop is running.

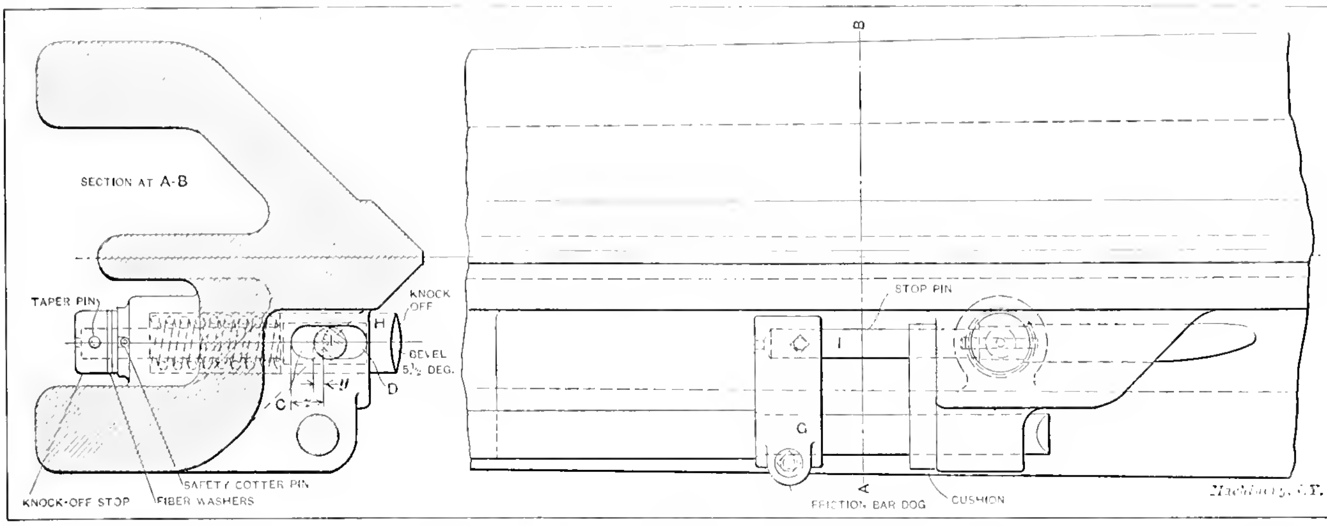


Fig. 8. Details of the Automatic Knock-off Arrangement

An even pressure must be brought to bear across the entire face of the board, or a rapid wearing away will result, and many times this causes it to split. A double pressure on one side also has a bad effect on the bearings.

Seasoned maple boards have been found to stand better than any other kind of wood or metal. Paper fiber has been tried with fairly good results—but as yet the cost of this material is prohibitive. All running bearings of the hammer illustrated are exceptionally long, bronze bushed and provided with large oil reservoirs.

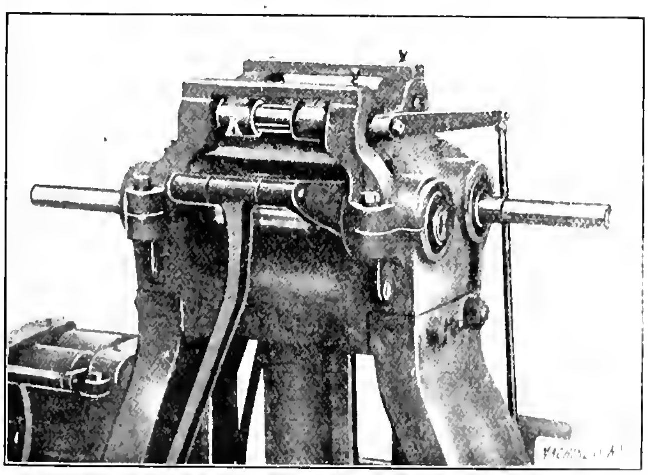


Fig. 9. Head Construction of Board Drop-hammer

Fig. 10 shows the foundation construction, which, like the ratio of 15 to 1 between base and hammer, was adopted after a long and varied series of experiments. The concrete mixture is made up of three barrels of stone, two barrels of coarse sand, and one barrel of cement. To meet the various classes of work that comes into the average drop-forge shop, these hammers were built very wide between uprights, *viz.*, 400-pound hammer, 12 inches; 800-pound, 14 inches; 1,200-pound, 17 inches; 2,000-pound, 20 inches; 3,000-pound, 24 inches. It does not seem practical to build board drops larger than 3,000 pounds falling weight. The field in which heavier blows than this are required is best covered by the steam drop and the hydraulic press.

THE MAKING OF AN ACCURATE LEAD-SCREW

In a paper read before the Institution of Mechanical Engineers, of Great Britain, by Mr. H. F. Donaldson, an incident is related showing the pains which are sometimes taken by mechanical men to accomplish their ends. The author of the paper states that some years ago he visited certain British works where it was claimed that micrometer screws were produced with exceptional accuracy. He there had a conversation with one of the members of the firm who claimed to have produced, by his own efforts, an accurate master screw upon which the accuracy of all the firm's subsequent work of this character depended. This man first cut a screw as accurately as possible by the common methods, and he then shut himself in a room, the temperature of which was constantly kept nearly at the heat of the human body, so as to in this way by artificial means minimize the effect of the heat of his body on the work in which he was engaged. His screw had a square thread and was about twelve inches long;

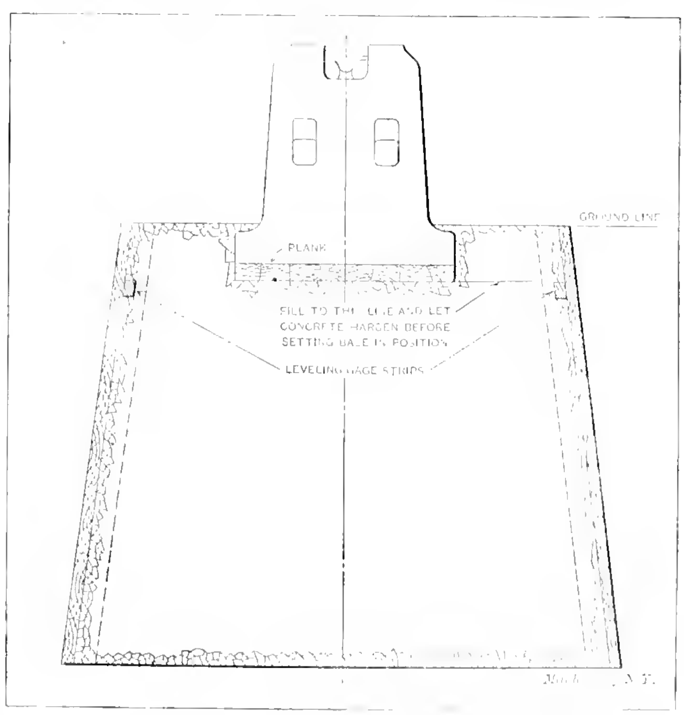


Fig. 10. Foundation of Drop Hammer

when the temperature of the room had been brought to a level as high as he considered he could stand, he shut himself in the room and proceeded to measure short lengths of the whole of the screw and lap the inaccuracies on both sides of the thread until he secured, as near as could be obtained, absolute accuracy in the screw. He remained in the room until he had gone over the whole length of both sides of the thread which required about twenty-four hours, when he came out of the room with the screw in its finished state.

SOME CAUSES OF BELT FAILURES*

G. S. BAKER†

Nearly every large manufacturing plant is constantly making changes and improvements in its machinery for the sake of effecting greater economy in its output. Strangely enough, many of our largest manufacturing plants, though equipped with most modern machinery, have most inefficient methods of installing belting equipment. There seems to be a general feeling that belting a machine is something that everybody understands and something which needs no particular study or attention. The result of this indifferent attitude toward belting and its proper installation, has been constant extravagance in the belting equipment of plants where the greatest possible economy is followed in other directions.

The causes of belt failures are many. In some instances the cause may be traced direct to the manufacturer of the belt, who has not furnished in the goods delivered the qualities which he should. But, let us assume, that only the best belting is bought and delivered, and then analyze why the best belting, wrongly installed, will have need for frequent replacement. Under such conditions the causes are two-fold: First, belt failures are often due to a defective working out of the underlying principles of practical belt transmission; and second, belt failures are often the result of the selection of an improper type of belting for the particular kind of work to which it is to be put.

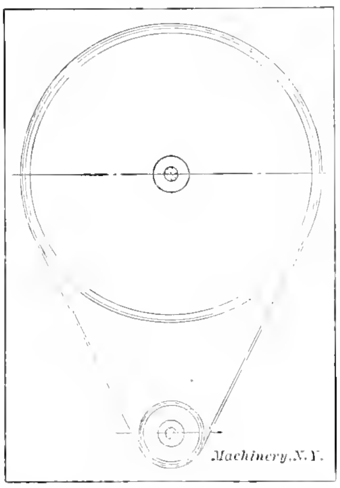


Fig. 1. Drive from Large to Small Pulley, showing Decreased Arc of Contact

We shall, in this article, attempt to show how a large percentage of the unnecessary costs of belting could be eliminated by following out three suggestions: First, by foreseeing and modifying the mechanical and architectural plans in the building of plants, so that they will conform to the most modern principles of practical belt transmission; second, by modifying pulley conditions in a plant already built; and third, by the selection and proper installation of the right type and size of belting for the particular machine and pulley upon which the belt must operate.

Very often slight changes in transmission conditions would save great losses of time on many types of machinery in many of our factories. Here for example are some of the common mistakes in transmission which could easily be rectified, if attention were called to them.

Allowing too short centers between the shafting. This practice works havoc with the belt where the load is heavy. Owing to its limited length, the belt does not sag on the top side, as it would when driving from the bottom of the pulleys, which is the correct way; therefore it becomes necessary to draw the belt very tight to avoid slippage, thus straining it and adding to the frictional resistance in the bearings. When the diameters of the driving and driven pulleys differ to any extent, as shown in Fig. 1, there is a material reduction in the arc of contact on the smaller pulley, as the distance between the centers of shafting is lessened, and as the driving power of the belt, in a measure, depends upon the area of contact between the belt and pulley surfaces, the advantage of increasing the distance between centers is apparent.

Installation of pulleys which are too small. A slow-running belt must be heavy if any strain is put upon it.' It must also be wide to get the proper area of contact to insure it against slippage. Where small pulleys are used, the above condition is doubly true. Were the pulleys at their installation enlarged proportionately, they would still give the same number of revolutions, but the belt speed would be increased, the grippage area increased and a narrower and lighter belt could be used. Such a belt will invariably outlast a shorter, heavier and thicker belt. In determining the minimum diameter of pulleys to be used with single and double belting, it is necessary to take into consideration the width of the belt to be used, belt speed and horse-power transmitted. In a very general way it may be said that it would be well, whenever possible, to have the pulleys on which single belting is to run not less than 8 inches in diameter, and those for double belting not less than 12 inches in diameter.

The avoidance, as far as possible, of quarter-turn drives. Quarter-turn drives (Fig. 2) bring about one of the hardest conditions found in belt transmission. This character of drive can often be avoided in one of three ways: (a) By installing two loose pulleys so that the belt will operate over them, as well as over the regular driving pulleys, as shown in Fig. 3. The loose pulleys must correspond to the tight pulley on the same shaft, and be so placed that the crowns of all four pulleys in plan would form a rectangle. The advantage of this arrangement, generally speaking, may be said to be in the fact that when the belt operates at a quarter-turn with the delivering faces of the driver and driven pulley plumb, the belt does not get the full degree of contact with the pulley which it does with the loose pulley arrangement, which gives for pulleys of the same size a full 180 degrees contact. This condition, of course, makes for greater driving efficiency of the belt than when the area of contact between the pulley surface and belt is lessened by the quarter-turn arrangement.* (b) By the use of a right-angle transmitter. (c) Possibly by installing two idler guide pulleys on the top side of the belt.

An avoidance of the use of small pulleys on extra long center drives. This condition taxes the tractive power of a belt to the utmost. Under such conditions it is necessary that the belt be kept under a certain tension at all times. The result of this is usually either constant taking-up during damp seasons, or lengthening in dry periods.

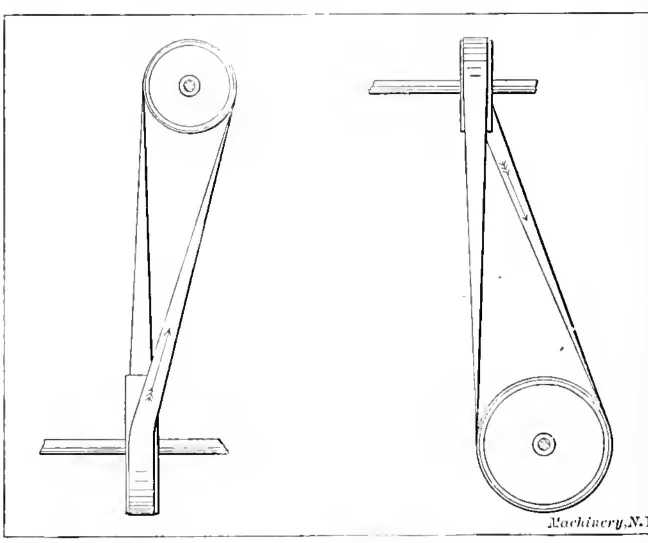


Fig. 2. Quarter-turn Drive showing Distortion of Belt as it leaves Pulley

By so installing the belt that the slack side is above and the driving side on the bottom of the pulleys. If this condition is reversed, the slack side being below, as shown in Fig. 4, the arc of contact of the belt with the pulleys is materially lessened.

Types of Belting for Different Classes of Work

Perhaps the most common cause of wastefulness in belt transmission is the selection of improper types of belting for particu-

* For additional information on this subject, see the following articles previously published in MACHINERY: Apparatus for Measuring the Slip of Belts, May, 1908; Loss of Velocity Ratio Due to Belt Elasticity, January, 1906; The Manufacture of Belting at the Schieren Factory, May, 1906; Tests of Belt Preparations, March, 1906; Horse-power Transmitted by Belts, July, 1906; Belting, June, 1905; Belt Drive for Shafts at Right Angles, June, 1902; Belt Drive for Three Pulleys, March, 1901.

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* Where the quarter-turn drive cannot be avoided because of lack of room or for other reasons, the straining of the belt can be minimized by lacing the joining ends so that the flesh side of one and the hair side of the other is out. This method was described in the February, 1899, number of MACHINERY. As will be understood, when a belt is placed over the pulleys in this way it is not twisted any more than with the common arrangement, for what was a quarter twist one way becomes a quarter twist in the other direction when the belt end is turned half way around. The advantage of connecting a quarter-turn belt in this way is that there is equal stretching of the belt on both sides, as a given point on one side of the belt is first on one side and then the other of the pulleys for each revolution, whereas with the usual arrangement all the stretching occurs on one side.—EDITOR.

lar classes of work or machinery. We cite in the following a few instances where practical mechanical knowledge of conditions should govern the selection of the belting.

Drives with varying loads should be equipped with belts that have an abundance of elasticity and which are capable of retaining it. The elastic qualities should be such that upon the relaxation of the load, the belt will go back to its original state. Another instance where elasticity has great bearing upon the selection of the proper type of belting is in connection with quarter-turn belts. Here the belt must be able to form a long side and yet be elastic enough to insure of it not becoming permanent.

On drives where there is a long distance between centers, it is necessary that the belt be absolutely uniform and have perfect balance throughout. Unless a belt is procured which contains these qualities, its tractive powers and its driving powers will be materially reduced. Its life will be short and it will be continually running off the pulleys. Nothing but the best woven types of textile belts should be used on this character of drive, or leather belts made from absolute center stock. Often textile belts are selected for use with shifters. This is a mistake and should never be done, unless roller shifters are used. In the event that a belt is wanted which is to carry a heavy load, and where it is necessary that the belt should be kept tight at all times, it is always well to select a belt sufficiently heavy to give it a large factor of safety with regard to tensile strength.

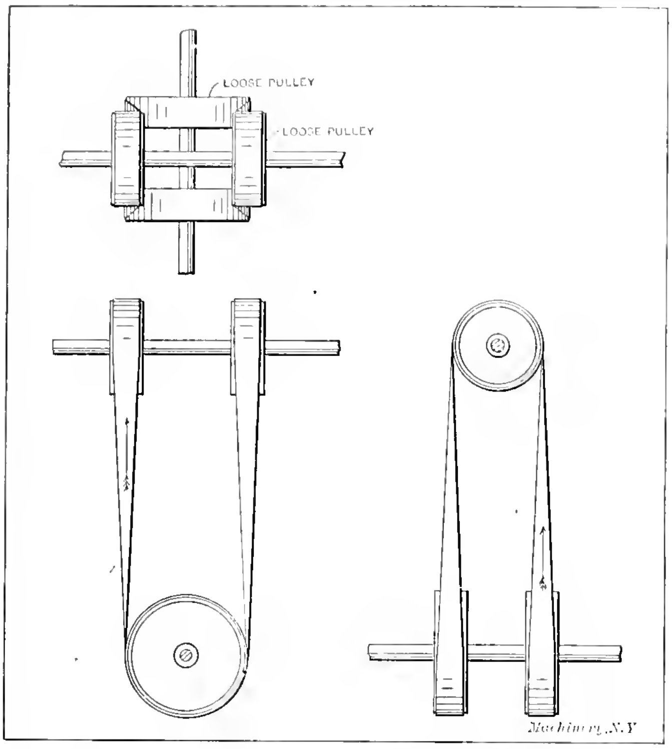


Fig. 3. Four-pulley Drive for Eliminating the Quarter Turn

As to the Arc of Contact

On the drives where the arc of contact that the belt has with the pulley is small, the transmitting efficiency of the belt will depend mostly on its width, since only in this way can an approach be made to the proper area of contact. Tensile strength, under these conditions, has very little to do with the horse-power the belt will transmit. The horse-power depends almost wholly upon the speed at which the belt travels. The area of contact of the belt with the pulley should, however, be large enough to prevent slippage.

Starting Machines with Full Load

One blunder very often made by the engineers of large plants, which plays havoc with the belting, is the starting up of machinery with the full load on. The belting is then required to transmit at a speed of, say, 100 feet per minute, the full amount of horse-power that it was designed to carry when running at a speed of, perhaps 2,500 feet per minute. Unnecessary strains of this sort are among the prime factors which cause belting to go to pieces.

Effect of Water and Dampness

Another condition which is a large factor in belting difficulties, is water and dampness. To meet conditions of this sort, selection of the proper type of belting is of first importance. Dampness is, without doubt, the cause of more belt replacements than any other condition. While water itself may not splash on the belt, or the room in which the belt is operating may be free from water, nevertheless the action of dampness will often work havoc with belting. Dampness, unless the leather is specially treated to withstand its action, will cause the very best of leather belting to stretch, run crooked and in many cases open up the laps and piles. Belting at rest is affected much more by the action of moisture than when driving, as the frictional heat generated by the belt when driving tends to keep the belt dry. The problem of waterproofing and damp-proofing belting is a very important one at the present time, as our largest factories at the present day are being constructed of reinforced concrete and cement blocks. It is a well-known fact that unless special precautions are taken, as is seldom the case, that it is next to impossible to keep a factory constructed in this manner free from dampness, especially in warm seasons when no heating system is in operation. Since so many of our factories are being constructed in this manner, it means practically the dawning of what may be termed "the water-proof belting age." Dampness will penetrate readily through concrete walls. In one instance, which the writer recalls, underground concrete conduits were built in which the driving pulleys were to operate. The object of this idea was to save space by putting these belts under the floor, and also to get solid bearings for their shafting. The superintendent of this factory desired to use untreated, flat leather belting. He claimed that there would be an absence of water and moisture in conduits of this sort. It worked out, however, that the dampness from the ground penetrated the concrete walls and made the place very unsuitable for belting which had not been specially waterproofed.

As to Fasteners

Seldom does the question of belt fasteners receive the attention that it deserves. Almost invariably the complaint registered against the belt because it has torn out where joined, reflects more upon those who had charge of the installation than upon the belt with which fault is found. In determining the type of fastener to use, consideration must first be given to the mechanical conditions under which the belt will operate. If it runs under a tightener or drives from both sides it follows that the joint must be of the hinge or flexible variety, or the belt made endless, and under these conditions we must eliminate from consideration some types of fasteners which are very satisfactory where the belt operates on free open drives. In the selection and application of fasteners, textile belting calls for even more care than does leather. The punching of a hole which is too large or too close to the end frequently results in the fastener tearing out. In punching a hole in leather belting you weaken it only to the extent of the material removed, but a like operation on textile belting goes further in that it severs many of the interwoven strands and weakens the construction. The aim, therefore, should be to make the holes as small as possible and to place them at regular intervals. In preparing the ends of a belt for lacing or fastening, invariably use a square so that the ends will be at right angles with the edges of the belt. It has often been found, where fasteners do not give entire satisfaction, that this condition was due to the fact that the ends had not

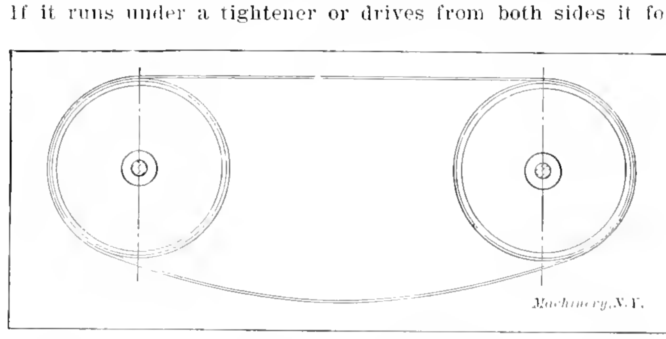


Fig. 4. Belt driving on Top Side, showing Decreased Arc of Contact

been cut true, consequently, when joined together, the strain was not evenly distributed across the width of the belt, falling more on some points than on others and resulting in the tearing out of the fasteners.

As to Belt Dressings

If a belt does not operate properly or does not seem to grip the pulleys as it should, the average shop superintendent gives the belt a generous dose of belt dressing. It is the writer's belief that as a general thing belt dressings do little good and tend to shorten the life of the belting. In most belt dressings a certain amount of resin is used and in almost all dressings some form of graphite. While both of these compositions possess certain adhesive qualities, in time they are bound to ruin the fiber of the leather. If leather belting is properly curried, it seldom becomes hard or dry, unless it is working under conditions where it is impractical to install a leather belt. In practical experience, it has been found advisable, under such conditions, to use as a belt dressing tallow mixed with a certain amount of castor oil. The tallow softens the fibers of the leather and the castor oil restores to a large extent the adhesive qualities in the belt. But even this most harmless type of dressing should be used sparingly, or the result will be a stretching of the leather. Where trouble is experienced through slippage of the belt, a few drops of castor oil on the pulley where the slipping occurs will be found to give good results. The oil will not injure the leather to the extent that most dressings will. Most all the slippage of belts is due to the fact that frictional heat causes the grain or pulley side of the belting to become dry. Castor oil tends to soften the grain and reduce slippage. Belt dressings, if not used very sparingly, in places where there is a certain amount of dust in the air, will invariably clot on the belt and cause it to run unevenly.

General Service Conditions

The problem of selecting a proper type of belting for different classes of work is one that requires careful study and much experimenting on the part of those who operate different classes of machinery. Considerable money could be saved in belt replacements if the type of belting best adapted for the place were used. The writer knows of many instances where for years leather belting had been used on some particularly difficult drive, where it had an average life of only from two to three months. After allowing this condition to continue for years, the factory superintendent would finally instal some other type of belting which would be found to last much longer than the leather belting. This condition works both ways. Most of the largest belt manufacturers have experimented with different types of belting on different classes of machinery and are able to give authoritative recommendations as to which type of belting will prove most economical for each machine. Such recommendations should receive careful attention with a view to economies. The problem of properly belting machinery is a large one. New types of belting, new methods of fastening and new types of belt dressings are being introduced almost every day. While the proposition of belt transmission is an old one, there is still much room for improvement and need for closer attention on the part of those who use belts.

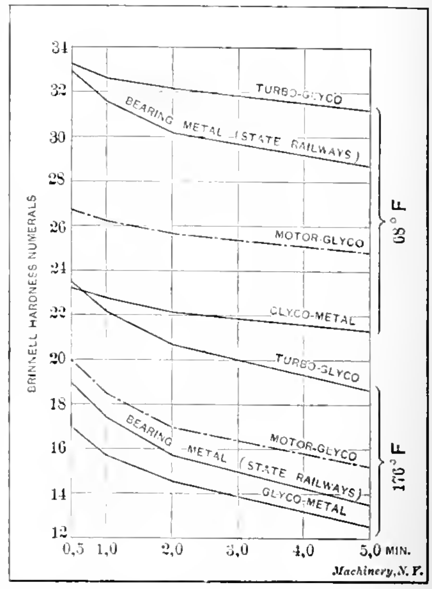
* * *

A NEW METHOD OF GALVANIZING

A new method of galvanizing has recently been patented by George L. Paterson, Thomas L. Mornes and Carl H. Zieme of New Castle, Pennsylvania. The iron or steel to be galvanized is first coated with a paste composed of 88 parts of zinc flue dust, 2 parts of lamp black and 10 parts of clay. These ingredients are mixed with water and applied to the cleaned surface. The material is then placed in a furnace and heated to a temperature of from 600 to 1,000 degrees F. The heating is continued from one-half to four hours, when the article is removed from the furnace and allowed to cool in a place free from oxidizing influences. The paste, now dried, is easily removed, but the surface of the iron or steel is coated with zinc. The inventors claim that the coating thus produced is superior to that obtained by "sherardizing," and that much less zinc dust is used. From a sanitary point of view, the process is also commendable, as the operators are not subjected to the influences of the dry zinc dust.

THE TIME ELEMENT IN HARDNESS TESTS BY THE BRINELL SYSTEM*

A diagram indicating the effect of the time element in hardness tests made by the Brinell method is given in the September 25, 1909, issue of the *Zeitschrift des Vereines deutscher Ingenieure*, and is reproduced in the accompanying engraving. The tests were made by the German Glico Metal Co. On the lower scale in the diagram is given the time, in minutes, during which the pressure on the metal was permitted to act, while the scale on the left-hand side gives the hardness numerals according to the Brinell hardness scale. It will be noted that the longer the pressure was permitted to act, the greater was the impression made on the metal, so that a lower hardness numeral resulted. Two sets of curves are shown, one with the metal heated to 176 degrees F., and one with the metal at 68 degrees F. It is interesting to note that the curves in each set are almost parallel, except in one case, thus indicating that for *comparative* purposes the Brinell test is accurate no matter what the length of duration of pressure, provided, of course, that the various samples tested are all subjected to pressure for the same length of time. It is also interesting to note the difference in the hardness of the metal brought about by the change of temperature. It will be seen that at the higher temperature its hardness numeral is not only less than at the lower temperature, as, of course, would be expected, but when the pressure on the metal is permitted to remain for a longer time, the metal apparently gives away much easier to continuous pressure when heated than when at a lower temperature. Tests of this kind should be of great value in determining the relative value of bearing metals which for long periods are to be subjected to heavy pressures under increasing temperatures. A new factor in hardness testing is also introduced, which the Brinell method is particularly adapted to measure, *viz.*, the power of resistance to *continuous* pressure of various metals, a factor which may be found to vary considerably for different materials.



Curves showing the Variation in Results obtained in Hardness Tests of Varying Duration

* * *

An apparatus was exhibited by Mr. S. H. Schneider at the meeting of the British Association for the Advancement of Science at Winnipeg, which seems to claim the distinction of being a new *perpetuum mobile*. The apparatus, which was not satisfactorily described, consists of a collapsible air-tight box which, when closed, sinks in water by its own weight. On reaching the bottom it is expanded by a magnet, when, being lighter than the water displaced, it rises to the surface where it again folds up and sinks. The inventor states that a full-sized generator weighing 600,000 pounds and displacing 10,000 cubic feet of water would generate 50,000 horse-power at practically no cost of operation. Surely the millennium is fast approaching!

* * *

To prevent the formation of rust inside boilers, experiments have been made at the Berlin Technical Institute, Germany, to use water deprived of the air it contains by means of charcoal. Sacks of freshly prepared charcoal have been put into the water from which the boilers were fed, and the decrease of rust in the boilers fed with this water has been about twenty-five per cent.

* See MACHINERY, September, 1908: The Brinell Method of Testing the Hardness of Metals.

ASSEMBLING A 24-INCH ENGINE LATHE*

ALFRED SPANGENBERG†

While the problems encountered in assembling engine lathes are not as difficult of solution as those met with in assembling machine tools of a more complicated nature, thorough and careful consideration of the methods employed is essential in order to minimize the cost. The most important operations involved are the scraping of the bed and carriage and the lining up of the head- and tail-stock. To a large extent the cost of these operations is dependent on the accuracy of the machine work.

It is the object of the present article to discuss the methods employed in machining, and to illustrate and describe the erecting process on the bed, the principles involved in assembling the units having been fully outlined by the author in previous articles in the September and October issues of MACHINERY. For the purpose of giving a concrete example, a 24-inch engine lathe with quick-change gear device is selected, the general features of which are shown in Fig. 1.

Planing the Bed and Carriage

The practice of some makers to rough out the surfaces to be planed on the bed and carriage, and allow them to season before taking the finishing cuts is indicative of the modern tendency toward accurate machine work as a means to avoid unnecessary scraping. The seasoning process simply consists in letting the casting stand in some convenient place in such a way that it will not be subjected to any outside forces, and allowing the stresses in the casting itself to become equalized.

Next in importance to providing accurate planers on which to machine the bed and carriage, is the necessity for gages that will enable interchangeable work to be produced. The gages shown in Fig. 2 are particularly well adapted to this class of work, and are far superior to the common type having a bearing on both sides of each V. Feelers or thickness gages are used in connection with the gages illustrated, in order to measure the amount of error. The advantages this form possesses over the common type are that the V's on the casting being fitted will both be of the same width, and no difficulty is experienced in keeping the gage level, since it always lies in a horizontal plane by resting on the top of each V. At *A* and *B* are shown gages for the bed and carriage respectively; these gages are made of steel ¼ inch thick.

Assuming, for example, that the V-surface on the bed at *C* is tight to the gage, and a 0.002 inch feeler will just pass between the bed and gage at *D*, then 0.002 is the exact amount that must be planed off the surface *C*. When these two surfaces fit the gage so that no error can be detected with a 0.001 feeler, the gage is turned end for end, and the surfaces *E* and *F* are tested in the same manner. It is, of course, necessary to set the gage square with the bed and this is accomplished by trying the feelers on both sides of the gage. The same remarks apply to the carriage gage *B*. At *G* and *H* in the same engraving are shown gages in the form of cast iron blocks about 6 inches long which are used for testing the ways on bed and carriage as indicated; *I* is a sheet steel strip fastened to one end of gage *H* and this is used to test the apron seat *J*. All other measurements are tested with ordinary height blocks or caliper gages, as the case may require.

Referring now to the carriage, the sequence of operations in finish planing it is to plane the bearing for the shoe, and square up the ends, and then turn it over in the position shown in the engraving and plane the V's and other surfaces on this side. It is good practice to plane lathe carriages of this size in lots of six at a time by placing them in a "string" on the planer table. When completing the final operation, that of planing the V's, it is evident, however, that the carriages farthest away from the angle plate by which they are squared up, are particularly liable to error. With careful setting up, this error should not exceed 0.003 inch, which is easily and quickly scraped off by the assemblers.

Machining the Head- and Tail-stock

The methods of machining head- and tail-stocks vary greatly in different shops, and also with different sizes. Some makers first finish all the planing and then perform the boring operations and scrape in the head-stock spindle, while others leave a finishing cut to be taken on the bottom of the head- and tail-stock after the boring and scraping are completed, by setting up the castings on arbors held in V-blocks on the planer table. Both systems, or modifications of both, are frequently used in the same shop. While the first-mentioned system is the most economical in that it saves setting up the work on the planer twice, it is essential that the machining be such that very little scraping is required on the head-stock boxes; otherwise the head-stock will be thrown out of line in fitting the spindle, which necessitates replaning the head-stock and possibly the tail-stock.

In any event, it will always pay to leave 1-16-inch stock to be bored out of the bearing boxes, so that after the boxes are fitted in the head-stock it can be replaced in the boring jig and a finishing cut taken in the boxes, allowing 0.005 inch to be reamed out. Adjustable shell reamers are mounted on the boring-bar for this purpose. When this precaution is taken, and

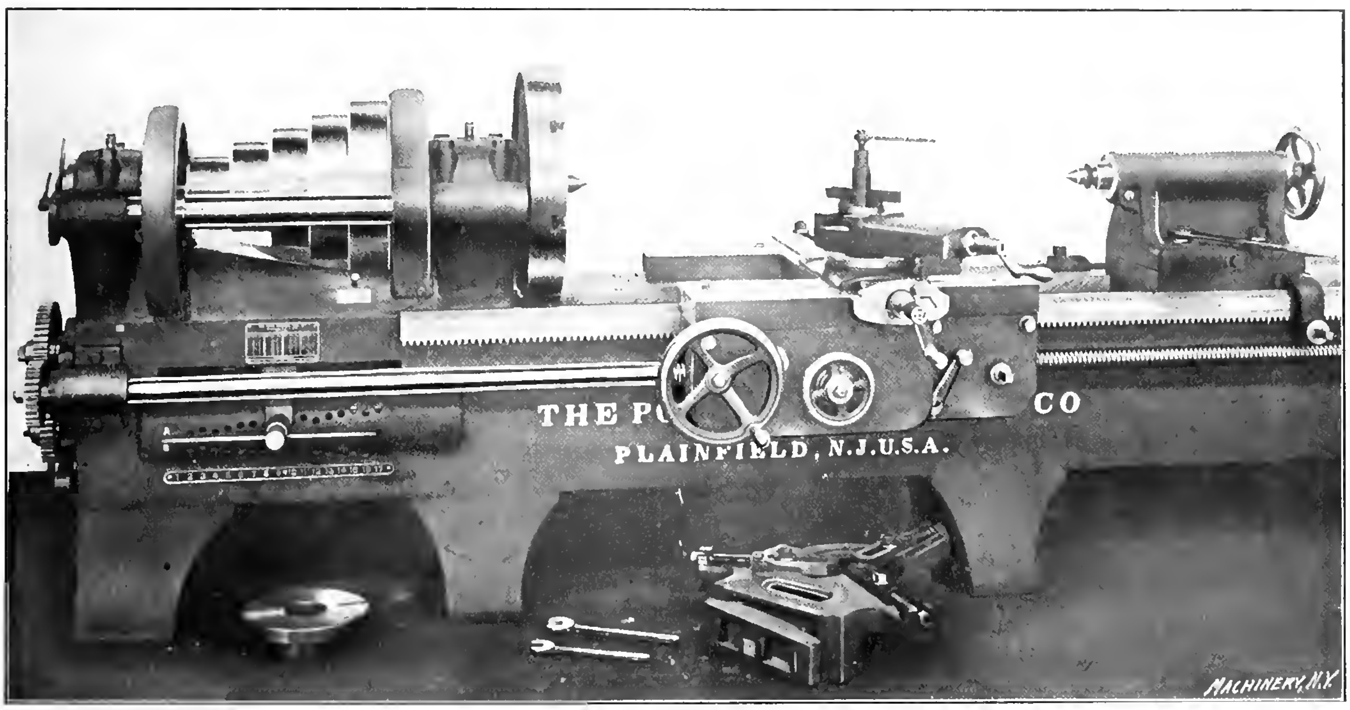


Fig. 1. Twenty-four-inch Engine Lathe with Quick-change Gear Device

* For additional information on this and kindred subjects, see "Assembling Machine Tool Units," in the October, 1909, issue of MACHINERY, and articles there referred to.

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the spindle is accurately ground to size, very little scraping should be necessary to make a good bearing. The object of leaving the 1/16-inch to be bored out with a cutter before reaming, is to insure that the reamer has an even cut and that sufficient stock is left for reaming.

Boring and Drilling the Bed

When all the planing is finished on the bed, it is next sent to the drilling department where the first operation consists in boring the shaft holes for the tumbler mechanism shown in Fig. 3. This operation is performed on a horizontal drilling and boring machine with the aid of a jig which also locates the sweep clamping bolt hole. The shafts *A* and *B* run in long cast-iron bushings that are a light drive fit in the bed, and to provide for standardization and enable the bush-

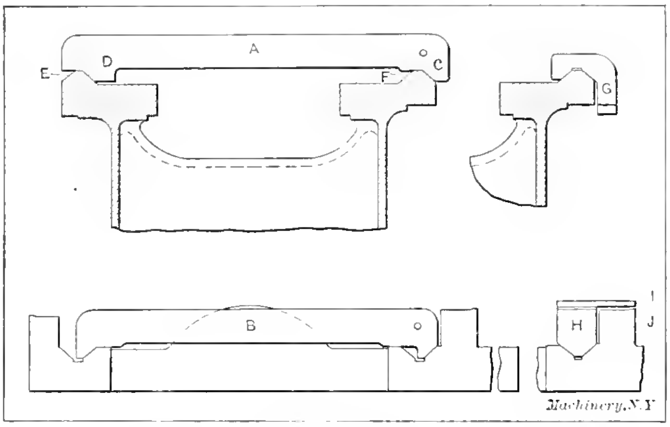


Fig. 2. Gages for Testing the Planing of Lathe Bed and Carriage

ings to be finished in large quantities, the holes in the bed are reamed to gage, adjustable shell reamers being mounted in the boring bar for this purpose. The hole for stud *C* is drilled and then finished with a rose reamer, after which it is hand reamed to gage. This hole and the sweep clamping bolt hole are the only ones that require facing, the method of taking the measurements being apparent from Fig. 4; *A* is a sheet-iron templet having an outline indicated by the heavy line; the opening at *B* locates the surface to which the stud boss is faced, while at *C* is shown whether there is sufficient clearance cored out for a feed gear. The templet is located sideways by the spline *D* which is riveted to the templet and

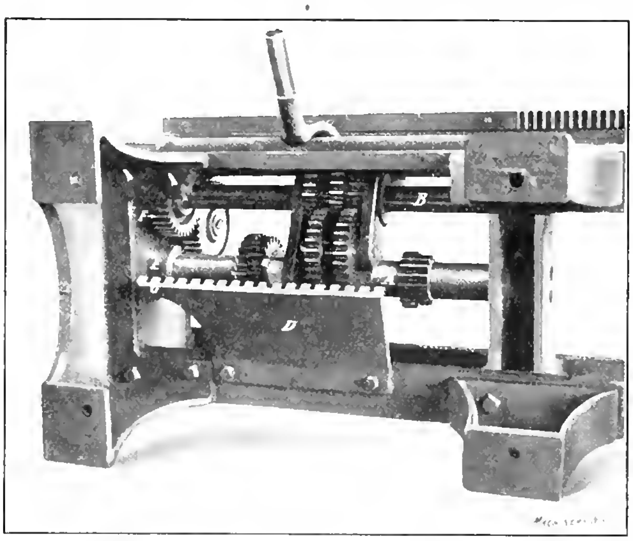


Fig. 3. Quick-change Gear Mechanism of Lathe shown in Fig. 1

fits the keyway in the bed; and endwise by being brought flush with the end of the bed. When in this position lines are scribed at *B* and *C*, after which the templet is removed and the hole counterbored to the line; *C* is chipped out later on if necessary.

To locate the surface *E* for the sweep clamping bolt hole, the gage *F* is used, its construction being clearly shown in Fig. 4. All lateral measurements on the bed are taken from the surface *B*. Facing surface *E* completes the operations for this setting, and the bed is then moved around for drilling and tapping the lead-screw box bolt holes.

In Fig. 5, *A* and *B* are jigs for drilling the front and rear lead-screw box seats, respectively. As will be seen, both jigs are located from the flat surface on top of the bed, the rear jig clearing the front V. Jig *A* is located endwise by seating against the hub *C*; the wooden pole *D* is used to set jig *B*. This pole has lines cut on one side, giving the settings for various lengths of beds up to 16 feet, so that the distance between the boxes, when bolted on, will be correct for the lead-screw. For longer beds, especially those in two sections, jig *B* is set from the rear end of the bed, and after the boxes are bolted on, the measurement is taken for the length to cut the lead-screw; it is not practicable to set the rear box or cut the lead-screw in the same way in this case as in the previous one, due to the error that is likely to occur in the length of the bed. This completes the work at the horizontal drill, and the bed is now moved to a radial drill, where the holes for the rack are next drilled. Special eccentric clamps are used for holding the rack in place, one of which is seen resting on top of the bed in Fig. 7. The advantages of this clamp over the common C-form are that it does not mar the work, no copper packing is needed, the clamping and loosening is quickly accomplished, and there is no danger of shifting the rack when clamping it.

When holes for the rack are all drilled, including the pin holes, the drill-hand taps and enters one screw in each rack section, so as to keep the rack in place after the clamps are removed, and until the bed reaches the assemblers. This avoids tying up the radial drill while the rack is being fastened on the bed, which is the practice in some shops.

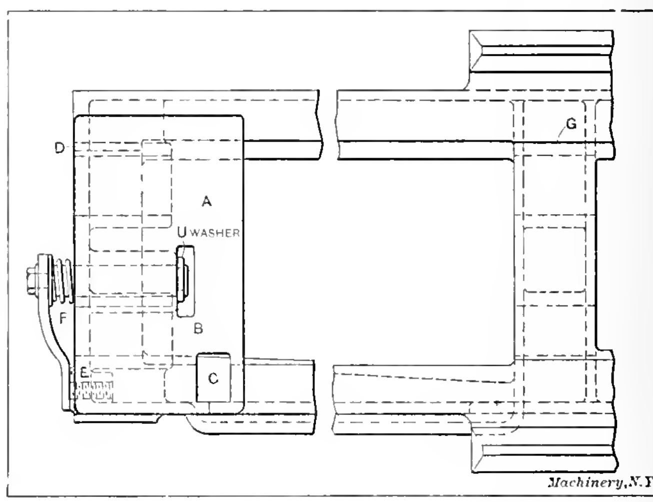


Fig. 4. Templet and Gage used when boring the Bed, shown in Position

On top of the bed in Fig. 7 are shown two fixtures *A* and *B*, respectively, which are used to locate the tumbler locking bar *D*, Fig. 3. Fixture *A* is also used to set the bushings *E* and *F*, Fig. 3, by inserting the stud in the fixture in place of the stud *C*, and bringing the bushings (which are straight) up against the hubs shown on the fixture. Now, with fixture *B* in position in the tumbler shaft hole, the locking bar is set so that its first notch *G*, Fig. 3, fits over the projection *C* of fixture *A*, Fig. 7. The plates *D* and *E* on fixture *B* are then moved so as to enter slots near the ends of the locking bar, after which the locking bar is set so that its slots bottom in the fixture plates. In this position the bar is marked off, and after drilling the two bolt holes, which have 1/16-inch clearance, it is again placed in position and clamped by its bolts. It is then shifted so as to bring it in the correct relation to the fixtures, and then the pin holes are drilled. With the bushings *E* and *F* (Fig. 3) located as previously mentioned, their set-screw holes are now drilled.

The legs are set and marked off on the bed with the aid of a wooden pole having lines scribed on it representing the center line of each inner leg. After these holes are drilled and tapped and the legs bolted on, the bed is next turned right side up for drilling the head-stock clamping bolt holes. The jig for drilling these holes is located on the bed by the keyway *D*, surface *G*, and hub *B*, Fig. 4, so that when the head-stock, which also was drilled by this jig, is bolted on, the feed gear on the spindle will line up with the intermediate feed

gear in the bed, and the head-stock casting will match the end of the bed. This completes the drilling, and the bed is next sent to the assemblers, where the actual work of assembling proper begins.

Scraping the Carriage and Assembling the Tumbler Mechanism

It is the general practice to keep the head-stocks, tail-stocks, carriages, tumbler members, etc., in stock, completely assembled, these units being identical for any length of bed. This method will be considered here, it being assumed that the units already have been brought to the assemblers. Two men usually are employed in assembling a lathe of this size, since a larger number cannot advantageously be used. Two men should be able to assemble such a lathe in 40 hours, total time. The operations of scraping on the carriage and assembling the tumbler mechanism are, of course, carried on simultaneously, one man working on each job; but for the purpose of description, each operation will be considered separately.

The preliminary operations on the bed consist of rough scraping the V's and inside bearing for the tailstock, fastening on the rack, and polishing the sides and top. When fastening on the rack, and polishing the sides, the bed is turned over for convenience of the workmen. The rack, which was temporarily fastened on by the drill-hand, is now removed and all the holes tapped, after which it is screwed fast, the pin holes reamed, and the pins driven in. A carpenter's brace is used for the taps and reamer. As the rack already has been polished on a disk grinder, it is only necessary to rub it with emery cloth to obtain a good finish. The bed is now turned right side up and carefully leveled, using iron wedges. During these preliminary operations the painting and any necessary chipping is done.

For scraping the carriage to fit the bed a special lifting device is used to facilitate turning the carriage over. This device was described by the author in the February issue of MACHINERY. When the carriage is being pulled along the bed for the purpose of finding the bearing, the lifter bolts are slackened off so as to prevent any danger of springing the carriage.

Fig. 6 clearly indicates the method of squaring the carriage with the bed. As will be seen, the sweep bar A is held in firm contact with the angle and bottom bearing of the carriage by means of two flat steel springs B, bent to the shape shown.

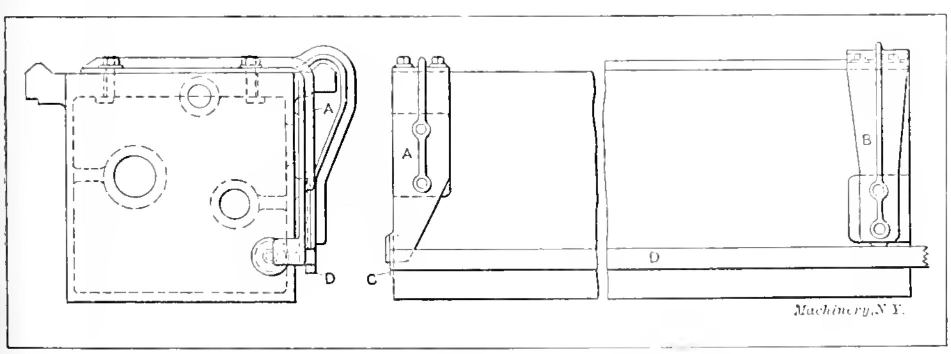


Fig. 5. Jigs used for Drilling Lead-screw Box Bolt Holes in the Bed

Brass shoes C, riveted to these springs, prevent the latter from cutting or scratching the bar. The function of coiled spring D is to hold the sweep bar collar E in close contact with the end of the carriage. With this device, the sweep is easily and quickly applied or removed, more precise measurements are obtained than by having an operator hold it, as is the usual practice; and besides, only one man is required to perform the operation of testing. In operation, micrometer point F is set to one position as shown, using a piece of cigarette paper as a "feeler"; then the sweep is rotated to the opposite side and a measurement taken as before. The carriage is scraped so as to turn the face-plate about 0.001 inch concave.

Very little scraping is necessary on the bed, merely enough to smooth the V's and break up the bearing, the tool marks being visible after the scraping is completed. When this work is accomplished, the carriage gibs are fitted, the apron is bolted in place, and the cross-feed screw, shoe, etc., are placed in position. Next, the tail-stock cricket is placed on the bed and its packing fitted, after which it is pulled the entire length of the bed to determine if the latter is straight. After any high spots on the bed are scraped off, the tail-stock traverse bracket is bolted onto the cricket, and then the tail-stock and its shoes are placed in position.

Referring again to Fig. 3, the tumbler mechanism is assembled in the bed as shown in the illustration, the operation being so simple that no explanation is necessary. Holes in the bed for the oil pipes (not shown) are drilled by means of a pneumatic drill, this being done, of course, preceding the assembling operation. The slot in the interlocking plate H is now marked off, the plate removed, and the slot cut. The position of this slot is determined by having the tumbler gears in a central position between the largest change gears. With the interlocking plate again screwed onto the tumbler, the thirty-four holes in the bed for the tumbler locking pin are now ready to be drilled.

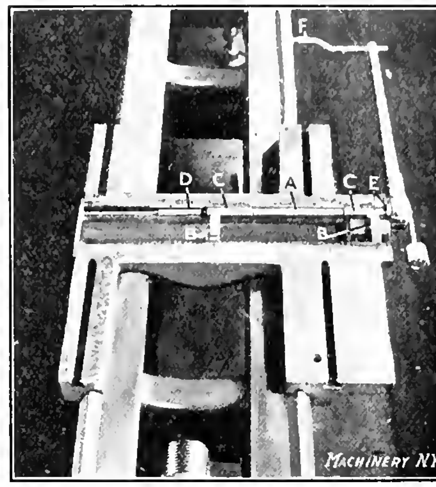


Fig. 6. Top View of Carriage, showing Method of Squaring the Carriage with the Bed. Springs B and D hold the Sweep in Position, enabling One Man to make the Test

Drilling these holes is the most interesting operation on this part of the lathe, the manner of accomplishing it being immediately apparent from Fig. 8, which shows the tools used, some of them being seen on top of the bed. The method of holding the tumbler in engagement with the various change gears while drilling the holes in the bed is clearly shown in Fig. 9. Paper, to the thickness of about 0.005 inch, is placed between the teeth of the engaging gears before they are brought into mesh, and when the jack screw A is tightened sufficiently to hold the tumbler rigidly in place, the gears are in proper mesh. The holes are first drilled with a special drill that fits the locking pin hole in the tumbler and has flutes milled only a short distance up from the point, so as to avoid cutting the hole in the tumbler. Fig. 8 shows this drill in position in the air drill. For finishing the holes, a special rose reamer, shown at B, is used in the same manner.

The tools are fed into the work by means of the bar C, which is pointed on one end so that it can be driven into the floor to prevent slipping. The operator presses his shoulder against the upper end of the bar, holds the throttle of the air drill with the left hand and pulls on the bed with the right hand. Each hole is drilled in succession, alternating between the top and bottom rows. The record for drilling and reaming these thirty-four holes, including the time required to set the tumbler, is 50 minutes. In setting the tumbler for drilling, its lateral movement for the various positions is controlled by the interlocking plate engaging the respective slots in the locking bar. (See Fig. 9.)

To mark off the groove which is seen between the two rows of holes in Fig. 1, a special scriber is used that fits the tumbler locking-pin hole, the tumbler being held in a neutral position by the locking bar. Two circles are scribed, one at each end of the groove to be cut, and then a straightedge is used in scribing lines connecting the two, the lines acting as a guide when chipping the groove with an air hammer. Inserting the handle, chipping the groove, and fastening on the number and index plates completes the operation on the tumbler mechanism.

Lining up the Head-stock and Tail-stock

The bed is now ready to receive the head-stock and while this is being fitted on by one of the assemblers, the other is working on the lead-screw, lead-screw boxes, and change gear sweep. As the head- and tail-stock were tested for alignment before being sent to the store-room, it is now only necessary to line up the head-stock on the bed and fit the taper dowel pins.

The method of testing these parts is interesting, inasmuch as the test arbor used is somewhat out of the ordinary. A jig is used that represents the head-end section of a 24-inch lathe bed. The jig and whole outfit of fixtures used, together with a head- and tail-stock in position for testing, is shown in Fig. 10. As will be seen, the test bar is square at *A*, near each end, the object being to use the indicator on a flat surface when testing the spindle for parallelism with the V's, and on a cylindrical surface when testing the spindle taper hole for concentricity. The two squares are integral with a sleeve that can be turned independently of the bar, and in this way one plane surface can be set at a mean between the "high" and "low" point on the bar. This adjustment is obviously necessary, since the bar is particularly liable to run out at its free end, due to a number of conflicting elements, the error in any one of which may be infinitesimal. When using the plane surfaces, one of these is always trued up with the square *B*, as shown in the engraving.

The reason for providing a plane surface on which to indicate is this: Suppose, for example, that we are testing the spindle for alignment sideways, and further that the axis of the spindle actually is parallel sideways with the bed, but

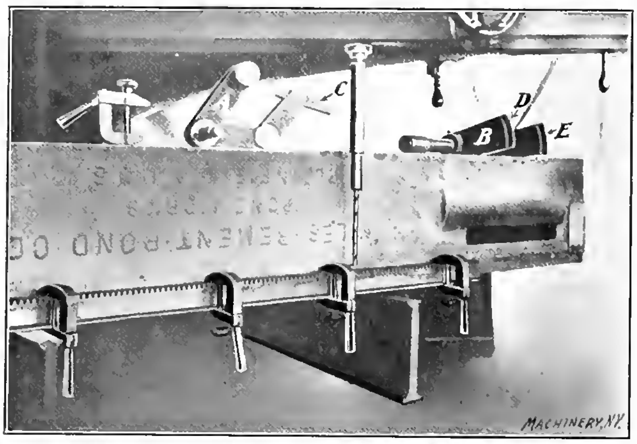


Fig. 7. Special Clamps for Holding Rack in Position when Drilling, and Fixtures used for Locating Tumbler Locking Plate

that the axis does not lie in a horizontal plane, it being high on the front end, say 0.005 inch in the length of the test bar. Then in indicating on the older type of bar with cylindrical collars, the line of motion of the indicator point in traveling from one collar to the other is not parallel with the axis of the test bar and therefore the readings are false. Now, with the form of bar having plane surfaces, assuming the conditions to be the same as regards the alignment of the spindle, the reading will show that the alignment is perfect sideways, because the indicator point is moving on a plane surface.

Referring again to Fig. 10, the fixture *C* is guided on the V tracks of the bed and is constructed so that it is adjustable for holding a Starret indicator *D* either on the side or top of the bar as the case may require. Having explained the use of the tools and fixtures, the method of "lining up" the head-stock and tail-stock, both with reference to the V's and to each other, is to place them on the bed and approximately set the head-stock true sideways by inserting keys in the keyways planed in the head-stock and bed for this purpose.

With the clamping bolts tightened lightly (the bolts have 1/16-inch clearance), the head-stock spindle taper hole is first tested for concentricity by indicating on the cylindrical surface *E* while slowly rotating the spindle. Then with the squares *A* set as previously explained, the head-stock is moved around by knocking it with a babbitt hammer until the reading on both surfaces is the same. The bar is then moved over into the tail-stock spindle hole, and after the set-over screw *F* is adjusted so as to bring this spindle in line with that in the head-stock (the reading being the same as before) the tail-stock spindle is tested for alignment sideways. Now the indicator is set on top of the bar, with the latter turned so as to use the same surface, and then the tail-stock spindle is tested for alignment in a horizontal plane, after which the bar is again set into the head-stock spindle hole and that spindle tested both with reference to the V's and to the tail-stock spindle. It is understood, of course, that if any errors are discovered which exceed the allowable limits of variation, the part at fault is either filed and scraped to bring it true, or machined, if the circumstances warrant.

Turning again to the lathe bed, we will assume that the head-stock is lined up as just described, and the clamping

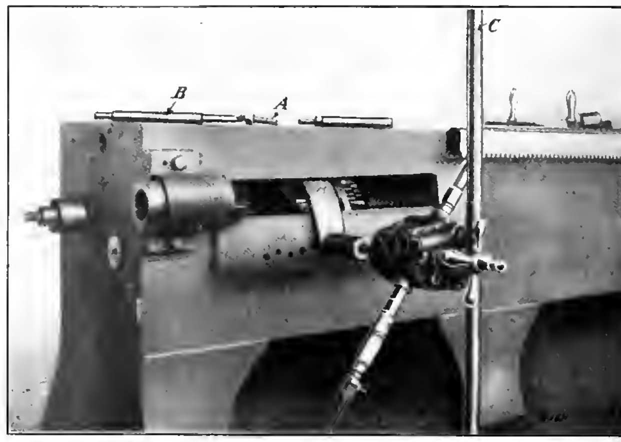


Fig. 8. Method of Drilling and Reaming the Holes in the Lathe Bed for the Tumbler Locking Pins

bolts are tightened down hard. The taper dowel pin holes are then drilled, reamed, and the pins driven in, care being exercised to see that the pins are a good fit. Next the face-plate is screwed on, ready to be turned off.

Lining up the Lead-screw Boxes

As was previously stated, work has been progressing on the lead-screw boxes and other minor details. For the purpose of lining up the boxes and also to test the alignment of the lead-screw bearings in the apron, a short arbor is used that represents the lead-screw. First the apron is tested, and then the lead-screw boxes are bolted onto the bed and lined up with the apron. Sometimes it is necessary to file the apron seats or adjust the boxes to bring them into proper alignment; but with careful planing and thorough inspection of the parts, this should not be required. Two special gages are used to

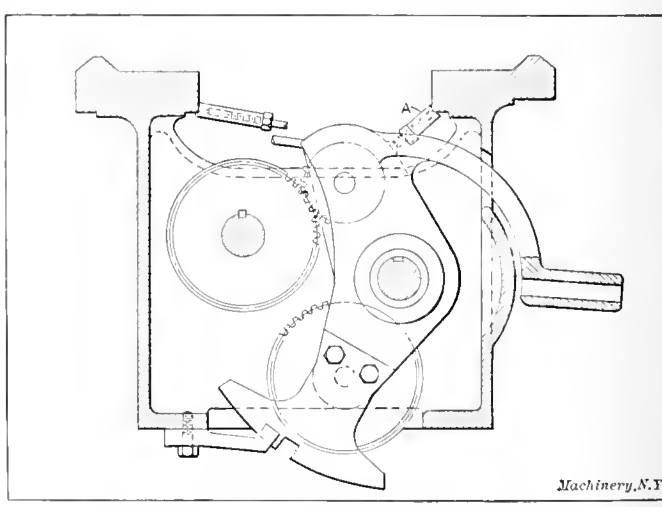


Fig. 9. Method of Holding Tumbler when Drilling and Reeming the Locking Pin Holes by the Method shown in Fig. 8

facilitate the aligning; one gage reaches down from the flat track on top of the bed for horizontal measurements, while another is held against the side of the bed just below the V to test sideways. Both gages are provided with micrometer points to enable the accurate measurement of error.

Referring to Fig. 1, the head-end lead-screw box is set longitudinally when the change gear sweep is in place, so as to line the box with reference to the sweep bearing on the end of the bed. When properly set, the boxes are drilled and reamed for the taper dowel pins; then the lead-screw is put

in place, its checknuts screwed on, and the gears on the sweep brought into proper mesh.

The Finishing Operations and Inspection

With the cone belted up to a countershaft or other source of power, the bearings are thoroughly oiled, and the lathe is run idle for a while preparatory to turning off the faceplate. The V's on the bed and bearings on top of the carriage are now spotted with a scraper, while all other finished surfaces receive their final polishing. The centers and their respective holes in the spindles were fitted to male and female gages during the machining process, so that now it is only necessary to place the centers in position. Clamping on the center-rest is the final assembling operation.

All machines are more or less defective, as it is practically impossible to make anything absolutely perfect. Knowing this, the builder establishes a limit within which the error will not materially affect the working of the machine, and furnishes the inspector with a list of allowable limits.

The inspection is carried on as the work proceeds, so that no part is neglected, and no defective material or faulty workmanship is allowed to pass. Gearing of all kinds is inspected and tested for alignment and smoothness of operation. The fits of all wearing surfaces are tested, as well as the fit of the

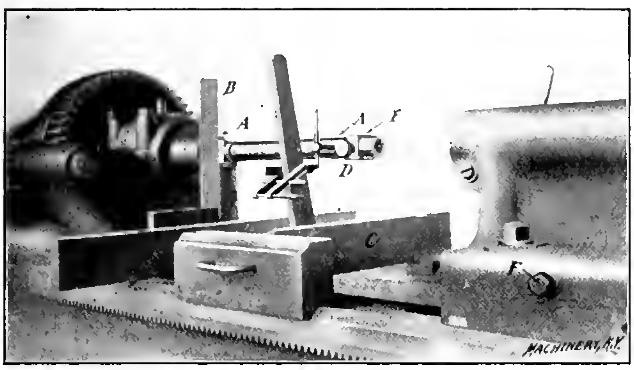


Fig. 10. Special Form of Test Bar for Aligning Head- and Tail-stock. Plane Surfaces are used for Testing Parallelism, and Cylindrical Surfaces for Testing Concentricity

various screws and binding and clamping fixtures. All information obtained from the inspection is entered on a printed form. Each machine is given a serial number, and the reports are filed in the office, so that in case of any trouble arising or any repairs being required for a given lathe, an exact record of its condition when it left the shop is available.

After truing up the face-plate, it is tested by means of a straight-edge and cigarette paper, this kind of paper being the best for the purpose. The spindle is tested for end motion when running, by application of the Starrett indicator to the face of the spindle nose. To prove the alignment of the head spindle with the shears of the lathe and the alignment of the taper hole with the spindle, under actual working conditions, a steel test bar is provided which fits the taper hole and projects 18 inches from the spindle. This bar carries three cast-iron collars, placed one at each end and one in the middle, from which all measurements are taken. A light cut is taken across these collars with a keen diamond-point tool, and the collars are then measured with a micrometer. As it is desirable when boring a hole, to have the taper, if any, large toward the front end, the front end of the head-stock was purposely set slightly toward the rear of the bed so that the outer collar should be found 0.0005 inch larger than the collar next the spindle. The alignment of the spindle in the vertical plane is again tested by attaching the indicator to the tool-post and traversing the carriage along its ways with the contact point of the indicator pressing against the top surface of the collars.

In testing the alignment of the taper hole with the spindle itself, after the collars have been turned off, the test bar is removed, turned half way round and replaced in the spindle; the indicator is then put in the tool-post in place of the turning tool, and with the contact point on the center line the indicator is traversed past the collars, the variation in readings showing twice the error in the alignment of the taper. The alignment of the tail-stock spindle is now tested, the method being the same as in the previous instance.

APPROXIMATE HORSE-POWER FORMULAS FOR GASOLINE ENGINES

In the September 3, 1909, issue of *Industritidningen Norden*, Mr. E. Hubendick reviews the various approximate formulas which have been adopted or proposed by a number of societies and individuals for the horse-power of gasoline engines. In these formulas

D = diameter of cylinder,

N = number of cylinders,

S = length of stroke,

n = number of revolutions per minute.

The French Automobile Club's formula is:

H. P. $= 0.07\ D^2N$, when the diameter is given in centimeters,

H. P. $= 0.45\ D^2N$, when the diameter is given in inches.

In this formula the mean pressure has been assumed to be 5.3 kilograms per square centimeter (75 pounds per square inch), and the piston speed 5 meters (16 feet 5 inches) per second.

The Royal Automobile Club's (British) formula is:

H. P. $= 0.0625\ D^2N$, when the diameter is in centimeters.

H. P. $= 0.405\ D^2N$, when the diameter is given in inches.

Mr. Arnon's formula is:

H. P. $= 0.0061\ D^3N$, when the diameter is in centimeters.

H. P. $= 0.1\ D^3N$, when the diameter is given in inches.

Mr. Faroux's formula is:

H. P. $= 0.0074\ D^{2.4}\ S^{0.6}$, when the diameter is in centimeters.

H. P. $= 0.121\ D^{2.4}\ S^{0.6}$, when the diameter is given in inches.

Another French formula is as follows:

H. P. $= 0.02562\ D^{2.4}\ N$, when the diameter is in centimeters,

H. P. $= 0.24\ D^{2.4}\ N$, when the diameter is given in inches.

Mr. T. Thornycroft's formula is:

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{35{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{2{,}700}$, when the diameter is given in inches.

Prof. H. L. Callender's formula is:

H. P. $= 0.0875D\ (D - 2.5)\ N$, when the diameter is given in centimeters.

H. P. $= 0.565D\ (D - 1)\ N$, when the diameter is given in inches.

In this latter formula the mean pressure is assumed to vary in the same proportion as $\left(1 - \dfrac{2.5}{D}\right)$ if the diameter is given in centimeters, and $\left(1 - \dfrac{1}{D}\right)$ if the diameter is given in inches.

The Royal Automobile Club's (Swedish) formula is:

H. P. $= \dfrac{D^2SnN}{250{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2SnN}{15{,}240}$, when the diameter is given in inches.

In this connection the formula of the Association of Licensed Automobile Manufacturers, which has previously been published in MACHINERY, should be included:

H. P. $= \dfrac{D^2N}{2.5}$, when the diameter is given in inches.

H. P. $= 0.062\ D^2N$, when the diameter is given in centimeters

The horse-power of automobile engines, based on this last formula, for various diameters of cylinders, was tabulated in the Data Sheet Supplement accompanying the October, 1909, issue of MACHINERY.

Some of the formulas proposed, with fractional exponents, are more cumbersome to use than would be the exact horse-power formula, and are of very doubtful value for their purpose. It is difficult to understand why one should be given an approximate formula at all, unless the form of that formula be such that it greatly facilitates computations, as compared with the exact formula. In this respect the A. L. A. M. formula is one of the best of those given above.

NORWEGIAN LATHE OF MODERN DESIGN*†

The accompanying half-tone, Fig. 1, illustrates a 20-inch engine lathe embodying some new and interesting features, including a special all-gear head-stock, which has recently been brought out by Brödrene Sundt, Christiania, Norway, one of the most prominent of the Norwegian machine tool building firms.

The special feature of this lathe is the interesting and original design of the gearing in the head-stock. As will be seen from the half-tone illustration, the machine is of the single-pulley all-gear head type; a section through the head, indicating the arrangement of the gearing, is shown in the line engraving in Fig. 2. Through an interesting arrangement of the driving mechanism, the number of gears and shafts in the head-stock is reduced to a minimum, so that only nine gears in all are used to obtain eight different speeds.

Referring to Fig. 2, the gear *A* runs loose on the spindle *K*, while gear *B* is keyed to the spindle and is capable of sliding back and forth, so that it may be either in engagement with gear *C* on the intermediate shaft *L*, or engaged by clutch teeth on its end with similar clutch teeth on gear *A*. Gear *C* is keyed to the intermediate shaft *L* and gear *D* is made in one piece with this shaft. Gear *E* on shaft *M* meshes with gear *C*. It is keyed to its shaft, and is capable of sliding out of engagement with *C*. The rawhide gear *F*, also keyed to shaft *M*, meshes with gear *G*, which runs loose on a bushing on the main driving shaft *N*. Finally, gear *H* is also keyed to shaft *M* and meshes with gear *I* on the main driving shaft. This latter gear is keyed to its shaft, but is capable of sliding so that it may either mesh with gear *H*, or be brought into engagement by means of the clutch teeth on its end with corresponding clutch teeth on gear *G*.

The different speeds are obtained by the operation of the three handles or clutch levers shown in Fig. 1, two in the front of the head-stock and one on the top. One of the handles, which provides the sliding motion for gear *E*, as indicated in Fig. 2, operates also, simultaneously, by means of the rack *P*, the sleeve *O* keyed to shaft *L*, on the end of which clutch teeth are provided, meshing with similar teeth on the projecting hub of gear *G*. Another of the levers operates gear *I*, and the third lever gear *B*.

The eight spindle speeds are obtainable by the following gear combinations:

1st speed—Through gears *I, H, E, C, D* and *A*.
2nd speed—Through gears *G, F, E, C, D* and *A*.
3rd speed—Through gears *I, H, F, G, D* and *A*.
4th speed—Through gears *D* and *A* directly.
5th speed—Through gears *I, H, E, C* and *B*.
6th speed—Through gears *G, F, E, C* and *B*.
7th speed—Through gears *I, H, F, G, C* and *B*.
8th speed—Through gears *C* and *B* directly.

These speeds are doubled by means of a two-speed countershaft running, respectively, at 200 and 260 revolutions per minute. The sixteen spindle speeds thus obtainable by means of the head gearing and the two-speed countershaft are as follows: 9, 12, 15.5, 20, 24, 30, 38, 50, 55, 70, 90, 115, 135, 175, 225 and 290 revolutions per minute.

There is no clearance between the clutch teeth on the various gears. They are milled with an angle of 7 degrees on the sides and can be thrown in mesh without difficulty, under any conditions. When gear *B* occupies its medium or neutral position the spindle can easily be rotated by hand. The driving pulley is provided with a special friction which can be instantly released by operating the friction clutch lever con-

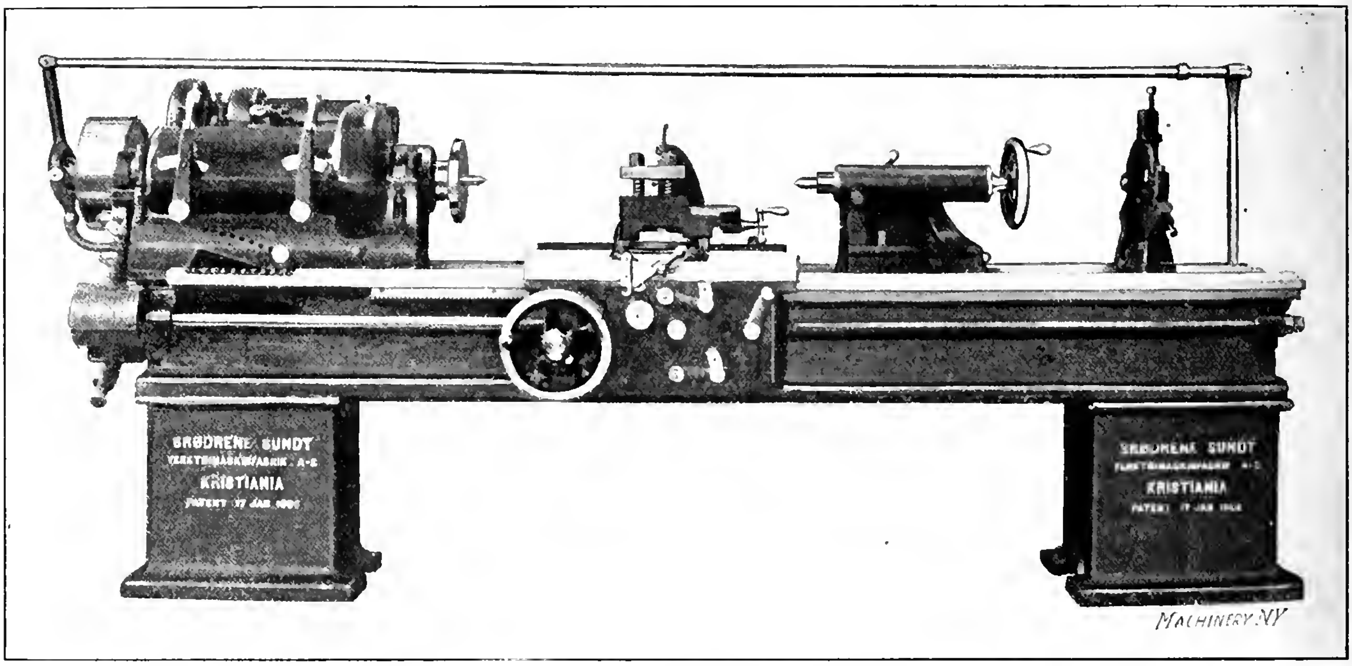


Fig. 1. Twenty-inch Lathe built by Brodrene Sundt, Christiania, Norway

* The following articles dealing with machine tools of European design have previously been published in MACHINERY: Some Notes From an English Shop, September, 1897; English Amateur Tools (Foot Power Milling Machine), June, 1902; Heavy German Milling Machine, June, 1903; Koehler's Profile Lathe, June, 1904; A Large Vertical Planer, June, 1904; Some English Lathes, September, 1904; German Lathe Carriage for Screw Cutting, October, 1904; The De Fries Precision Lathe, November, 1904; An English High-Speed Planer, July, 1905; A Pendulating Electric Drill, September, 1905; Portable Tools From Europe, November, 1906; A Vertical Miller and a Turret Lathe of English Design, March, 1907; Recent Development of British Machine Tool Industry, July, 1907; Some British Machine Tools, November, 1907; Notes From the Olympia Exhibition, December, 1907; Advanced Designs of German Drilling Machines, June, 1908; A Large Planer of English Design, August, 1908; Modern German Milling Machines, August, 1908; Large Horizontal Boring and Turning Mill, August, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908, engineering edition; Herbert Automatic Turret Lathe, with Self-Selecting Feeds, November, 1908; Germaan Design of Vertical Spindle Presses, December, 1908; German Designs of Internal Grinding Machines, January, 1909; Societe Francaise de Machines-Outils Single Pulley-Drive Lathe, March, 1909, engineering edition; Modern Swedish Machine Tools, March, 1909, engineering edition. See also, for descriptions of European gear cutting machines, a series of articles entitled Gear Cutting Machinery, January to September, 1908, and Recent Developments in Gear Cutting Machinery, February, 1909.

† The following articles describing lathes with geared heads have previously been published in MACHINERY: A New "American" Motor-driven Lathe, December, 1902; A New Motor-driven Lathe, March, 1903; The "Ideal" Engine Lathe with Motor Drive, January, 1904; New Flat Turret Lathe, May, 1904; Sixty-inch Roll Turning Lathe, October, 1904; Thirty-inch American Engine Lathe, October, 1904; Lodge & Shipley Lathe with Motor, November, 1904; American Twenty-two-inch Lathe, December, 1904; Motor-driven Lathe with Geared Head, June, 1905; The Draper Geared Head Lathe, July, 1905; Rapid Reduction Lathe, Nineteen-inch Capacity, July, 1905; Hendey-Norton Lathes, April, 1906; Pratt & Whitney Sixteen-inch Toolmakers' Lathe, March, 1907; New Design of the Lo-swing Lathe, September, 1907; The Full Swing Side Carriage Turret Lathe, December, 1907; Notes from the Olympia Exhibition, December, 1907; Motor Drive Mechanisms for the Le Blond Lathes and Milling Machines, February, 1908; Bridgeford Geared Head Lathe, March, 1908; Libby Turret Lathe, March, 1908; Springfield Motor-driven Brass Finishers' Lathe, April, 1908; Bridgeford Thirty-six-inch Geared Head Lathe, May, 1908; Hendey Single-pulley and Motor-driven Geared Head Lathes, May, 1908; Schellenbach Sixteen-inch Geared Head Lathe, June, 1908; Rahn-Carpenter Sixteen-inch Motor-driven Lathe, June, 1908; Springfield High-power Motor-driven Lathe, July, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908; Lodge & Shipley Heavy Axle Lathe, January, 1909; Prentice Brothers' Sixteen-inch Shaft Turning Lathe, January, 1909; Whitcomb-Blaisdell Single-Speed-Pulley Gear-driven Lathe, January, 1909; Societe Francaise de Machine-Outils Single-Pulley-Drive Lathe, March, 1909; Modern Swedish Machine Tools, March, 1909; Lodge & Shipley Crank-Shaft Lathe, June, 1909; Lodge & Shipley Lathe With Automatic Feed Stops, July, 1909; The Lodge & Shipley "Marvel" Lathe, August, 1909; Bradford Sixteen-inch Motor-driven Engine Lathe, October, 1909; Bridgeford Bevel Gear Turning Lathe, October, 1909.

nected with the rod passing the full length of the machine, as shown in Fig. 1.

The construction of the friction drive in the pulley is briefly as follows: The friction ring *R*, Fig. 2, is made in halves enclosing the spindle driver *S*. Both halves of the ring can be made to grip the spindle driver *S* by means of the tighteners *T*, operated by the fingers *U*. Only one set of these is shown. Two helical springs hold the rings away from the driver *S* as soon as the friction is released.

The clutches in the geared head are so arranged that two different speeds can never be applied simultaneously, and therefore there is no danger of breakage to the gears due to the carelessness or ignorance of the operator. All the speeds can be changed without stopping the belt or motor.

The bed of the lathe, as seen in Fig. 1, is of deep box construction, and is ribbed on the inside at short intervals with strong cross ribs. The spindle is forged of Bessemer steel and runs in journals of phosphor bronze. As shown in Fig. 2, there is a hole clear through the spindle. The end pressure is taken up by hardened steel and phosphor-bronze washers, cased in so as to be perfectly dust-proof. All the bearings are provided with automatic lubrication, and as the spindle is free from belt pull, the accuracy of the work done on the lathe is not affected by this influence.

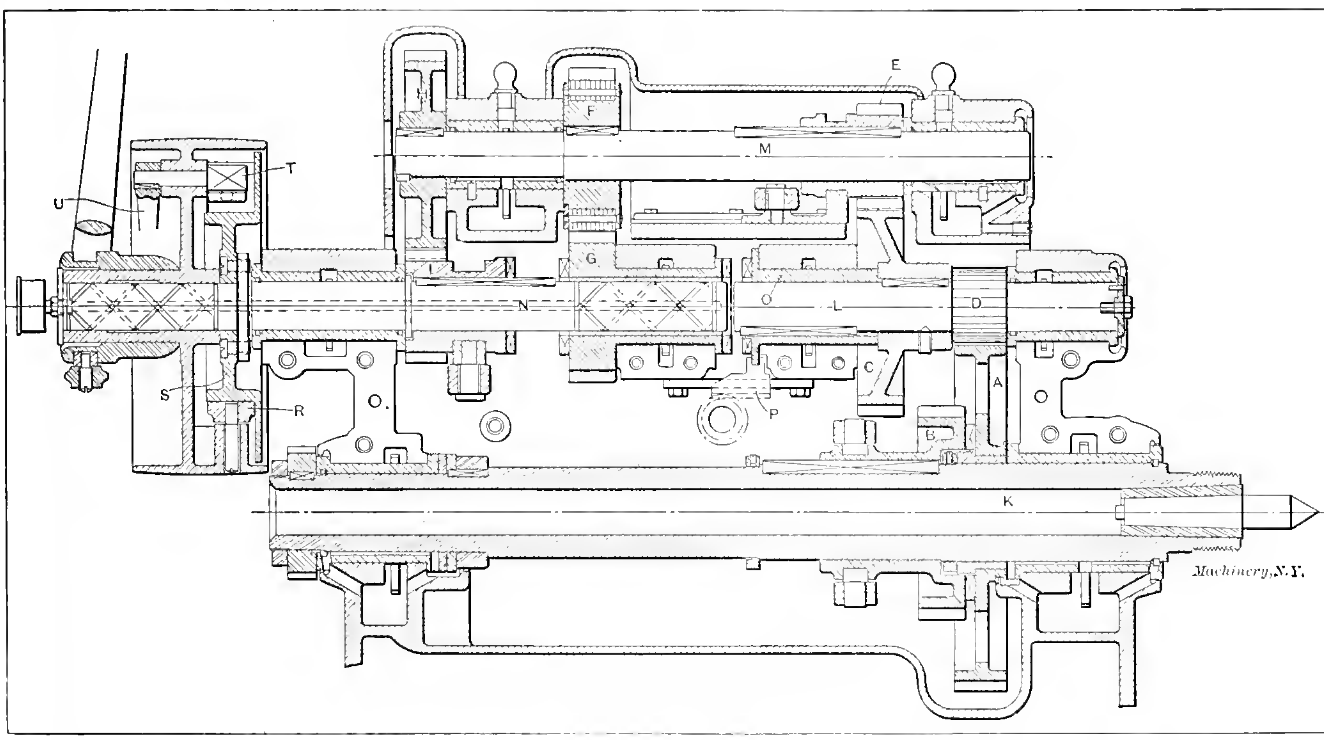


Fig. 2. Section of Head-stock, showing Geared Drive of Norwegian Lathe

The screw cutting and feed arrangement is through a feed gear box operated by two handles. Thirty-seven different pitches can be obtained for thread cutting without changing any gears or stopping the machine. The carriage is of heavy construction; the gears in the apron are cut and of steel, the same as all the gears in the head-stock. The studs for the gears are hardened and ground on the bearing ends. There is no separate feed rod, the lead-screw being splined, and the half-nuts disengaged when the lathe is not used for thread cutting, the rack-feed being used for ordinary feed of the carriage. Provision is made for preventing simultaneous engagement of the lead-screw and rack-feed, and the feeds are reversed directly from the apron. As will be seen in Fig. 1, all gears are properly protected by guards.

The general dimensions of the lathe are as follows: The swing over the bed is 20 inches, and the swing over the carriage 13¾ inches. The length of the bed is 10 feet, and the maximum distance between the centers, 5 feet 6 inches. The hole through the spindle is 1¾ inch in diameter. The machine can be either belt-driven from a countershaft, or provided with direct motor drive. A five horse-power motor is required. The approximate weight of the machine is 5,100 pounds. A 22-inch size of the same design is also made by the builders.

THE CREATION OF MACHINISTS*

Referring to the title of the paper, namely, "The Creation of Machinists," I will merely mention the matter of apprentices, because the subject of this paper is more to show how to create machinists without passing through an apprenticeship, because of the extreme shortage of machinists throughout the whole United States.

A few years back we found that we were unable to obtain boys as apprentices, for the reason that they could get better pay in other trades, such as shoe factories, tobacco factories, tanneries, dry goods and other stores, and this caused us to raise the hourly rate, which was originally 5 cents, to 8 cents. But at that time we were allowed to use boys between the ages of 14 and 16 years. Since then a law has been passed in Ohio prohibiting boys working more than eight hours when under 16 years of age; and in order to comply with this law, we discharged all boys who were under 16 years. We then found, speaking for our own company, that in order to get a sufficient supply, the rate must again be raised from 8 cents to 9 cents per hour.

Simultaneously with this difficulty of obtaining boys, came the great activity among the builders of automobiles. This occurred during the time that business was very dull in the machine tool line. When business became active once more, having the addresses of all of the machinists who were formerly employed by us, we sent to each one a letter, stating that they could return to work, and we were surprised to receive almost no responses; and we then saw that we would be obliged to go into the creation of machinists on rather a large scale. Advertising in the daily papers and in the *American Machinist* brought comparatively no results. We then decided to re-arrange our work and divide it into very much smaller items than heretofore, arranging the parts so that they could be machined with the greatest possible simplicity, and then set about inquiring for men, not machinists, and the following advertisement was put in the daily papers:

WANTED—Young men between the ages of 20 and 30 years. Fair wages and good opportunities for advancement. Men accustomed to safe making or carriage making preferred.

The first day following this advertisement we obtained twelve out of possibly thirty applicants. They were selected largely because of their former experience, and somewhat upon their personality, personal appearance and address. These twelve men were placed, one in each of twelve departments, with instructions to the foremen as to the pieces they

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

should be taught how to produce. We found that by this method the first installment of twelve were readily assimilated, so that within one month we were ready for similar installment.

Now I will give you an idea as to how we proceeded in the matter: We arranged with a first-class machinist who has been with us a long time, in whom we have a great deal of confidence, and who possesses the art of knowing how to teach, to go from one man to another, see how he was performing his part of the work, set him right when he was wrong, and give him further explanations when an additional piece was added to the work he had already been taught. All of this involved the installment of some new tools, and in the beginning a slower production; but as these young men became better acquainted with the work, we advanced them from 15 cents to 17½ cents per hour, and some of them to 20 cents per hour, and it now appears that quite a number of them within a very short time may be advanced to 22½ cents, from that to 25 cents, and so on. As this advance takes place, they will, of course, have been taught how to do additional pieces.

All of this taxes the patience of the foremen quite considerably, and results of course in more spoiled pieces of work, but the final result of obtaining a sufficient number of men to run the establishment is brought about. There is the further advantage that men with the limited knowledge that these men must necessarily have, do not have the confidence to change into other shops so readily as the regular machinist.

There is another reason why machinists are so scarce, and that is the many fields to which they are called, and which fields do not make machinists. Let anyone call to mind how many machinists are now employed in hotels and large office buildings for running the elevators and electric light plants; how many are now taken for street railroads; besides all those who are taken into the office and drawing rooms or who are sent out on the road. Every consumer of machinists should be a producer; in the trades mentioned they are not producers, and consequently it is advisable for every machine shop, regardless of business conditions, to start more beginners than they need. The shop itself will require an increased number when the beginners graduate; some will drop out, some will be dropped, and others will be enticed into new enterprises which must have machinists ready-made. Beginners once obtained should be encouraged at every step. They should be given as little disagreeable work to do as practicable. They should be given the best work that they are capable of doing. They should be made machinists at once if their capabilities permit of it. A vacancy for even one hour in a higher place should be filled for that hour by one from a lower place. All the employes should be given all the encouragement possible that would take them into night schools, trade schools and correspondence schools. Wherever there is a serious shortage the men in your employment should be asked to invite any of their acquaintances to make application for employment in the machine shop.

To carry out the above recommendations it is necessary to make the machine shop something of a school. It is not likely that young men with a very limited knowledge of the machine making business will know just where the points of excellence are wanted, and in order to place the matter before them permanently, rather than to depend upon their foreman telling them, certain instructions, which are issued in any event to the inspectors, should be issued to each and every one of the men in the establishment, or if not, then at least they should be hung in such a position that each and every man and boy may read them.

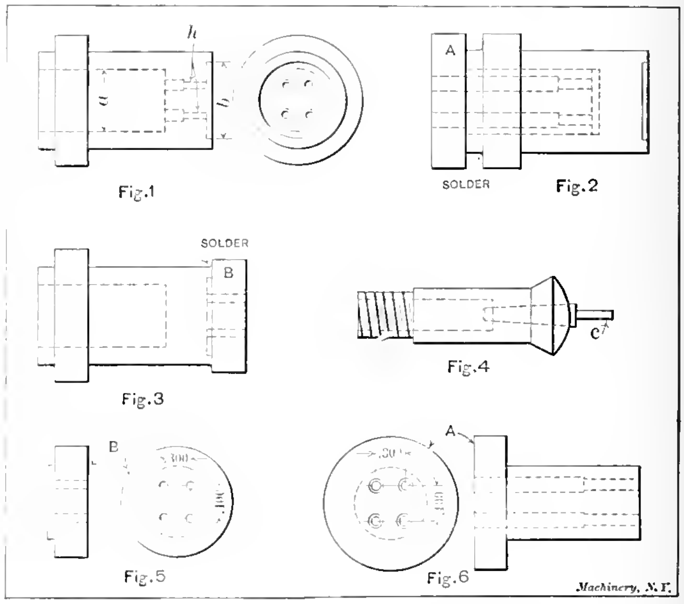
Very strict orders should be given to all foremen and superintendents to make every endeavor to retain any man who wants to leave, or anyone they are inclined to discharge. This is of the utmost importance, as otherwise it keeps a regular stream of men coming into the place and leaving it. One of the manufacturers in Detroit told me a few days ago that he was obliged to discharge and take on seven hundred and fifty men every month. It is not to be expected that we can create machinists in a short space of time without giving the method of doing it a great deal of care, and unless the man is a drunkard, or has an exceedingly bad disposition, good treatment and a sufficient amount of tact and patience will retain a great many who are otherwise discharged.

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE—1

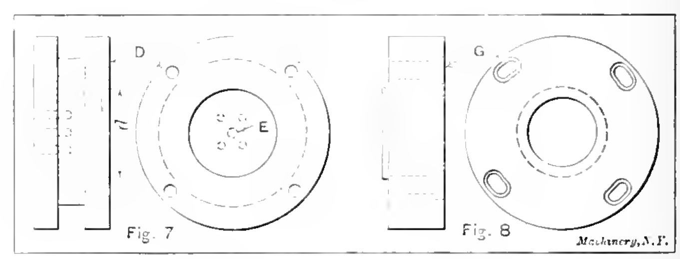
A. L. MONRAD†

In the manufacture of fine machinery, and for the finer work of the tool-room, the bench lathe is found invaluable, as the ordinary engine lathe is too large and unwieldy for this class of work. As the bench lathe is used exclusively for light precision work, it is made with great accuracy, and it is usually equipped with milling, grinding, screw-cutting and other attachments which make it suitable for a wide range of work. As an example of the kind of work for which



Figs. 1 to 6. Die and Jigs for Drilling it

the bench lathe is adapted, we have selected and will describe in detail the way in which two small jigs are made, which are to be used for drilling the holes *h* in the die shown in Fig. 1. As the inner half of each of these holes is enlarged, the drilling is done from each side of the die, the jigs *A* and *B* being inserted as shown in Figs. 2 and 3, respectively. Jig *A* is used for the larger holes, and *B* for the smaller ones. These jigs, which are shown in detail in Figs. 5 and 6, are made of brass. While they are being turned, they are held in a universal chuck screwed on the bench lathe spindle. The shoulder on jig *B* is fitted accurately to the recess *b* in the die, and the body of jig *A* is also turned to a close fit for the hole *a*. In order to bore the holes in each of these jigs in exactly the same relative positions, a steel master-plate *D*



Figs. 7 and 8. Master Plate and Attached Piece used in drilling Holes in Jigs, Figs. 5 and 6

(Fig. 7) is first made, the use of which will be explained presently. This plate should be first turned in an engine lathe; it is then strapped to the face-plate *F* of the bench lathe (Fig. 9), and both sides are faced so that they are exactly parallel. The outside of the master-plate should be set perfectly true by the use of a test indicator, after which a central hole *E* is bored and reamed to fit a plug gage 0.050 inch in diameter. The master-plate is then removed, and the four outer holes shown in the end view are laid out from the center hole to the dimensions given in Figs. 5 and 6. The centers of these holes are next drilled and tapped for 1/32-inch screws, which are to be used for holding indicator buttons in place. These buttons are small cylindrical pieces which are

* With Shop Operation Sheet Supplement.
† Address: 58 Connecticut Boulevard, East Hartford, Conn.

used by tool-makers for accurately locating work. Four of the buttons are fastened to the plate with small screws, and then by working from a plug in the central hole, the buttons are shifted until their center distances exactly coincide to those given in Figs. 5 and 6. When the buttons are accurately set, the master-plate is again strapped to the face-plate, and a test indicator is used to set one of the buttons perfectly true. This one is then removed so that a hole may be bored and reamed. In the same way the other three holes are bored and reamed, and the size of each is made to coincide with that of the central hole *E*. It will be seen that if the buttons are accurately set, the center distances of the holes will also be accurate, as they are bored concentric with the buttons. A piece of wire *C* (Fig. 4) is next turned to fit the taper hole in a collet, as shown, after which both the collet and wire are placed in the lathe spindle, the face-plate is removed, and the end of the wire is turned to a close fit for the holes in the master-plate. The face-plate is again screwed on the lathe spindle, and the master-plate is strapped to it with the wire plug *C* in its center hole. The recess *d* (Fig. 7) is now turned in the plate after which it is removed

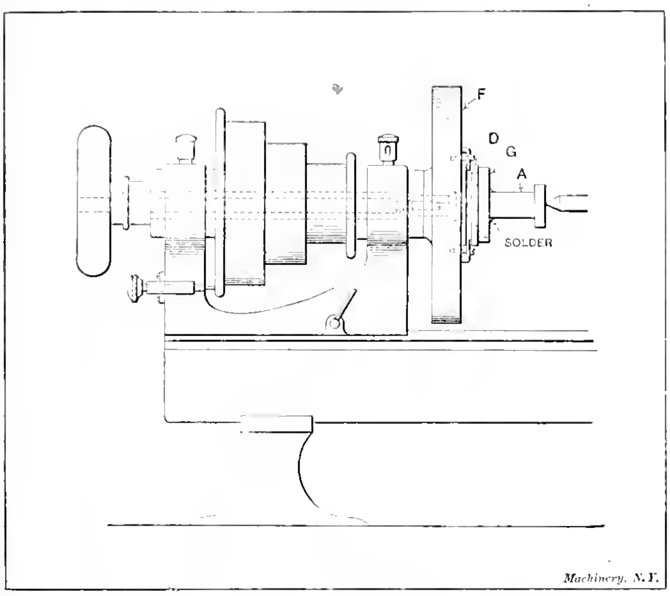


Fig. 9. Master Plate and Jig strepped to Face-plate

so that the four 3/16-inch screw holes shown may be drilled and tapped in its outer flange. A brass piece *G* (Fig. 8) is next turned and a shoulder is formed on it which is an accurate fit in the recess *d* in the master-plate. Four elongated holes are also milled in a piece *G* to match the holes in the flange of the master-plate. Piece *G* is then fastened to the master-plate, and the latter is strapped to the face-plate of the lathe, with the wire plug *C* in its central hole. A recess is then bored in *G* to an accurate fit for the small end of jig *A*, which is then soldered to *G* while the tail center is against the end, as shown in Fig. 9. The master-plate is now shifted so that one of the four outer holes fits over the wire plug in the spindle. When the master-plate is changed to a new position, care should be taken to see that no dirt or chips get between it and the face-plate, as these would, of course, impair the accuracy of the work. One of the four holes is now bored, reamed and counterbored in jig *A*. In the same manner the remaining three holes are finished, and, obviously, their location will correspond to the holes in the master-plate. When the holes are finished, the jig is easily removed by turning off the solder with a side tool. The master-plate should now be placed in its central position and a larger recess turned in *G* to fit the shoulder on jig *B*. This jig is then soldered to *J*, and four holes are drilled in it in the same manner as described for jig *A*. In a continuation of this article, a method of drilling holes in a hardened die, which was employed for special reasons, and also the way in which the drilled holes are ground, will be explained.

* * *

Plans have been approved by the Swiss State Railways for building the Hauenstein Railway, which will shorten the route from St. Gotthard to Basilea by about 40 miles.

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE CINCINNATI PLAN*

F. A. GEIER†

The rapid development of the manufacturing interests of our country during the past decade, particularly in the metal-working lines, is yearly increasing the problem of finding an adequate supply of labor, and of a proper degree of efficiency. The system of education in this country has not, until the recent past, taken cognizance of the change of the requirements of labor that has come about through this industrial development. Manufacturers have for some time realized that the efficiency of the labor that offers itself for employment is not as high as it should be. To a large extent this is due to the fact that the great majority of applicants have not gone beyond the elementary schools, and are not prepared to meet the problems that confront them upon entering the manufacturing establishments. The courses of these elementary schools, have not been such as to hold the interest of the boys, a great many leaving the schools entirely too young and with a very poor foundation even in the rudiments of education.

Manufacturing processes are becoming more highly organized and while there is a greater subdivision of labor, I believe it is true that we need a working force to-day of greater general intelligence than in the days when simpler machines and simpler processes were employed in producing our work. A careful analysis of the conditions in any manufacturing plant, will reveal a tremendous waste, because of the abuse of machinery and tools, a low standard of work, spoiled pieces, etc., a great part of which waste could be eliminated if there were a higher degree of intelligence on the part of the workmen.

America has led the world industrially, because of the natural advantages of a large home market, and of its superior advantages as to cost of raw materials. Europe and notably Germany, largely offset our natural advantages by a superior training of its employes. Our advantages as to sources of raw materials are lessening year by year. If we are to increase our home and foreign trade we must train our employes better. The movement to this end has begun, and I am asked to speak to you more specifically as to what has been done in Cincinnati.

Cincinnati has the oldest mechanics' institute in this country. This institution, with its night classes, has been doing pioneer work along these lines for many years. It is, however, not a natural condition for young men to be compelled to get their education in this way. Boys attending these schools, tired out from the day's work, cannot make the progress that they should, and often become discouraged.

About four years ago the Board of Education of Cincinnati established manual training in the elementary grades. Two magnificent technological high schools are about completed, and in these schools such training will be given as will be exceedingly useful to the boys, as they subsequently enter manufacturing establishments. The courses comprise woodworking, metal working, foundry work, mechanical drawing, and such allied branches as physics, chemistry, etc.

You all know about the cooperative course for engineering established three years ago at the University of Cincinnati, in which boys who have passed through the high schools can enter this six-year course, working one week at the shop, and one week at the university, earning, during the period of six years, about $1,800. About 200 of these boys are now employed in Cincinnati shops. While there are exceptions to the rule, as a class, these boys have surprised their employers as to the character and quality of work they are able to do. In fact, the experience has been very satisfactory. Right in the beginning there was considerable skepticism on the part of the manufacturers and a reluctance to accept these boys. The shops to-day are offering to take on more new men than the university facilities can take care of at present.

In our own plant, we have found some of these boys available for some of our difficult work, and this is also true in

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

† President of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

other shops. I call attention to this because the experience with these engineering students has practically demonstrated to the Cincinnati manufacturers the value of educated and properly trained young men. The great mass of our employes, however, in the future, as in the past, will be supplied from those who only complete the elementary courses.

About three years ago the firm of Houston, Stanwood & Gamble established a school in their own shop, giving instructions to their apprentices during shop hours. Their experience was so profitable that about a year later the Cincinnati Milling Machine Co. established a similar school. We first attempted to operate this school at night, but because of the difficulty of insuring an attendance ou the part of the boys, we soon decided to also operate this school during working hours. These two schools were noticed by other manufacturers, and were also brought to the attention of the Board of Education. After a number of conferences between the manufacturers and the members of the Board of Education it was decided, beginning with September, to operate a continuation school under the auspices and at the expense of the Board of Education. It was agreed by the manufacturers that they would send their apprentices and other young men to this school four hours per week, paying regular wages while the boys were in attendance. Over 200 boys are now enrolled and as fast as additional teachers can be provided, there is no doubt that this enrollment will be very greatly enlarged. You must remember that at present the boys that attend the Cincinnati school are all employed in machine shops. The course has not yet been brought to embrace the other industries in Cincinnati. These classes of this continuation school are limited to about 20 boys. They are taught elementary and higher mathematics, including problems in geometry and trigonometry. The whole plan of the school is to teach directly the problems that the boy encounters in the shop. The catalogues and blue-prints of the machine manufacturers of Cincinnati are the text-books, and through the cooperation of the superintendents and engineers employed in the shops of Cincinnati, the work done at this school to-day is probably more practical and more effective than of any school in this country and Europe.

The efficiency of these boys in the shop is already showing substantial improvement, and will increase as the teaching force and courses at this continuation school are amplified.

So much for the efficiency. Now as to the increase in the supply of labor. It was formerly exceedingly difficult to secure a sufficient number of candidates for apprenticeships. You can readily see that parents whose attention is now called to this new plan appreciate at once that here is an opportunity for their sons to learn a trade, and at the same time to supplement their education. It also appeals to the boy. He wants to go to work, and while heretofore he has been indifferent to his studies at school, he now finds instruction that is alive with interest. The supply, therefore, of young men to learn the trade is more than sufficient. So much already has been accomplished that I look forward to the future with much hopefulness, and I sincerely trust that other communities will rapidly imitate Cincinnati.

Let me repeat, that the big problem before manufacturers of this country is to secure a larger and more efficient supply of labor. Industrial education is the remedy.

* * *

Young (college) men who work in any first-class establishment find that men who cannot talk grammatically, that men who chew tobacco, slouch along the street with greasy overalls on, who hardly look up, who are scarcely willing to speak to you politely as you go along, are intellectually as clear as they are. That is what the young men learn. I remember very distinctly the perfectly astonishing awakening at the end of six month of my apprenticeship, when I discovered that there were three men in the paintshop, I being the fourth, who were all smarter than I was. Now when a young man gets it clearly in his head that he is made of the same clay as those other men, then his only hope, not to be outstripped, is in better education. He sees clearly enough, if he uses his eyes, that it is energy, grit, pluck, determination, ability to stick to it, character, which makes success in the manufacturing and in the engineering world.—*F. W. Taylor.*

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE FITCHBURG PLAN*

M. A. COOLIDGE†

The Fitchburg‡ plan of cooperative education, or cooperative industrial education, as applied to mechanics, is an arrangement between the high school and the manufacturers of metal machinery, saws, engines, pumps and condensers, and other metal products, for a four years' course of apprenticeship, the first year all school work, the next three years school and shop work, one week in school and one week in the shop. The boys work in pairs—as an example, if a shop takes eight apprentices it has four working at all times. The boy going to work next week goes to the shops on Saturday before closing time, for an hour or half hour, according to the nature of the work, and watches the job his alternate is on, and then is prepared to take up on Monday morning the operations he has previously made himself familiar with, having obtained the additional information he may need from his foreman.

When the shops are able to take a sufficient number of operatives under this system, the course can be very much improved, we believe, by a special instructor in each shop whose only duty will be to attend to his boys, giving them all the time and attention necessary. We expect to carry out this feature shortly.

The Fitchburg plan differs from the trade school idea where any student may enter and go wholly through a three years' course without regard to his mechanical ability or fitness for such work, whereas we drop out the dead wood and try to bring out every boy a good, high grade mechanic. In one trade school they wanted some plumbing done in the school itself and, though they taught plumbing in this very school, they had to send out and get a plumber to do the work. With the exception of the Williamson school in Philadelphia it is, as far as I have heard, the only one where the shop part is made at all prominent.

Manual training schools have also failed in their effort to do practical work along the line of the Fitchburg plan primarily, I believe, for two reasons: They have failed to put the shop part on an equality with the academic and were not able to work under real commercial conditions. Under the Fitchburg plan the boys are paid for their time in the shops 10 cents per hour the first year, 11 cents the second year, and 12½ cents the third year. The young man taking this course has just the same standing in the high school on the football team, athletics, lectures, and all advantages as the other students and put it all over the other boys by always having some real money to do as they wish with, and enjoying that feeling of independence, human in us all.

The apprenticeship or school year commences July 1 and for two months it is a trial period exactly the same as in our former apprenticeship systems. If the boy does not care to continue he may stop, and if the manufacturer feels that he will not make good as a mechanic, he is told so. If he continues, he is under the same apprenticeship bond to go through the three years' course as formerly. We believe this form of bond, or obligation, is just as valuable as formerly, and is kept in mind by the apprentice that he has entered into a business agreement, approved and guaranteed by his parents.

The four years' course follows:

	Periods per Week
First year, all school work—	
English	5
Current events; industrial history	2
Arithmetic, tables and simple shop problems	5
Algebra	5
Mechanics, simple machines	3
Freehand drawing	6
Second year, school and shop work—	
English	5
Industrial history, civics, American history	3
Shop mathematics	7
Physics	4
Mechanism	5
Freehand and mechanical drawing	6
Third year, school and shop work—	
English and industrial history	5

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

† President of the Fitchburg Machine Works, Fitchburg, Mass.

‡ See MACHINERY, October, 1908, and August, 1909.

Shop mathematics	5
Physics	4
Chemistry	4
First aid to injured	1
Mechanism	5
Freehand and mechanical drawing	6
Fourth year, school and shop work—	
English	5
Shop mathematics	5
Physics, electricity	4
Chemistry	4
Commercial geography and business methods	2
Mechanism	4
Freehand and mechanical drawing	6

The above scheduled studies, detailed as follows, show how interesting and instructive the school work may be made:

English: Throughout the four years' course in order that he may speak and write intelligently, forms of business papers, shop terms and spelling.

Mathematics: Simple tables, lengths, areas, volumes, metric system, circular measure. General shop mathematics dealing with problems on cutting speeds and feeds, gearing, belting, strength of material. Algebra to facilitate in working out shop formulas.

Mechanism: Parts and construction of different shop tools, gearing, cutting threads, forms and action of cutting tools.

Freehand drawing: For quick shop sketching.

Mechanical drawing: To help in reading blue-prints and make up shop drawings if necessary.

Industrial history: History of iron industry, factory system and labor problems, new inventions, reading mechanical journals to keep in touch with progress in mechanical affairs.

Physics and chemistry: As applied to everyday shop practice, simple and common methods of testing iron and steel, hardening and tempering.

Commercial geography: Centers of machine manufacture, source and cost of materials, labor conditions, railroad systems, waterways and cost of transportation.

William B. Hunter, a technology man, with ten years practical shop experience, is the special instructor in charge of this work, and the subjects taught in the course as just outlined are from special text books following the shop work very closely, cutting out the old academic studies entirely.

Joseph G. Edgerly, for thirty-five years superintendent of the Fitchburg schools, has done everything possible to make this cooperative plan a success, and it has proved, up to date, that this idea as outlined is the best course along cooperative lines.

The city authorities, high school committee, high school principal, teachers, citizens, and various organizations, have done all possible to make it such a success that the apprentices, their parents, and the manufacturers seem pretty well satisfied that here is a line of study and work on an actual commercial educational basis.

The scheme is adopted and worked out to fit our conditions along University of Cincinnati lines, as conducted by Prof. Herman Schneider, to whom we owe a great courtesy for the attention he has shown us.

* * *

HOW JOHNNY FORCED IMPROVEMENTS

E. B. GAFKEY*

At one time when the writer was roving around the eastern part of the United States, he happened to find a position with a firm that manufactured a line of small machinery and factory supplies. The man that built the shop had the foresight to take advantage of an unfavorable location, for the factory was located on the side of a hill, with the railroad siding on top. The shop was two stories high on the railroad side, and four in the rear. Our heavy tools, erecting and shipping rooms were on a level with the shipping platform, while the light tools were placed in the two stories below and were connected with the receiving platform by slides or chutes lined with light tank plates. The company used a vast quantity of small castings and forgings, which they did not make. These were received in barrels and boxes which were unloaded from the cars to the platform and thence down the slides to their respective departments where they were machined, finished, and placed in storage bins for use when wanted.

Our superintendent was a man, who, according to the way he talked, had never had a man in his employ who had ever done a fair day's work for the firm. He said they always worked and walked as though they were going to a funeral; but as no one paid any attention to him, we took it for granted that he was a natural grumbler, and let it go at that. However, one day things took a change, and it all happened on account of a small casting and a sharp order to hurry up, and the order didn't come from the superintendent either. That particular day my partner and myself were assembling a machine, when one of the parts used proved to be defective, and our helper, whose name was Johnny, was told to go downstairs and get another, and to be quick about it. He was quick, all right. Instead of going down the elevator or stairs, of which there were two of each, he went into the gangway at the top of the chutes where someone had left a scoop. Here was a chance. What's the use of going down two flights of stairs or waiting for a pokey elevator? Why not slide down? So suiting the action to the word, he seized

"The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section"

the scoop, and after firmly seating himself therein, he placed the casting in his lap and "cut loose." Well, I suppose everything would have been all right, but when Johnny reached the bottom he had attained a speed of about fifty miles an hour, and it happened, at that instant, that the superintendent was just in the act of crossing his path. The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section. The next instant there was a deafening crash as superintendent and Johnny landed in a pile of empty barrels stored near by. About two seconds later, Tom, the foreman of that floor appeared with "What the h—l is that leather-headed clerk sending material down here for without letting me know?" But there was no material in sight. Johnny managed to get out of the wreck first, and then stood in open-mouthed wonder, his eyes as big as moons, expecting to get fired; but nothing of the kind happened. The superintendent, with Tom's help, managed to scramble to his feet, and as he shook the loose barrel hoops from his person, straightened up as far as his one unbroken suspender would allow and says, "Well, I'll be d——d. There is nothing so important around here that any one has got to be so quick that they have to use that blamed slide."

Johnny got his casting and returned, while the superintendent went home to change his dishevelled appearance, but inside of fifteen minutes after the affair happened, the shipping clerk posted two big, glaring notices about the danger of using the slides, and that afternoon the millwright put up a sliding gate in front of them, with an electric bell at the bottom that would always ring when the gate was up. But that was not all. The next day, a gang of electricians appeared on the scene and installed a complete telephone system connecting the different departments.

One day shortly after, my foreman came to me and said: "Ted, that helper of yours deserves a medal. By using the superintendent to break up a few old barrels, he got more improvements in five minutes than all the foremen in the shop have been able to get in the last five years." We never heard any more talk of "moving faster" from the superintendent.

* Address: 16023 Hilliard Road, Lakewood, Ohio.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

DEFECTS IN JIG DESIGN

The first consideration of the jig designer should be to determine what degree of accuracy is absolutely essential in the part that is going to be produced and also whether absolute interchangeability is necessary. This information will be a guide for the economical production of the jig. The designer should also consider any operations which are to be performed on the work prior to the one for which the jig under consideration is intended; for while this preliminary machining may not need to be accurately done, inaccuracy or ununiformity may result in improperly locating the work in the next jig, which should be so designed as to locate the part with the required accuracy. The writer's experience is that many jigs have been designed by those who have not considered the points mentioned in the foregoing.

Again, the locating parts of any jig should be such as to allow as wide a range of inaccuracy on any preceding operation which may be performed, as is compatible in the part. For example, if the part has to be turned to say a limit of 0.001 inch, it will require more skill and time than if a limit of 0.005 of an inch is allowable. Again, as far as practicable, the portion of the work that requires to be the most accurate should be used in locating it in the jig for the succeeding operation. Often a surface is selected to locate from which,

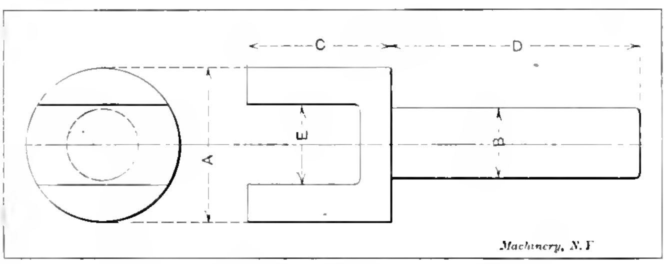


Fig. 1. Work which is milled as indicated at E

in consequence, has to be machined to an accurate limit, but which accuracy otherwise would be unnecessary. This, of course, only adds to the cost of production. After considering the points mentioned, the best method of arranging the details of the jig so that it has as few dimensions as possible requiring absolute accuracy, should also receive attention. That is, the jig should be as simple as possible, and still be so

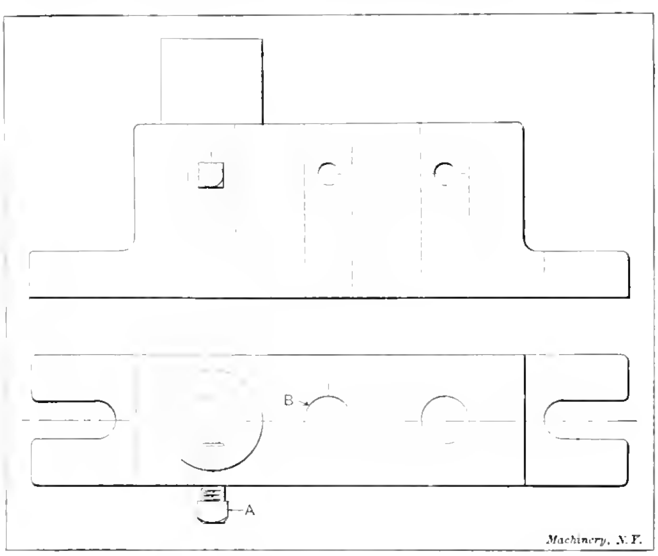


Fig. 2. Defective Design of Fixture for Holding Piece shown in Fig. 1

designed as to accurately locate the parts to be machined. Sometimes jigs are so designed that owing to the arrangement of the details, much time is expended in making test pieces to determine their accuracy.

In Figs. 2 and 3 are shown two jig designs which will serve to illustrate the points we have in mind. The part for which a jig is required is shown in Fig. 1. In the preliminary machining operation the work is turned to diameters *A* and *B* and to lengths *C* and *D*. The limit of accuracy required on end *A* is — 1/64, or any diameter from 1 39/64 inch as a minimum to 1⅝ inch. For end *B* a finer limit of — 0.002 is necessary, so that this end should be used as the locating part for the next operation; *viz.*, the milling out of the slot *E* which must be central with the part *B*. A design

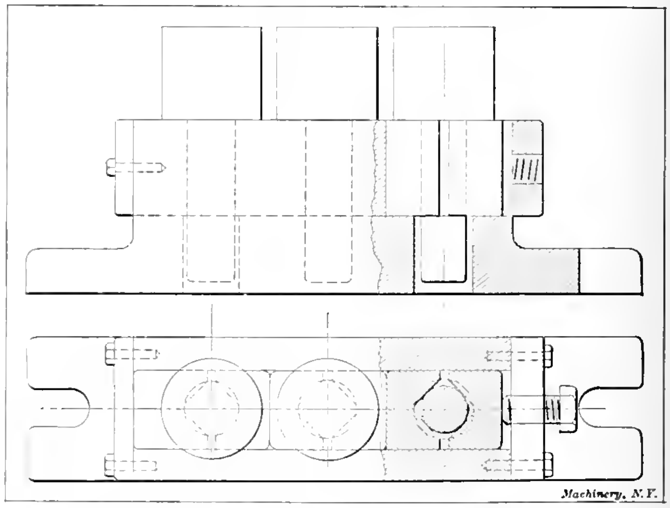


Fig. 3. Fixture which will hold a Number of Pieces, Fig. 1, properly, even though Diameters of Locating Parts vary

such as shown in Fig. 2 is not uncommon for this operation, and with it fairly accurate results will be secured; but if we assume that the locating diameter on the work is slightly small, say 0.002 inch, then forcing the piece over to one side by the locking screw *A* will result in an inaccuracy in the milling operation. The locating holes *B* must be the exact size of the locating part of the work, and unless every piece is a push fit (which is unnecessary accuracy in the part) the location is not accurate as the work is clamped against a

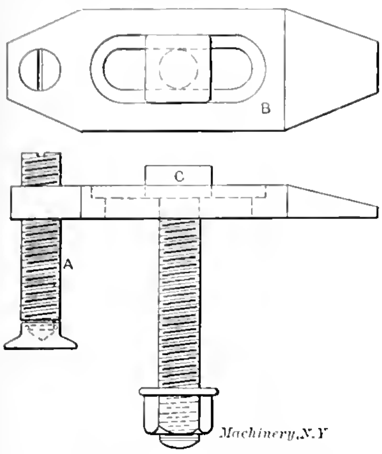
Fig. 4. The Way the V-blocks for the Jig, Fig. 3, are planed

small area on one side of the hole and the point of the setscrew on the other. This can be avoided by locating the part against V-blocks as shown in Fig. 3, which locate each shank central, irrespective of the variations in their diameters. The construction of this jig illustrates the points which have been referred to. The V-blocks provide four lines of contact, and the part is secured very rigidly in a central position irrespective of the variations in the diameter of the locating part. This jig, though more expensive than the one shown in Fig. 2, is quite simple in its construction. A central slot is machined to a width which need not be to any particular dimension as the steel V-blocks will be accurately fitted to this slot. Steel plates are secured to the ends of the jig after machining the slot as shown. By closing these ends after the slot is machined, the tool has a clear passage through, which, of course, would be impossible were the ends cast on. The V-blocks are planed in one piece, as shown in Fig. 4. The only important dimension is the width of the block. The exact position of the V in relation to the sides is immaterial provided that after the blocks have been sawed off they are inserted in the slot in the jig with the long or short sides together. To avoid trouble from this source, one side of the slot and a corresponding side on the blocks should be marked to ensure the correct insertion of the latter. In the event of a design requiring the V's to be strictly central with the sides, the cost would, of course, be increased, as much more care would be required in machining. The jig shown in Fig. 3 is for holding three of the pieces shown in Fig. 1 at one time. Obviously, this number could be increased as desired.

CONTRIBUTOR.

AN ADJUSTABLE STRAP

One of the neatest and most convenient face-plate straps that I have seen is shown in the engraving. How tiresome it is to hunt around the shop after blocks and pieces of the right height to line up the strap to a parallel position with the work to be machined. As will be seen, the rest *A* of this strap is easily adjusted to the proper height. Another desirable feature is that the oblong hole for the clamp bolt permits the strap to be located in the most desirable position by sliding it to and fro. A set of these straps of different sizes can be made with little extra expense, which will be more than offset by the saving in time. The strap *B* should be made of tool steel so that it will stiff, and the elongated hole should be milled to fit the head of the bolt *C* in order to avoid the use of two wrenches and facilitate the handling of the work. The end of the strap is drilled and tapped for a suitable sized screw *A*, which has a shoe on the bottom to prevent marking the face-plate. This shoe is held in place with a pin to keep it from dropping off. A. L. Monrad.



An Adjustable Strap or Clamp for the Face-plate

East Hartford, Conn.

A LATHE SPINDLE KINK

There is one very simple point in connection with the manufacture of lathe and milling machine spindles which builders in general would do well to consider, as I think it would result in great good to the Christianity of machinists and toolmakers, as well as being a profit producer to users of these machines. In order to briefly state the case I will relate a circumstance that occurred in actual practice, which is similar to several others of my own experience.

A new lathe had been in the shop for a considerable time, and when I had occasion to put the face-plate on the spindle I found it to go extremely tight, in fact it would not go up to the shoulder, which was, of course, aggravating and also a hindrance to progress; then I proceeded to take it off and spend about five minutes trying to clean the dirt out of the internal threads, though not succeeding very well. I finally wound up by getting out of patience and doing the job with the face-plate standing away from the shoulder. At my first opportunity I said to a toolmaker: "What is your private opinion as to the proper shape for the starting end of a thread on a lathe or milling machine spindle?" to which he replied: "It's a small question, I never gave it a thought." Then I told him of my grievances with the tight face-plate and he told me that when that lathe came into the shop the chuck and face-plate both went on all right and it was his opinion that someone must have strained the first thread. My convictions on the subject were that if the end of the thread were cut off straight instead of being left wedge-shaped (as it commonly is), the blunt end of the thread would scrape all the dirt out of the chuck thread as it entered; therefore there would be no dirt left to wedge in the thread, which was the cause of the tightness. The toolmaker was open for conviction and asked me to show him, so I took a small chisel and started at the place where the thread came to its full size and cut out a piece of the first thread about one inch long, which left a gap or open space in the thread. We then put the face-plate on and found that it went easy clear up to the shoulder. When the face-plate was taken off again, the gap in the thread was nearly filled up with dirt and chips which the end of the thread had scraped out. This spindle will always clean the thread ahead of itself and it is a source of permanent economy.

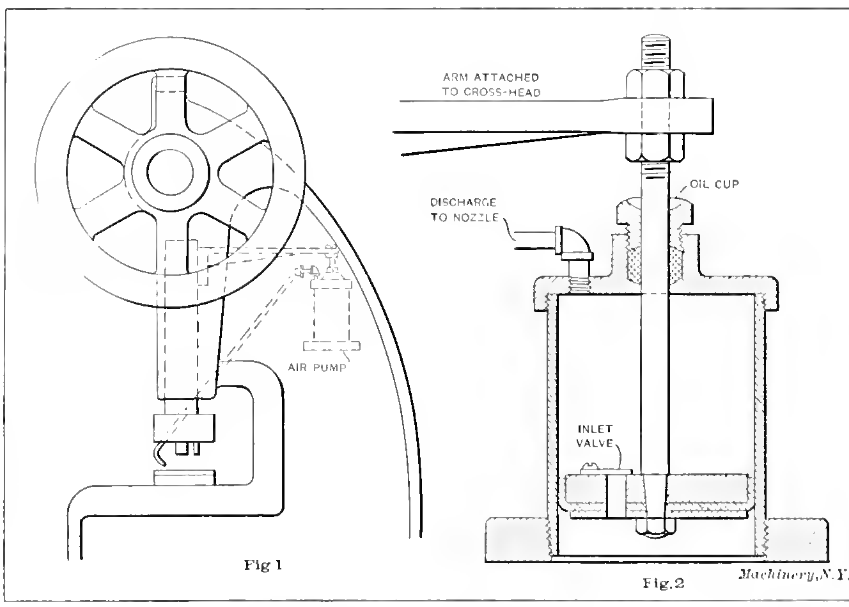
We take it for granted that a man should not put a chuck or face-plate where it will get dirt into it, but that does not change the fact that he will do it just the same; first because of carelessness, and second because he has something else to do besides taking care of the tools. Then again, even though all possible care is used, dirt will sometimes get into the threads so that it is better to adopt this simple method and put a stop to all future troubles in this line.

Here is another valable pointer concerning threads. In many cases where case-hardened finished nuts are used on soft bolts for the planer, slotter, milling machine, or almost any machine in the shop (especially where oil is used) the finer chips will accumulate in the nut with the result that the nuts are soon tight, and someone is blamed for straining the bolt. After a hand die is run over the bolt, if the nut is still tight, some have been known to get the tap and try to put it through the case-hardened nut. Here is a little kink that will overcome the difficulty: Take the corner of a file and file a notch down to the bottom of the thread of the bolt and in the majority of cases the nut will go on easily. The notch does not need to be large enough to damage the strength of the thread very materially.

Bridgeport, Conn. H. E. Wood.

EJECTING WORK FROM THE PUNCH-PRESS WITH COMPRESSED AIR

The article by Mr. Barnes in the August number of Machinery descriptive of an arrangement for blowing away finished stock from a punch-press, recalls to the writer's mind a device designed and built by him to accomplish the same result. As there was no compressed air of sufficient pressure



Side Elevation of Punch Press with Air Pump attached, and Enlarged Section of the Pump

available, an independent pump was attached to the press, as shown in Fig. 1. The piston-rod of this pump is connected directly to the cross-head of the press, and, consequently, the pump has the same stroke as the throw of the crank-shaft. The air is compressed on the up stroke, and it is delivered against the work by means of a ¼-inch pipe which is fitted on the end with a nozzle. The pump cylinder is made of a piece of 3-inch brass tubing which is screwed into a base-plate, as shown in the enlarged sectional view, Fig. 2. This tubing is fitted with a head containing a stuffing box, and a ¼-inch pipe outlet. The piston is a regular 3-inch hydraulic cup, and a piece of leather belting is used as packing. A piece of leather fastened by one screw to the inside of the piston, covers a ¾-inch hole and acts as an inlet valve. The finished work has an upturned portion on the front end, and the nozzle is

placed so as to direct the blast against this point. This arrangement has also been used to blow away small scrap.

Baltimore, Md. Benjamin E. Teale.

HANDY TABLE FOR THE SOLUTION OF RIGHT-ANGLE TRIANGLES

The table below gives in a convenient form the rules necessary for solving right-angle triangles. To the toolmaker or apprentice who has not had the privilege of becoming familiar with trigonometry, it is put up in a very handy form for reference. There are a great many who do not understand the meaning of "square" and "square root," and who will find

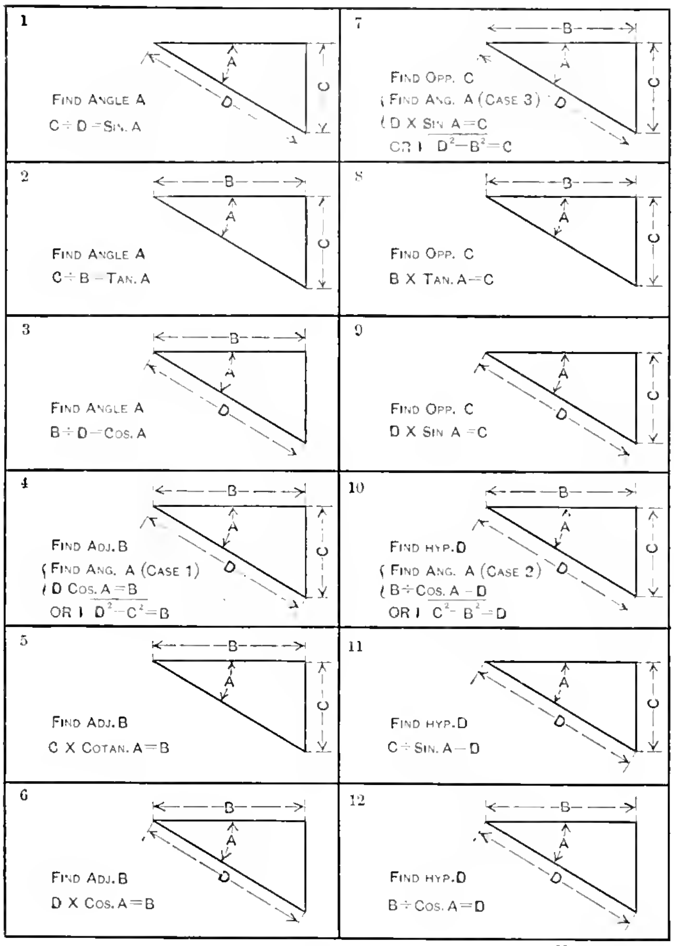


Table for Solution of Right-angle Triangles

it easier to first find the angle when two sides are given, and then find the required measurement of the third side from the angle by the rules as stated. It will be noted, however, that the formulas giving the length of the third side when two sides are given in the form of a square root is also included.

F. J. Bouve.

Wenham, Mass.

FILING DRAWINGS

Commenting on recent articles by Mr. Breath and Mr. Davis on the sizes and filing of drawings, permit me to say that I have been employed where this matter was long ago settled in a very satisfactory manner. The filing cases used are 17 x 23 inches inside, practically, the intention no doubt being to have them 18 x 24 inches outside measurement. They are made of very heavy cardboard, cloth covered, and are sold by nearly all dealers in office supplies. Their supposed use is for the filing of legal documents, etc., as well as maps and drawings.

The largest drawings used are 16 x 22 inches, with a half-inch border all round, thus reducing the space inside the border to 15 x 21 inches. Then there are other drawings 8½ x 11 inches, the size of an ordinary sheet of letter paper. The filing cases cost a dollar and a half each, and open along one edge in a manner that permits of easy withdrawal of the contents. These filing cases are placed in a case on their back edges, so the contents are always in a vertical position. They occupy a minimum of office space in this way, and are very convenient for reference. The drawings are divided by subjects, and heavy folders such as are used in vertical filing cabinets are made from detail paper. The boxes containing the smaller sized drawings have a thin partition down the middle. When the scheme was started it was alphabetic and each envelope had on it the name of the work contained on the sheets of drawings in it. Now, however, the system is a numbered one, and there is a card index for reference.

Small drawings have come to stay because of their convenience, and this filing scheme I mention is certainly inexpensive and being on the vertical plan with heavy paper folders, is capable of indefinite expansion.

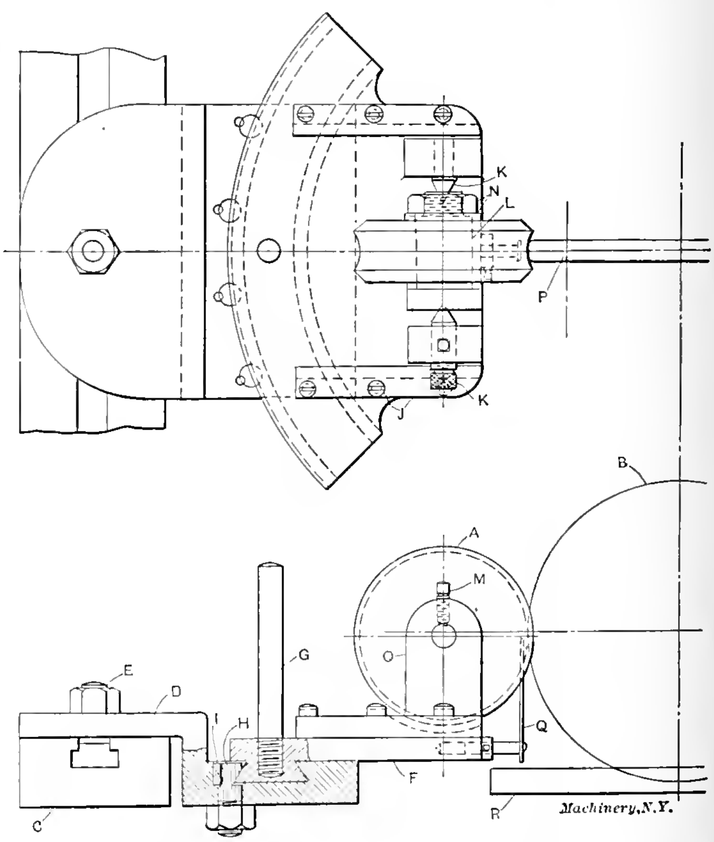
Chicago, Ill. James Davios.

FIXTURE FOR GRINDING RADIUS CUTTERS

Some of the parts on our automobile transmission which have to be milled can best be done with radius cutters, and as it is necessary to use an old grinder to keep these cutters sharp, this necessitated a fixture of rather an odd design.

The reason for this odd design in the fixture is that the grinder has no fixed method of adjustment, and this feature was rather hard to overcome, as it was absolutely necessary to have an adjustment to take in several sizes of cutters, and get a circular movement; provide for clearance; do without a pivot, and all perpendicular adjustment.

The construction of the fixture can be understood by referring to the engraving which shows a plan and a side view partially in section. The lines *A* represent the largest size cutter, and *B* the standard size of emery wheel for this grinder. *R* is a fixed table and *C* the platen with a horizontal



Special Fixture for Grinding Radius Cutters

motion only, which in this case was required to remain stationary. Thus it is seen that this grinder was not convenient for this class of work. The stationary support *D* for the fixture is clamped to the grinder by T-bolt and the nut *E*. *F* is a movable body, *G* a steel stud to be used as a handle in moving *F* back and forth in a semi-circle, *H* brass studs which are prevented from turning by dowel pins *I*, and which are beveled to fit the projecting tongue on *F*. As the four studs *H* are brass against cast iron, and in a corresponding radius to the tongue on *F*, provision is made for wear and accurate adjustment, while a circular or radius motion is obtained without a pivot. In this particular case a pivot

joint would necessarily come in the way of either the cutter *A*, emery wheel *B*, or table *R*.

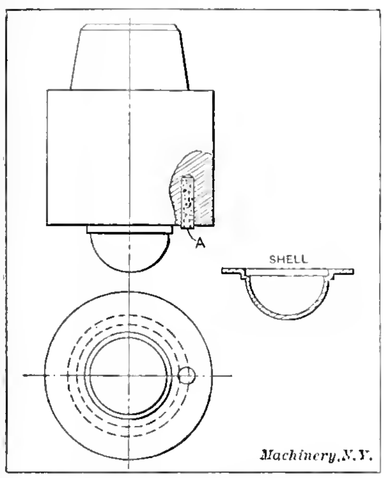
The required horizontal adjustment for the various size cutters is obtained by moving cutter holder *O* toward or away from the center *P*. This holder is clamped in place by side strips and screws *J*. The cutters are fitted to arbor *L* and clamped by a nut and washer *N*. The arbor is mounted on centers *K*, one center being movable for removing or replacing the arbor. The correct spacing is provided for by adjustable stop *Q*.

This gave us a practical fixture for this work on a machine of little value, and thus the fixture soon paid for itself.

JIG AND TOOL DESIGNER.

STRIPPING SHELLS THAT ADHERE TO THE PUNCH BY OIL CONTACT

A simple and very successful method used in connection with the drop press for stripping small shells that adhere to the punch by oil contact, is illustrated in the accompanying sketch. The principle is the same as that of the method described by Mr. C. Howell Dockson in the August number of MACHINERY, for stripping cup-shaped drawn shells, although perhaps of a cruder nature. The stripper consists of a stiff piece of rubber *A* inserted in a small hole in the punch, the end of which projects 1/32 inch below the surface of the punch. This rubber should be of proper size to hold itself in place by friction. In some cases it is preferable to locate the rubber in the center of the formed portion of the punch. Of course, the rubber has to be renewed occasionally on account of deterioration. The frequency of renewal depends on two things: Namely, the amount of pressure required to strip the shells and the grade of rubber used. It is safe to say that one rubber will do for from 1,500 to 2,000 gross of the piece being formed, without renewing. Rubber of the right size should be kept on hand so that worn-out pieces may be quickly replaced.

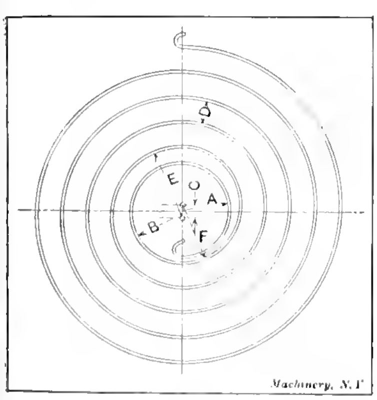


Punch with Rubber Insert A, which Sheds the Shell held by Oil Contact

Winsted, Conn. CHARLES RICHARDS.

LAYING OUT A SPIRAL

It is seldom that a draftsman has occasion to draw a spiral of many turns (like a watch spring) and when the occasion does arise, recourse is had to some handbook which usually gives the method of four centers. The use of the two center method with semi-circles, I find to be sufficiently accurate, much more rapid, besides giving a smoother job by reason of fewer joints. While this method is not at all new it does not seem to be commonly known. The engraving shows a drawing of a spring, made by this method. Starting at the inside with radius *A* from the actual center, draw a semi-circle at the right of the vertical line. With radius *B* (equal to *A* plus thickness of spring) find center below true center from which the arc will connect with the arc struck by *A*, and draw the semi-circle at left of vertical, thus completing the first turn. Having decided on the pitch *D*, two centers are next located on the vertical, one being ¼ *D* above true center, the other ¼ *D* below true center; thus $C = \frac{1}{2} D$. From the upper center with a radius *F* draw the semi-circle at the right of vertical and from the lower center with a radius *E* connect with end of arc *F*, and draw the semi-circle at the left. By thus changing centers and increasing the radii the spiral is easily produced. RALPH W. DAVIS.

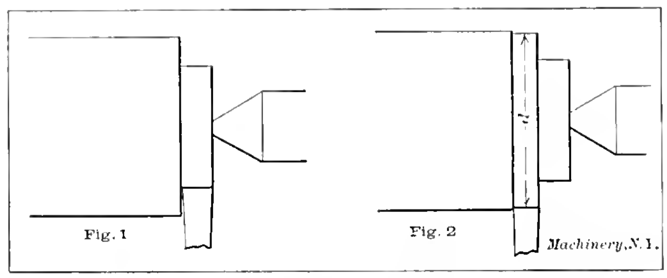


A Spiral Laid Out by the Two-center Method

Rochester, N. Y.

CUTTING A DOUBLE THREAD

Among machinists it is generally known that when the number of threads per inch of a screw being cut is an exact multiple of the number of threads per inch of the lead-screw, the split-nut may be disengaged at the end of each cut and re-engaged at random when beginning a new cut, there being no need to stop or reverse the lathe. In the case of screws having a number of threads which is not a multiple of the number of threads per inch of the lead-screw, it is necessary to have recourse either to some means of insuring the correct re-engagement of the split-nut and screw, as by the use of an indicator designed for the purpose, or by keeping the lead-screw and nut always in mesh and reversing the lathe, thus bringing the carriage and thread tool back to the starting point. It may not be generally known, however, that when the lead of a double-threaded screw is exactly twice that of the thread on the lead-screw of the lathe, such a screw can be cut without stopping or reversing the lathe or employing timing or other devices. To illustrate, if a double-threaded screw having say, ½-inch lead were being cut on a lathe, provided with a lead-screw of ¼-inch lead, the split nut could be engaged at any time and the tool would always follow in one of the two thread spaces.



Figs. 1 and 2. End of Blank turned to Depth of Thread and to Depth of First Cut

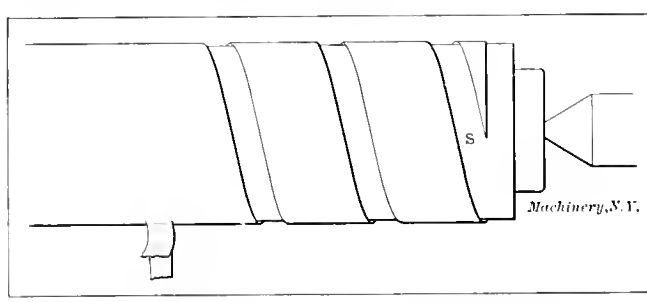


Fig. 3. Tool taking the First Cut on a Double-thread Screw

The accompanying engravings illustrate the method employed by the writer when cutting double threads, the lead of which is twice that of the lead-screw, which enables the work to be done very quickly. As shown in Fig. 1, the end of the work is first reduced to the diameter of the bottom of the required thread. In repetition work, this operation would first be completed on all the pieces to be threaded. It could, however, be omitted entirely if the lathe is equipped with an indicator or stop to give the exact depth. The practical man will no doubt have observed that in cutting a square thread, the moment the tool meets the work, it lags behind slightly. This is due to the fact that the tool is held up or is cutting at this moment only on its leading edge; consequently it yields more or less according to its stiffness or rather lack of stiffness. Hence it is often necessary to cut away a portion of the leading end of the screw. When performing the operation indicated in Fig. 1, allowance should be made for this distortion of the thread.

The next step is to reduce the end, as shown in Fig. 2, an amount equal to the depth of one cut. The split-nut is then engaged with the lead-screw at random, and the first cut taken along the work as shown in Fig. 3. When the carriage is brought back (by hand) to the starting point, the tool is set against the reduced end, as in Fig. 2, and the split-nut is engaged with the lead-screw immediately after the opening of the thread space S (Fig. 3) has passed the point of the tool. The tool will now take a second cut midway between the turns of the first, as shown in Fig. 4, and the depth of the second cut will also be equal to that of the first. When the tool is again started the diameter d (Fig. 2) is reduced an

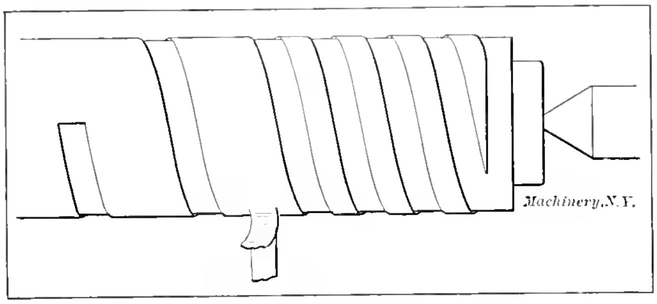


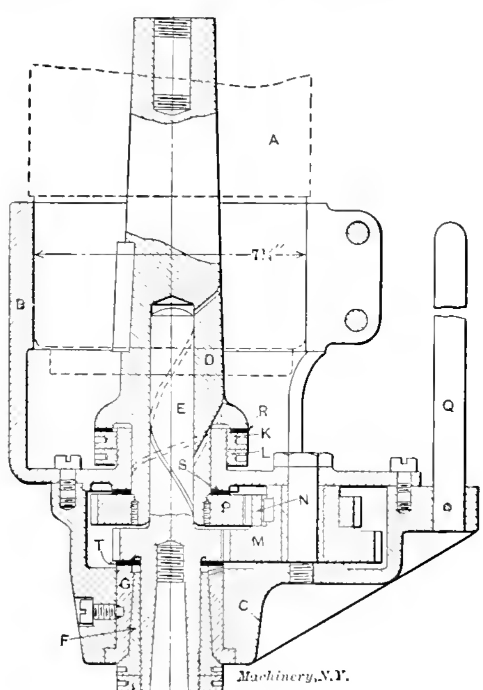
Fig. 4. Tool taking the Second Cut

amount equal to the desired depth of the cut, and the split-nut engaged at any point. Then when the succeeding cut is taken, it is again necessary to engage the split-nut at the proper moment; that is, when thread space S has just passed the tool. This operation is repeated until the thread is cut to the correct depth as shown by the coincidence of the tool point with the reduced end, or by a stop if the lathe is so equipped. In one instance within the writer's experience, the replacement of the old method by the one here described reduced the time per piece from about one hour to twenty minutes, or an increased output of 300 per cent.

Coventry, England. FRANCIS W. SHAW.

SPEEDING HEAD FOR VERTICAL MILLING MACHINE

The high-speed milling attachment illustrated herewith was designed to fit an Ingersoll milling machine, the spindle speed of which was too slow for some classes of work. The attachment is designed so that it is easily attached or removed

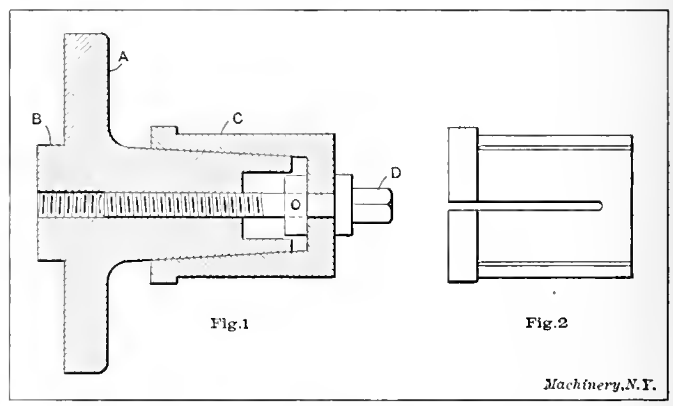


High-speed Attachment for the Vertical Milling Machine

from the machine. The following is a description of the construction of this attachment as made in the Thomson-Houston shop of the General Electric Co. The casting B was bored to fit the outside of the spindle A. The part B is fastened to the spindle by two bolts as shown. The gear case C is centered with the spindle by a boss on B, and it is bored out to receive the brass sleeve G, which forms a bearing for the conical, tool steel, hardened sleeve F; the latter is screwed on the milling cutter holder E. The upper end of E has a bearing inside the part D which fits into the spindle and is keyed to it. On D is fixed a gear P, which drives the holder E through the gears N and M. The attachment is prevented from turning in either direction by a stud Q, which comes into contact with the machine head. The box C forms a reservoir for the oil into which the hardened steel gears run constantly. Spiral grooves are cut in all bearings, and fiber washers are used at R, S and T as thrust washers. The nut H permits compensating for the wear that may take place in sleeve G. This device, as before stated, is very easily attached to the machine, and the only change that was necessary in the latter was to cut a keyway inside of the spindle for the key which drives the shank D. P. P. F.

FIXTURE FOR TURNING AND FACING COLLARS

As we have quite a number of collars to make, the fixture shown in the sectional view, Fig. 1, was made for holding them while they are being turned, faced and polished. This fixture has a disk A which is fastened to the lathe face-plate and centered by a boss B. The projecting end of this disk is turned to a taper of ⅝ inch per foot, and on this tapered part



Fixture with Expanding Sleeve for Holding Collars while Turning and Facing them

is fitted a flanged sleeve C. This sleeve has six ⅛-inch slots cut into it, three being cut from each end and extending to within ⅜ inch of the opposite end, as shown in Fig. 2. These slots permit the sleeve to expand when it is forced upon the tapered part by the screw D, which fits into A. As the collars for which the fixture was made are slightly longer than the expanding sleeve, they can be turned on the outside and faced on the end at one setting of the tool. They can also be very quickly placed on or removed from the fixture by simply turning the screw D in the proper direction. The ends of the collars can be easily polished, as it is not difficult to get in the corner with the polishing stick as when using an ordinary mandrel. One hundred collars were made on this fixture in ten hours' less time than was required when a mandrel was used. L. J. GETZ.

Salem, O.

DON'TS FOR SCREW MACHINE OPERATORS

Don't use a box tool for a roughing cut; use a hollow mill.

Don't use a cut-off tool without some top rake.

Don't put an extension on a wrench when trying to make a tool hold; if the tool slips after tightening with the proper wrench something is wrong.

Don't use a steel hammer for adjusting tools; have a copper one handy and some pieces of brass of different sizes and lengths.

Don't use a monkey-wrench; show the boss how much cheaper it is to standardize the screw heads and furnish proper wrenches.

Don't put a new bar of stock into the machine without measuring the first two or three pieces that come off.

Don't measure up a piece of work without measuring all of the dimensions.

Don't change collets or jaws without cleaning out the spindle nose.

Don't put a screw-driver into the slots of a feed finger to loosen it; use a spanner or a pin in the holes provided.

Don't use a cut-off tool which is too narrow; a wider one can be pushed faster and it will stand up better and leave a better finish.

Don't throw in the feed until you are sure everything about the machine is all right.

Don't let the first few pieces get by without looking to see if the feed finger is scratching the work.

Don't move a tool after measuring just one piece; it is better to measure two or three, as any automatic will make a piece now and then which will be out.

Don't put a new bar of stock into an automatic in a haphazard manner; different jobs require different ways of starting a new bar.

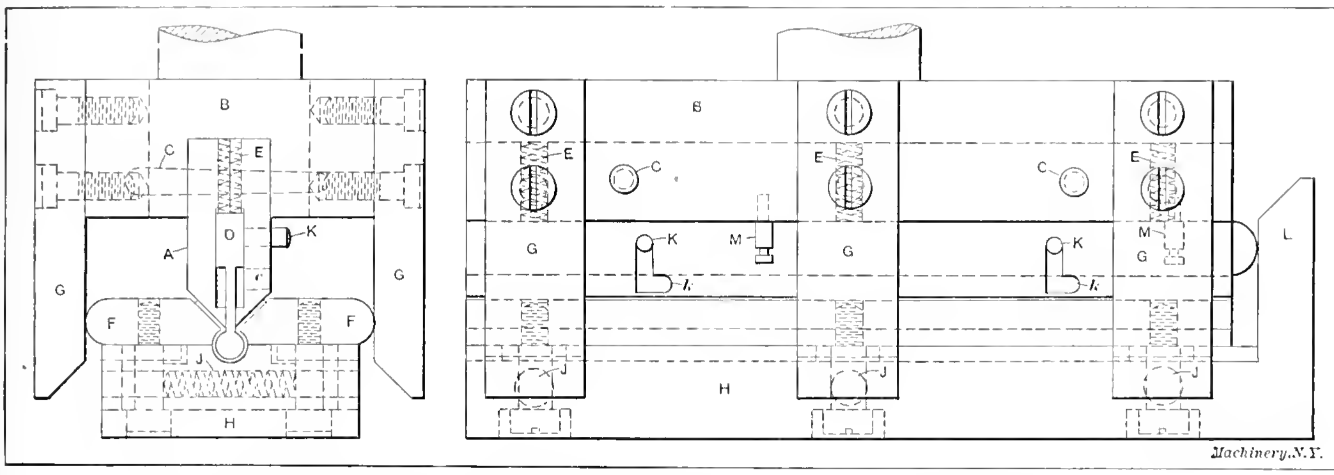


Fig. 1. Side and End Elevation of a Bending and Forming Die for Forming in One Operation the Piece shown in Fig 2

Don't let your machines run without measuring the work often.

Don't take two roughing chips if one is possible; use a little finer feed and only take one chip.

Don't let the tools get choked up with chips; clean them out once in a while.

Don't say you can't do a hexagon or a square job just because you haven't a collet; a round one will hold both square and hexagon on a pinch.

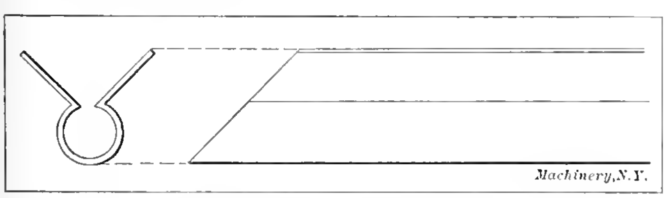


Fig. 2. Corner Piece formed by the Die shown in Fig. 1

Don't run the feed belts too tight; when a trifle loose, if something sticks they will slip and not smash things.

Wilkes-Barre, Pa. PAUL W. ABBOTT.

PRESS TOOL FOR BENDING CORNER PIECES

A press tool is shown in Fig. 1 for forming in one operation the copper corner-piece for lamp frames illustrated in Fig. 2. These corner pieces vary in length from 8 to 36 inches. The copper from which they are made comes in rolls cut to the width required, and they are cut to the right length in the press with an ordinary punch and die, which also forms the ends so that they will fit together when placed in position on the lamp frame.

The construction of this bending and forming die is clearly shown by the side and end elevations, Fig. 1. The forming punch *A* is fixed into punch-holder *B* by taper pins *C*. This punch is made in two pieces as shown in the end view. The punch *D*, which also acts as a mandrel on which the cylindrical part of the corner-piece is formed, is made a sliding fit in *A* The two forming slides *F*, which fit in slots in the casting *H*, are normally held open by helical springs *J*, which are compressed between fixed studs.

When the press is on the upper part of its stroke, punch *D* is forced to the bottom of the slot in *A* by the springs *E*. As this punch descends, it bends the stock to a U-shape between the slides *F*, which are then forced inward by the finger-cams *G*, thus forming the corner-piece against the lower ends of *D* and *C*, to the required shape. While the slides *F* are at work, punch *D* moves upward with relation to the slot in *A*, and, at the end of the downward stroke of the press, it occupies the position shown. In order that *D* will not begin this upward movement as soon as it comes into contact with the stock and begins bending it, pins *K* are inserted into it which fit into the right-angle slots cut through one side of the punch *A* as shown in the side elevation. When the downward stroke begins, these pins are in the part *k* of their slots. When it is time for *D* to begin its upward movement, it is forced to the left by cam *L* so that the pins *K* are brought in line with and can ascend the vertical parts of the right-angle slots. When the press begins the upward stroke, *D* begins to descend, being forced downward by the springs *E*. When pins *K* reach the bottom of the vertical part of their slots, springs (not shown) which are attached to them and to the pins *M* in the punch-holder, draw punch *D* to the right. The pins are then once more in the right-hand end of the horizontal part of the slot, or in position *k*; the punch is then ready to begin bending a new piece.

The gages or stop-pins for the stock are not shown, but are fixed on the slides *F*. These two slides come against a dead stop each time they are opened by the springs *J*. The punch *D* should be an easy fit in the slot in *A*, and the cam *L* should come in contact with this punch before it can bind the stock against the die, so that it can slide freely to the left or in a position that will enable *A* to descend. This tool should be used in a press having at least a 2- or 3-inch stroke, as it would not work well in a press having a shorter stroke than this. C. PETITJEAN.

London, E. C.

LATHE ATTACHMENT FOR BACKING OFF TEETH OF STEPPED REAMER

We had orders for about 200,000 gas cocks, the bodies of which had to be drilled and reamed. When this work was started there was considerable trouble as the reamer would clog up with chips and break because it had to remove so much stock in reaming the large end of the hole. In addition, the hole was distorted so much that there was always trouble when grinding the seats. This trouble, however, was eliminated after the tool shown in Fig. 1 was designed, which enabled the drilling and reaming to be done in one machine, and at the rate of 8 per minute or 480 per hour. This combined drill and reamer prevented the breaking of the finishing reamers and made it possible to grind the plugs in the body in one quarter the time previously required. It was necessary in order to secure satisfactory results to have the cutting edges on each side for the different steps, in the same plane, and in Fig. 2 is shown a diagrammatical view of the attachment used for backing off the cutting edges of the different

steps. It consists of casting *A*, which is threaded to fit the lathe spindle, carrying on its face two raised surfaces or cams *B*, which for this particular job are located 180 degrees apart. The shape of each of these raised surfaces corresponds to the required shape for the clearance. Bearing against the plate *A* and in line with cams *B* is a roller *C*, mounted in a shank which in turn is fastened to the cross-slide of the lathe carriage. The work *D* is held in a hole in the center of the casting *A* by suitable means. When the lathe is to be set for cutting clearance on the reamer, the roller *C* is brought in contact with the highest point of one of the cams as shown

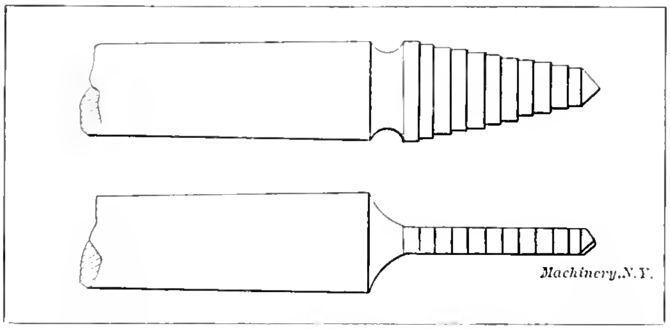


Fig. 1. Combined Drill and Reamer after the Turning and Milling Operations

in the illustration. The cutting point to be backed off and the turning tool are then set so that they just touch each other. By keeping a constant pressure on the hand-wheel at the side of the carriage, the cams as they come in contact with the roller will cause the carriage to advance and return at just the proper moment to give the required form to the cutting edges. Of course, if the work has more than two cutting edges to be turned, it will be necessary to have as many cams

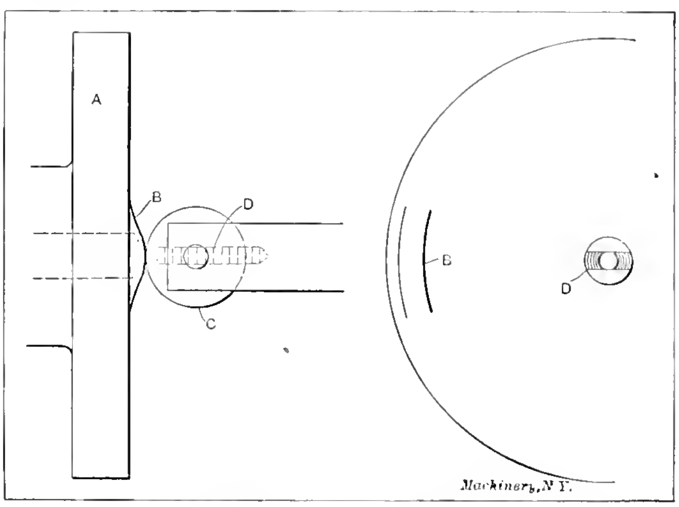


Fig. 2. Diagrammatical View of Special Lathe Attachment used for Backing Off the Reamer Teeth

as there are flutes. I have used this attachment for making forming drills for a large variety of brass cast work and it is the best thing that I know of for backing off cutting edges of tools of this type. JOHN M. FRUIN.

Waterbury, Conn.

DRAWING WITH CROSS-SECTION PAPER UNDER TRACING CLOTH

In the April number of MACHINERY there is a note telling about the use, in England, of tracing cloth with cross-section rulings. As many offices may not find it advisable to obtain a supply of this special cloth the following will doubtless be of interest. Take a sheet of first-class section paper with black ruling and fasten to the drawing board with small tacks. Place the regular tracing cloth over the ruled paper and draw directly on the cloth. In many lines of work it is possible to make the complete drawing in ink without the use of a pencil. I have seen entire switchboards of large size drawn in this manner. When drawing the detail parts such as angle irons, copper bars, rods, etc. (when the dimensions are important and the picture only a place to hang them) the ruled paper beneath the tracing will prove a great time saver. It is, of course, necessary for the draftsman to have his work clearly in mind, or a rough sketch before his eyes. RALPH W. DAVIS.

Rochester, N. Y.

BENDING FORM FOR SPIRAL SCROLLS

While visiting a small railing shop, where considerable scroll work is done, I saw a number of pieces with spiral ends, as shown in Fig. 1, and I could not imagine how they were

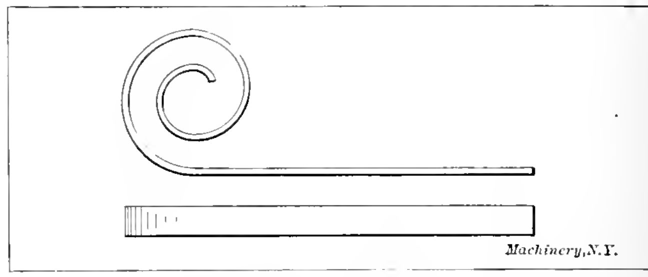


Fig. 1. Scroll which is bent on the Form shown in Fig. 2

bent, as it was a shop without power and equipped only with a few hand tools; yet the scrolls were an example of good workmanship. I began to look around and ask a few questions, when I found that the method of bending these scrolls was "as easy as rolling off a log." A piece of straight, flat stock was heated to a dark red, and then bent on a form, similar to that shown at *A* in Fig. 2, which was held in the vise. The work, after being removed from the form, was

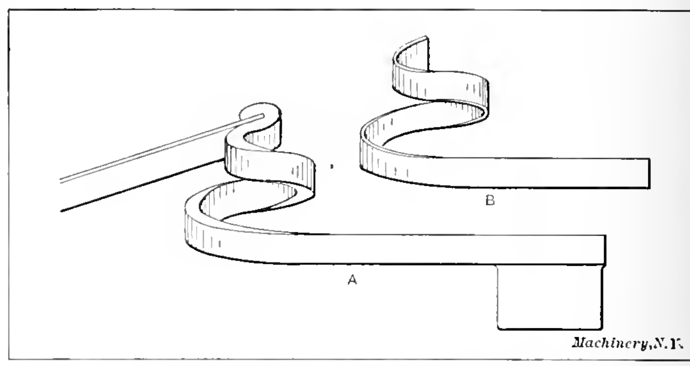


Fig. 2. Bending Form and Shape of Work before it is flattened

then in the shape of a conical spiral, as shown at *B*. In order to form the scroll shown in Fig. 1, the piece was simply flattened down on a straight plate. HERMAN JONSON.

New York City.

* * *

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The National Machine Tool Builders' Association held its eighth annual convention at the Hotel Astor, New York, October 12 and 13, with the following official organization: President, Fred L. Eberhardt; first vice-president, C. A. Johnson; second vice-president, E. P. Bullard, Jr.; treasurer, W. P. Davis; and secretary, P. E. Montanus. The list of members including the concern admitted to the association at this meeting follows on the next page.

President Eberhardt in his address referred to the Hudson-Fulton celebration and the great advances in transportation that this celebration commemorated. He referred to the position of the association favoring the reduction of the tariff on the metal-working classifications; and expressed the conviction that the government authorities in Washington—Department of Commerce and Labor—were impressed by the movement initiated in New York last year to bring to their attention the size, importance and needs of the machine tool industry. He expressed confidence in the future of the industry, it being evident that the trade depression has been passed and that good times are in sight. Paul E. Montanus, chairman, presented the report of the committee on standardizing electric motors as applied to machine tools, which was discussed by Mr. Lodge. The report in part was as follows:

"Regarding the maximum speed of motors, both constant and variable, and the peripheral speed of gears, the committee finds quite a diversity of opinion. From the report we find

that for constant-speed work the majority seem to favor 1,200 revolutions per minute on most of the smaller motors, at least up to five horse-power. There was, however, a difference ranging from 900 to 1,800 revolutions per minute. Where rawhide pinion is used it was found that the maximum speed was somewhat higher, but that still 1,200 revolutions per minute was most commonly used. With metal pinions this was somewhat lower.

LIST OF MEMBERS OF THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

Allen, Charles G., Co.	Barre, Mass.
American Tool Works Co.	Cincinnati, Ohio
Aurora Tool Works	Aurora, Ind.
Automatic Machine Co.	Bridgeport, Conn.
Barnes, W. F. & John, Co.	Rockford, Ill.
Barnes Drill Co.	Rockford, Ill.
Bath Grinder Co., Inc.	Fitchburg, Mass.
Baush Machine Tool Co.	Springfield, Mass.
Besly, Chas. H., & Co.	Chicago, Ill.
Binsse Machine Co.	Newark, N. J.
Bradford Machine Tool Co.	Cincinnati, Ohio
Builders Iron Foundry	Providence, R. I.
Bullard Machine Tool Co.	Bridgeport, Conn.
Carter & Hakes Machine Co.	Winsted, Conn.
Champion Tool Works Co.	Cincinnati, Ohio
Chandler Planer Co.	Ayer, Mass.
Cincinnati Bickford Tool Co.	Cincinnati, Ohio
Cincinnati Lathe & Tool Co.	Cincinnati, Ohio
Cincinnati Milling Machine Co.	Cincinnati, Ohio
Cincinnati Planer Co.	Cincinnati, Ohio
Cincinnati Shaper Co.	Cincinnati, Ohio
Colburn Machine Tool Co.	Franklin, Pa.
Davis, W. P., Machine Co.	Rochester, N. Y.
Detrick & Harvey Machine Co.	Baltimore, Md.
Dill, T. C., Machine Co.	Philadelphia, Pa.
Dreses Machine Tool Co.	Cincinnati, Ohio
Dwight Slate Machine Co.	Hartford, Conn.
Fairbanks Co.	Springfield, Ohio
Fellows Gear Shaper Co.	Springfield, Vt.
Fifield, G. W.	Lowell, Mass.
Fitchburg Machine Works	Fitchburg, Mass.
Flather & Co., Inc.	Nashua, N. H.
Flather, E. J., Mfg. Co.	Nashua, N. H.
Flather, Mark, Planer Co.	Nashua, N. H.
Foote, Burt & Co.	Cleveland, Ohio
Fosdick Machine Tool Co.	Cincinnati, Ohio
Fox Machine Co.	Grand Rapids, Mich.
Gang, Wm. E., & Co.	Cincinnati, Ohio
Gardam, Wm., & Son	New York, N. Y.
Gisholt Machine Co.	Madison, Wis.
Gould & Eberhardt	Newark, N. J.
Greaves, Klusman & Co.	Cincinnati, Ohio
Hamilton Machine Tool Co.	Hamilton, Ohio
Heald Machine Co.	Worcester, Mass.
Hendey Machine Co.	Torrington, Conn.
Henry & Wright Mfg. Co.	Hartford, Conn.
Hilbert Machine Co.	Cincinnati, Ohio
Hoefer Mfg. Co.	Freeport, Ill.
Ingersoll Milling Machine Co.	Rockford, Ill.
International Machine Tool Co.	Indianapolis, Ind.
Johnson, I. H., Jr., Co., Inc.	Philadelphia, Pa.
Jones & Lamson Machine Co.	Springfield, Vt.
Kearney & Trecker Co.	Milwaukee, Wis.
Kelly, R. A., Co.	Xenia, Ohio
Kempsmith Mfg. Co.	Milwaukee, Wis.
Kern Machine Tool Co.	Cincinnati, Ohio
King Machine Tool Co.	Cincinnati, Ohio
LeBlond, R. K., Machine Tool Co.	Cincinnati, Ohio
Lodge & Shipley Machine Tool Co.	Cincinnati, Ohio
Lucas Machine Tool Co.	Cleveland, Ohio
Lutter & Gies	Milwaukee, Wis.
Mechanics Machine Co.	Rockford, Ill.
Mueller Machine Tool Co.	Cincinnati, Ohio
National-Acme Mfg. Co.	Cleveland, Ohio
National Automatic Tool Co.*	Dayton, Ohio
Newark Gear Cutting Machine Co.	Newark, N. J.
Niles-Bement-Pond Co.	New York, N. Y.
Norton Grinding Co.	Worcester, Mass.
Owen Machine Tool Co.	Springfield, Ohio
Poole, J. Morton, Co.	Wilmington, Del.
Powell Tool Co.	Worcester, Mass.
Prentice Bros. Co.	Worcester, Mass.
Queen City Machine Tool Co.	Cincinnati, Ohio
Quincy-Manchester-Sargent Co.	Plainfield, N. J.
Reed, F. E., Co.	Worcester, Mass.
Reed, Francis, Co.	Worcester, Mass.
Rivett Lathe Mfg. Co.	Brighton, Mass.
Rockford Drilling Machine Co.	Rockford, Ill.
Rockford Machine Tool Co.	Rockford, Ill.
Schumacher & Boye	Cincinnati, Ohio
Seneca Falls Mfg. Co.	Seneca Falls, N. Y.
Sibley Machine Tool Co.	South Bend, Ind.
Snyder, J. E., & Co.	Worcester, Mass.
Springfield Machine Tool Co.	Springfield, Ohio
Steptoe, John, Shaper Co.	Cincinnati, Ohio
Stockbridge Machine Tool Co.	Worcester, Mass.
Von Wyck Machine Tool Co.	Cincinnati, Ohio
Walcott & Wood Machine Tool Co.	Jackson, Mich.
Warner & Swasey Co.	Cleveland, Ohio
Western Machine Tool Works	Holland, Mich.
Whitcomb Blaisdell Machine Tool Co.	Worcester, Mass.
Whitney Mfg. Co.	Hartford, Conn.
Wilson, W. A., Machine Co.	Rochester, N. Y.
Windsor Machine Co.	Windsor, Vt.
Woodward & Powell Planer Co.	Worcester, Mass.

* Admitted at this meeting.

"It is with respect to the speed of motors and their variations we found the greatest difficulty at the joint meeting with the Electrical Association. The speeds were so arranged and based on the following suggestions: That the starting basis of constant speed of the A. C., 60 cycles be used as the basis of the D. C. constant-speed motors, and also that this be used as a basis for the working out of the variable speed requirements. The speeds suggested are 600, 720, 900, 1,200 and 1,800 revolutions per minute. These figures are not absolutely correct for the above condition, but are approximately close enough for discussion purposes. In all the speed tabulation it is understood that the variation of five per cent up or down can be allowed. The table which we submit below is the first and the basis upon which the two committees are working.

VARIABLE SPEED MOTORS

H. P.	Max. Speed	Range: 4 to 1	3 to 1	2 to 1	1½ to 1
1	2200	550	740	1,100	1,480
2	2200	550	740	1,100	1,480
1	1800	450	600	900	1,200
2	1800	450	600	900	1,200
3	1800	450	600	900	1,200
5	1800	450	600	900	1,200
7½	1800	450	600	900	1,200
10	1800	450	600	900	1,200
2	1500	375	500	750	1,000
3	1500	375	500	750	1,000
5	1500	375	500	750	1,000
7½	1500	375	500	750	1,000
10	1500	375	500	750	1,000
15	1500	375	500	750	1,000
15	1200	300	400	600	800
20	1200	300	400	600	800
25	1200	300	400	600	800
30	1200	300	400	600	800
20	900	225	300	450	600
25	900	225	300	450	600
30	900	225	300	450	600
40	900	225	300	450	600
30	720	180	240	360	480
40	720	180	240	360	480
50	720	180	240	360	480

"In order to explain this table, we will take the 2-H. P. size. In it we will suggest the maximum speed as 2,200; the 4 to 1 range would therefore be 550 to 2,200; 3 to 1 range, 740 to 2,200; 2 to 1 range, 1,100 to 2,200; 1½ to 1 range, 1,480 to 2,200. This would require four motor frames to carry out this standard. If any manufacturer should decide that 2,200 revolutions is entirely too high, he has the following option:

"If he uses a 2 to 1 motor, he can use a speed variation as low as 500 to 1,100 or 740 to 1,480. If the 3 to 1 is required, he could use 550 to 1,480, or at least that frame. Therefore, it would seem that while the table may be somewhat high, the number of combinations which could be taken therefrom would be sufficient to meet the requirements of nearly every motor manufacturer. In this table he could also take a 2-H. P. motor with maximum speed 1,800 revolutions. With this he could get a 4 to 1 speed variation, 3 to 1, 2 to 1, and 1½ to 1, with maximum speed of 1,800, 1,200, or 900 for a 2 to 1 motor. This is also sufficiently large to meet nearly all requirements."

A paper entitled "The Creation of Machinists" presented anonymously was interesting to the majority of the members of the association inasmuch as it outlined a plan that has been successfully followed by a machine tool builder in Ohio in training young men to become skilled in the operation of machine tools under conditions that differ materially from those ordinarily surrounding the education of apprentices. In an address on the same subject made by E. P. Bullard, Jr., he referred to his experiences with the partial apprenticeship system successfully used in his company, the Bullard Machine Tool Co., for training men of mature years to become skilled machine men. The following papers were also presented:

"Industrial Education—A Source of Supply Increasing the Efficiency of Machinists," by Mr. F. A. Geier, who described the Cincinnati plan, and M. A. Coolidge on the Fitchburg plan. (See another part of this issue for the text of each.) Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, New York, gave his famous stereopticon lecture "The Perils of Peace, or a Safer America." Dr. Tolman's remarks and views strongly impressed the machine tool builders, and when it became known that he had an itinerary that covered the manufacturing districts of the Middle West, arrangements were made by a number of the western leading machine tool builders to accord him a hearty welcome. The concluding paper delivered on the afternoon of Wednesday was "Reinforced Concrete Construction from the Machine Tool Industry Standpoint," by J. P. H. Perry. This paper was illustrated with stereopticon views showing the features of construction details of interest to those contemplating the use of concrete for manufacturing structures.

The following officers were elected: President, F. A. Geier, Cincinnati, Ohio; 1st vice-president, Fred L. Eberhardt, Newark, N. J.; 2nd vice-president, P. E. Montanus, Springfield, Ohio; treasurer, George W. Fifield, Lowell, Mass.; secretary, Charles E. Hildreth, Worcester, Mass. Rochester, N. Y., was chosen as the meeting place for the spring convention next year.

MACHINERY'S SEVENTH ANNUAL OUTING

Following the convention of the National Machine Tool Builders' Association in New York, MACHINERY gave its annual outing October 14 to nearly 500 invited representatives of the machine tool trade and closely allied industries. The steamer *Sagamore*, chartered for the day, was loaded with eatables, drinkables and "smokables" appropriate for the occasion. The party met at the Battery shortly before noon, and with some misgivings on the part of those inclined to be seasick, the steamer started on a course south by southeast through the choppy waters of the upper bay, Narrows and lower bay. After a somewhat windy trip Sandy Hook was sighted and taken by assault, notwithstanding the presence on the dock of Col. Rogers Birnie of the Ordnance Department of the Sandy Hook Proving Ground, Col. H. L. Harris, of the Coast Artillery Corps, and other officers. Yielding gracefully to the inevitable, the officers guided the invading host through a well-equipped machine shop, where the weapons of war are repaired and supplied with missing members, to the proof battery where the big and little machine tool builders were finally gathered together and photographed *en masse* with the result noted in the accompanying illustrations—but "the worst was yet to come."

The party was ordered to climb up on the five concrete parapets back of the proof battery where the big guns are tested, see Fig. 2, and after being cautioned to stop their ears when the whistle sounded, a 12-inch gun was fired with 270 pounds of nitro-cellulose powder. The 12-inch shell was hurled through two sets of vertical wires about 100 feet apart, comprising part of the Le Boulenge chronograph apparatus used for determining the velocity, and far out to sea, where it was seen to ricochet twice before disappearing. Adequate description of the sight and the sensation produced is quite impossible; it must be seen and felt to be appreciated. Following the firing of the 12-inch gun came the firing of a 6-inch gun mounted on a 6-inch disappearing carriage. Two rounds of shrapnel were followed by one common 7-inch steel shell filled with explosive "D" fired into a sand parapet about 500 yards from the proof battery.

The party of visitors then divided into two groups, one

Fig. 1. MACHINERY'S Steamer "Sagamore" approaching Sandy Hook

Fig. 3. Machine Tool Builders, Members of the Machine Tool Trade on MACHINERY'S Outing, October 14

taking the train on the Sandy Hook R. R., the only railroad owned by the U. S. Government, to the spot where the 16-inch gun is located, while the other party inspected the fortification known as Battery Richardson and mortar battery, Battery Granger, and each party in turn visited the objects of interest

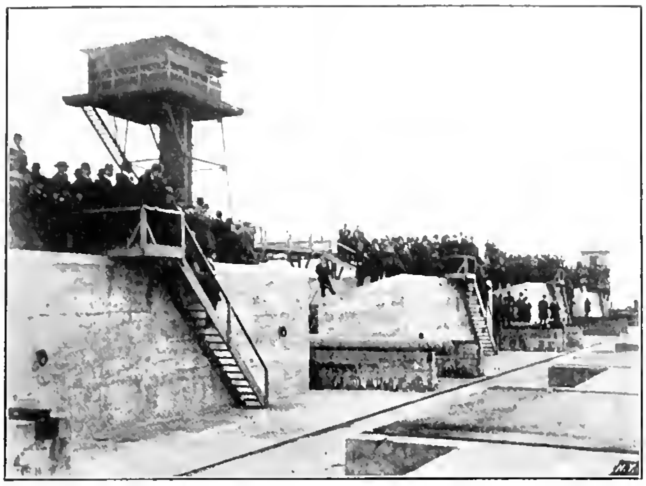


Fig. 2. Machine Tool Builders watching the Firing of Big Guns at Sandy Hook Proof Battery from the Concrete Parapets in the Rear

The inspection of the 16-inch gun under the direction of Col. Birnie was made enjoyable especially by his interesting account of the history and construction of the gun, with some remarks on the experiments made with the Gathmann gun, on a nearby armor plate and with a regular 12-inch gun on 5- and 6-inch armor fitted to a section of a battleship's hull. The 16-inch gun, which is the largest in the world, firing a projectile weighing 2,370 pounds with a velocity of 2,300 feet per second, has been discharged about fifteen times. No duplicate has been built and none is likely to be made because the great weight of the gun makes manual operation practically impossible. (See MACHINERY, December, 1903.) The lighter 12-inch, and the 14-inch guns recently authorized can, if necessary, be operated by hand, which is a great advantage, as defects in the operating machinery are likely to develop when the total disability of a gun might mean great disaster. The fortifications, Battery Richardson and Battery Potter, facing the main channel, are built of monolithic concrete behind a bank of sand and are practically invisible from the sea. The guns are mounted on disappearing carriages, and beneath the barbettes are ammunition rooms in which shells and powder are stored. Automatic hoists, driven by electric motors, convey the ammunition to the guns when in action.

The party returned to the Battery about 5:45 o'clock after having spent the afternoon on the desolate strip of sandy land

grouped on the Proof Battery, Sandy Hook. Picture taken just prior to the Firing of the Big Guns

seen by the other. Opportunity was given to a limited number to inspect the workings of the range-finding towers in which the positions and distances of vessels miles out at sea are accurately determined, and from which the angles of elevation are telephoned to the batteries.

near New York that is frequently mentioned in the public press, but on which very few Americans have ever set their feet, it being a government reservation to which admittance is usually denied. The fortifications, of which only a fraction were inspected, are said to be the strongest in the world.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

THE BRYANT CHUCKING GRINDER

A great many interesting machine tools built in the small machine tool manufacturing towns in Vermont have from time to time been illustrated and described in MACHINERY. The latest interesting machine brought out by the machine tool builders in this state, is the Bryant chucking grinder, built by the Bryant Chucking Grinder Co., of Springfield, Vt. The inventor of this machine is Mr. W. L. Bryant, for eight years chief draftsman of the Jones & Lamson Machine Co., of the same town. Its purpose, though perhaps not the full intent of its field, is indicated by its name. The ingenious features of its construction and mechanism will be made manifest as the description proceeds.

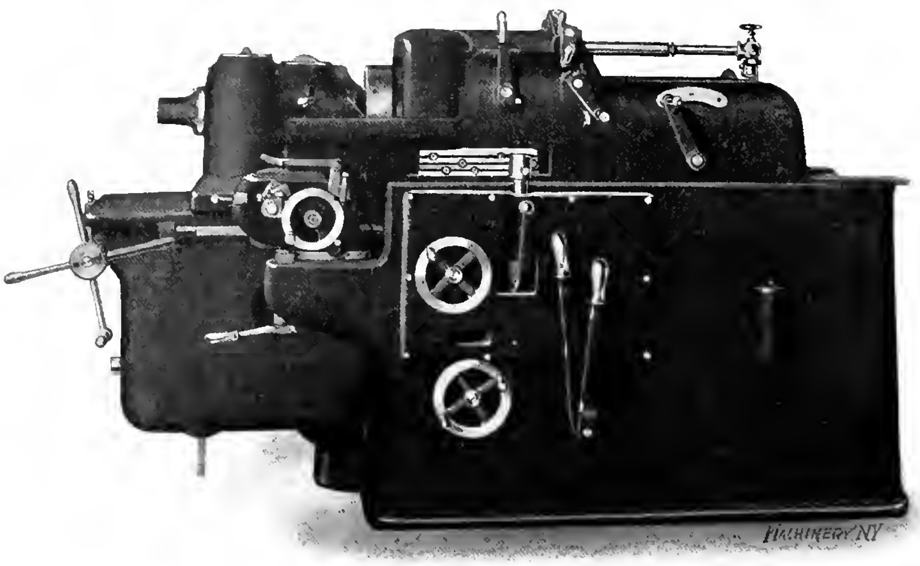


Fig. 1. The Bryant Chucking Grinder, for completing Several Grinding Operations at One Setting

General Description

Briefly, this machine is intended for work held in the chuck, and on such work presents the advantages, first of a number of wheels, constantly set, and each of suitable grain, grade, shape and surface speed for its work; second, of a number of convenient stops, for both longitudinal and cross adjustments, making the accurate duplication of lengths, thicknesses and diameters an easy matter; thus permitting, also, the performing of several operations at one chucking; and, finally, it offers those conveniences of feed and speed change, adjustment and control which make the turret lathe such a profitable investment in a well-managed machine shop.

The general design of the tool will be understood best from a study of Figs. 1 to 4, inclusive. The bed of the machine is a massive casting, A, of rigid box form. On its upper surface it is provided with one V and one flat way, on which slides the wheel-carrying head, B, carrying three spindles, any one of which may be adjusted outward to permit its wheel to operate on the work without interference from the other two. To the left of the main bed in Figs. 1, 3 and 4, is swiveled the bracket C, about the vertical axis of pivot E. The angle is read by a graduated circle, and the swivel is brought back to parallel position against a positive stop. Lever L_2 binds this adjustment. This bracket C, in turn, supports the work spindle head D; the swiveling about the axis of E thus gives provision for grinding tapers. A longitudinal adjustment of the head on the bracket, by pilot wheel E_2, against any one of three adjustable stops, permits a change of adjustment to agree with the length of the work projecting from the chuck; a cross adjustment at this point gives control of diameters, and feeds the work across the cup wheel for facing cuts. This cross feed is operated automatically from the power traverse of the wheel spindle head. Having thus briefly described the structure of the tool, we are prepared fot a detailed description.

The Wheel and Work-driving Mechanism

The whole machine is driven from a constant speed pulley F. No complicated overhead works are required, the machine may be located without strict reference to the countershaft space, and the motor-driving problem is reduced to its simplest terms.

Pulley F is keyed to shaft G, which, in turn, is keyed to drum H. Over the latter passes a belt which runs over a series of tight and loose pulleys (see J and J_1) on the wheel spindle driving shafts. These are so arranged that the shifting of the driving belt connecting drum H with pulleys J, J_1, etc., transmits the power to either the rear, or facing wheel, the center or internal wheel, or the front or external wheel. Lever K and belt shifter L control the driving belt for this purpose. Drum H and shaft G are mounted in a swing cradle, to keep the driving belt tight. The adjustment for this cradle is shown at M in Fig. 3. It should be noted that the driving belt does not pass directly over the pulleys on internal spindle N. Instead, the pulleys on this spindle are driven at an increased speed from pulley Z_1 on the idler shaft. The central position of lever K normally stops all the wheel spindles, but by the operation of lever O, the internal wheel may be started or stopped.

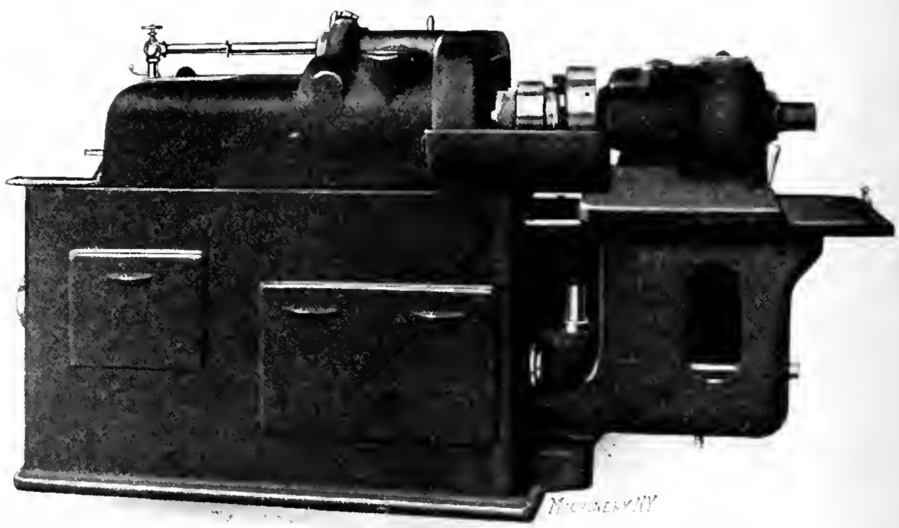


Fig. 2. Rear View of Grinder, showing Massive Construction

Levers P, P_1 and P_2 are connected with the wheel spindle quills by a rack and pinion movement, which allows them

to be projected or withdrawn, as required for clearance. These levers are provided with positive adjustable stops for this movement, permitting the duplication of the adjustments on each successive piece of work. Lever O binds or loosens all the quills simultaneously, for making this adjustment.

in which is journaled a drum, connected by spur gearing with shaft V. From this drum a belt passes around idler X, and over driving pulley Y on the work spindle. A spring Z (see Fig. 3) keeps the drum in the swinging yoke drawn down, so the belt is always taut. Lever A_1 controls a reversing

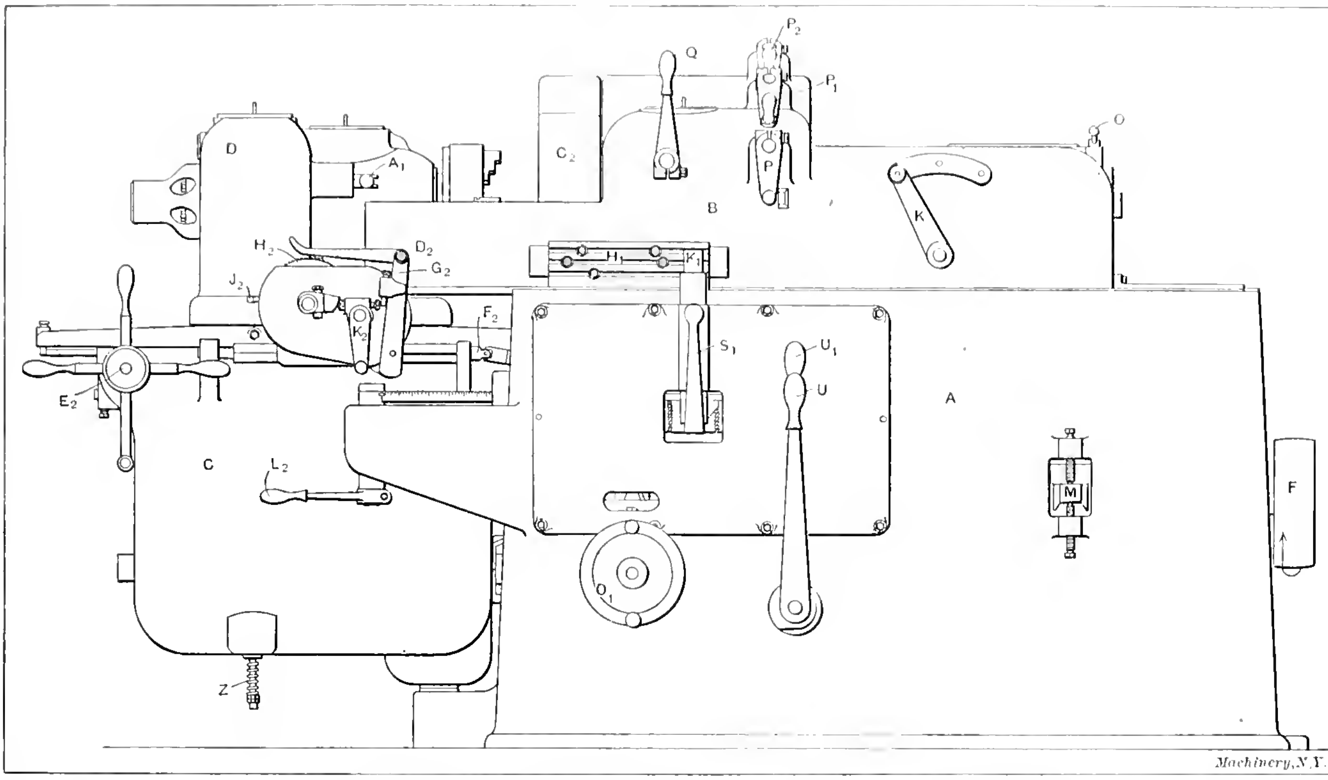


Fig. 3. Front Elevation, showing Arrangement of Slides, Controlling Levers and Hand-wheels, etc.

Shaft G, see Fig. 4, carries also a small pulley R for driving the usual water pump, and also the pinion S, which meshes with the driving gear for the work speed changing mechanism. This latter is mounted as a unit in an oil bath casing, and is of the double clutch, silent ratchet type made familiar in the spindle drive of the Hartness flat turret lathe. It is

mechanism for the work spindle, operating through shaft B_1, and the connecting gearing shown. This is employed for certain cases in which the rear or facing wheel spindle is used for cylindrical or internal surfaces. The same lever A_1 is used for stopping the work spindle, and is connected with a brake for doing this expeditiously.

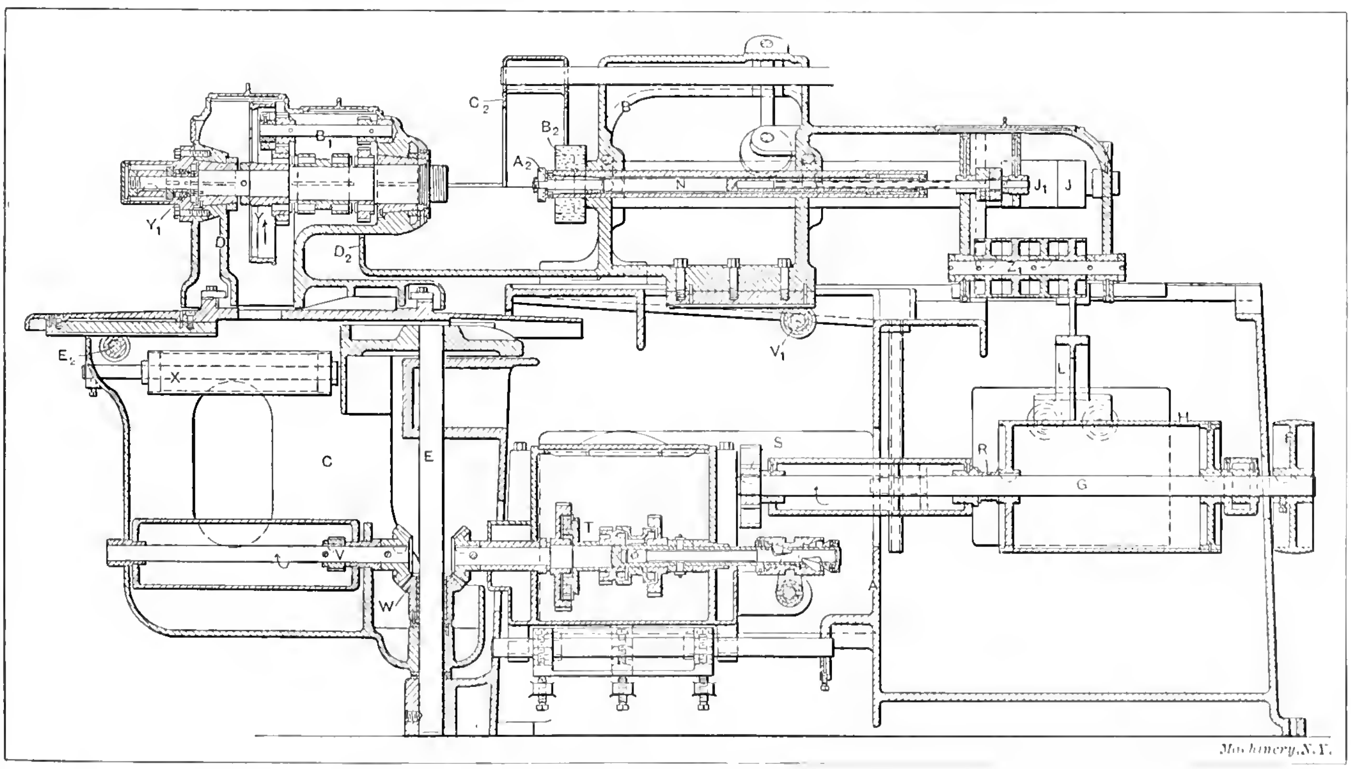


Fig. 4. Longitudinal Section, showing Work and Wheel-driving Mechanism, and General Structure of the Machine

incompletely shown at T, in Fig. 4. The nine changes of speed are controlled by the two levers U and U_1.

From the speed box, the motion is transmitted to shaft V in swiveling bracket C, through the angular bevel gear drive at W, about the axis of E. About shaft V is pivoted a yoke,

The Longitudinal and Cross-feed Mechanisms

The variable feed mechanism for operating the traverse of the wheel spindle head is best seen in Fig. 5. It is connected by a train of gears with the driven shaft of the work speed change mechanism, so that the linear feed of the wheel per

revolution of the work is not affected by changes in work speed. The variation in feed is obtained by the Hartness modification of the Sellers friction disks, in which a very slight swing of the female disks changes the point of contact so rapidly as to effect a great change in the feed. The male or driven disk is shown at C_1, in Fig. 5. The change of feed is effected by a cam connected with hand wheel D_1 in Fig. 3.

Disk C_1 is connected with shaft E_1 by a bevel gear reverse F_1, controlled by the clutches at G_1. At H_1, on the side of the wheel spindle slide are cut three T-slots, in which are clamped

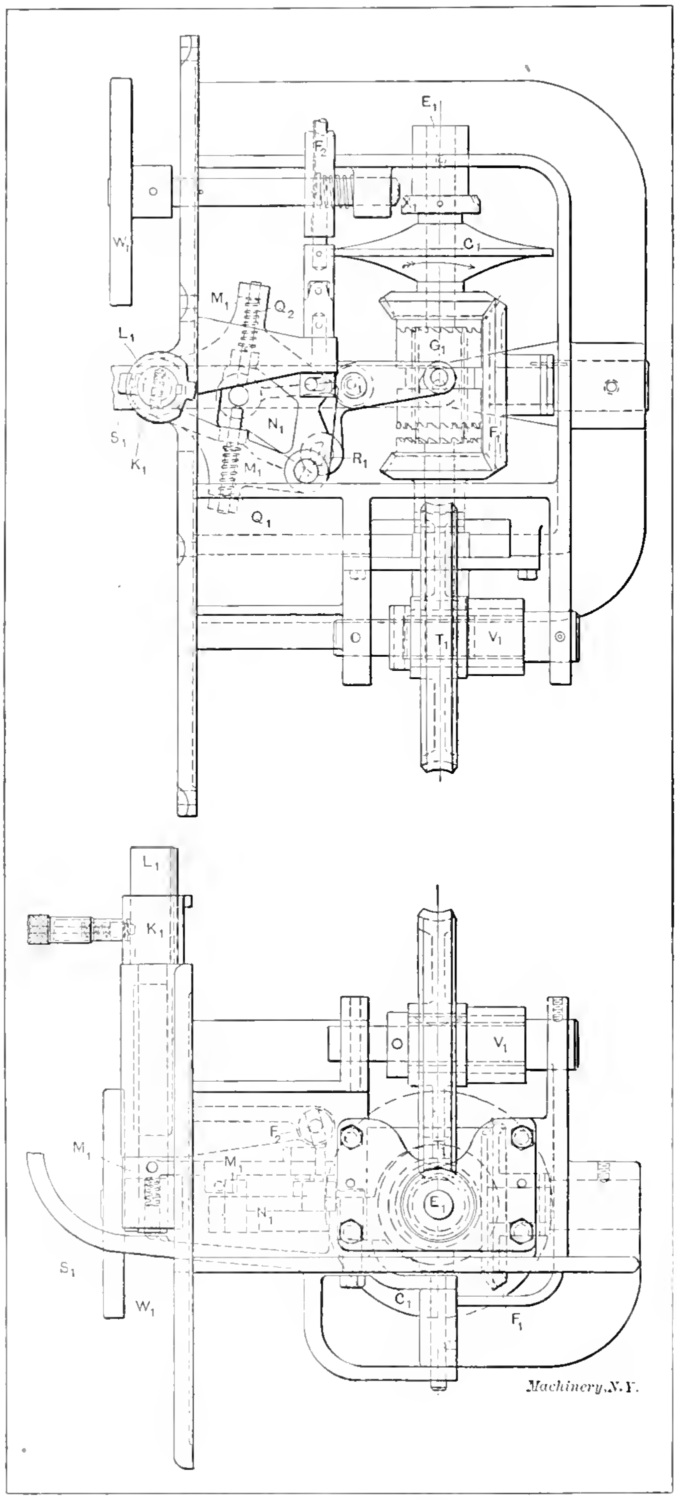


Fig. 5. The Wheel Head Traverse Mechanism

three sets of automatic reverse dogs, one for each wheel. These dogs strike a projection on collar K_1, which may be raised or lowered on rock shaft L_1 to line with the set of dogs it is desired to use. To L_1 is keyed the sector M_1, which is one member of a "load and fire" mechanism for controlling clutch G_1; its purpose is to prevent the clutch from stopping on dead center. It is the simplest in construction of any mechanism of this kind the writer remembers having seen.

Clutch G_1 is shifted to the right or left by a fork and sector N_1, pivoted at O_1. In the position shown, when sector M_1 is swung to the left by the reversing dogs, spring Q_1 is thereby compressed against a pin in sector N_1 tending to throw it to the left, and thus throw the clutch G_1 to the right, reversing the movement. This is prevented for the time being, however, by the interference of the ledges milled in the faces of the pins at R_1, one of these being fast in sector M_1 and the other in N_1. When M_1 has been turned so far to the left, however, that spring Q_1 is properly compressed, these pins snap by each other on the further side, allowing the clutch to be thrown.

Going in the opposite direction, this process is reversed. The dog at H_1 swings sector M_1 to the right, compressing spring Q_1 against the pin in N_1. The swinging of the latter under this spring pressure is resisted as before by the pins R_1, which finally snap by at the end of the movement. The pivot O_1 of segment N_1 is mounted in lever S_1, which thus furnishes means for stopping and starting the traverse movement at any point in the travel, independently of the automatic reverse.

The motion from the reverse clutch at G_1 is transmitted to the wheel spindle head through worm gearing at T_1 and a

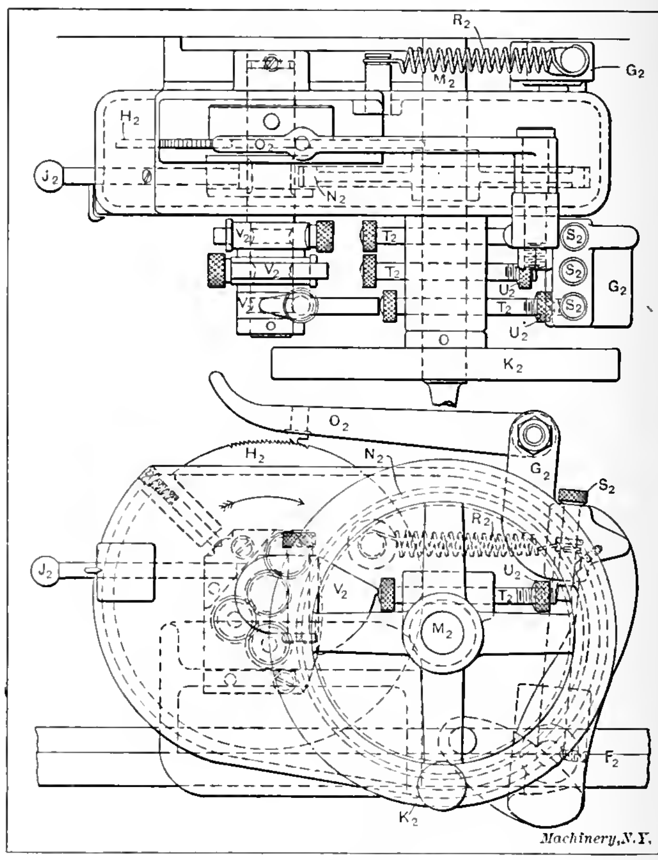


Fig. 6. The Cross-feed Mechanism, with Automatic Diminishing Device and Stop

pinion at V_1, which engages the rack under the slide. Fine hand adjustment for facing, etc., is effected when the power feed is thrown out, by hand wheel W_1, through bevel gears at X_1. This hand wheel is shown in Figs. 1 and 5, but not in Fig. 3, the latter being incomplete in this respect. When not in use, it is withdrawn until bevel gears X_1 are out of engagement, and the wheel is free.

A telescopic shaft, F_2, leads from the automatic traverse mechanism on the main base of the machine, to the cross feed mechanism for the work spindle head on the swiveling bracket. This shaft is rocked at each end of the stroke by a cam surface on sector M_1, which is, as we have seen, controlled by the reversing dogs at H_1. The telescopic shaft transmits this movement properly at whatever angle the swiveling bracket and work spindle may be set.

The cross feed screw M_2 (see Fig. 6) has mounted on it a hand wheel K_2 (a crank is shown in Fig. 3) and a spur gear N_2. This latter is connected with ratchet wheel H_2 by a tumbler gear arrangement, controlled by lever J_2, which thus provides for reversing and throwing out the feeds. The

ratchet wheel is operated by a pawl O_2, pivoted to lever G_2, which in turn receives its movement from rock shaft F_2 shown in Figs. 3 and 5. This movement is positive in the direction which operates the ratchet wheel H_2, and through it the cross feed. In the other direction it is drawn back by spring R_2 until the point of plunger S_2 brings up against the adjustable stop T_2. As the position of T_2 allows a greater or less amplitude of movement to the swinging of lever G_2, a greater or less cross feed is effected at each stroke.

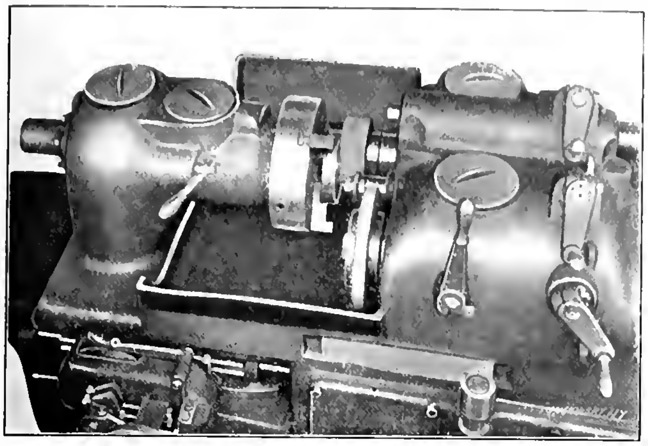


Fig. 7. The Facing Wheel in Use

The position of stop T_2, and the consequent amount of feed, is governed by two things. In the first place, the knurled nut U_2 furnishes a check to its backward movement, and thus regulates the rate of cross feed. Screwing this nut out increases the feed—screwing it back decreases it. In the second place, the feed is controlled by cam V_2, which is adjustably clamped on the shaft of ratchet wheel H_2, and revolves with it in the direction of the arrow. As the feeding progresses, the lower edge of V_2 comes into contact with the left-hand end of stop T_2, gradually limiting its movement from that permitted by the adjustment of U_2 until finally, in the position shown, the swinging of lever G_2 is stopped altogether, thus stopping the cross feed. The diminishing depth of cut thus provided for, as the desired finished diameter is approached, gives the best results obtainable from the standpoints of accuracy and finish.

It will be noted in the top view in Fig. 6 that there are three each of stop cams V_2, stops T_2, feed adjusting nuts U_2 and plungers S_2. Any one of these three latter may be pressed down into working position, thus giving a separate cross feed stop and rate of feed for each of three operations.

Salient Points in the Design

The reader might perhaps be pardoned for skipping the detailed description of the mechanism just given. It is made necessary by the fact that the machine is new from "the ground up," so it has to be described in the same way, there being no similar machine with which mental comparisons may be made. The reader, however, should not fail to examine certain noteworthy features of the design which are of universal interest, being applicable to machines of other types, made for other purposes.

One of the points of interest in the machine is its strength and rigidity. This is rather unusual in the matter of weight alone, which is about 4,200 pounds. Rigidity has been secured by very careful design. This might not seem to be important in a grinding machine, where the strains are light as compared with machines of the lathe and miller type. If

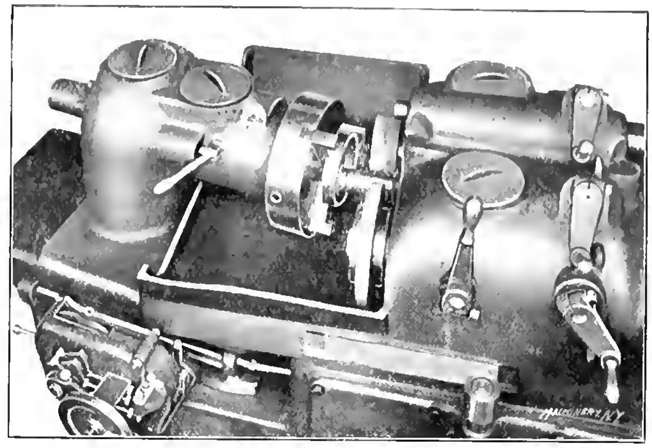


Fig. 8. The Work Head Swivelled for Taper Work

there are no heavy strains to contend with, however, there is liable to be enough of vibration to cause serious trouble, and weight and stiffness are needed to counteract this.

In the matter of rigidity, note first the heavy box-like form of the main castings. This form also serves, of course, to protect the mechanism from emery dust and other grit. Then again, the solid, long bearing of the swivel adjustment should be compared with that found on the ordinary design of universal grinder. All unnecessary sliding surfaces are

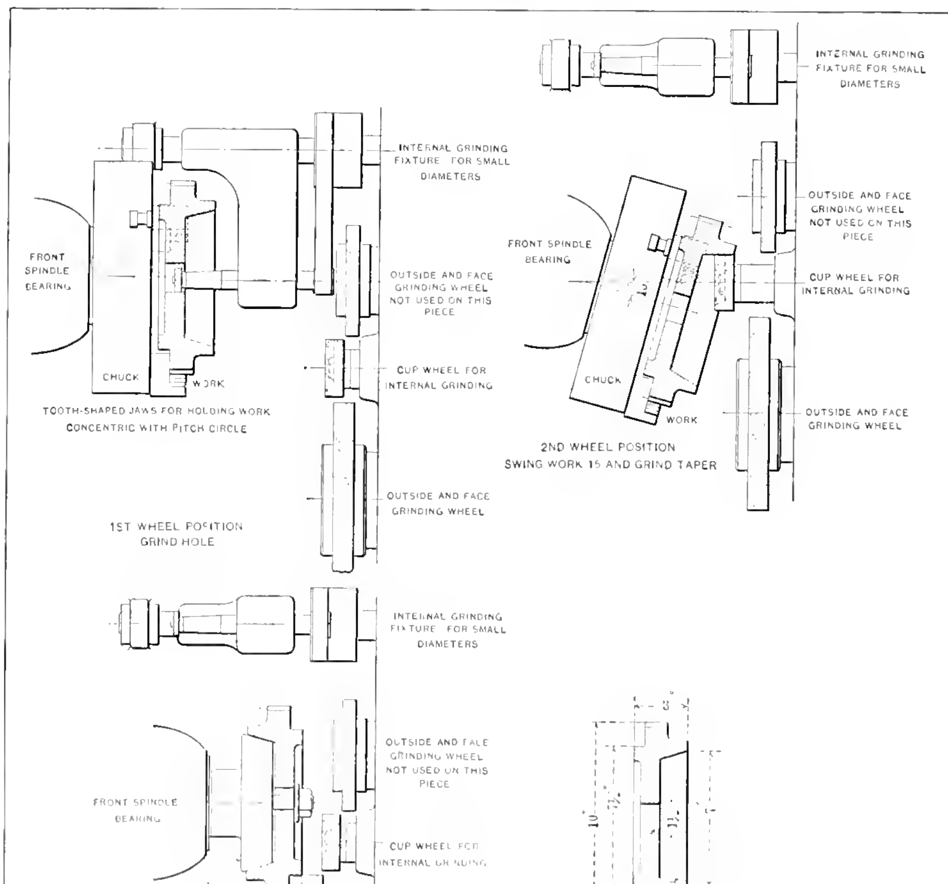


Fig. 9. Diagram showing the Method of Finishing a Hardened Gear with Conical Clutch Surface

avoided, and the connection between the work and the wheel, through the main castings, is strong and direct, there being a notable absence of built-up constructions.

An interesting point, along this line, should be noticed. The work spindle head slides crossways on a thin platen, which, in turn, slides longitudinally on the top of swinging bracket *C*. This platen at first sight appears to be an example of the built-up construction which the designer tried to avoid. This is not the case, however. It is thin and flexible, receiving its stiffness from the head and bracket to which it is gibbed. Furthermore, the gibbing points for this platen on the upper member are directly over those for the lower member, so that strains are transmitted in direct tension and compression, with no possibility of the deflection strains (even in this thin platen) which usually "raise hob" with rigidity.

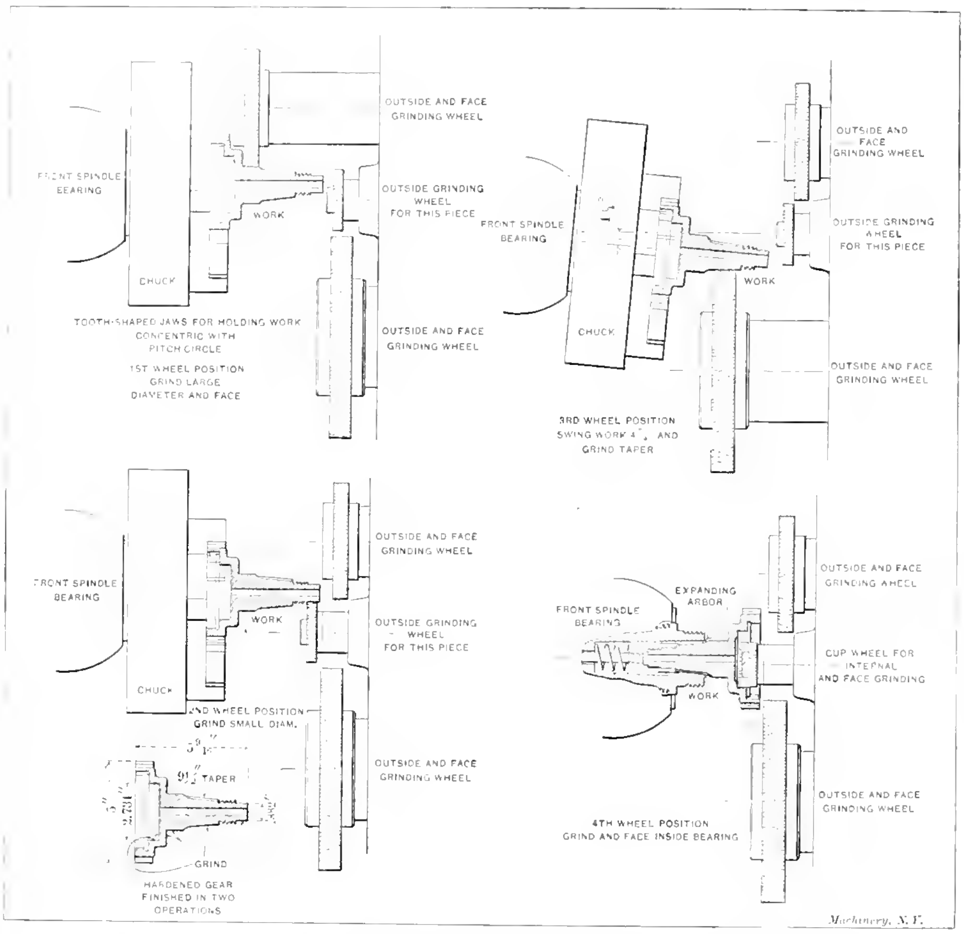


Fig. 10. Method of Finishing a Piece requiring Two Settings, and having Cylindrical, Face and Taper Surfaces to be ground

Criticism might perhaps be directed toward the large overhang of the work spindle. This is given to permit the entrance of guard D_2 to catch the water and dust. This overhang is apparent only, however, as the base of the head is extended to a long bearing out under the working point. It is similar in this respect to the spindle heads used on the Beaman & Smith duplex cylinder boring machines, having the advantage, however, of having the head and extended slide one solid casting, instead of being bolted together, as is necessary in the other case.

Another point shown, though not very plainly, in Fig. 4 at Y_1, is a device used for taking up the end movement of the work spindle. This is very necessary in accurate face plate and chuck work, whether in the lathe or grinding machine, as every good mechanic knows. It is not possible to do it well enough or to do it permanently by adjusting the take-up for the thrust bearing. It is therefore common practice, wherever possible, to put a stick against the center of the work, and bring the tail center up against it, thus taking out the slack. This machine has the stick incorporated in it. Springs at Y_1 are always in action, forcing the spindle up to a firm bearing on the end thrust.

Typical Operations

In Figs. 9 and 10 are shown diagrams which illustrate the use of the machine quite clearly. The first of the parts, in Fig. 9, is a cast iron gear with a conical clutch surface. This has to be ground, as shown, in the bore, the clutch surface, and on one face and outside diameter. In the first operation the work is held by tooth-shaped jaws which hold it concentric with the pitch line. Here the bore is ground with a supplementary internal attachment, as shown, provided for work having small holes. (This supplementary spindle may also be used for buffing and polishing with rouge and a soft wheel.) In the second wheel position the work spindle and the bracket on which it is mounted are swiveled to the angle of the conical surface 15 degrees, as shown, which is finished with the regular internal wheel. For the second operation and third wheel position (which finishes this piece) the work is held by its finished clutch surface on a taper arbor mounted in the work spindle. This arbor may be ground in place to insure absolute accuracy.

The piece of work shown in Fig. 10 is also a gear, but of much more complicated form. It is made of hardened steel. For the first operation (including the first three wheel settings) it is held in gear-tooth chuck jaws the same as in the case shown in Fig. 9. In this first operation all three of the regular wheels are used, all on external surfaces. First the large bearing is ground with the rear wheel, then the small outer bearing is ground with the central wheel, and finally, in the third position, the 9½-degree taper is finished with the outside wheel. This operation shows quite plainly that only a small lateral adjustment of the work spindle is required for the different positions. This will be seen by comparing the center lines of the work and of the central wheel spindle in each case. This is due to the fact that the three wheel spindles are located in this natural position, and to the fact that the swiveling adjustment for taper grinding is about an axis which approximately passes through the point of contact of the wheel and work.

In the fourth wheel position and the second operation, the work is held on the conical shank by a special expanding chuck, made to fit it. For this operation the middle or internal wheel only is used, this being employed for both the grinding of the hole and the facing of its internal seat.

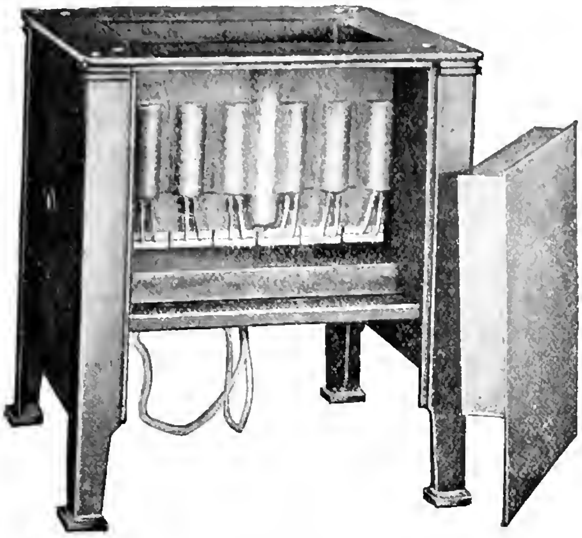
The Field of this Grinding Machine

These two examples will serve to show the convenience and time-saving qualities of this design of grinder, with its three (or four) wheels permanently mounted in place, its variety of adjustments, and its conveniently controlled stops, feeds, speeds, etc., for each operation.

It will readily be seen that this chucking grinder bears the same relation to the standard universal grinding machine, that the turret lathe on chuck work does to the standard engine lathe. Its field is thus a large one, though its particular adaptability to automobile work will be at once recognized. It is entirely conceivable that it may open up a new field of its own, in finishing certain parts from rough turned, or even rough castings and forgings. Mechanics will readily recognize its advantages, as a labor- and time-saving machine, and being, as it is, radically new in its design, it will undoubtedly create considerable interest among machine users.

ELECTRICALLY-HEATED OIL TEMPERING BATH

The accompanying illustration shows an electrically-heated oil tempering bath manufactured by the General Electric Co., Schenectady, N. Y. The bath is contained in a cast iron tank or pot, having 12 lugs evenly spaced around the sides. These lugs are drilled to receive standard cartridge units, and by thus distributing the units an even temperature can be maintained



Electrically-heated Oil Tempering Bath, made by the General Electric Co., Schenectady, N. Y., showing Removable Cartridge Units

in all parts of the oil. Around the pot is placed a heat retaining jacket, consisting of an inner and outer wall of sheet metal, the space of three inches between the walls being filled with mineral wool. The jacketing on the back side of the tank is easily removed, thus allowing quick access to the internal connections of the units. Around the top of the tank a wide flange is provided, to which four cast iron legs are screwed. A drain pipe controlled by a globe valve provides a means for drawing off the oil. A protected recess is provided in one end of the tank in which a thermometer may be placed for indicating the temperature of the oil bath.

Two methods are in vogue for using the oil bath. In the first method the temperature of the oil is raised to 250 degrees F., and then the work is placed in the bath and the full current turned on. When the oil reaches the desired temperature, the work is removed and the current turned off. The second method is to turn on the full heat at once, and bring the oil to the required temperature, and then to introduce the work, and by means of regulating switches, maintain the temperature constant for any required length of time.

A cast iron basket or tray may be supplied in which the work can be placed. This basket has eye-bolts at each end to facilitate its handling, and the bottom is perforated with ⅞-inch holes to permit free circulation of the oil. Short legs are provided on the bottom of the basket which keep the work about an inch above the bottom of the bath.

Any desired temperature is obtained by throwing in the necessary number of units to give the approximate heat. Close regulation is then secured by varying the voltage on one of the units by means of a rheostat. Three sizes of tempering baths are made, the smallest having a capacity of nine gallons of oil, the medium size, of 11 gallons, and the largest, of 37 gallons, the first requiring 6 K. W. per hour, the medium, 7.2, and the largest size, 20 K. W. for its operation. This energy consumption is sufficient to heat the oil to a temperature of 450 degrees F. in less than one hour, when starting cold. The lengths of the three sizes are 22, 18, and 30 inches, respectively; the widths, 12, 12, and 16 inches, and the depths, 8, 12 and 18 inches. The smallest oil bath weighs 420, the medium, 475, and the largest, 900 pounds.

CINCINNATI-BICKFORD 20-INCH GANG DRILL

The accompanying illustrations Figs. 1 and 2 show front and rear views, respectively, of a new arrangement of 20-inch sliding head drills operating in gang, and manufactured by the Cincinnati-Bickford Tool Co., Cincinnati, O. As shown in the illustrations, four individual drills, each fitted with power feed, automatic stop, and quick return, have been placed on a common base pedestal. The rear view, Fig. 2, shows the driving arrangement, transmitting the power through a continuous shaft provided with clutches, admitting of the throwing in and out of any one drill at any time. The continuous shaft is provided with a tight and loose pulley at one end, as shown. The lever for operating the clutches by means of which each spindle can be stopped independently, is bent over towards the front, so that the operator at the front of the machine can conveniently reach it.

These drill presses are provided with sliding heads and the table has also a sliding movement as shown in Fig. 1, so that it can be operated up and down by means of a crank on ways planed on the face of the column, giving the table a rigid support and bearings at points far apart. The arrangement of sliding heads in combination with a vertically movable table gives the machine a considerable range for handling pieces of comparatively large proportions. The table is continuous across the whole front of the machine as shown, and is provided with two T-slots. The sliding heads are balanced

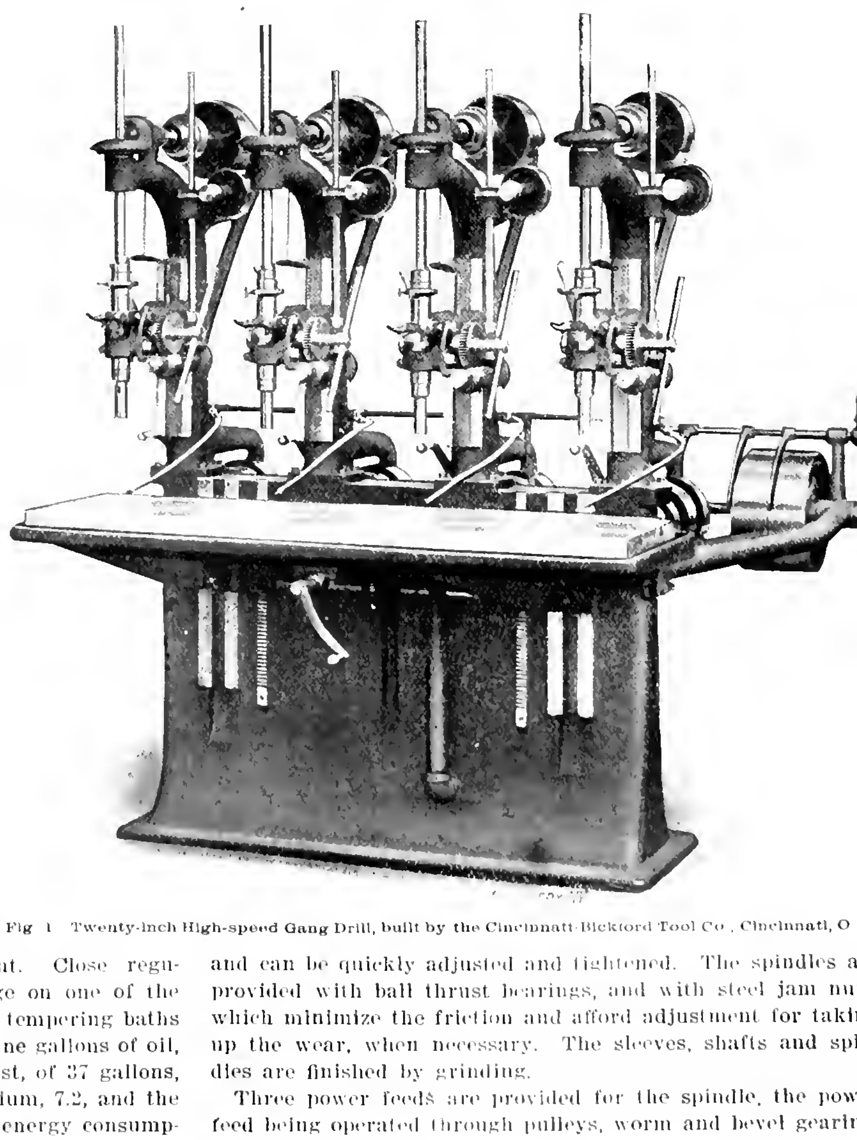


Fig. 1. Twenty-inch High-speed Gang Drill, built by the Cincinnati-Bickford Tool Co., Cincinnati, O

and can be quickly adjusted and tightened. The spindles are provided with ball thrust bearings, and with steel jam nuts, which minimize the friction and afford adjustment for taking up the wear, when necessary. The sleeves, shafts and spindles are finished by grinding.

Three power feeds are provided for the spindle, the power feed being operated through pulleys, worm and bevel gearing.

The worm operating the worm-wheel on the pinion shaft in the head revolves in an oil bath contained in the worm casing, thus insuring long life to the worm gearing. All the bevel gears are planed so as to provide proper contact between the teeth and silent running. Proper guards are provided for all exposed gearing. The spindle sleeve is graduated, and on

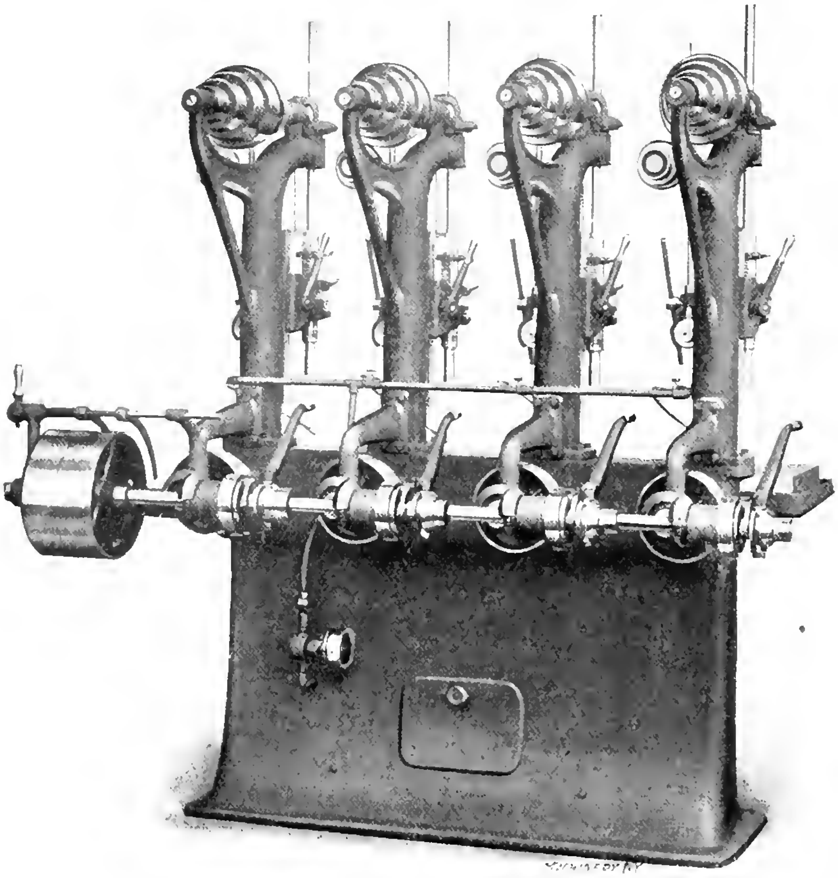


Fig. 2. Rear View of Gang Drill, showing Arrangement for Driving with one Continuous Shaft

the power feed machines provided with automatic trip, this graduation affords a means for setting accurately the automatic trip collar.

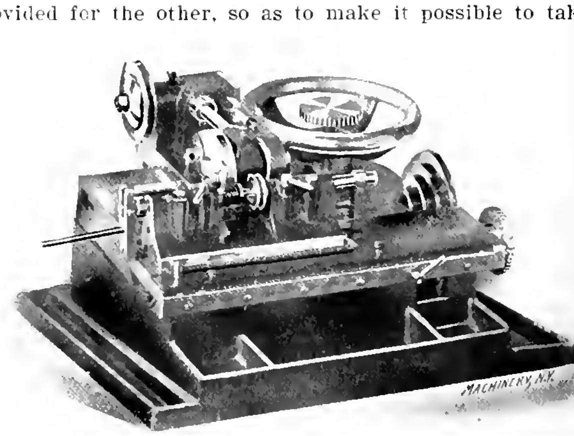
These machines are also furnished without power feed and can be arranged in gangs with any number of spindles from two up. They are also furnished on individual base columns, both with and without power feed construction, and with a variety of tables furnished according to the needs and requirements of the customer. An oil pump and the necessary piping is provided as shown, and a tank or reservoir for the oil is placed within the base.

WALTHAM AUTOMATIC STAFF TURNING MACHINE

The machine shown in the accompanying illustration has recently been brought out by the Waltham Machine Works, Waltham, Mass. It is built for automatically turning several shoulders on small work, such as the staffs of watches clocks, etc., at one setting. The general design of the machine is as follows: Two slides are provided, one of which carries the work supported on dead centers and driven by a dog from a belt-driven plate. The other slide has a motion at right angles to the first, and carries the tool or tools. A vertical shaft at the rear of the machine carries two cams, one for each slide, the cams actuating the slides by means of sliding wedges which are in contact with hardened rolls on the slides. These latter are kept up against the wedges by springs and the wedges are kept in contact with the cams by similar means. The angles of the wedges are such that the longitudinal movement of the wedge transmits a reduced movement of the slides. For watch work the movement of the work slide is made one-quarter, and of the tool slide one-eighth, of the longitudinal travel of the wedge, but for larger work a different reduction may be made. This arrangement is advantageous, inasmuch as it makes it possible to greatly reduce any small inaccuracies in the cams, the rises of which are several times the required travel of the slides.

The head- and tail-stock spindles which carry the dead centers have longitudinal adjustment in their bearings, and are so designed that when the head-stock center is in its proper position, the other can be withdrawn for changing the work, by means of the lever at the left of the tail-stock. In this way staffs can be turned with all the lengths gaged from the same end, thus throwing all of the errors of the blank to the extreme of the other end where they can be easily rectified. The centers are kept in contact with the work by light springs. For watch work and other work where the total length of the blanks is less than three-quarters inch, the head- and tail-stock are made in a single casting so that correct alignment is more easily maintained. For larger work, however, they are made separately adjustable on a bed plate. In both cases a screw adjustment is provided so that a slight swivel motion is possible for bringing the axis of the centers parallel with the work slide.

A worm and worm-gear drives the cam shaft, and a friction clutch connects the gear with the shaft. This clutch, when released, permits the shaft to be turned by the hand-wheel at the top, so as to make it easier to set the tools. The cams can be cut so that the tools will turn either straight or tapered work, or partly straight and partly tapered. A screw adjustment on each side permits the diameter of the most particular part and the distance of the most important shoulder from one of the ends to be obtained very accurately. The other diameters and lengths will be in correct relation, and duplicate parts can be turned as long as the tool retains its cutting edge. For very delicate watch work and also for work where a considerable amount of stock is to be removed, two cuts should be taken over the work. In order to facilitate this operation a two-tool turret has been provided. This turret is automatically indexed on the completion of each cut. The position of one of the tools in the turret is determined by the screw on the slide, but a separate screw adjustment is provided for the other, so as to make it possible to take the



Automatic Staff Turning Machine, built by the Waltham Machine Works, Waltham, Mass.

finishing cut with independent adjustment. With this arrangement only the finishing tool is required to have the keen point necessary for delicate work, and as but a small amount of stock is removed in the finishing cut, the tool will hold its edge for a long time.

The operation of the machine is briefly as follows: The blank is dogged by the operator, who places it between the centers and starts the machine by a foot treadle. The tool follows the course determined by the cams, turning and squaring all the shoulders on one end of the staff. In a sin-

gle-tool machine the tool then returns to its original position, and the machine stops for the insertion of a fresh blank, which has been dogged by the operator while the machine was running. In a two-cut machine the turret is automatically indexed on the return, bringing the finishing tool in position, and the movements are repeated, the machine stopping first after the completion of the finishing cut, but with the turret indexed again and the roughing tool in position for the next blank. With the two-cut, or with the one-cut machine on long work, the operator can take care of two machines. The capacity of the machines when arranged for larger work is up to $2\frac{1}{2}$ inches long between the centers, and up to $\frac{1}{2}$ inch diameter, but the longest total turning is $1\frac{1}{2}$ inch. The base of the machine is 15 inches square, and the weight about 140 pounds. The machine can be made to take either rectangular or circular tools, as required by the user.

KEARNEY & TRECKER UNIVERSAL MILLING ATTACHMENT

The accompanying line engraving Fig. 1 and the half-tones Figs. 2 to 5 show the construction and application of a uni-

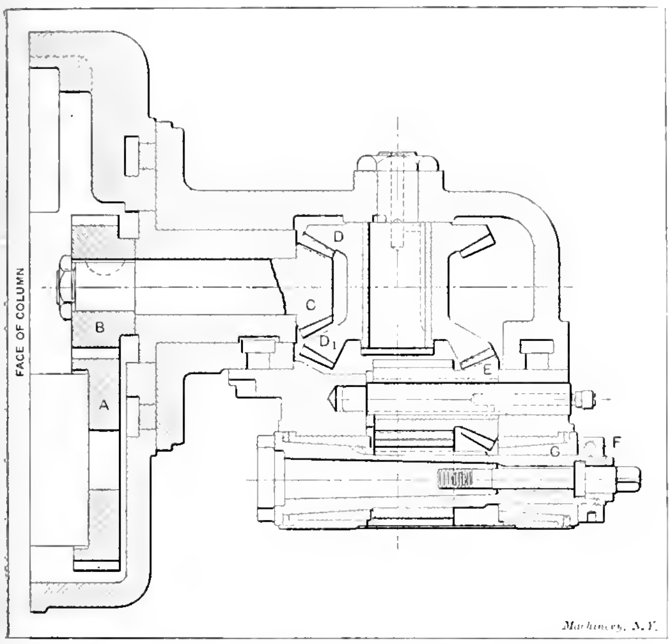


Fig. 1. Section through Universal Milling Attachment made by the Kearney & Trecker Co., Milwaukee, Wis.

versal milling attachment which has recently been brought out by the Kearney & Trecker Co., Milwaukee, Wis. Referring first to the line engraving, Fig. 1, showing a section of the device, it will be seen that the gear *A* is attached to the regular horizontal spindle of the milling machine, and drives

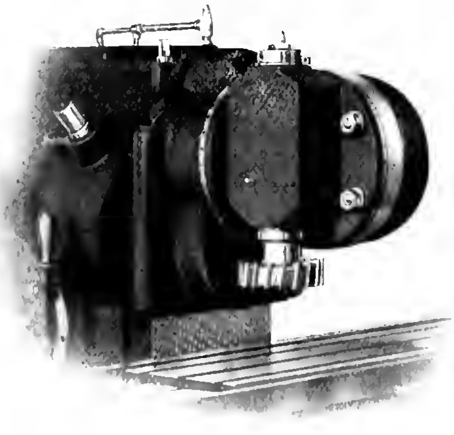


Fig. 2. The Attachment in Position for Vertical Milling

gear *B* keyed to a horizontal driving shaft on the end of which is cut a bevel pinion *C*; this pinion drives the bevel gear *D*, which latter is made in one piece with the bevel gear D_1. This arrangement permits the pinion *E* to revolve to any position without interfering with the driving pinion *C*. The bevel pinion *E* is cut on a steel sleeve on which also are cut spur gear teeth of wide face meshing with a similar gear provided on the cutter spindle of the attachment. All of the gears as well as the cutter spindle are made from hardened steel, the spindle being ground on the outside as well as in the tapered hole.

The wear on the bronze boxes is taken up by an adjustment nut or collar shown at *F*. The bushing *G* rotates with

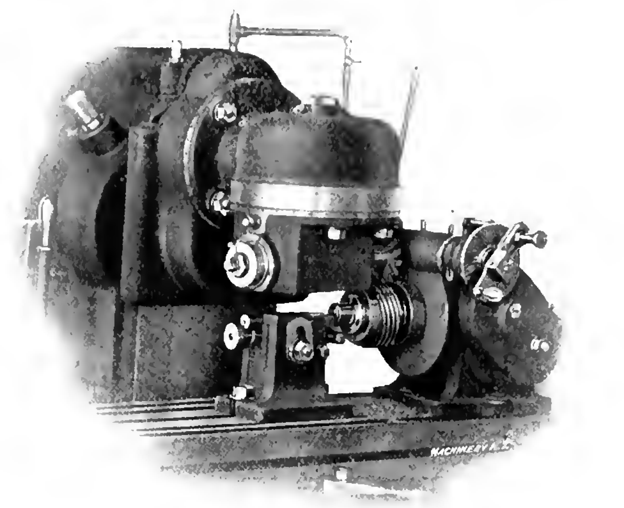


Fig. 3. The Attachment used in Connection with the Spiral Head

the spindle, it being keyed to the latter, although this is not shown in Fig. 1. Thus when the nut *F* is tightened, this bushing slides forward, and the spindle is at the same time drawn back into the taper box of the front bearing. The end of the spindle is provided with a slot or keyway for driving arbors carrying face mills and large milling cutters in general. The attachment has been made unusually heavy and rigid, and the object in bringing it out has been to provide means for using the milling machine on all kinds of unusual

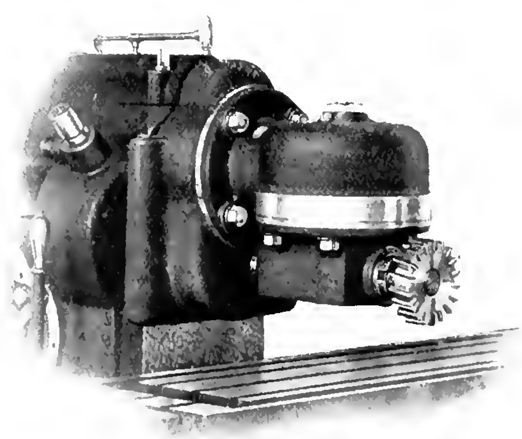


Fig. 4. Using the Attachment for Horizontal Milling at a Slight Angle with the Axis of the Main Spindle

jobs that from time to time arise in every shop, and which the ordinary machines with regular equipment are not sufficient to handle. The attachment will fit all sizes of milling machines built by the makers. It is held in place by being clamped to the knee slide on the column of the machine, the same as the vertical spindle and other attachments of this type, and it can be attached or removed very quickly and without difficulty.

In Fig. 3 the attachment is shown applied to the machine, with its spindle at right angles to the axis of the regular milling machine spindle but parallel with the table. It is here shown operating in connection with the spiral head. In Fig. 2, the attachment is shown in position for vertical milling, and in Fig. 4, for horizontal milling but in a position at a slight angle with the axis of the main spindle. Finally in Fig. 5 it is shown set for angular milling.

This device in connection with the regular horizontal milling machine makes it possible to do all classes of milling on this type of machine, and due to the fact that the attachment has been built along heavy lines, it is possible to perform vertical and angular milling practically to the full capacity of the main spindle of the machine. It has a capacity for face milling with cutters up to 6 inches in diameter. The attachment is made in three different sizes, all being

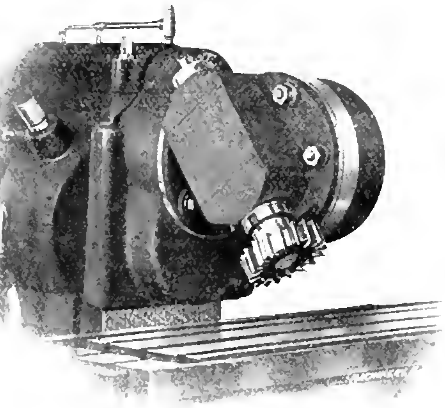
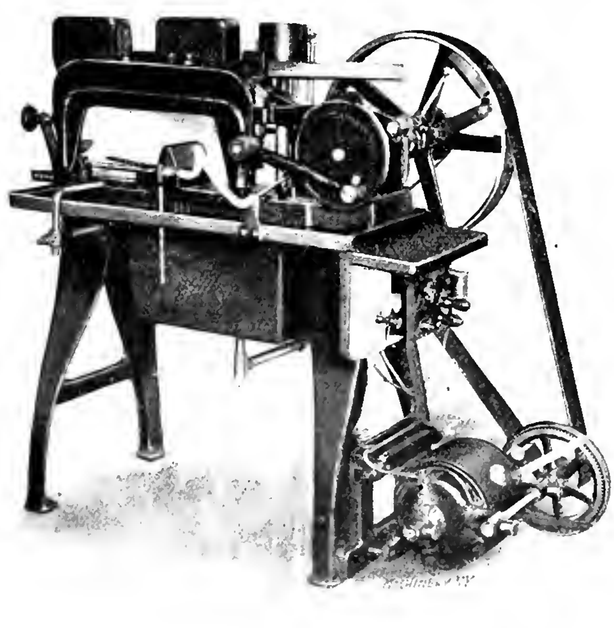


Fig. 5. The Attachment in Position for Angular Milling

provided with No. 10 Brown & Sharpe taper hole in the spindle. The distance from the center of the spindle to the bottom of the attachment does not exceed 1 9/16 inch, and the distances from the center of the spindle to the face of the column when used for vertical milling is 10⅞, 11¼ and 11½ inches, respectively, for the three different sizes. The net weights of the attachments are 265, 290 and 325 pounds, respectively.

RACINE MOTOR-DRIVEN HACK-SAW MACHINE

A hack-saw manufactured by the Racine Gas Engine Co., Racine Junction, Wis., was illustrated and described in the New Machinery and Tools department in the July, 1908, issue of MACHINERY. This machine has now been equipped with direct motor-drive, as shown in the accompanying illustration.



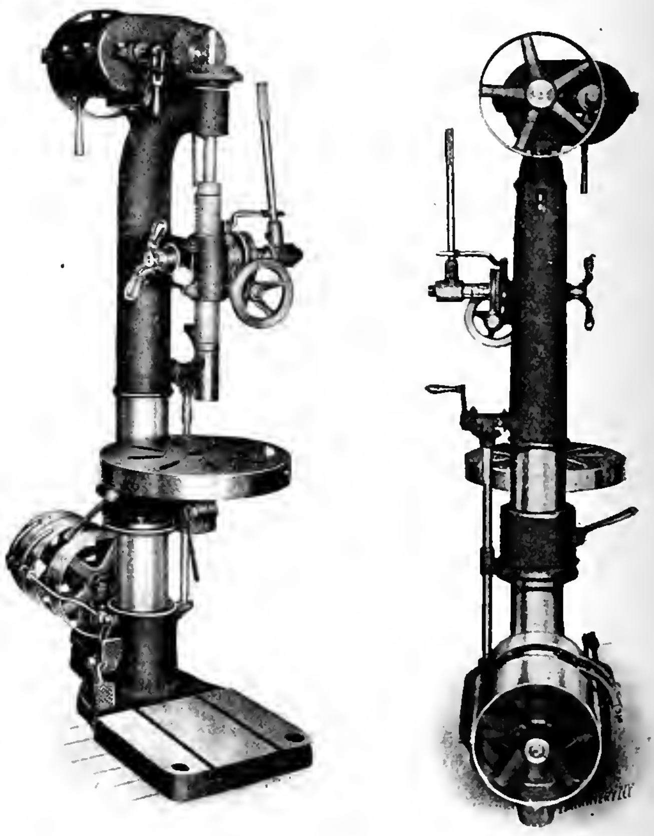
Motor-driven Hack-saw Machine, manufactured by the Racine Gas Engine Co., Racine Junction, Wis.

An important feature in this machine is that means are provided for lifting the saw from contact with the work on the back stroke, thus lengthening the life of the saw and increasing the rapidity of the cutting as well as leaving a smooth surface on the ends of the cut-off work. As will be seen in the illustration the motor is mounted on the lower part of one of the legs of the machine, reduction gearing being provided, and a belt transmitting the motion from the small lower pulley to the large driving pulley. As examples of the capacity of the machine it may be mentioned that a 1½-inch round cold-rolled steel bar can be cut off in 1½ minute, using common hack saw blades, no special blade being required in the machine. Another example of the capacity is that a 70-pound steel rail can be cut off in six minutes.

A special arrangement has been introduced for lubricating the saw while cutting. As seen in the illustration, a rubber hose connects a pipe to the right, which is fed directly from the oil pump, with an adjustable spout over the saw. As will be seen, this spout is mounted on the top of a rod which passes through the side of the bed and is held in position by means of a thumb screw. At the top of the rod a bracket is provided so that the spout can be swiveled about it. This combination makes it possible to raise or lower the spout as well as turn it to any position required.

SIBLEY HIGH-SPEED DRILL PRESS

The accompanying illustrations show a front and rear view of a high-speed drill press recently brought out by the Sibley Machine Tool Co., South Bend, Ind. It has been designed es-



Figs. 1 and 2. Front and Rear Views of 24-inch Drill Press, built by the Sibley Machine Tool Co., South Bend, Ind.

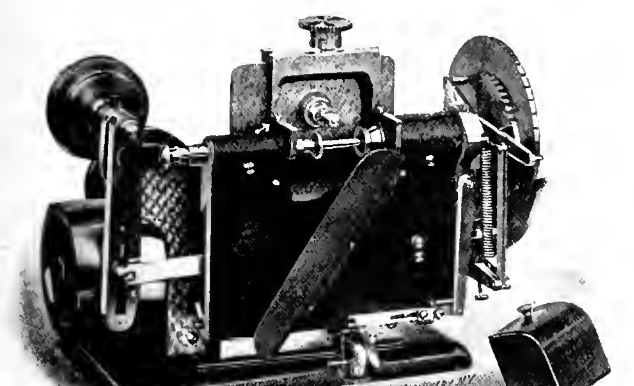
pecially with the view of meeting the demands of the automobile trade, and is provided with some features, new in upright drills, the most prominent of which is the location of the change gear box, which is placed on the top of the column, thus eliminating cone pulleys entirely, the drive being by means of a single constant-speed pulley. The gear box permits of eight changes of speed, and the construction is such that any speed can be thrown in instantly while the machine is running. The change speed gears in the gear box run in oil. The machine shown in the illustration is provided with combined hand-wheel and lever feed, but the machine is also made with geared power feed, if desired. The spindle is fitted with a hole for No. 4 Morse taper, and is provided with ball thrust end bearings. All running bearings are made of bronze. The machine has ample power to run high-speed steel drills of 1½ inch diameter up to the limit of their capacity.

WALTHAM AUTOMATIC GEAR-CUTTING MACHINE

In the June, 1908, issue of MACHINERY an automatic precision gear cutting machine built by the Waltham Machine Works, Waltham, Mass., was illustrated and described. The

accompanying engraving shows an improved design of this machine, differing from the one previously described in many important details. The machine is especially well adapted for cutting brass gears on account of the complete protection from chips provided for the indexing mechanism, the cams and the slides; but it is also suitable for other work and will cut steel gears and pinions of fine pitches satisfactorily. The protection for the working mechanism is obtained by means of a plate attached to the cutter slide and held in contact with the back side of the hood on the work slide. A removable cover also completely encloses the work and cutter, except for an opening below the work through which the chips fall.

During the return of the work slide, after the cut is taken, the cutter is lifted from the work so that the indexing can take place on the return stroke without loss of time. The location of the work slide in relation to the cutter can be adjusted laterally, and the depth of the cut is adjusted by a small handwheel, provided with graduations, at the top of the cutter slide. A large index plate is provided so as to insure accuracy of the divisions, and the different divisions are obtained by the adjustment of a single screw.



Automatic Gear-cutting Machine for Small Work, built by the Waltham Machine Works, Waltham, Mass.

With a "one-cut" machine, *i. e.*, a machine intended to cut to full depth at once, the feeding of the slides and the indexing of the work is continued automatically until all the teeth have been cut, and then the machine stops. With a "two-cut" machine, after the completion of one revolution of the work, the cutter is fed downwards a little deeper for a finishing cut, and the operations are continued another cycle, the machine stopping first after the completion of the second revolution of the work. This feature is of great value when cutting fine pitch teeth or very smooth work, as a finishing cut can, in this way, be made automatically without the attention of the operator.

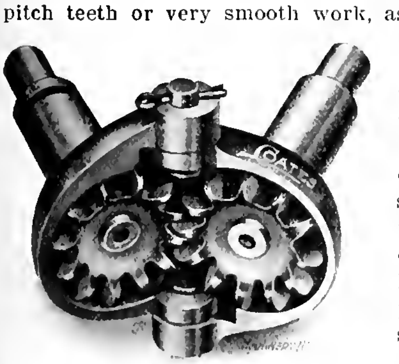


Fig. 1. Universal Coupling Drive operating at any Angle, made by the Coates Clipper Mfg. Co.' Worcester, Mass.

Two sizes of this machine are made; the smaller size is adapted for work up to 1¼-inch diameter, 32 diametral pitch in brass, and 48 diametral pitch in steel. The longest stroke of the work slide in this machine is 1¾ inch. The base of the machine is 9½ x 12½ inches, and the weight is 115 pounds. The larger machine cuts up to 3 inches diameter, 24 diametral pitch in brass and 32 diametral pitch in steel, the longest stroke of this machine being 3 inches. The size of the base is 11½ x 19½ inches and the weight 285 pounds. If required, a pump and a pan base will be provided for steel work.

COATES MONGREL GEAR UNIVERSAL COUPLING DRIVE

The problem of a satisfactory universal joint, which will work well and transmit power without excessive losses, whether the two shafts to be connected are entirely in line or at a very acute angle with each other, has always been an interesting one to machine designers. A great many universal joints have been brought out which will work very satisfactorily as long as the angles between the two shafts connected do not become too great; but few universal drives will work well when the angle of deviation of the axis of one

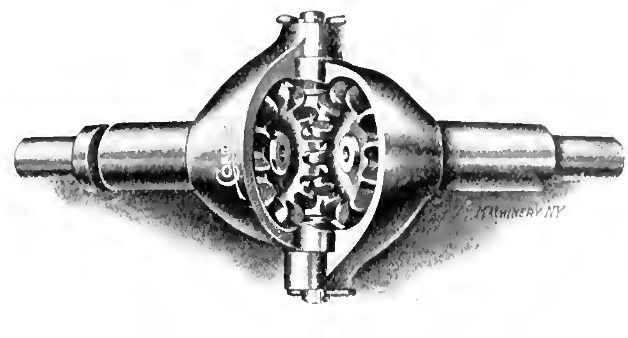


Fig. 2. The Universal Coupling in a position where the Two Shafts are more nearly in Line than in Fig. 1

shaft to the axis of the other becomes more than 45 degrees. The accompanying illustrations, therefore, of the Coates mongrel gear universal coupling drive, will be of particular interest.

This device is manufactured by the Coates Clipper Mfg. Co., Worcester, Mass., and its construction makes it possible to transmit power between two shafts either when they are practically parallel, or at a very acute angle as in Fig. 1, or when more nearly in line as in Fig. 2. When the two shafts are entirely in line, as in Fig. 3, the joint becomes practically a positive coupling, while in Figs. 1 and 2 the action is that of bevel gearing, the teeth cut on the parts keyed to the ends of each of the two shafts engaging with each other. The action and construction of the device is very plainly seen from the illustrations and there is little to be said in this respect. The cutting of the teeth in the gears is an interesting operation, and may deserve brief mention. The teeth are cut automatically on one of the Standard Mfg. Co.'s automatic gear cutting machines, shown in the May, 1906, issue

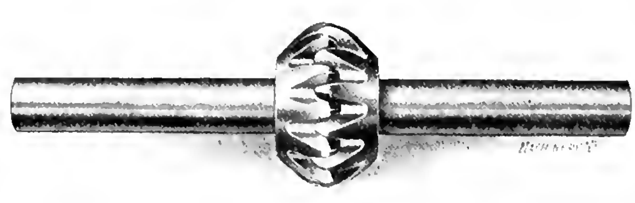


Fig. 3. The Mongrel Gear used as a Postive Coupling

of MACHINERY. This machine is provided with special cams so that the peculiar form in the bottom of the teeth which is not a straight line but a convex curve may be obtained while the cutter passes once across the work. By means of this machine it is possible to, automatically, first feed the cutter forward and then downward, thus obtaining the required shape of tooth.

Owing to its peculiar construction and the possibilities of drive which present themselves in this device, it will undoubtedly be of interest to mechanical men, as it is possible by means of this combination to use angular drives that would be difficult or impossible for regular universal joints or couplings.

DRAFTING TABLE

A new type of draftsman's table has recently been added to the line of drawing-room appliances manufactured by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The particular features of the table are the means for vertical adjustment, and the fact that the table or drawing board proper can be tilted to any angle desired. The top is made of well-seasoned white pine and is cleated to prevent warping, the cleats being so arranged that the shrinkage and expansion are taken care of. Universal drafting machines and parallel rules may be applied to the board if desired.

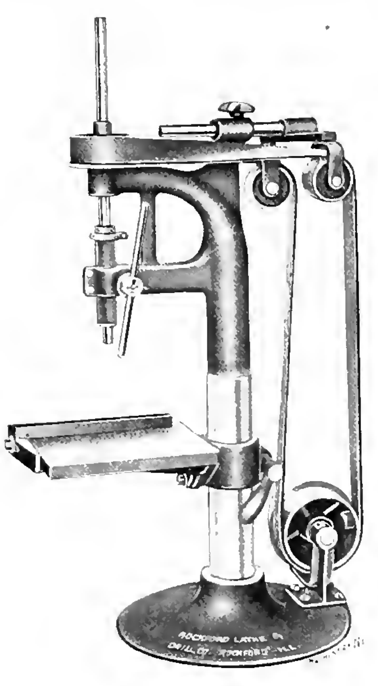
On the under side of the table two cast iron brackets are fastened, these brackets swiveling on the ends of the upright spindles. These swivels are clamped by two nuts operated by means of the small hand-wheel shown on the right-hand side directly below the board. The raising and lowering of the table top is accomplished by the hand-wheel shown near the right-hand upright. Two pinions meshing into racks set into

Draftsman's Table, built by the Washburn Shops of the Worcester Polytechnic Institute

the spindles are keyed to the hand-wheel rod. The raising and lowering feature is rather unique in that the spindles are always automatically locked in position and yet by simply turning the hand wheel in either direction the locking arrangement is released and the top is raised or lowered. The locking device is simple and requires no adjustment, and it has been shown by actual tests that it will stand 1,300 pounds pressure before slipping.

ROCKFORD TEN-INCH BENCH DRILL

The 10-inch sensitive bench drill illustrated in the accompanying half-tone engraving is manufactured by the Rockford Lathe & Drill Co., Rockford, Ill., formerly Rockford Machine & Shuttle Co. The countershaft for this drill can be placed either on the wall or on the ceiling, the driving cone being placed on the base of the machine to prevent vibrations. The driving belt from the pulley at the base to the pulley on the spindle passes over two idler pulleys. These are mounted in an adjustable bracket, so that by means of this adjustment the belt can be tightened as required. The table of the machine can be swung around the column, and can also be tilted to any position, making it very convenient in drilling angular and irregular work. A supporting bracket, as shown in the illustration, is provided, which can be placed on the table when drilling holes at an angle, for supporting the work and preventing it from slipping. The bracket can also be used for preventing work being drilled from revolving.



Ten-inch Bench Drill, made by the Rockford Lathe and Drill Co., Rockford, Ill.

The spindle is ¾ inch in diameter, its length being 17 inches. The lever feed of the spindle is 3 inches, and the vertical adjustment of the table 7¼ inches, the greatest distance from the spindle to the table being 10¾ inches. The table is square, 8 × 8 inches. The driving pulley on the countershaft is 5 inches in diameter for a 1½-inch belt, and the speed of the countershaft is 550 revolutions per minute. The weight of the machine is 112 pounds.

BARNES 24-INCH UPRIGHT DRILL

The 24-inch upright drill illustrated herewith, has recently been brought out by the Barnes Drill Co., 602 S. Main St., Rockford, Ill. This machine is of the same general design as the 20-inch upright drill which was illustrated and described in the May, 1908, issue of MACHINERY, and which has now been on the market for more than one year, during which time it has proved exceptionally satisfactory. The 24-inch drill, while of the same general appearance is, of course, stronger and more powerful. It is of the all-geared type, and is capable of handling as heavy work as the ordinary belt-driven 28-inch drill. The machine has 20 changes of positive power feeds, ranging from 0.0015 to 0.031 inch. All the feed changes can be made instantly by the operator from his position in the front of the drill, without stopping the machine.

Twenty-four-inch Upright Drill, built by the Barnes Drill Co., Rockford, Ill.

The speed changes, including the throwing in and out of the back-gears, can also be made when the machine is running.

The capacity of the drill is up to 2-inch high-speed steel drills, drilling steel. As an example of the power of the machine it may be mentioned that a 2 9/32-inch hole has been drilled in one minute with ordinary carbon steel drills through 2 inches of cast iron at the highest back-geared speed (64 revolutions per minute), or at a feed of 0.031 inch per revolution. In another case a 1 29/32-inch carbon steel drill was pushed through steel 1 inch thick in 55 seconds at a speed of 100 revolutions per minute and a feed of 0.011 inch per revolution. This, in fact, was all that the carbon steel drill could stand. With a 1-inch high-speed steel drill, the machine will drill through 1½ inch in steel in 23 seconds without the back-gears, at a speed of 258 revolutions per minute.

The machine is regularly furnished with back-gears and positive power feed box, but if desired, it can be supplied without the back-gears and the power feed. The machine can also be supplied with back-gears, but without power feed. The table of the machine is provided with T-slots as shown in the engraving, or elongated holes or slots through it, as required. When an oil pump is provided with the machine, it is furnished with a square table, having an oil channel around the edges.

The total height of the drill is 78 inches. The distance from the column to the center of the table is 12¼ inches. The maximum distance from the spindle to the table is 30 inches, and the maximum distance from the spindle to the base is 44½ inches. The diameter of the table is 20 inches, and the diameter of the spindle is 1¾ inch. The spindle is provided with a No. 4 Morse taper hole. The vertical travel of the spindle is 14 inches and of the table 19¾ inches. The ratio of the back gears is 4 to 1. The driving pulley, which is 12 inches in diameter by 4 inches wide, should run at 325 revolutions per minute. The floor space, exclusive of the tight and loose pulleys, which overhang 10½ inches, is 44 by 20 inches. The net weight of the machine complete is 1080 pounds.

LANGELIER SIX-SPINDLE GANG DRILL

The accompanying half-tone illustrations, Figs. 1 and 2, show a front and rear view, respectively, of a sensitive six-spindle gang drill recently brought out by the Langelier Mfg. Co., Providence, R. I. This machine embodies some rather interesting features, the principal one of which is that any of the drill spindles may be brought down independently by operating the foot lever shown in Fig. 1. The machine is not intended for work requiring the drilling of six holes at once, but the object of the machine is to perform six drilling, tapping or reaming operations when they occur in the same piece of work; each spindle performs one operation and the jig or work is passed from one spindle to the other, successively. In a machine of this type it is evidently desirable that all the spindles be brought as close to each other as possible, so that the operator sitting in front of the machine can perform the work without moving from his seat. In order to make this possible, however, it is necessary for each of the spindles to be brought down independently of the others when it is performing its work, so that there is no interference between the other spindles and the jig or the work. This is accomplished by operating the foot lever which actuates the feed for each spindle separately in rotation.

Fig. 1. Six-spindle Sensitive Gang Drill, built by the Langelier Mfg. Co., Providence, R. I.

The connection between the foot lever and the spindles consists of a segment gear which meshes with a ratchet gear on the cam shaft, shown in the rear part of the machine. On this cam shaft is mounted a feed cam for each spindle, these cams being adjustable so that the feed of the spindle can be actuated in any desired manner. The ratchet arrangement prevents the cams from returning to their original position when the pressure on the lever is released so that in this manner one spindle after the other is successively brought into operation by the foot lever. Each spindle has also a hand feed acting independently of the foot feed and an adjustable stop is provided for regulating the depth of holes when drilling.

The spindles are fitted with No. 11 Skinner chucks and are capable of drilling 3/16-inch holes in steel. The vertical feed of the spindles is 2¼ inches. The distance from center to center of the spindles is 3¼ inches. The table of the machine has a working surface of 8 x 28 inches, and is adjustable vertically 4½ inches. The greatest distance from the end of the chucks to the lowest position of the table is 7 inches. The tight and loose pulleys on the countershaft are 5 inches in diameter for 2-inch belt, the countershaft running at 200 revolutions per minute. These machines may be made in gangs with any number of spindles from two up to six, inclusive, and the distance between the centers of the spindles can be made to suit the requirements of the customer.

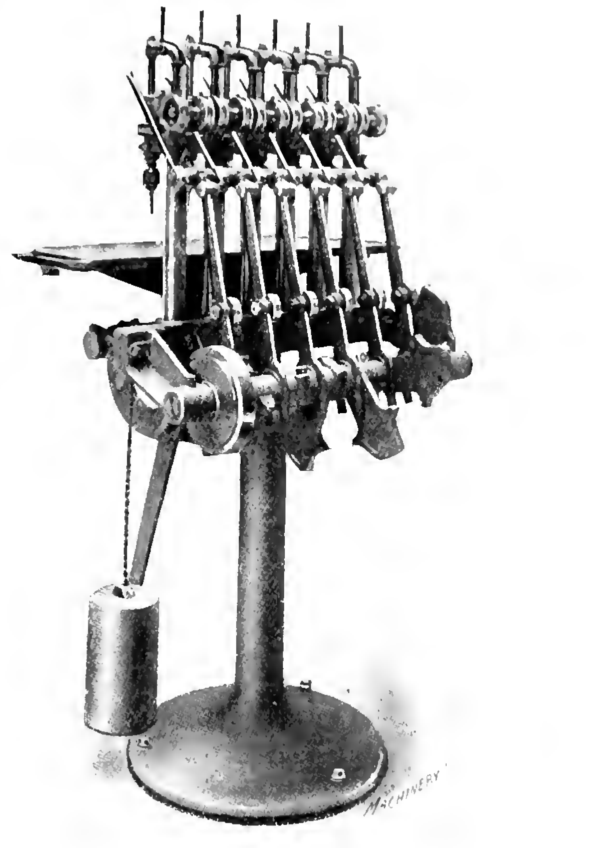
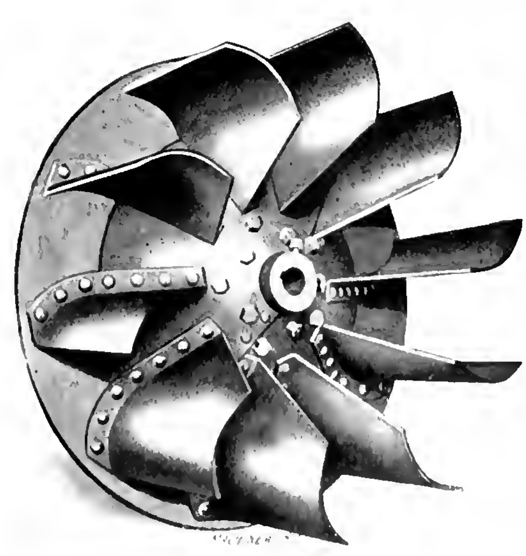


Fig. 2. Rear View of Gang Drill, showing Cam-shaft and Cams for actuating each Drill Spindle independently

BUFFALO SLOW-SPEED EXHAUST FAN

A slow speed exhaust fan, designed particularly with a view of reducing the power consumed for driving, has recently been brought out by the Buffalo Forge Co., Buffalo, N. Y. The fan is known as the Buffalo slow speed low power exhaust fan, and runs at a 20 per cent lower speed than standard exhausters of the same size. It will, however, perform the same work as the standard fans with a 10 per cent reduc-



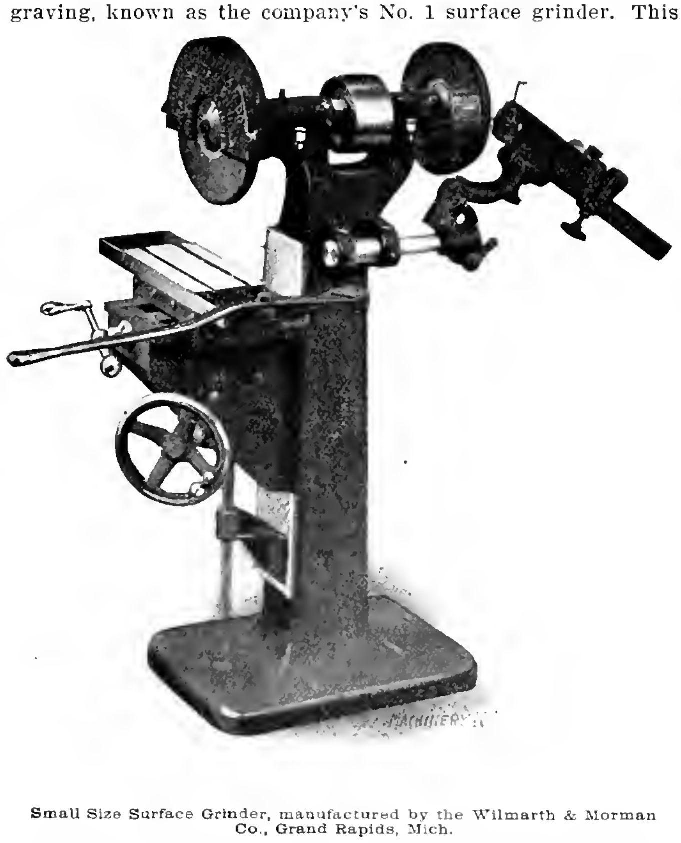
Slow-speed, Low-power Exhaust Fan, made by the Buffalo Forge Co., Buffalo, N. Y.

tion in power consumption. The blast wheel is built of heavy steel plate and instead of the spider usually employed for supporting the vanes, a steel plate cone is used. The apex of this cone is at the inlet of the fan so that the material to be exhausted, when entering the fan, strikes the cone, the direction of the material being gradually changed in this way without the loss of momentum due to sudden changes in direction. The cone offers no obstruction to the free passage of the material. The vanes are securely riveted to the cone and also to a heavy steel plate flange at the side opposite the inlet. This flange is extended beyond the tip of the vanes, preventing any material, thrown from the vanes, from coming in contact with a dead surface and retarding the progress. The fan is overhung on a shaft running in long journal bearings of the double ring oiling type. These bearings are supported on heavy cast iron pedestals in such a manner that the alignment of the fan is constantly maintained. The housing is built of heavy steel plate, securely bolted to a steel frame. It is adjustable to any angle of discharge on either side. All the necessary adjustments are quickly made on the outside of the housing. To change the direction of the discharge the bolts in the ring of each pedestal are loosened, and then the housing is revolved to the desired position.

These exhausters are applicable to various purposes, such as the removal of shavings, sawdust, refuse from wood-working machines and from buff and emery wheels, and from other abrasive processes. They can, of course, also be used for the exhaust of gases, acid fumes, etc.

WILMARTH & MORMAN SURFACE GRINDER

In order to meet the demand for a small convenient surface grinding machine of moderate capacity at a reasonable price, the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has placed on the market the machine shown in the engraving, known as the company's No. 1 surface grinder. This



Small Size Surface Grinder, manufactured by the Wilmarth & Morman Co., Grand Rapids, Mich.

machine has been built with a view of producing a machine equal in accuracy to larger machines, but limited to smaller work. The working surface of the table is 6 inches wide by 12 inches long, and sufficient movement is provided so that the grinding wheel can clear the working surface perfectly at both sides and at both ends. The transverse and vertical feed screws are provided with graduated dials with graduations reading in thousandths of an inch. These graduations are sufficiently coarse, so that even smaller sub-divisions can be readily obtained when such a degree of accuracy is required. The table is supported by the well-known knee and saddle construction used in milling machines, ample bearings being provided so as obtain the required rigidity. The vertical adjustment is obtained by a screw, as shown.

The machine is regularly provided with a grinding wheel of 12 inches diameter by 1 inch face, this wheel being intended to run at a speed of 1,400 revolutions per minute. The spindle bearings are cast in one piece with the column of the machine, which provides for rigidity and strength impossible to obtain when the spindle is carried by removable bearings. There is practically no overhang of the spindle at the end where the wheel is carried, thus increasing the capacity of the grinder for heavy cuts. On the opposite end of the spindle an additional grinding wheel is provided and the machine can be furnished either with or without the drill grinding attachment shown. Regularly it is furnished with this attachment which is of the well-known "New Yankee" type, which does not require any preliminary adjustments for bringing the drill in the proper position for grinding. The capacity of the attachment can be varied to suit the requirements of any individual shop.

NEW MACHINERY AND TOOLS NOTES

Four-Spindle Drill: American Watch Tool Co., Waltham, Mass. This machine consists of four independent sensitive bench drills mounted on a cast iron base-plate and adjustable to any position along the base. The spindles are operated by a foot treadle on the floor. The base-plates can be furnshed in lengths varying from 10 to 23 inches.

Quick Adjusting Micrometer: H. O. Costello, 87 Oakland Ave., Providence, R. I. This tool is an improvement on the quick adjustment micrometer mentioned in a brief note in the November, 1908, issue of Machinery. By means of a ratchet arrangement the barrel is adjusted rapidly for position without making use of the micrometer screw for the full length of the adjustment.

Bolt Pointing Machine: Webster & Perks Tool Co., Springfield, O. This machine is intended for pointing the ends of rods from 1/4 to 1/2 inch in diameter. The operation is very simple: The operator places the piece to be pointed in a vise against a stop and presses a foot lever; this grips the work and brings the cutter head forward. In this way, bolts can be pointed as rapidly as the operator can handle them.

Sixty-Degree Drafting Board: Emmert Mfg. Co., Waynesboro, Pa. This drawing board, known as the Noyes board, slides at a 60-degree angle, its weight being balanced so that it moves easily up or down. The frame is placed on any flat top table, and is usually provided with a board or leaf in addition to the inclined one, which is nearly horizontal and which can be used for calculations and reference drawings.

Saw Sharpening Machine: Hunter Saw & Machine Co., 59th and Butler Sts., Pittsburg, Pa. This machine has been designed for sharpening circular milling saws, and sharpens not only the faces and the tops of the teeth, but also bevels the cutting points in such a way as to materially add to the life of the saw and at the same time make it consume less power when in operation. Saws from 6 to 54 inches can be sharpened on the machine.

Breast Drill: North Brothers Mfg. Co., Philadelphia, Pa. With this drill two speeds are available, either of which can be obtained instantly, even when the drill is in motion. The tool is also so designed that it can be used either as a regular breast drill or as a right- and left-hand ratchet brace. These and other special features introduced in this drill, which differs considerably from the ordinary type, make it a very convenient tool for a great many different purposes.

Electric Hoist: Gustav Rasmus, 514 West 57th St., New York City. This hoist, while having a capacity of 5 tons, requires only 35 3/4 inches head-room, and weighs only 500 pounds. This is due to the fact that the motor is placed inside of the hoist drum, which constitutes the motor frame. The drive from the armature shaft is through a worm and worm-wheel, so that load and speed brakes are not required, as the gears are locked in position by the worm when the motor is at rest.

Large Drop Hammer: Erie Foundry Co., Erie, Pa. This machine is of very large dimensions, it being a 3,500-pound hammer, with an anvil block weighing 70,000 pounds. The entire weight of the hammer is 98,000 pounds. The hammer is provided with a piston stop placed at the top of the cylinder, which protects the cylinder head against damage due to carelessness or to the breaking of the rods or pulling loose of the cross-head. Adjusting screws are provided for cross movement of the anvil for lining up the dies quickly.

Precision Bench Lathe: American Watch Tool Co., Waltham, Mass. This machine is of the usual bench lathe type but some improvements have been introduced, particularly as regards the bearings for the spindle in the head-stock. The front end of the head-cone is also provided with graduations corresponding to the index holes at the back of the cone, mak-

ing it unnecessary for the operator to move from his position in order to set the index. The machine has a bed 36 inches long with a swing of 8½ inches and a chuck capacity of ⅝ inch.

Bench Profiling Machine: American Watch Tool Co., Waltham, Mass. This miniature profiling machine is designed along the same lines as the ordinary profiling machine with a vertical spindle and a guide located beside it. The vertical movement of the spindle is 1 inch and the cross movement 1⅞ inch. The slide or table below the spindle is capable of a 4-inch movement. By a simple arrangement the same handle operates both the vertical movement of the spindle and the side movement along the cross-rail of the slide carrying the spindle bearings.

Disk Grinder: Ransom Mfg. Co., Oshkosh, Wis. This grinder, designed especially to meet the requirements of the automobile trade, is furnished with disks either 23 or 27 inches in diameter; one grinding disk is provded at each end of the frame or column, the driving pulley being placed in the center between the spindle bearings. The work-tables at each end of the machine have independent lever feed, so that two operators can work simultaneously. Both tables can be tilted to an angle of 45 degrees with the face of the disk, and can be raised or lowered as desired.

Armor Plate Slitting Shear: Buffalo Forge Co., Buffalo, N. Y. This machine is not intended for cutting armor plate, as the name would imply, but the frame of the shear is made from armor plate which is a particularly touch and tenacious material and possesses a high elastic limit, especially suited for a machine of this character, subjected as it is to sudden and severe strains. The shear will cut metal of any width up to ¼ inch in thickness, and while possessing the requisite strength, it is, owing to the material from which it is constructed, lighter than any shear of similar capacity.

Milling Attachment for the Drill Press: E. C. Bliss Mfg Co., 91 Sabin St., Providence, R. I. This attachment is intended to be placed on the regular drill press table and is provided with slides in two directions so that milling operations can be performed by an end milling cutter placed in the drill press spindle. The working surface of the table is 8¾ by 21¼ inches, having a longitudinal movement of 9 11/16 inches and a cross movement of 5¾ inches. No swivel is provided, as the drill press table can be swung around when required. The adjusting screws have graduated collars reading to 0.001 inch. The weight of the device is 110 pounds.

Improved Lifting Magnet: Cutler-Hammer Clutch Co., Milwaukee, Wis. An improvement of this company's lifting magnet, shown in the September, 1907, issue of Machinery, has recently been made. The new magnet is of a smaller size and lighter than those previously described, but its lifting capacity is nearly as great. In the design, attention has been given to the conditions under which a device of this kind is operated, and the magnet can be used out-of-doors in any kind of weather without damage. Pig iron has been unloaded from gondola cars by means of it at the rate of 100 tons per hour and at a cost of ½ cent per ton, as against 5 or 8 cents per ton for manual labor.

Universal Monitor Lathe: Dreses Machine Tool Co., 227-239 West McMicken Ave., Cincinnati, O. This machine, as the name indicates, is provided with a turret and turret slide, the latter being provided with set-over and swivel. The top slide has combined lever and screw feed, and all slides have taper adjusting gibs. The turret is locked by a gibbed square key. The head and bed of the machine are cast in one piece, with entirely enclosed friction back-gearing. The entire operating mechanism of the friction in the head can be put in place and removed without taking out the spindle. A taper attachment is provided, placed separately on the bed below the V's, having knurled screws for fine adjustment.

New Line of Upright Drills: Cincinnati-Bickford Tool Co., Cincinnati, O. This company has redesigned its line of upright drills, including the 20-inch sensitive drill, the 21-inch drill with stationary head and the 21-inch drill with sliding head. Among the improvements included in the 20-inch drill are graduations on the spindle sleeve and an automatic stop for tripping when the required depth of hole has been drilled. In addition, ample guards have been provided for all gearing. The 21-inch machine has been provided with a new tapping attachment. This machine is back-geared, the back-gears being operated by a lever-controlled clutch. Power feed is provided by means of cone pulleys and worm and bevel gearing. In the sliding head machine, the head has a movement of 17½ inches, the table a movement of 16¾ inches and the spindle a traverse of 9 inches, giving the machine a large range. Improvements in the design of the full line of upright drills from 24 to 42 inches have been made, to make the machines capable of using high-speed drills to their full capacity.

* * *

"Most of the books on trigonometry are elaborate enough for a surveyor or an astronomer. A machinist doesn't want so much. For him to learn it all is too much like scraping something true to a surface-plate where it only fits against thin air."—*Extract from a letter.*

CHICAGO DUPLEX FEATHER KEYSEATING MACHINE

In the August, 1909, issue of Machinery a description of the Chicago duplex hand milling machine was published. The accompanying half-tone engravings, Figs. 1 and 2, show this machine in operation with both the vertical and horizontal spindles in use simultaneously. When thus arranged, the machine is intended in particular for the quick handling of feather keyseating work. The horizontal spindle is fitted with an arbor having a No. 9 Brown & Sharpe taper shank, the shank being held in place by a draw bar. On this arbor is mounted the required cutter for cutting the desired width of the feather keyseat. In the vertical spindle is placed an end mill of the required size, which is held in place by a draw-in collet.

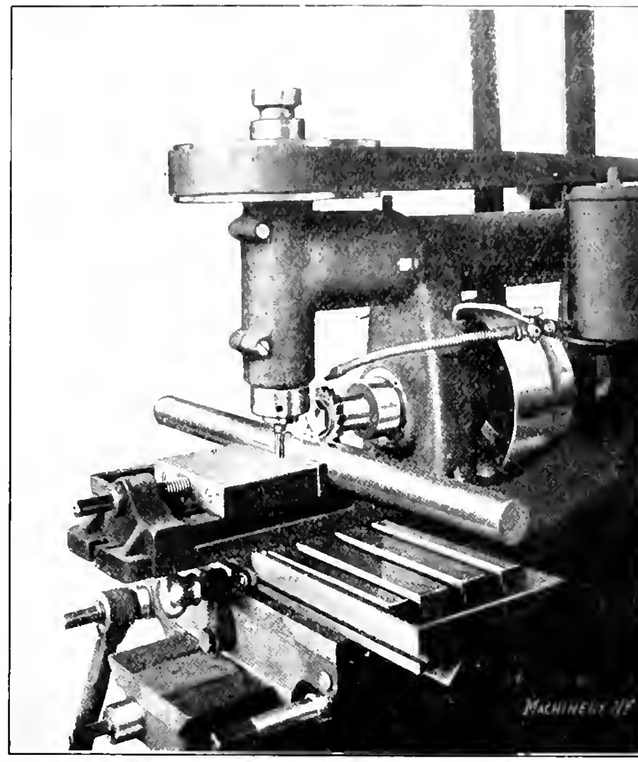


Fig. 1. First Operation in milling a Feather Keyseat on the Chicago Duplex Milling Machine

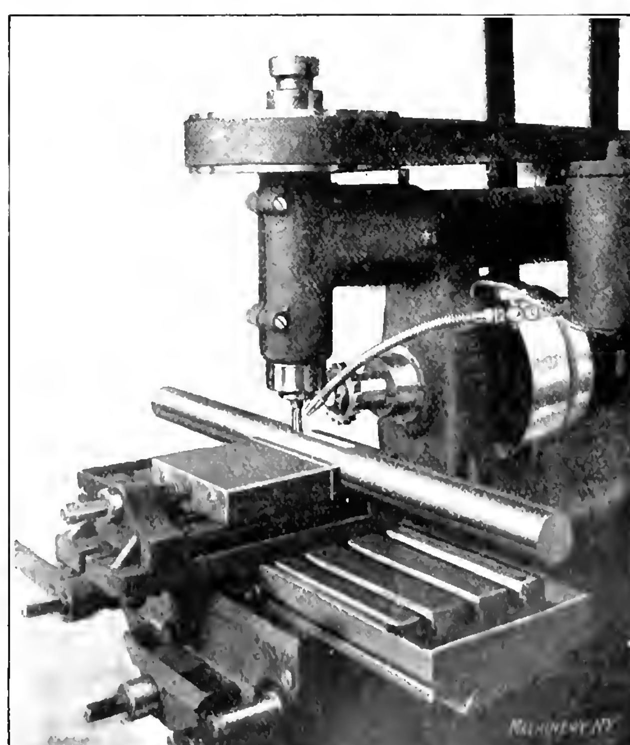


Fig. 2. Second Operation in milling the Feather Keyseat

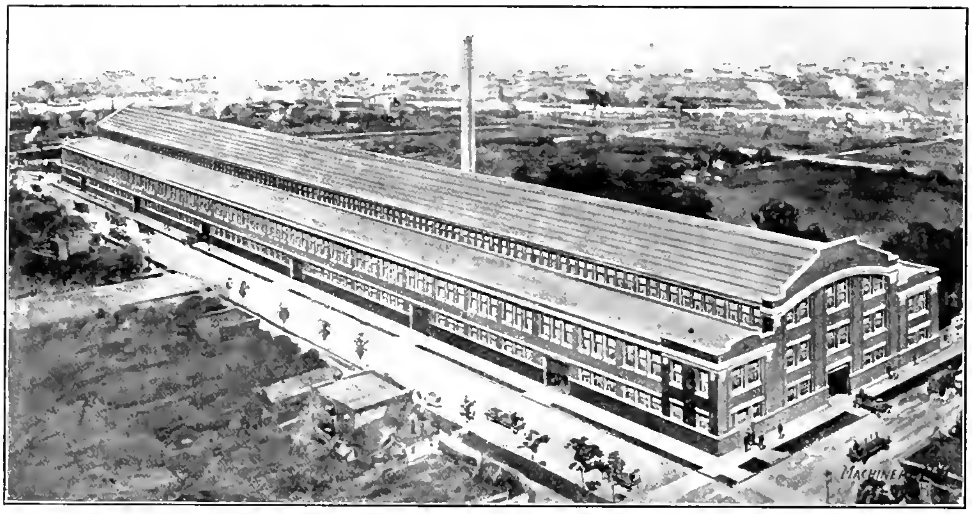
In Fig. 1, the machine is shown performing the first part of the operation of cutting a feather keyseat. The shaft in which

the keyseat is cut is held in a vise, and the side milling cutter shown mills out the keyseat excepting the finishing of the ends. This part of the operation is performed by the end mill in the vertical spindle, as shown in Fig. 2, where the table carrying the vise and shaft has been brought directly beneath the end mill. This makes a very handy arrangement for milling feather keyseats, as the two complete operations necessary for the milling can on this machine be made without resetting the work or even stopping the machine; thus, in reality, it may be considered as a continuous operation. The machine is equipped with six changes of power feed as well as crank and lever feeds, thus having a sufficient range to cover all ordinary work. The hand-lever feed is brought into service when the table is quickly returned after a cut has been taken. An adjustable automatic stop to the table feed is also provided which can be set for the length of keyseat desired. Hill, Clarke & Co., Inc., 125 North Canal St., Chicago, Ill., are the selling agents for this machine.

* * *

CHICAGO MACHINERY EXHIBITION WAREHOUSE

The illustration shows a new machinery exhibition warehouse just completed in Chicago that is 100 feet wide and 400 feet long and absolutely fireproof, being built of reinforced concrete throughout. It is located at 37th St. and Ashland Ave., on the Chicago Junction Railway, connecting with all railroads and boat landings. It was built by the Pfannmueller Engineering Co. to plans supplied by architect A. S. Alschuler, and was erected by general contractors J. P. & J. W. O'Connor.



Reinforced Concrete Machinery Warehouse just completed in Chicago at 37th Street and Ashland Avenue

The building is three stories high in front, two stories on the sides and one story in the center. The offices are on the three floors in the front of the building and run across the entire width of the building, giving office space on the second story 20 by 100 feet and on the third story 20 by 50 feet. The space in the center of the building, 50 feet wide by 40 feet high, runs the entire length of the building and is absolutely unobstructed. It is spanned by a 50-foot 25-ton Alliance traveling crane having a 6-ton auxiliary. The balconies on the sides are supported by massive concrete columns 20 feet apart, and these also support the crane runway. The spaces on the ground floor beneath the balconies are 20 x 25 feet, and may be partitioned off when so desired and thus make individual exhibition and storage rooms. In order that heavy machinery may be handled readily on the first floor, eye-bolts are set every ten feet in the brick wall to provide a means of attaching block and tackle to be used in connection with the crane for pulling heavy machinery into and out of these spaces. The balcony floors extend into the middle space 5 feet under the crane and are equipped with removable rails, thus providing a passageway and means by which the crane can serve the balcony. The building will be finished with all modern conveniences, including electricity, steam heat, ample toilet arrangements, shower baths, telephone switch-board with several trunk lines, etc.

Fig. 1. Ratchet Wrench for Tightening Tie-rod Nuts on Pipe laid in a Trench

In the rear of the structure there is a paved yard, fenced in, 100 feet wide and 160 feet long which will be used for rough machinery and metal products that do not necessarily have to be kept under cover. This space provides for the extension of the building. A private switch from the Chicago Junction Railway enters the building at the rear.

The building is located in the center of the manufacturing district and in the geographical center of Chicago. It is accessible by numerous car lines, and in view of the unsatisfactory conditions generally existing in Chicago affecting salesrooms and warehouses, it is believed that the new venture will fill a long-felt want. The fact that the equipment will handle heavy machinery at a minimum cost and that there will be no switching charges on carload shipments either incoming or outgoing, makes possible a big saving of charges now borne by the machinery warehouses not located so advantageously or provided with modern handling equipment.

* * *

RATCHET WRENCH FOR TRENCH WORK

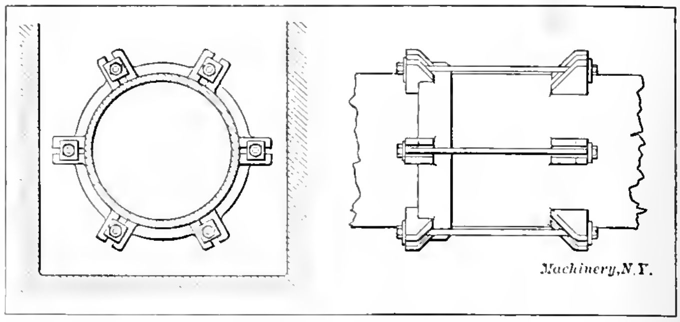


Fig. 2. Illustration showing the Work for which the Wrench shown in Fig. 1 was designed

The Philadelphia Gear Works was called upon recently to design some form of wrench for tightening 1¼-inch hexagon nuts at the bottom of a trench 3 feet wide and 10 feet deep. These nuts were on the tie-rods of a 20-inch cast-iron pipe line (see Fig. 2) where there was very little room in which to work, and some special arrangement was necessary for tightening them. To enlarge the trench was not advisable as excavating was done at so much per cubic yard, and as there were fifteen miles of pipe being laid, the idea of widening the trench at each joint to permit of the use of an ordinary wrench, was abandoned. The device shown in Fig. 1 was designed and does the work admirably. This wrench is simple in its construction as it consists of nothing more than a hexagon cup to fit the nut, a pair of miter gears mounted on a light frame, and a reversible ratchet and lever. As will be understood, the miter gears are to bring the ratchet shaft at an angle of 90 degrees with the axis of the wrench proper, so that the wrench lever is in line with the trench, thus giving plenty of room for its operation. With this device one man can tighten the two bottom nuts with less profanity and

time than is required to set up the four more accessible nuts with an ordinary ratchet wrench.

* * *

SPARKS AS INDICATIONS OF DIFFERENT KINDS OF STEEL*

The sparks given off when grinding iron and steel, by means of emery wheels, present a different appearance according to the kind of material ground. In the following, a review is made of the appearance of the sparks of different materials, and explanation is given of the causes of the differences, and the practical applications of this method of steel testing are pointed out.

The path of the spark from its origin to its extinction forms a line of light which may be called the spark-ray. This spark-ray consists of a line of light the end of which branches out in every direction, having an explosion-like appearance. It is this end of the rays that, in particular, varies for different classes of steel, and which in the following will be called the spark-picture. Some of these spark-pictures contain only a very few lines, while others contain a great many, some of them presenting secondary explosions and projections. The rays extending from the drop formation in the spark-picture have a strikingly higher speed than the particles in the spark-rays, and it appears as if they were suddenly thrown out in various directions by an internal force.

With a carbon content of from 0.07 to 0.08 per cent, the number of the lines in the spark-picture is from two to three. With an increase of the percentage of carbon the number of the branching lines also increases. At low carbon contents the lines appear to start from different points of the drop formation at the end of the ray, but when the carbon content is as much as 0.25 to 0.27 per cent the lines spring from a common point of the drop formation. The larger the carbon content the greater is the crowding of the lines projecting from the end of the ray. (See Fig. 1.)

The spark-picture of steel containing manganese (see Fig. 2) shows at the end of the individual branching lines a secondary explosion-like phenomenon, shorter lines collecting like leaves around a common central point. The number of the primary branching lines in this case also is in proportion to the carbon percentage in the steel; the extent and shape of the spreading ends of the primary branching lines appear to be in a certain relation to the percentage of manganese contained by the material.

In the case of tool steel, the spark-picture resembles the branch of a blossom, and the individual branching lines have a lilac-like form.

The spark-rays of steel containing wolfram are dark red lines, the ends of which show no spark-picture if the emery wheel is not sufficiently sharp and the pressure between the wheel and steel is small. Only the very end of the ray has a broader and more brightly glowing appearance, indicating the beginning of a spark picture. If the steel is pressed more firmly against the wheel, branching lines spring out in an explosion-like manner. These lines, however, take the form of small shining pin-head-like balls.

The spark-sheave (the combination of spark-rays and spark-pictures) of chrome-wolfram high-speed steel is distinct from that of the wolfram steel by the fact that two kinds of rays appear, some very thin dark red, and some thicker bright red ones, which are absent in the regular wolfram steel. The spark-pictures consist solely of short curved drop forms.

The spark-picture of nickel steel, containing less than three per cent nickel, is identical with that of carbon steel with a corresponding percentage of carbon. In case of larger percentages of nickel, however, the nickel steel can readily be recognized by the aid of the spark test, because the spark-pictures show themselves in a sporadic manner whereas in the case of carbon steel they occur in close proximity and in close succession to one another.

Dark gray cast iron is characterized by fine dark red spark-rays, spark-pictures here and there, and lines collecting around the drop formation like a net. The net-like lines disappear more and more with the increase of assimilated carbon, and with light gray cast iron they disappear altogether.

Fig. 1. Spark-picture indicating High-carbon Steel Fig. 2. Spark-picture of a Tool-steel containing Considerable Manganese Fig. 3. Spark-picture of Steel containing Wolfram Fig. 4. Spark-picture of Molybdenum High-speed Steel

Theory of Spark Formations

The spark emitted when grinding is of course a particle of the metal being ground, heated to a high temperature by the friction between the emery wheel and the material. This particle of metal is thrown out in a tangential direction. At a certain point of its line of flight, the red hot spark assumes a red heat; it changes to white heat, and then transforms itself in an explosion-like manner into a spark-picture. At the moment of the explosion-like transformation the spark is in a fluid state. The latter statement can be proved by introducing a plate of glass at right angles to the line of flight and microscopically examining the glass. It is apparent that the sparks must be in a fluid condition, as they either splash asunder when striking the glass or form crystals of different shapes.

The increase of heat of the spark is caused by an internal source of heat represented, partly, by the combustion heat of the carbon, which suddenly burns. The heat of oxidation of

* Abstract from a paper by Mr. Max Bermann read before the Copenhagen Congress of the International Association for Testing Materials.

the exterior surface of the mass of sparks prevents too rapid cooling of the spark. The heat of cumbustion of the carbon provides the quantity of heat necessary for melting the metal. As a matter of fact, however, this heat is not sufficient to melt the whole mass, because the amount of carbon is too small, and only the mass of the unoxidized core within the oxidized iron crust is melted by the quantity of heat available. The combustion gases of the carbon burst the outer crust of the spark mass and throw out the fluid contents in the direction of the primary branching lines. The silicon and phosphorus contained also burn at the melting heat of the iron, and raise the temperature of the fluid mass. This theory explains why the size of the spark picture increases with the percentage of carbon.

Practical Applications of the Spark Test

The most important practical applications of the spark test may be stated as follows: Different kinds of iron may be classified according to their carbon percentage and the metals principally alloyed with them; ends of rods which may have been wrongly arranged on the storing racks may be placed against the revolving emery wheel and thus identified. It is stated that the spark test is so sensitive that differences of 0.01 per cent of carbon may be perceived. In the inspection of received material the method is valuable for making a rapid test to make sure that the material complies with the requirements. The spark test also supplies a sensitive means of ascertaining differences in chemical composition at different places of the same bar or piece of material, it being possible to apply this test to both steel and cast iron. In the hardening room the spark test may also be of value in order to make sure before hardening what grade and class of steel has been used for making the various tools, so that the proper hardening process may be applied. In the forge shop the method may be of value for determining with certainty good malleable wrought iron.

* * *

PERSONAL

G. W. Hoffman has been appointed sales engineer in charge of the Chicago office of the Hill Clutch Co., Cleveland, Ohio.

R. K. Loofbourrow is the newly appointed purchasing agent of the Electric Welding Products Co., Cleveland, Ohio.

H. O. Connelly, recently assumed the management of the New York office of the Cleveland Pneumatic Tool Co., Cleveland, Ohio.

B. L. Waters, of Aurora, Ill., is establishing an Eastern Branch of the Lyon Metallic Mfg. Co., in New York, with headquarters at 1365 Hudson Terminal Building.

Richard B. Sheridan has been promoted from chief sales engineer to assistant general manager of the Brown Hoisting Machinery Co., Cleveland, Ohio.

Charles F. Baehr, for twelve years with the Northern Electric Mfg. Co., has taken the position of superintendent of the Globe Machine & Stamping Co., Cleveland, Ohio.

Ernest L. Smith, lately eastern representative of the Standard Roller Bearing Co., Philadelphia, is now sales manager of the Grant-Lees Machine Co., Cleveland, Ohio.

Albert Bayton, formerly tool-room foreman for the Reed Mfg. Co., Erie, Pa., is now superintendent, succeeding F. Hubbard, deceased.

George W. Johnson, for the past four years superintendent of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned his position.

H. L. Hunter has been transferred from Edgemont, South Dakota, to Alliance, Neb., to take charge of the machine shops of the C. B. & Q. R. R.

W. M. Corse, secretary and treasurer of the American Brass Founders' Association, has been made works manager of the Lumen Bearing Co., Buffalo, N. Y.

William Perrine has been appointed master mechanic of the New Jersey Central and Lehigh and Susquehanna divisions of the Central Railroad of New Jersey.

George W. Fuller, for forty-seven years master mechanic of the Estey Organ Co., Brattleboro, Vt., has resigned his position and will spend the remainder of his life on "easy street."

Frank Davis, superintendent of the Haydenville Co.'s brass works, Haydenville, Mass., has resigned, and Fred Noble, assistant superintendent, has been made superintendent.

William Spire, formerly superintendent of the Marine Gas Engine Co. of New Jersey, has taken the position of mechanical engineer of the Electric Welding Products Co., Cleveland, Ohio.

A. N. Frecker, who has been for some years in the electric drill and grinder business at 95 Liberty St., New York, has been made general sales manager of the Van Dorn Electric & Mfg. Co., Cleveland, Ohio.

W. S. Howe, formerly advertising manager in charge of the small tools sales department of the Canadian-Fairbanks Co., Ltd., Montreal, has become associated with the S. A. Woods Machine Co., wood planer specialists, Boston, Mass.

Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., has been made president and general manager of the Springfield Drop Forge Co., Springfield, Mass, recently acquired by the Lakeside Forge & Wrench Co., Springfield, Mass.

W. S. Giel, lately superintendent of the Stoever Foundry & Mfg. Co., Myerstown, Pa., has severed his connection with that concern. Mr. Giel will devote his time to special work. His address is 3 Hamilton Park, New Brighton, Staten Island, New York.

Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, 29 W. 39th St., New York, delivered an illustrated lecture before the National Machine Tool Builders' Association, Hotel Astor, October 13; also the same before the Liability Insurance Association at the Hotel Astor, October 20.

Howard Terhune, author of the article "Board Drop Hammer Design," published in this number, engineering edition, has resigned from the employment of Billings & Spencer Co., Hartford, Conn., and has taken a position with the E. W. Bliss Co., Brooklyn, N. Y.

Augustus M. Kelly, has resigned his position of foreman of the machine molding department of the Chapman Valve Mfg. Co.'s foundry, Springfield, Mass., to take the position of superintendent of the American Blower Co.'s foundry, Detroit, Mich., and has assumed his new duties.

H. A. Elliott, formerly with Alfred Schütte of Cologne, Paris and New York, has taken the position of American agent of Usines G. Derihon of Loucin, Belgium, specialist in the manufacture of automobile forgings. Mr. Elliott's headquarters are at 7502 Carnegie Ave., Cleveland, Ohio.

The personal note published in the April number stating that James W. Ogden, formerly superintendent of the Bridgeport Foundry & Machine Co., Bridgeport, Conn., had been made superintendent of the Wolverine Motors Works, Bridgeport, was erroneous. Mr. B. A. Yarrington is the superintendent.

H. J. Brandes, formerly connected with the Bullard Machine Tool Co., Bridgeport, Conn., in the capacity of superintendent, has severed his connection and has taken up the active management of the Springfield Mfg. Co., Bridgeport, Conn., maker of special grinders and emery wheels. Mr. Brandes purchased the business from Mr. George Jackman, who has retired.

Dr. William H. Tolman, director of the Museum of Safety and Sanitation, 29 West 39th St., New York, has completed arrangements for a lecture tour dating from October, 1909, to March, 1910, the itinerary of which includes the principal cities and towns in the New England, Middle and Middle Western States north of the Ohio and east of the Mississippi River, and a few cities west of the Mississippi, comprising St. Louis, Cedar Rapids, Davenport, Des Moines, and Burlington.

Aguste Isaac, president of the Chamber of Commerce, Lyons, France, visited America in October to study industrial conditions with special reference to the apprenticeship training of young men for the machinist's and other trades. He found a striking similarity between labor conditions in France and America as regards difficulty of holding boys to the terms of their indentures. They have the bad habit in France of working a year or two and then leaving and hiring out to other manufacturers as journeymen. The consequence, of course, is that there are many "half-baked" French machinists.

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OBITUARIES

Edward T. Coe, treasurer of the Coe Brass Co., Torrington, Conn., died at his home in New Haven, Conn., October 5.

Carl Wilcox, of Wilcox & Gibbs, New York, a sewing machine inventor, died at his home in Westport, Conn., aged sixty-five years.

L. L. Heller, president of the Sterling Motor Car Co., Binghamton, N. Y., was killed October 6 by being struck by a Lehigh Valley R. R. train, near Waverly, N. Y.

Albert J. Perks, partner of the Webster & Perks Tool Co., Springfield, Ohio, died at his home in Springfield, October 4, aged fifty-eight. Mr. Perks was born in Birmingham, England, and came to America with his parents when a child. His parents located at Dayton, Ohio, where Mr. Perks spent his boyhood. He moved to Springfield when about eighteen, and since then has been actively engaged in manufacturing enterprises. For a number of years he was superintendent of the bar and knife department of the old Whiteley Machine Co., located where the Foos Gas Engine Co. now is. In October, 1891, he severed his connection with the Whiteley interests and entered into partnership with John F. Webster to manufacture machine tools under the firm name of Webster & Perks

Lewis C. Grover

Tool Co. Mr. Webster died in December, 1893, and Mr. Perks carried on the business alone until 1898, when Mr. Herman Voges, Jr., became associated as a partner in the business, which arrangement was carried on up to the time of Mr. Perks' death. Mr. Perks was an expert mechanic and machine designer, and an inventor of a number of valuable appliances. He is survived by his widow and two sons, George W. and Bert W.

LEWIS C. GROVER

Lewis C. Grover, chairman of the board of directors of Colts Patent Fire Arms Mfg. Co., Hartford, Conn., and for several years president of the company, died at his home in Hartford, September 30, following an illness of about three years. Mr. Grover was born, 1849, in Springfield, Mass., and was educated in the public schools. He served an apprenticeship to the machinists' trade in the Norwalk Iron Works, South Norwalk, Conn., and such was his aptitude for mechanical work that he was made foreman on the completion of his apprenticeship term. When only twenty-eight he accepted the position of general manager of the Whitney Arms Co., at New Haven, which position he held six years. In 1886 he was made assistant superintendent of the Colts Patent Fire Arms Mfg. Co., and soon became superintendent, and then general manager. In 1902 he was elected president and a director of the company to succeed John H. Hall. He was also elected president of the Colts Arms Co., of New York. He resigned the office of president of both companies last January because of poor health, but was elected chairman of the board of directors of each company. Mr. Grover was a man highly esteemed by his friends and employes. He was an indefatigable worker, and, although a broad-minded manager who understood how to delegate authority to subordinates and hold them responsible for results, no detail of the large manufacturing business which he managed was too trifling to receive his attention.

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COMING EVENTS

November 9.—Monthly meeting of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York. Two papers will be presented; one by Prof. Gaetano Lanza and Lawrence S. Smith of the Massachusetts Institute of Technology on reinforced concrete beams, and the other by Prof. Walter Rautenstrauch of Columbia University on stresses in curved machine members. The paper on reinforced concrete beams compares the results of tests upon full size beams made at the Massachusetts Institute of Technology and the University of Illinois with three different theories of beams of this type. The paper on stresses of curved machine members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results will be submitted in support of the theory presented. Calvin W. Rice, secretary, 29 West 39th St., New York.

November 18 19.—Annual meeting of the Society of Naval Architects and Engineers, Engineering Societies Building, 29 West 39th St., New York. W. H. Baxter, secretary, 29 West 39th St., New York.

November 19-20.—Annual meeting of the Ohio Society of Mechanical Electrical and Steam Engineers, Lima, Ohio. David Gaehr, secretary, Schofield Building, Cleveland, Ohio.

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 20 West 44th St., New York.

December 7-10.—Annual meeting of the American Society of Mechanical Engineers in the Engineering Societies' Building, New York. Mr. Calvin W. Rice, secretary, 29 West 39th St., New York.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Vieweger, American manager, 50 Church St., New York.

NEW BOOKS AND PAMPHLETS

Annual Report of State Geologist of New Jersey for 1908. 159 pages, 6 x 9 inches. Published for the State by Mr. Henry B. Kümmel, State geologist, Trenton, N. J.

Transactions of the National Association of Cotton Manufacturers: No. 86. 556 pages, $6\frac{1}{2} \times 9\frac{3}{4}$ inches. Secretary and Treasurer C. J. H. Woodbury. Room 501, 15 Milk St., Boston, Mass.

Manual of Steam Engineering. By W. H. Wakeman. 411 pages, $3 \times 5\frac{1}{2}$ inches. Published by New York Belting & Packing Co., Ltd., for distribution.

This manual will be found valuable by those concerned with the common problems coming up in the power plant. It treats of boilers, boiler feeders and steam engines. Many tables and rules are given that should be appreciated by the stationary engineer and others. Description for setting the valves of duplex pumps and calculating the horsepower of engines are examples.

Manual for Engineers. By Chas. E. Ferris. 165 pages, $3 \times 5\frac{1}{2}$ inches. Published by University of Tennessee, Knoxville, Tenn. Price, 50 cents.

This manual, which is a revised edition, contains in convenient form many valuable tables and other data for engineers and business men. Some of the most important tables in the book are as follows: Areas and circumferences of circles; square and cube roots; natural sines, tangents and secants; steam tables dealing with capacity of turbines; extensive tables for electric wiring; interest tables, etc.

Mechanical World Pocket Diary and Year Book for 1910. 391 pages (including advertising), $3\frac{3}{4} \times 6$ inches. Published by Emmott & Co., Ltd., Manchester, England. Price, 6 pence.

This publication has become quite well known in the United States, this being the twenty-third year of publication. It treats of steam and steam engines, including compound and triple expansion types, details of construction, condensers and condensing plants and condenser details; steam turbines, boilers and boiler construction, chimneys, super-heating, feed water, fuels, gas and oil engines, gas producers, centrifugal pumps, beams and girders, shafting, gearing, ball bearings, belting, rope drives, wire ropes, bolts and nuts, screw threads, screw cutting, miscellaneous mathematical tables, etc.

Metal Spinning. By Fred D. Crawshaw. 74 pages, $4\frac{3}{4} \times 6\frac{3}{4}$ inches. 33 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Bound in cloth. Price, 25 cents.

Metal spinning, while once of considerable importance, is an art that is going into decline and, strange to say, it is one on which it is claimed no book had been published until the appearance of this work. The present practice is to employ drawing and forming press tools to produce the work that was formerly made on the spinning lathe. The work recognizes this fact and was written largely for the instruction of amateurs, trade schools, and the crafts which produce art work in limited amount. The tools, chucks and samples of work produced are illustrated and described. The book will be found of considerable general interest because of the fact that no other work on the subject has been published and also because of the interesting character of the operations and tools employed.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. 171 pages, 5 x 7 inches. Published by the *Engineering Magazine*, New York. Price, $2.

This work is based on the articles published under the same title in the *Engineering Magazine* from July, 1908, to March, 1909, revised, rearranged and expanded by the author. Mr. Emerson is a well-known works management engineer who has given years of scientific study to the problem of efficiently employing labor and securing the highest efficiency by intelligent direction of effort. The philosophy of works management is slowly taking shape, and Mr. Emerson's treatment will be found exceedingly interesting by those concerned with it either in theory or in stern practice of everyday life. The contents by chapters are: Typical Inefficiencies and their Significance; National Efficiencies—Their Tendencies and Influence; The Strength and Weakness of Existing Systems or Organization; Line and Staff Organization in Industrial Concerns; Standards—Their Relations to Organization and to Results; The Realization of Standards in Practice; The Modern Theory of Cost Accounting; The Location and Elimination of Wastes; The Efficiency System in Operation; Standard Times and Bonus; What the Efficiency System may Accomplish; The Gospel of Efficiency.

Notes on Practical Mechanical Drawing. By Victor F. Wilson and Carlos L. McMaster. 186 pages, 6 x 9 inches. 86 illustrations. Published by Wilson & McMaster, East Lansing, Mich. Price, $1.50.

This book which treats of lettering, orthographic projection, isometric and oblique drawing, use of instruments, working drawings, geometrical drawing, machine sketching, etc., has been revised, rearranged and enlarged by 25 pages for the third edition. The chapter on lettering describes the various types of lettering commonly used on mechanical drawings, and illustrates a number of examples. Considerable attention has been given to orthographic projection, examples being given from which the student can get a clear idea of the relation of the three common views used in the ordinary mechanical drawing. The sketches in phantom perspective are well executed and give the work an attractive appearance. Practical instructions are given for making working drawings that agree very well with the common usage of draftsmen in manufacturing establishments. The book is one that can be recommended to industrial schools and all students who wish to study mechanical drawing at home or to others who wish to obtain a knowledge of the common relations of views and methods of making drawings without going to the trouble of learning to draw.

Power, Heating and Ventilation. By Charles L. Hubbard. 647 pages, 6 by 9 inches, 412 illustrations. Published by the Technical Press, Brattleboro, Vt. Price, $5.

This book is intended for designing and constructing engineers, architects, etc. The subject of power is treated especially from the steam side, but sufficient information bearing on electrical matters is given to enable the intelligent arrangement of the steam plant with reference to the requirements of electric lighting and the distribution of electrical power. The subject of boilers is quite fully treated, and much valuable information is given on the construction of various types, the design of tubular boilers, boiler accessories, care and management, etc. The theory of the steam engine is taken up and descriptions of different types given, including the steam turbine. The subject of condensers is also treated, and the use and construction of cooling towers explained. A chapter devoted to steam and feed piping contains many valuable tables and formulas and also considerable information of practical value to the engineer. The problem of heating and ventilation as applied to all classes of buildings, from a small furnace-heated dwelling to buildings with central plants of the largest size, is fully treated. The various chapters dealing with this subject are as follows: Systems of Warming; Ventilation; Heat Loss from Buildings; Furnace Heating; Direct Steam Heating; Indirect Steam Heat

ing; Direct Hot Water Heating; Indirect Hot Water Heating; Forced Hot Water Circulation; Fans; Forced Blast Heating and Ventilation; Exhaust Steam Heating; Electric Heating; Special Devices; Heating and Ventilating Different Types of Buildings; Care and Management of Heating and Ventilating Plants.

ELEMENTS OF MACHINE DESIGN. By Dexter S. Kimball and John H. Barr. 446 pages, 6 x 9 inches, 196 illustrations. Published by John Wiley & Sons, New York. Price, $3.

We have often been impressed by the fact that there is no American book on machine design that gives all of the many common subjects of machine design on which the designer is likely to require specific information. Reference usually must be made to a number of the available works before a satisfactory treatment of a given subject is found. The authors of the present work evidently having noted the shortcomings of previous writers have presented, we believe, a book on machine design that is more complete than anything of a similar nature put on the market by American publishers. The work is the outgrowth of the experience of the authors in teaching machine design to engineering students in Sibley College, Cornell University. The treatment of friction, lubrication and efficiency are sufficiently comprehensive for a work of this kind, as is also the work on springs, riveted fastenings, screws and screw fastenings, keys and cotters. The theory of stresses produced by force fits and the calculation of allowances is satisfactory, but an improvement is suggested in the shape of a table giving the results of practice in making shrink and force fits. So many factors enter into the problem that the result of practice on various classes of work would be exceedingly helpful to the designer who has not had the benefit of much experience. The treatment of tubes, pipe, cylinders, flues and tin plates was written with the advantage of the knowledge gained from the experiments made by the University of Illinois Engineering Experiment Station and the paper by Prof. Reid T. Stewart presented before the American Society of Mechanical Engineers, and, of course, is much more satisfactory than previous treatments available in other works on machine design. Journal bearings, pivots and roller bearings, are not treated in as comprehensive a manner as one who is especially interested in these subjects could wish, but probably as much space is given to these important subjects as the general plan of the work and the course of instruction for which it was prepared would permit. A portion of the book is devoted to axles, shafts and shaft couplings, belt, rope and chain transmission, application of friction including friction reels, friction brakes, friction clutches and pulleys. The treatment of tooth gearing is fairly satisfactory, there being forty-two pages devoted to the theory and practice of spur, bevel and helical gearing. Of course, the treatment of helical and spur gearing is brief and leaves a great deal unsaid. Following this chapter are chapters on fly-wheels and pulleys and machine frames and attachments. The work is one that we can heartily recommend to machine designers and others concerned with the problem of machine design, but it is not quite the comprehensive treatment that should be presented by some author. Whether a comprehensive treatment is practical is a matter for the publishers to decide, but the need for a good all-around work is evident to those who frequently refer to the present available books on machine design.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4698 of luminous arc head-lights.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4691 illustrating and describing small polyphase motors.

VALLEY BOAT & ENGINE CO., Baldwinsville, N. Y. Catalogue of marine engine castings and finished machine parts.

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating the Gisholt 30-inch motor driven vertical boring mill.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4692 describing the General Electric No. 210 Railway Motor.

BICKFORD & WASHBURN, INC., Greenfield, Mass. Blotter illustrating the Bickford & Washburn pipe tap thread milling machine.

PRENTISS TOOL & SUPPLY CO., 115 Liberty St., New York. Circular of the 20-inch universal drilling lathe built by Fay & Scott, Dexter, Me.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4099 superseding Bulletin No. 4444 on motor-driven air compressors, geared type.

SPICER UNIVERSAL JOINT MFG. CO., Plainfield, N. J. Catalogue of Spicer dust-proof and oil-tight universal joints for motor cars, motor boats and other machinery.

ARGUTO OILLESS BEARING CO., Wayne Junction, Philadelphia, Pa. Folder advertising the Arguto oilless bearings which save oil and prevent ruined journals.

W. S. CALDWELL CO., Louisville, Ky. Catalogue of Caldwell wooden tanks for manufacturing plants and other users requiring large and small tanks for the storing of water, etc.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Folder entitled "The Paragon Way" illustrating the new "Paragon" flat taper shank high-speed twist drill lately brought out by the company.

W. S. ROCKWELL CO., 50 Church St., New York. Circular illustrating the Rockwell furnaces, and fuel oil or gas-burning appliances. A new catalogue is in preparation and will be issued shortly.

GEORGE W. SOUTHWICK CO., 35 Warren St., New York. Circular illustrating the Hammond wire belt lacing tool for making a wire hinged joint for machine belting. The cost of the outfit is $7.50.

HARBISON-WALKER REFRACTORIES CO., Pittsburg, Pa. Catalogue of silica, nickel, chrome, and fire-clay brick used by steel mills, brass foundries, and other concerns employing furnaces for melting metals.

J. S. OSGOOD, 131-138 Erie County Bank Building, Buffalo, N. Y. Blotter illustrating the Osgood indestructible file and tool handle which was recently specified by the United States Government for the Rock Island Arsenal.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Circular of the Cutler-Hammer pressure controlled speed regulator for use with motor-driven boiler draft fans, boiler feed pumps, gas pressure exhaust, etc. For description see MACHINERY, September, 1909.

ARTHUR D. LITTLE LABORATORY, Boston, Mass. Pamphlet by Harry S. Mork, engineering chemist, entitled "Selective Economy in Raw Materials," being a paper presented at the annual meeting of the American Chemical Society at the New Haven meeting, July 3, 1908.

MANVILLE BROS. CO., Waterbury, Conn. Circular of the "Yankee" power bench press, designed to take the place of the ordinary foot and screw press. It is made in three sizes with or without table. The stroke is 1, 1½ and 2 inches respectively.

PLANET ENGINEERING CO., 5 Beekman St., New York. Circular illustrating the constructive features of the Planet roller bearings for motor boats, thrust bearings, electric motors, centrifugal pumps, etc. This bearing is composed of rollers with the periphery a section of a spherical surface.

GEM MFG. CO., 3253 Spruce St., Pittsburg, Pa. Catalogue of "Gem" specialties, comprising steel and brass oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, flexible shafts, rope-driven or motor-driven portable grinders and drills, electric polishing machines, universal joints, etc.

H. BRACHARACH, 720 Lewis Block, Pittsburg, Pa. Advance sheets of 1910 catalogue illustrating a German recording gage which measures and records pressure, draft, and velocity of gases. These gages are used in boiler plants, mine ventilating systems, gas producer plants, regenerative furnaces, etc.

THE GRAHAM MFG. CO., Providence, R. I. Blotter illustrating a Universal jig vise, which is made in three sizes with jaws 6, 9 and 12 inches long. This jig vise can be used as a plain drilling vise or for the drilling of interchangeable parts. It is a cheap substitute for expensive jigs on a large class of work.

GARDNER MACHINE CO., Beloit, Wis. Circular illustrating the Gardner grinder in use on intake manifolds, universal joints, pump cases, exhaust connections, jacket plates, and cylinder covers, all being examples of automobile work for machining which the disk grinder has been found to be a valuable tool.

BOGERT GAS POWER ENGINE CO., 1116 Chamber of Commerce, Buffalo, N. Y. Folder illustrating the Bogert tandem gas engine built in sizes from 50 to 500 horse-power; also Bogert tandem gas engines with no cross-head built in sizes from 50 to 150 horse-power and single cylinder gas or gasoline engines in sizes from 20 to 100 horse-power.

B. F. STURTEVANT CO., Hyde Park, Mass. General catalogue No. 165 illustrating the company's complete line of fans, blowers, dust collectors and conveyors, fuel economizers motors, engines, turbines, generating sets, forges, hot blast apparatus, etc. Principal dimensions and other information regarding the apparatus illustrated is given briefly.

FRANK MCHALE, 302 Havemeyer Building, New York City. Catalogue of books relating to engineering subjects, including chemistry, mining, mechanical, electrical and steam engineering, construction, hydraulics, etc. Books will be furnished at the lowest market prices and forwarded prepaid to any part of the world on receipt of advertised price.

BRUCE-MACBETH ENGINE CO., Cleveland, Ohio. Catalogue of Meriam vertical gas engines for electric lighting, pumping, and general power purposes. The catalogue illustrates the four cylinder engine built in sizes from 75 to 300 horse-power, and shows the details of construction. The two-cylinder type is also illustrated, and the four-cylinder engine with a gas producer plant.

NORTHERN MACHINE & REPAIR WORKS, Wausau, Wis. Circular of the "Little Giant" cutting-off machine for cutting tool steel, mild steel, cast iron, brass and other metals. The machine is of simple construction, being designed for use in shops that do not require an elaborate equipment and where a cutting-off machine with hand feeds answers all practical requirements

H. W. CALDWELL & SON CO., Western Ave., 17th-18th St., Chicago, Ill. General catalogue No. 34, of hoisting, elevating, conveying and power transmitting machinery for flour mills, grain elevators, cotton-seed oil mills, starch works, breweries, distilleries, malt houses, sugar refineries, cement works, phosphate works, tanneries, etc. The catalogue contains 847 pages, 6 x 9 inches.

OSCAR E. PERRIGO, 6 Beacon St., Boston, Mass. Circular outlining systematic methods in shop management and cost accounting, which Mr. Perrigo is prepared to install. He is a consulting and systematizing engineer who has given a great deal of attention to manufacturing methods and systems, and invites correspondence from officials having troubles with shop or office management.

DIAMOND MACHINE CO., Providence, R. I. Catalogue of grinding and polishing machinery, comprising floor grinding machines, motor-driven grinders, wet tool grinders, automatic face grinders, locomotive guide bar grinders, roll grinders, surface grinders, gun barrel machinery, internal grinders, lathe grinder attachments, drill grinders, polishing and buffing machines, polishing wheels, emery wheels, strapping machines, etc.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. Catalogue of forging, heating and welding furnaces. The catalogue has a novel trade-mark on the cover showing an animal known as "Go-Sum" which is said to be a cross between a hippopotamus and a grasshopper. The catalogue illustrates a large number of furnaces adapted for practically all classes of work in which portable or stationary furnaces are employed.

WELLS BROS. CO., Greenfield, Mass. Catalogue and price list of die holders principally designed for use on screw machines. The holder is firmly clutched in its forward movement and when not cutting the die is held by friction, thus doing away with the noise ordinarily noticeable on screw machines. The holders are adapted for the "Little Giant" adjustable dies which are of the same quality as the regular dies supplied by the company.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Catalogue of lifting magnets, giving a list of users and illustrating the uses to which lifting magnets are put in steel mills and other plants where sheet metal, steel rails, scrap and other metals are handled in large quantities. The possibilities of the lifting magnet are startling. One illustration, for example, shows a magnet lifting a locomotive cylinder, the magnet being applied to the planed surface at the juncture between the two cylinders.

D. O. JAMES MFG. CO., Chicago, Ill. Catalogue D of speed-reducing transmission gears (see MACHINERY, August, 1908, for description), for spur, bevel, miter, internal, spiral and worm gearing. The speed-reducing gears are designed to transmit the power of electric motors and other high-speed apparatus, reducing the speed to that required for machine tools, centrifugal pumps, elevators, etc. The catalogue contains valuable data on gearing, tables of natural trigonometrical functions, diagrams of circular pitch gears, etc.

SKINNER CHUCK CO., New Britain, Conn. Catalogue of independent universal and combination lathe chucks, drill chucks, planer chucks, face-plate jaws, drill press vises and reamer stands. The catalogue contains 48 pages, is made up with rounded corners, and is perforated for a loose leaf binder. The construction of the new Skinner gear pattern drill chuck is illustrated in sectional views, and a phantom view is shown of the Skinner positive drive drill chuck. The catalogue is one that will be found of general interest by users of machine tools and accessories.

NEW JERSEY FOUNDRY & MACHINE CO., 90 West St., New York. Catalogue of overhead carrying devices comprising trolleys, hoists, cranes, buckets, cars and tracking, etc. The Newhall patent steel frame I-beam trolley is illustrated in combination with a differential hoist. Various other combinations are shown and examples of installations. The company builds jib cranes suitable for foundry shops and other places where a jib crane is profitably used. The catalogue will be found of general interest by those concerned with the problem of hoisting and conveying materials either in the shop or in the field.

KEARNEY & TRECKER CO., Milwaukee, Wis. Catalogue No. 17 of Milwaukee milling machines. The catalogue illustrates the construction of the Milwaukee miller and two views are reproduced with reference numbers in red, each part being named below. Details of con-

struction are illustrated, including a vertical section showing the flooded lubrication system which has made Milwaukee millers famous. The company manufactures universal milling machines in three sizes, plain milling machines in three sizes, and manufacturing milling machines in two sizes. All styles have single pulley drive, all geared feeds, and flooded lubrication.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. Treatise on the crank shaper, describing the characteristics of the cone pulley drive, speed-box drive, and variable speed motor drive with particular reference to the Lincoln variable speed motor which gives an infinite number of running speeds throughout its range. The treatise which is sent free on request will be found of much general interest to designers and users of shapers. It gives valuable information not only regarding the power required to drive crank shapers under definite conditions of work, but also compares the productive efficiency of the belt-driven and motor-driven shaper.

DAVIS-BOURNONVILLE CO., 97 West St., New York. Pamphlet illustrating and describing the Davis-Bournonville oxy-acetylene apparatus which produces a flame having a temperature of about 6,300 degrees F. that can be used either for welding or for cutting metals. The oxy-acetylene torch is described as a "putting on tool," which it is in fact, it being not only possible to weld together iron, steel, cast iron, brass, copper, platinum and other metals and to unite dissimilar metals but also to build up defective castings and other pieces wherein metal is required. As a cutting-off tool, the torch works with rapidity and efficiency, being one of the most rapid and practical devices known for cutting off steel sheet piling, beams and other heavy structural work.

HENDEY MACHINE CO., Torrington, Conn. Catalogue of an improved line of Lincoln milling machines. The Lincoln type milling machine is the standard manufacturing miller for armories, pistol factories, and other establishments where interchangeable parts are milled on a large scale. The company has developed this useful type of machine so that it is now being used successfully on operations which heretofore have been considered suitable for a knee type milling machine only. The catalogue illustrates the No. 8 Lincoln miller equipped with special table and chip pan; the same machine with high legs; improved Lincoln miller No. 5 with single and double spindles; and Nos. 4 and 2½ machines. All sizes are equipped with gear box giving twelve feed changes.

WATERBURY-FARREL FOUNDRY & MACHINE CO., Waterbury, Conn. General catalogue descriptive of all the lines of machinery built by the company, being a general reference book which briefly reviews the most prominent types of machines constructed. The catalogue comprises, rivet, bolt, and nut machinery, butt and hinge machinery, cartridge machinery, drop presses and hammers, screw presses, machinery for tubes and rods, hydraulic machinery, knuckle-joint press, special lathes, single-acting open-back presses, single-acting pillar presses, double-acting presses, shears and slitters, finishing machinery for sheet metal, mufflers and furnaces, wire-drawing machinery, eyelet machinery, gang slitting machines, etc. This catalogue is compiled in an attractive and interesting manner, making it a valuable work of reference as well as a catalogue of machinery in the various lines represented.

MANUFACTURERS' NOTES.

VAN DORN ELECTRIC & MFG CO., Cleveland, Ohio, has made Mr. A. N. Frecker sales manager. Mr. Frecker was for several years in the electric drill and grinder business in New York.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio, states that, owing to the heavy demand for the "Nugent" clutch, its machinery department is working full force day and night.

GENERAL ELECTRIC CO., Schenectady, N. Y., was awarded a grand prize at the Alaska-Yukon-Pacific Exposition for its exhibit of electrical apparatus and a completely furnished model apartment.

ROBBINS & MYERS CO., manufacturer of circular and desk fans, dynamos, motors, etc., has changed the location of its Chicago office from 48 West Jackson Boulevard to 501-515 West Jackson Boulevard.

KEUFFEL & ESSER CO., Hoboken, N. J., maker of drawing, mathematical and surveying instruments, measuring tapes, etc., was awarded the grand prize for its exhibit at the Alaska-Yukon-Pacific Exposition at Seattle.

GENERAL ELECTRIC CO., Schenectady, N. Y., and J. A. Roebling Sons Co., Trenton, N. J., were awarded the grand prize at the Alaska-Yukon-Pacific Exposition for their exhibit of insulated wire and cable.

ROCKFORD LATHE & DRILL CO., Rockford, Ill., succeeds the Rockford Machine & Shuttle Co. A. Floburg is president; W. B. Johnson, vice-president and superintendent, and Charles Holmquist, secretary and treasurer.

HILL CLUTCH CO., Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of Mr. G. W. Hoffman as sales engineer in charge of its Chicago office, located at 610 Marquette Building.

VARIABLE SPEED CLUTCH CO., Milwaukee, Wis., has opened a New York office at 50 Church St., Hudson Terminal Building, with Mr. W. L. Tenney, manager. Mr. Tenney was formerly with the Standard Heater Co., New York.

WARNER & SWASEY CO., Cleveland, Ohio, recently opened an office in Detroit, located in the new Ford Building. Mr. Thomas Farmer, who has for several years represented the Warner & Swasey Co. in the Detroit territory, will be manager of the new office.

SPRINGFIELD MFG. CO., Bridgeport, Conn., maker of special grinding machines and emery wheels, has been purchased by H. F. Brandes, former superintendent of the Bullard Machine Tool Co., Bridgeport, Conn. Mr. George W. Jackman, former owner, has retired.

LAKESIDE FORGE & WRENCH CO., Springfield, Mass., has acquired the plant of the Springfield Drop Forge Co., Springfield, which again began operations with a full force of men September 27. Mr. Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., is general manager and president of the company.

WARNER & SWASEY CO., Cleveland, Ohio, is building a large addition to its new plant which was partly completed before the late depression in business. The addition is a single story steel and concrete structure and is equipped with electric traveling cranes and other modern features. It will be completed about December 1.

JOSEPH T. RYERSON & SON, Chicago, Ill., are reported to be contemplating entering the field of machine tool manufacture, and negotiations have been made for a suitable location in Cincinnati on which to erect a large plant. The concern now is known as a manufacturer and distributer of boiler shop machinery and other iron-working tools.

LYON METALLIC MFG. CO., Aurora, Ill., has established an eastern branch with office at 1365 Hudson Terminal Building, New York. The concern manufactures a complete line of steel factory equipment, including lockers, racks, tables, etc., and its rapidly-growing business has made an eastern branch necessary. Mr. B. L. Waters, secretary of the company, is in charge of the eastern branch.

BAY STATE MACHINE CO., Erie, Pa., is the name of a concern newly organized to manufacture marine engines. The new company has bought the charter of the old company of the same name. The officers are John E. Waitz, president; Joseph Crawford, treasurer and manager; L. E. Safford, vice-president and sales manager; and Charles Boring, superintendent.

GENERAL ELECTRIC CO., Schenectady, N. Y., states that there is a large demand for its tantalum lamps, which because of their excellent life service and efficiency make a considerable economy in incandescent lighting possible. The life of a tantalum lamp will average about 600 hours. It can be used on an alternating current of 50 cycles or less.

LITHOPRINT CO., 41-43 Warren St., New York, is prepared to make black prints on white ground, absolutely true to scale, on any kind of paper including any drawing paper, bristol board or tracing cloth. The prints undergo neither water nor acid bath so are unchanged in scale. They are made as quickly as blue-prints, and are said to be superior to any blue-print in quality and finish.

SOCIÉTÉ FRANCAISE DES ROULEMENTS A BILLES, manufacturer of the RBF ball bearings, announces that Lavalette & Co. are no longer its representatives in the United States. The International Engineering Co., 1779 Broadway, is now the sole and exclusive agent for the sale of RBF ball bearings in America, and all inquiries should be addressed to it in the future.

S. A. WOODS MACHINE CO., Boston, Mass., manufacturer of wood planers, has taken Mr. W. S. Howe, formerly advertising manager in charge of the small tool sales department of the Canadian-Fairbanks Co., Ltd., Montreal, Canada, into its employ. The S. A. Woods Machine Co. has reduced its line of wood-working machinery to planers and molders, on which it now specializes.

B. F. STURTEVANT CO., Hyde Park, Mass., has established a savings bank life insurance agency at its works in charge of an instructor furnished by the savings insurance committee of the Boston Chamber of Commerce. This agency is established under the Massachusetts law which became operative November 1, 1907, permitting any savings bank to operate a department for issuing life insurance policies and old-age annuities.

DEPARTMENT OF COMMERCE AND LABOR, Bureau of the Census, Washington, D. C., has fixed on November 3 as the date for examining applicants for appointments as special agents for the collection of the 13th census of manufactures, mines and quarries. The circular lists the cities in the various States in which the examinations will be held and gives the requirements of the applicants and the rate of compensation for the work.

S. OBERMAYER CO., Cincinnati, Chicago, and Pittsburg, has placed a new foundry product on the market called "Bulldog" core wash. It is so called because of its adhesive qualities. Foundries using it have no troubles from the core wash burning or peeling off. The largest castings can be made with cores washed with the new preparation with no troubles from the iron sticking to the sand, and come out of the mold with clean, smooth surfaces.

SHEFFIELD GAS POWER CO., Kansas City, Mo., has acquired the entire assets, factory and good will of the Weber Gas Engine Co., at a bankruptcy sale. The factory has been in continuous operation throughout the receivership term and is being continued in full operation by the present owners. The management of the business is in entirely new hands; George M. Hawes is president; Freeman Field, vice-president and treasurer; and W. H. Spiller, assistant manager.

WARREN WEBSTER & CO., Camden, N. J., state that the patent decision in the case of Warren Webster & Co. *vs.* C. A. Dunham Co., mentioned in the October number, does not refer to about one hundred existing patents under which Warren Webster & Co. operate. The patent in this case expired over a year ago, and the suit merely involved a case of liability for damages on the part of the defendant. There are now pending in the Federal courts suits against users of the Dunham apparatus for infringement on patents which have not expired.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., is adding a substantial and commodious addition to its Niagara Falls, Ontario, works. The structure is to be 50 x 105 feet and the contract has been awarded to W. S. Homan, Niagara Falls, Ontario. The facilities afforded by this addition will make the Canadian works of the company quite complete and enable them to care for a rapidly growing Canadian trade. The building will contain a new grinding plant in which the lubricating, electrotyping and other grades of graphite will be prepared for the market.

MUSEUM OF SAFETY AND SANITATION, 29 West 39th St., New York, announces that a prize of 2,500 kronen ($612) was offered by Dr. Louis L. Seaman while at the XVI International Medical Congress, in Budapest, in September, for the best paper on the subject: "What should be the Status of the Medical Department of an Army in order that its Sanitation and Hygienic Conditions may be maintained at the Highest Efficiency so that in the Emergency of Battle its Units may best respond to the Call of its Commanders?" The award of the prize will be made by the executive committee of the XVII International Medical Congress.

DODGE MFG. CO., Mishawaka, Ind., lays claim to having the largest plant in the world for the manufacture of machinery for the mechanical transmission of power. Its buildings cover nearly 40 acres in a 60-acre plot on the Lake Shore & Michigan Southern Railway. In it there are annually worked up 2,000 tons of pig iron, 7,000,000 feet of lumber, 900 tons of steel and structural iron, 6,200 tons of steel shafting and 9,000 tons of coal. The resulting production is 250,000 "Independence" wood-split pulleys, 100,000 Dodge standard iron pulleys, 90,000 solid iron pulleys, 95,000 hangers, 150,000 bearings of all types, 4,000 friction clutches and over 2,000,000 pounds of bearing metal.

ROBERTSON DRILL & TOOL CO., Buffalo, N. Y., has moved from 1848 Niagara St., to its factory, corner of Grant and Letchworth Sts. The new building is of brick, two stories high with basement of concrete construction, the length being 150 feet and the width 50 feet. The basement is used for storage and a heating plant. The ground floor is the machine shop for the manufacture of its drill presses and power hack saws. The machinery is driven by a 30-horse-power electric motor, and the shop is equipped throughout with new tools. The office is at the east end of the factory, and the top floor is used for pattern making, etc. The foundry is adjacent to the new building to the north about 50 feet, and is equipped with modern foundry appliances including an electric crane. The anticipated output of the new plant is about twenty-five drills per day.

DAVIS-BOURNONVILLE CO., 97 West St., New York, has lately performed some interesting repairs with the oxy-acetylene apparatus. Among the repairs made are the following: A cracked kettle weighing two tons, thickness varying from 5 inches at the bottom to 3 inches at the rim was successfully welded. The crack was 18 or 19 inches long. A 15-ton gear wheel made in two sections was cracked through the rim which was about 22 inches wide. The rim was welded and one tooth 22 inches wide and 6 inches high was built up, machined to shape and made as serviceable as the original. The apparatus was used very successfully by a railroad company for cutting up old steam boilers. It is generally known that the cost of scrapping steam boilers is very heavy in comparison to the value of the scrap material. The apparatus did the work rapidly and at a comparatively low cost. Several other repairs were lately made,

CONTENTS FOR NOVEMBER

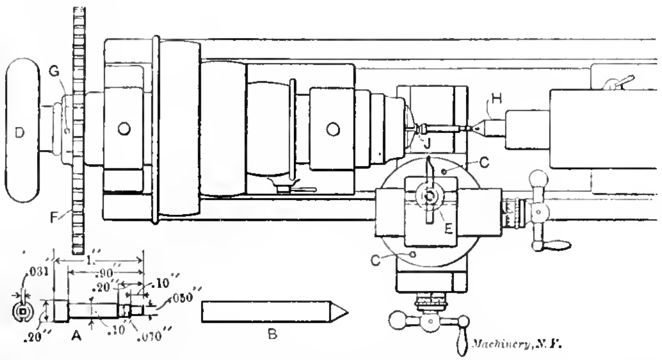
including welding steam dryer pipes, fly wheel spokes, broken hydraulic press platen, smoke-box heaters, cast steel water pipe tee 20 inches in diameter, etc. The cast steel tee was welded in the trench with about 4 inches of water flowing through it. It would have cost about $200 to repair the tee, beside shutting off the flow of water for a considerable time. The crack was about 9 inches long.

Supplement to MACHINERY, December, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Jig and Die Work in the Bench Lathe—II"

SHOP OPERATION SHEET NO. 118.

A. L. Monrad. MACHINERY, December, 1909.



Bench Lathe Practice—Turning

NOTE.—The method of turning the small pin *A* in the bench lathe will be outlined in the following. In the succeeding sheets the way in which this piece is milled and ground will be explained.

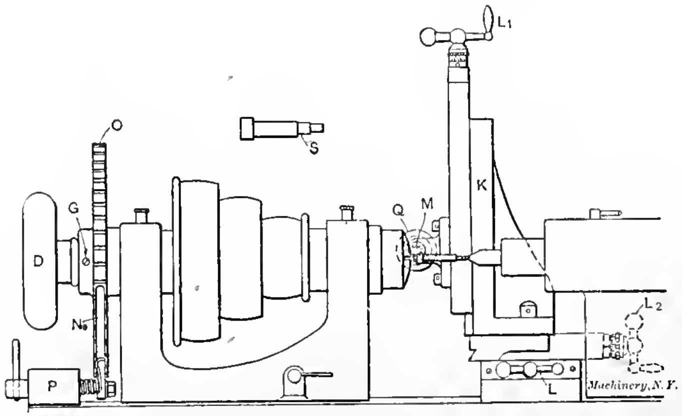
1. Saw off a piece of wire, No. 3 stub gage, to a length of 1½ inch. Insert a chuck into the spindle of lathe suitable for this size of wire. Examine the taper part of the spindle and chuck to see that they are perfectly clean. Insert the wire in the chuck so that it projects from the latter about ¼ inch, and tighten it by turning the handle *D*.

2. Unloosen the two screws *C* on the slide-rest and turn the latter around to an angle of 30 degrees. Move the carriage close to the spindle and clamp it to the lathe bed by a hand-nut underneath provided for this purpose. Fasten a diamond-pointed tool in the tool-post *E* of the slide-rest and set the tool so that its cutting edge is the same height as the axis of the work. This tool should be ground so that the point is sharp, as otherwise the work will tend to raise above its center and mount the tool. The end of the wire should now be turned to a point, as shown at *B* in the illustration.

3. Change the slide-rest back to the zero position and place an index plate *F* on the back end of the lathe spindle. In order to do this the handle *D* is first removed, after which the plate is put in place and secured by the set-screw *G*. After the handle *D* is replaced, the wire should be moved out so that it projects about 1¼ inch from the face of the chuck. Next move the tail-stock, which should be equipped with a small female center *H* in its spindle, up to the male center of the wire. Lubricate the center with a drop of oil, adjust it to the work so that it has a firm bearing. With the diamond-pointed tool, turn the whole length of wire to a diameter of 0.205 inch. Test the work with a micrometer to see if it is turned perfectly parallel; then continue the turning operation until the piece conforms to the dimensions given in the illustration, the shoulders being finished to length with a side tool, and 0.005 inch being allowed on the shoulders and diameters for grinding. Cut a groove just above the head of the pin, as shown at *J*. After hardening, the pin may be easily broken off at this point by holding it in the chuck by the head, close up to the groove.

SHOP OPERATION SHEET NO. 119.

A. L. Monrad. MACHINERY, December, 1909.



Bench Lathe Practice—Milling

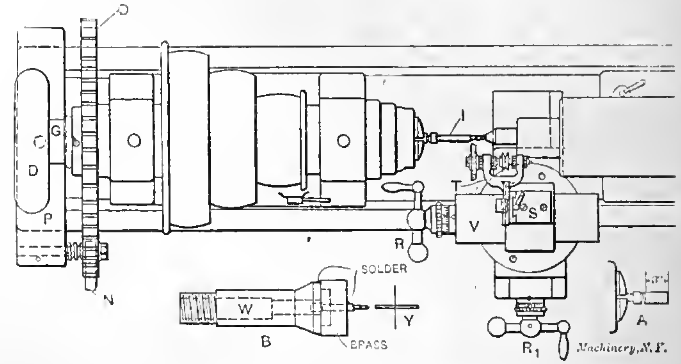
1. Without removing the work in the chuck, which is assumed to be in the lathe as in the previous operation, loosen the head- and tail-stocks and move them to the right to make room for the indexing block *P*. Replace the slide-rest, with a milling fixture *K*, and set this fixture so that the axis of the spindle is at right angles with the axis of the work. Place a 1/32-inch slotting cutter, 1/4 inch in diameter, in the milling fixture spindle. By means of the handles *L*, L_1, L_2, adjust the cutter *M* until its side just touches the side of the head on the pin shown. Move the thimble on the feed-screw *L* to zero, and then raise the cutter to clear the work. By the aid of this graduated thimble move the cutter inward an amount equal to half the diameter of the pin plus one-half the thickness of the cutter. Place the pawl *N* in the zero groove in the index plate *O* and mill a groove to a depth of 0.060 inch, by reading the graduation on the thimble of handle L_1 of the milling fixture. The spindle of the milling fixture is driven by a belt which passes over pulley *Q*.

2. As a second groove is to be milled in the opposite side of the work, turn the latter halfway around by placing pawl *N* in the 180 degree groove. The work will then be in position for milling the second groove.

3. Replace the slotting cutter by an end mill 0.150 inch in diameter. Place the pawl *N* in the zero groove of the index plate *O*. As the sides of the square *S* of the pin are to be 0.050 inch, or the same size as the cylindrical end, mill one side by feeding the cutter down by the handle L_1 until it is almost flush with this end, a slight amount of material being left for grinding. Raise the end mill so that the work will clear, and again feed it down after the work has been turned through 90 degrees by the aid of the index plate *O*. In this manner mill the four sides of the square. Remove the pin from the lathe by loosening the handle *D* which opens the chuck jaws. The pin is next hardened and drawn to a straw color, and polished all over with fine emery cloth preparatory to grinding.

SHOP OPERATION SHEET NO. 120.

A. L. Monrad. MACHINERY, December, 1909.



Bench Lathe Practice—Grinding

1. Insert a chuck in the spindle that will fit the body of the pin *I*, and place the work within it as shown at *A*. Set the slide rest *V* to zero for parallel grinding. Place the grinder equipped with a fine carborundum wheel, in the tool-post, set the spindle of the grinder in the same horizontal plane as the work, and grind the end *x* of the pin.

2. Obtain a chuck of a size corresponding to the end just ground, and place this end of the work in the chuck as shown in the illustration. Support the outer end of the pin by a female center and grind the three diameters of the work to the dimensions given, allowing 0.0002 for lapping. As the shoulders are to have perfectly square corners, they are ground with a diamond wheel charged to a sharp edge. In performing this operation the work should revolve very slowly.

3. The square, which was milled on the pin in the previous operation, as described, is next ground. Reverse the top slide *V* so that the handle *R* is on the left side as shown, to avoid the tail-stock. Mount a sliding angle-iron *S* on top of slide-rest *V* and clamp the grinder *T* in position, equipped with a charged diamond wheel. Place pawl *N* in the zero groove of plate *O*, and grind the top side of the square by moving the wheel across it by the handle R_1, and feeding it forward by handle *R*. When one side is finished flush with the cylindrical end, move the work 90 degrees by the aid of dividing plate *O*; then finish the next square, etc.

4. Grip the head of the pin in a chuck corresponding to its size, and break off the end *x*; then replace the lathe chuck with a brass soldering chuck *W*. Remove the indexing block *P* and place the head-stock in position for turning. Bore a hole in the brass chuck, and make it a push fit for the body of the pin. Remove the chuck and push the pin through it from the back, as shown at *B*. When chuck is replaced, move the handle *R* to the right side. With a grinding wheel *Y* in the position shown, face off the conical point of the pin to the proper dimension. With a side tool remove the solder; then withdraw the pin, and replace it in the chuck with the head out. Fasten the head with a little solder, and also grind it to the finish dimension.

I.—TYPICAL MACHINE AND JIG CLAMPING DEVICES

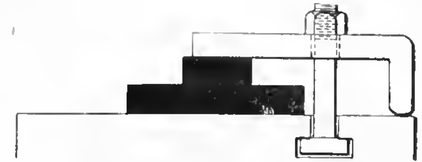


Fig. 1.

Common method of clamping work to the table of a milling machine or lathe face-plate.

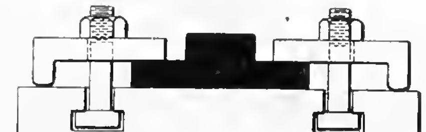


Fig. 2.

Clamps of the type shown in Fig. 1, applied differently to the work.

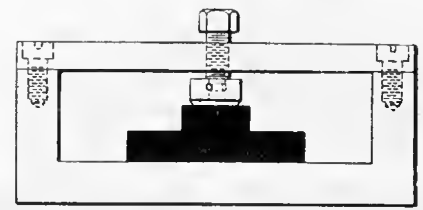


Fig. 3.

Common form of jig clamp when one bolt or screw is sufficient to hold the work.

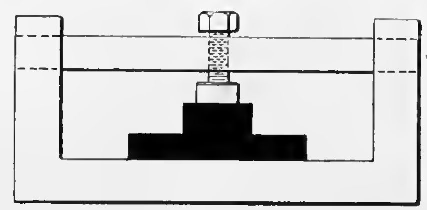


Fig. 4.

Clamp which is adapted to box jigs; it is easily removed by sliding it longitudinally.

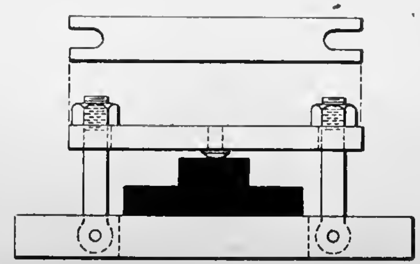


Fig. 5.

Removable clamp with slotted ends, which is tightened by swinging bolts.

Contributed by Lucien L. Haas

II.—TYPICAL MACHINE AND JIG CLAMPING DEVICES

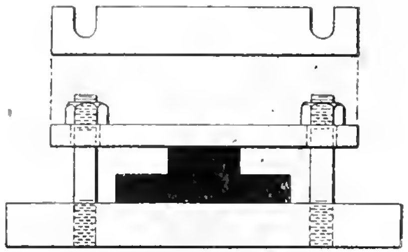


Fig. 6.

Clamp which is removed easier than the type shown in Fig. 5, and one with which fixed studs may be used.

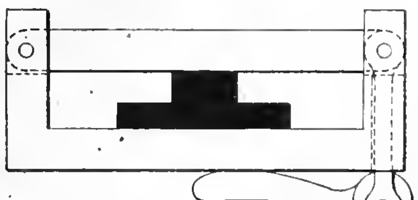


Fig. 7.

Illustration showing one of the many applications of the cam for clamping.

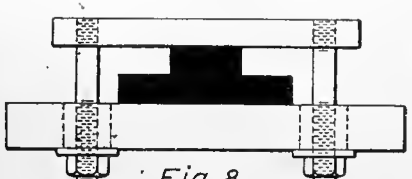


Fig. 8.

Type of clamp which may be detatched from jig or fixture by removing slip washers which allow nuts to pass through the large holes.

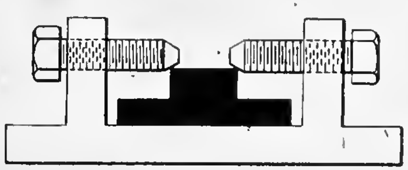


Fig. 9.

Method commonly used on milling fixtures for light clamping.


Fig. 10.

Objectionable type of clamp which is only used when necessary.

Contributed by Lucien L. Haas

III.—TYPICAL MACHINE AND JIG CLAMPING DEVICES

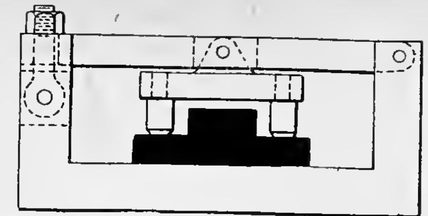


Fig. 11.

Clamp for box drill jig with two-point self-adjusting bearing.

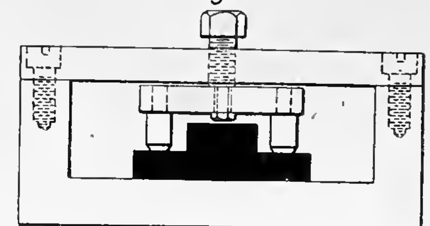


Fig. 12.

Clamp with two-point bearing which is intended for open end jigs.

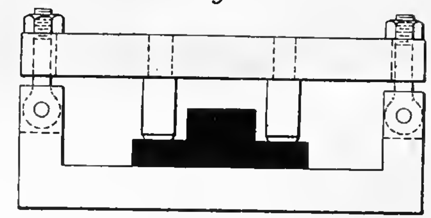


Fig. 13.

Clamp for box jigs with two-point bearing, which has the advantage of simplicity, but is somewhat objectionable because bearing points are non-compensating.

Fig. 14.

Two-point bearing clamp for open end jigs, which has the advantages and disadvantages mentioned in connection with the preceding design.

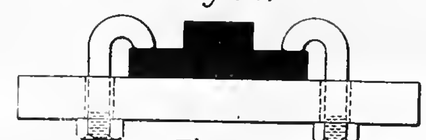


Fig. 15.

Simple method of clamping. The hook-bolt head should be more compact than here shown, bringing bearing point close to bolt body.

Contributed by Lucien L. Haas

IV.—TYPICAL MACHINE AND JIG CLAMPING DEVICES

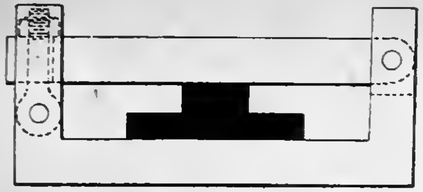


Fig. 16.

The method of clamping here illustrated is widely used on drill jigs of the box type.

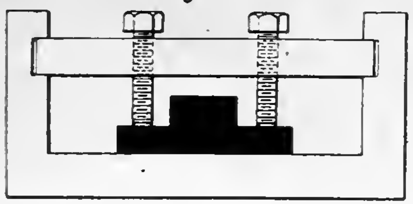


Fig. 17.

Removable clamp with two-point bearing, which is supported in retaining grooves; intended for open-end jigs.

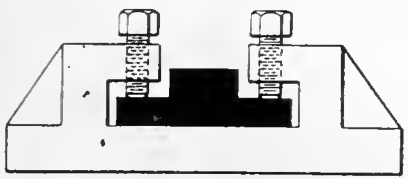


Fig. 18.

Clamping by means of set-screws; adapted to open-end jigs.

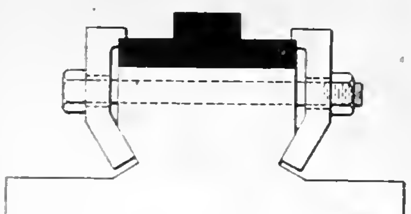


Fig. 19.

Efficient type of clamp for milling fixtures, which binds the work both vertically and horizontally.

Fig. 20.

Holding work by the use of a wedge; a method familiar to all mechanics.

Contributed by Lucien L. Haas

MACHINERY

December, 1909

CUTTING BEVEL GEAR TEETH—A NEW METHOD OF OBTAINING THE SET-OVER*

RALPH E. FLANDERS†

PERHAPS the most troublesome of the more common milling machine operations is that of cutting the teeth of bevel gears. Tables, explicit directions and formulas have been prepared for indexing, and for cutting spirals, cams, end-mill teeth, etc., but the shaping of a passably good bevel gear tooth has always been a matter of judgment and "cut-and-try." The writer, with the cooperation of the Brown & Sharpe Mfg. Co., herewith presents a method of setting the milling machine (or automatic gear cutting machine) for cutting the teeth of bevel gears, in which experimental trial cutting is nearly, if not quite, avoided, thus opening possibilities for a material saving in time, and improvement in the quality of the product. The method also enables much better results to be obtained in the hands of an operator unfamiliar with this rather difficult work. The whys and wherefores of the operation will be described from beginning to end, so as to give a clear understanding of the principles involved. First, however, the process itself will be described, so that the reader who does not care to go into the whys and wherefores will be able to use it.

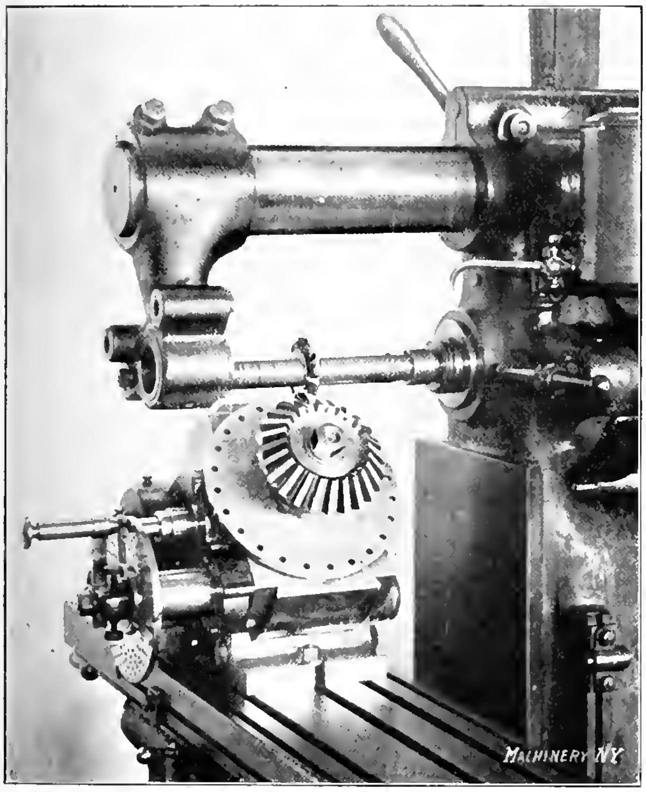


Fig. 1. Milling Machine set up for Cutting a Bevel Gear

Setting up the Machine

In cutting bevel gears by this process we are supposed to have given the number and pitch of the cutter we are to use, the diametral pitch of the teeth to be cut, the width of face of the gear (F in Fig. 2), the pitch cone radius of the gear (C in Fig. 2) and the thickness of the bevel gear cutter at the pitch line. The latter (which is variable) is best obtained by the Brown & Sharpe gear tooth caliper shown in use measuring a bevel gear tooth in Fig. 3. This should be set to measure the cutter at a depth $S + A$, in Fig. 2, which is the whole depth below the pitch line (this is given as $S + f$ in the tables in the Brown & Sharpe gear book for the different pitches, or may be found by dividing 1.157 by the diametral pitch). The thickness of the cutter at the pitch line as measured at this depth by the vernier tooth caliper is the dimension used in calculations.

It should be noted that when the table herewith presented is used for obtaining the set-over, the cutting angle must be determined as shown in Fig. 4. That is to say, the gears must be cut with a parallel clearance depth, in the way recommended by the Brown & Sharpe gear book as more closely approximating the true form than when the bottom of the tooth space is radial with the vertex of the pitch cone. This cutting angle is evidently found by subtracting the addendum angle θ from the pitch cone angle a. The milling machine is set up for cutting bevel gears in the usual manner with the work-spindle set at this angle, the cutter centered with the work and set for the full depth of tooth. If the gear is

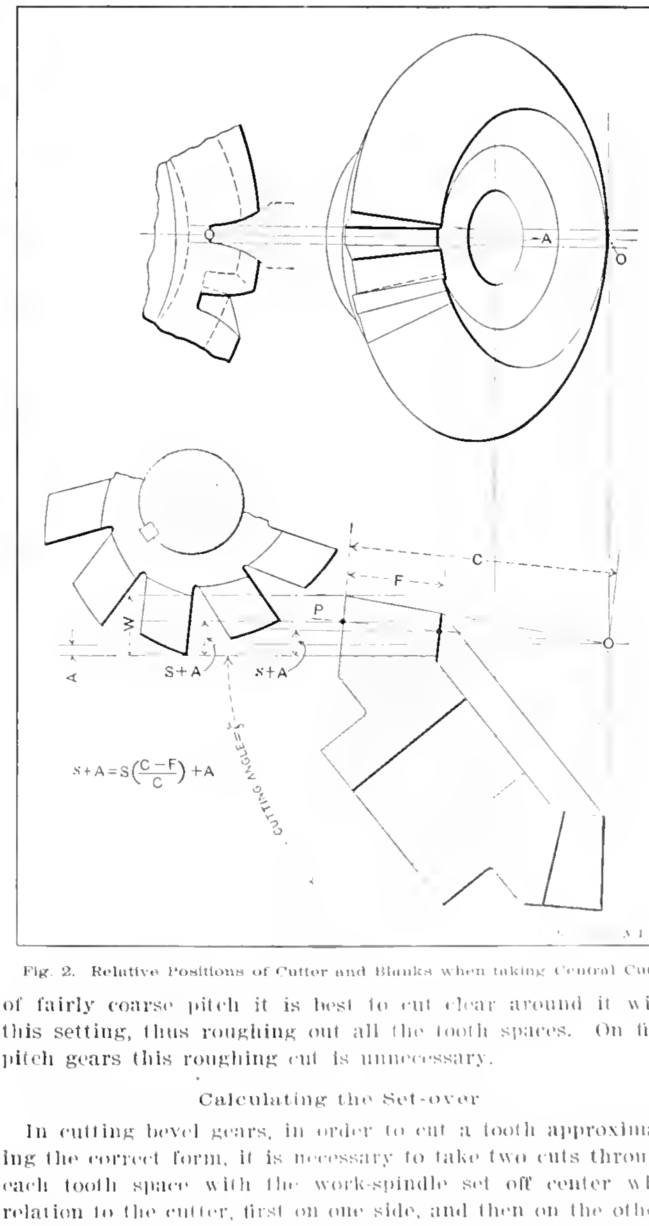


Fig. 2. Relative Positions of Cutter and Blanks when taking Central Cut

of fairly coarse pitch it is best to cut clear around it with this setting, thus roughing out all the tooth spaces. On fine pitch gears this roughing cut is unnecessary.

Calculating the Set-over

In cutting bevel gears, in order to cut a tooth approximating the correct form, it is necessary to take two cuts through each tooth space with the work-spindle set off center with relation to the cutter, first on one side, and then on the other, rolling the blank correspondingly to obtain the proper thickness of tooth at the large and small ends. It is proposed to

* For further information on this subject, see "Cutting Bevel Gears with a Rotary Cutter," October, 1907, and articles there referred to, and "Accurate Setting of the Bevel Gear Cutter," in this issue.
† Associate Editor of MACHINERY.

find the amount of this set-over from the accompanying table by the following formula:

$$\text{Set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P} \quad \text{..........(1)}$$

Given as a rule, this would read: *Find the factor in the table corresponding to the number of the cutter used and to the ratio of pitch cone radius to width of face; divide this factor by the diametral pitch, and subtract the result from half of the thickness of the cutter at the pitch line.*

As an illustration of the use of this table in obtaining the set-over we will take the following example: A bevel gear of 24 teeth, 6 pitch, 30 degrees pitch cone angle and 1¼ face. These dimensions, by the ordinary calculations for bevel gears* which it is not necessary to go into here, call for a No. 4 cutter and a pitch cone radius of 4 inches.

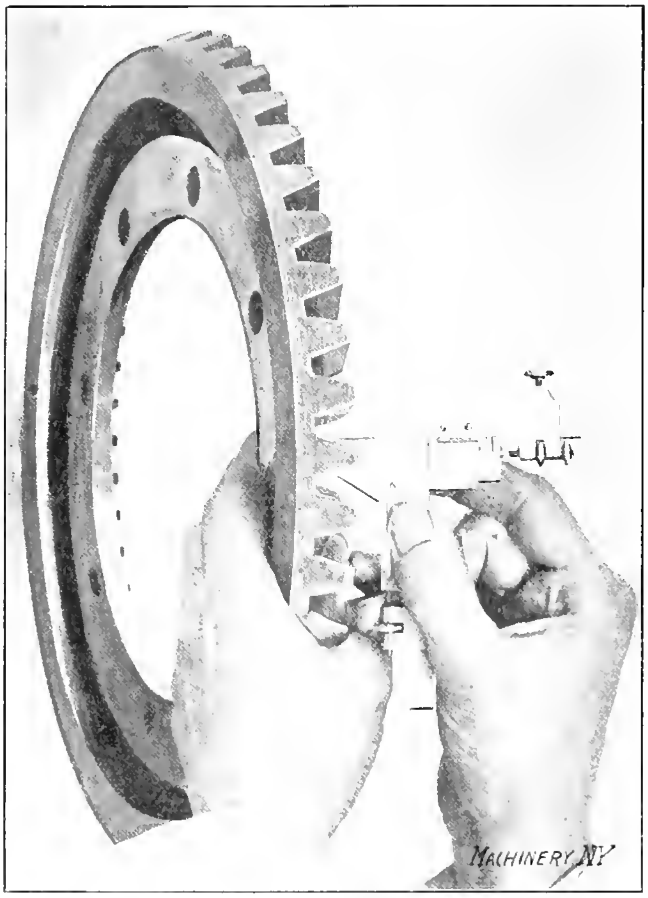


Fig. 3. Brown & Sharpe Gear-tooth Caliper in Use

In order to get our factor from the table, we have to know the ratio of pitch cone radius with length of face. This ratio is $\frac{4}{1.25} = \frac{3.2}{1}$ or about $\frac{3\frac{1}{4}}{1}$. The factor in the table for this ratio with a No. 4 cutter is 0.280. We next measure the cutter at the proper depth of $S + A$ for 6 pitch, which is found in the column marked "depth of space below pitch line" in a regular table of tooth parts, or by dividing 1.157 by the diametral pitch. This gives $S + A = 0.1928$ inch. We find, for instance, that the thickness of the cutter at this depth is 0.1745 inch. This dimension will vary with different cutters, and will vary in the same cutter as it is ground away, since formed bevel gear cutters are commonly provided with side relief. Substituting these values in Formula 1, we have

$$\text{Set-over} = \frac{0.1745}{2} - \frac{0.280}{6} = 0.0406 \text{ inch,}$$

which is the required dimension.

The work must now be set off center on one side of the cutter by this amount, taking the usual precautions to avoid errors from back-lash. In this position the cutter is run through the blank, the latter being indexed for each tooth space until it has been cut around. (If a central or roughing cut has been previously taken as suggested in an earlier paragraph, it will be necessary to line up this cut at the small end of the tooth with the cutter. This is done by rotating the tooth space back toward the cutter, either by moving the index crank as many holes in the dial-plate as are necessary, or by means of such other special provisions as may be made for doing this in the index head, independently of the dial-plate.)

Having thus cut one side of the tooth to proper dimensions, the work must be set-over by the same amount the other side of the position central with the cutter, taking the same precautions in relation to back-lash as before, and rotating the blank to again line up the cutter with the tooth space at the small end of the tooth. With this setting, take a trial cut. This will be found to leave the tooth whose side is trimmed in this operation a little too thick, if the cutter is thin enough, as it ought to be, to pass through the small end of the tooth space of the completed gear. This trial tooth should now be brought to the proper thickness by rotating the blank toward the cutter, moving the crank around the dial for the rough adjustment, and bringing it to accurate thickness by such means as may be provided in the head. In the Brown & Sharpe head, as shown in Fig. 1, this fine adjustment is effected by two thumb-screws near the hub of the index crank, which turn the index worm with relation to the crank.

Testing for Correctness of the Setting

With reference to the use of the table and formula, the Brown & Sharpe Mfg. Co., after trial in their gear cutting department, say: "We feel fairly confident it is within working limits of being satisfactory." While this sounds encouraging, it will evidently be wise to be sure we are right before going ahead, as the slight approximations involved in the derivation of the formula (to be explained later) may bring the setting not *quite* right, so that the thickness of the tooth at the large and the small ends is not what it ought to be. This point may be tested by measuring the tooth at both the large and the small ends with the vernier caliper as shown in Fig. 3, the caliper being set so that the addendum at the small end is in the proper proportion to the addendum at the large end—that is to say, that it is in the ratio $\frac{C - F}{C}$. In taking these measurements, if the thicknesses at both the large and the small ends, which should be in this same ratio, are too great, rotate the tooth toward the cutter and take another cut until the proper thickness at either the large or small end has been obtained. If the thickness is right at the large end and too thick at the small end, the set-over is too much. If it is right at the small end and too thick at the large end, the set-over is not enough, and should be changed accordingly, as is done by the regular "cut-and-try" process. The formula and table herewith given, however, ought to bring it near enough right the first time, and in the general run of work it can be safely relied on.

It may be said, in this connection, that nothing but a true running blank, with accurate angles and diameters, should be

TABLE FOR OBTAINING SET-OVER FOR CUTTING BEVEL GEARS

No. of Cutter	Ratio of Pitch Cone Radius to Width of Face $\left(\frac{C}{F}\right)$												
	3/1	3¼/1	3½/1	3¾/1	4/1	4¼/1	4½/1	4¾/1	5/1	5½/1	6/1	7/1	8/1
1	.254	.254	.255	.256	.257	.257	.257	.258	.258	.259	.260	.262	.264
2	.266	.268	.271	.272	.273	.274	.274	.275	.277	.279	.280	.283	.284
3	.266	.268	.271	.273	.275	.278	.280	.282	.283	.286	.287	.290	.292
4	.275	.280	.285	.287	.291	.293	.296	.298	.298	.302	.305	.308	.311
5	.280	.285	.290	.293	.295	.296	.298	.300	.302	.307	.309	.313	.315
6	.311	.318	.323	.328	.330	.334	.337	.340	.343	.348	.352	.356	.362
7	.289	.298	.308	.316	.324	.329	.334	.338	.343	.350	.360	.370	.376
8	.275	.286	.296	.309	.319	.331	.338	.344	.352	.361	.368	.380	.386

NOTE.—For obtaining set-over by above table, use this formula:

$$\text{Set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P}$$

P = diametral pitch of gear to be cut.
T_c = thickness of cutter used, measured at pitch line

* Rules and formulas for bevel gear calculations will be found in MACHINERY's Data Sheet No. 69, May, 1907, and in Reference Series No. 37, "Bevel Gearing."

used in setting up the machine. If such a blank cannot be found in the lot of gears to be cut, it will be necessary to turn one up out of wood or other easily worked material. Otherwise the workman is inviting trouble, whatever his method of setting up.

Filing the Teeth

The method of cutting bevel gears just described requires the filing of the points of the teeth at the small end. This can be done "by the eye" very skillfully when the workman is used to it. The operation consists in filing off a triangular area extending from the point of the tooth at the large end to the point at the small end, thence down to the pitch line at the small end and back diagonally to the point at the large end again. This is shown in Fig. 5, by the shaded outline.

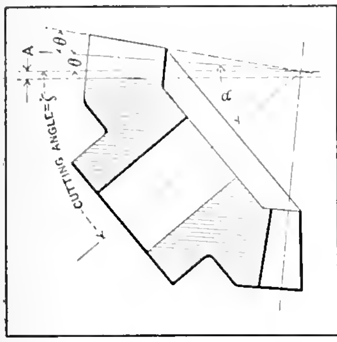


Fig. 4. Parallel Clearance, best adapted to shaping with Formed Cutter

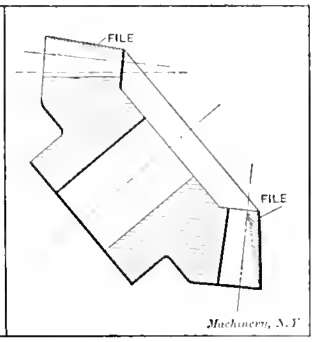


Fig. 5. Shaded Area shows Part of Tooth to be corrected by Filing

Enough is taken off at the small end of the tooth so that the edges of the teeth at the top appear to converge at vertex O in Figs. 2 and 6.

The bevel gears may be tested for the accuracy of the cutting and filing by mounting them in place in the machine and revolving them at high speed, or by mounting them in a testing machine made for the purpose. The marks of wear produced by running them together under pressure, with the back faces flush with each other, should extend the whole length of the tooth at the pitch line. If it does not, the amount of set-over allowed in cutting them was at fault, being too little if they bear heavily at the large ends, and too much if they bear heavily at the small ends. The bearing area should also be fairly evenly distributed over the sides of the teeth above the pitch line, from the large to the small end. If it is not, the filing is at fault. The marks of wear will not in any case extend far below the pitch line in a pinion of few teeth.

It is possible to get along without filing by decreasing the amount of set-over so as to make the teeth too thin at the pitch line at the small end, when they are of the right thickness at the large end. This does not give as good running gears, however, as when the method just described is followed.

Cutting Bevel Gears on the Automatic Gear-cutting Machine

The directions for cutting bevel gears on the milling machine apply in modified form to the automatic gear cutting machine as well. The set-over is determined in the same way, but instead of moving the work off center, the cutter spindle is adjusted axially by means provided for that purpose. Some machines are provided with dials for reading this movement. The cutter is first centered as in the milling machine, and then shifted—first to the right, and then to the left of this central position.

The rotating of the work to obtain the proper thickness of tooth is effected by unclamping the indexing worm from its shaft (means usually being provided for this purpose) and rotating the worm until the gear is brought to proper position. Otherwise the operations are the same as for the milling machine.

Derivation of Formula

The derivation of the formula and the method of calculating the table need not concern the workman who desires to use them, as he can employ them with no knowledge of mathematics other than that required for plain subtraction and division. For those, however, who desire to understand the origin of the table, the following explanation will be interesting.

Fig. 6 shows a section such as would be made by turning off the bevel gear blank down to the pitch cone—in other words, it is a section on the conical surface PO of Fig. 2. The same dimensions apply to both figures. We find, if we take a cut with the cutter set central, that the side of the tooth space will not pass through the vertex O, but through some point O' at one side. The distance between O' and O is X, which is the amount by which the cutter will have to be offset to bring the side of the tooth space at the pitch line radial with vertex O. A formula can be derived by simple proportion to obtain this offset, in terms of T_c, t_c, F and C. The formula is:

$$X = \frac{T_c}{2} - \left(\frac{T_c - t_c}{2} \times \frac{C}{F}\right) \qquad (2)$$

This determination of the set-over, of course, involves one or two approximations of minor importance, which will be readily perceived from an examination of the diagrams.

While this formula seems to furnish a means for obtaining by measurement and calculation the amount of set-over, it is rather clumsy. It remains therefore to put it in more usable form. From an examination of the formula, we note that while $\frac{T_c}{2}$ is a variable, depending on the thickness of the cutter, the quantity in parenthesis remains constant as the cutter grows thinner from being ground down. In fact, by taking the measurements T_c and t_c on a one diametral pitch cutter, and calling them T'_c and t'_c it would be possible to put this in the form:

$$X = \frac{T_c}{2} - \frac{1}{P}\left(\frac{T'_c - t'_c}{2} \times \frac{C}{F}\right) \qquad (3)$$

in which the quantity $\frac{T'_c - t'_c}{2} \times \frac{C}{F}$ would be constant for all cases of all pitches having the same ratio of $\frac{C}{F}$ and using the same number of cutter.

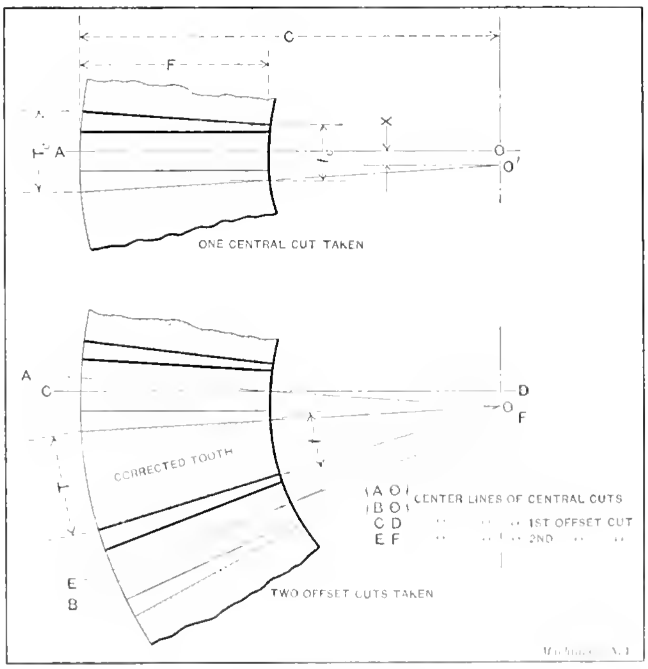


Fig. 6. Section on Pitch Cone Surface PO of Fig. 2, showing Central and Offset Cuts

Now it is possible to put this formula in still simpler form by tabulating the values of $\frac{T'_c - t'_c}{2} \times \frac{C}{F}$, as measured on a one pitch cutter, for different values of $\frac{C}{F}$. This has been done in the table for thirteen values of $\frac{C}{F}$, which cover the major part of the bevel gears cut by the formed tool process. Using the factor as given in the table, the formula reads:

$$X = \text{set-over} = \frac{T_c}{2} - \frac{\text{factor from table}}{P} \qquad (1)$$

as we have already given it.

The method of filling in the table will be easily understood. A one pitch cutter is measured with the Brown & Sharpe gear tooth caliper at depth $S + A$ for dimension T'_c and at depth $s + A$ for t'_c (see Fig. 2). Of course, $s + A$ and consequently t'_c will vary, as $\frac{C}{F}$ is taken $\frac{3}{1}$, $\frac{3\frac{1}{4}}{1}$, etc., respectively. Having found these dimensions, the quantities to fill in the table are evidently obtained by the formula:

$$\text{Factor from table} = \frac{T'_c - t'_c}{2} \times \frac{C}{F} \qquad (4)$$

Use of the Formula for Other Methods of Approximation

It would seem as though the form of table and formula here given would be suitable for recording for future use the amount of set-over obtained by the "cut-and-try" process for other methods of approximation than that here given. Transposing Formula 1 to solve for the factor, we have

$$\text{Factor from table} = P\left(\frac{T_c}{2} - \text{set-over}\right) \qquad (5)$$

in which the measurement as before is taken on the cutter used for the job. By recording the factors for all jobs done, and thus gradually filling in the tables from his own practice, the machinist would be able to put the data in usable form to apply to future jobs.

It is customary also among workmen expert in cutting bevel gears with formed cutters, to cut loose from rules and formulas for the selection of the cutters, and depend on their experience to get shapes which require somewhat less filing than would otherwise be necessary. Whenever this "cutting loose" requires, as it sometimes does, the use of a cutter of finer pitch than that of the teeth of the bevel gear at the large end, Formula 1 and the table are inapplicable. Formula No. 2 may then be used. This has been tried on several widely varying cases with good results. It requires, it will be seen, two measurements of the cutter in place of the single one required when the regular pitch of cutter is used.

Other Methods for Calculating the Set-over

At least two other attempts have been made to give values for the settings required in cutting bevel gears. The first of these was described by Mr. Jacques in the June 7, 1900, number of the *American Machinist*. The second was described by Prof. Forrest R. Jones in a paper at the December, 1896, meeting of the American Society of Mechanical Engineers. Of these methods the first, while aiming at the same results as obtained by the author, is impracticable, owing to the fact that it requires a peculiar design of machine for its successful use. The method here described may evidently be used in any machine in which the cutter can be adjusted axially, and in which the work can be rotated on its spindle. It may thus be used on the plain automatic gear cutting machine as well as on the milling machine. It may be even employed in the same identical way for a formed tool in the shaper, the same measurements being made and the set-over being read on the graduated dial of the table cross-feed screw.

Professor Jones' method was the result of long experiment and careful study. Its drawbacks are, first, the fact that it is designed for a method of approximation in which the tooth shape is obtained as nearly as possible from the cutter, without corrective filing; second (and principally) because it gives the setting in terms of rotation of the blank instead of the set-over of the cutter. There can be no question as to which of these dimensions is the deciding one in obtaining the proper tooth shape. It is the setting of the cutter off center which determines whether or not the side of the tooth at the pitch line shall be radial with the vertex of the pitch cone. The effect of the rolling or rotating of the blank is simply that of changing the thickness of the tooth, not of changing its shape. If the workman is directed to first roll the blank a certain amount and then shift the cutter sidewise to obtain the proper thickness, he has in mind the thickness and not the shape in making the last adjustment, and according to whether he makes the teeth thicker or thinner, so will the shape be changed; and for the same reason such a rule will give different shapes of teeth with similar cutters of varying thickness.

Practical Results from the Use of the Table

The methods obtained with the templet process and, above all, with the generating process, are so much superior to those obtained with the milling cutter that the use of the latter should be avoided wherever possible. It has a legitimate field, however, on gears too small to be cut on any commercial planing machine. In general, it is not considered advisable to plane gears having teeth finer than 10 to 12 diametral pitch. It is allowable, however, to mill gears of coarser pitch which are to run at slow speeds, or which are to be used only occasionally—such, for instance, as the bevel gears used for turning the elevating screws of a planer cross-rail, or those used in connection with other hand-operated mechanisms. Under ordinary conditions it is impracticable to mill bevel gears having teeth coarser than 3 diametral pitch, no matter what the service for which they are to be used.

Two of the approximations involved in this method may be mentioned. In Fig. 2, it will be noticed that the various dimensions W, $S + A$, etc., are taken perpendicular to the bottom of the tooth, instead of perpendicular to the pitch line as they should be. The setting of the cutter to depth by this usual method, therefore, involves an error, but it is so slight as to be negligible. The other approximation relates to the use of the uncorrected tooth thickness and addendum for measuring the cutters in preparing the table. The chordal tooth thickness might have been used, but at the cost of a considerable complication in the process. It was found by investigation that this refinement would not affect the final result enough to make it worth while.

The Brown & Sharpe Mfg. Co. has been trying this method of setting the milling machine and automatic gear cutter for the past four or five months, first in an experimental way, and later in regular practice. The workman can with confidence cut a trial tooth with the set-over given and expect to find it (in an 8-pitch gear, for instance) about as close to size as he would naturally measure, so far as thickness of the tooth at the large and small ends is concerned.

The writer's thanks are due to the Brown & Sharpe Mfg. Co. for the very kind attention given to this matter, both in the experimenting in the shop, and in the preparation of the table in the drafting-room.

* * *

The whitewashing of coal, says the *Railway and Engineering Review*, would seem to be a rather silly proposition; but it is not done for looks, nor to change the quality of the material. It is rather a simple detective scheme said to be effective. The purpose is to locate loss of coal from open cars by theft or otherwise, in transit. The top of the load is sprayed with lime water—an easy and cheap process. It is thus whitened as the water evaporates, and the appearance is that of a load of white coal. Any disturbance of this surface by removal of even a small quantity is readily noticeable. By observing this at division and junction points, the place of the disappearance can be approximately located. This plan has been tried on some western roads, but has been abandoned solely on account of the opposition of dealers who claim that their customers do not want coal so treated. As the quality of the coal is unaffected, there can be no reasonable objection to it. The real reason is believed to be that dealers prefer not to get the protected coal but prefer the opportunity of making claims for alleged losses in transit. If this is the fact, there is a condition into which railway commissions, state or national, might well look. It is to the best interest of shippers and carriers that there should be no losses in transit, and no bogus claims for alleged losses.

* * *

About one-third of an ounce of radium-chloride, equivalent to about one-thirtieth of an ounce of pure radium, was the total output of the Joachimsthal mines in Austria for eighteen months. The radium will be sold for about \$5,000 a grain.

DIES AND METHODS FOR MAKING WATCH CROWNS

GEO. J. MURDOCK*

The art of making watch crowns is one of the most interesting branches of precision mechanics, and of comparatively recent development, as watches, like clocks, were originally wound with a key. In the course of the refinement of the watch it was discovered that a watch key was a very elusive article, which, being small, was easily mislaid or lost.

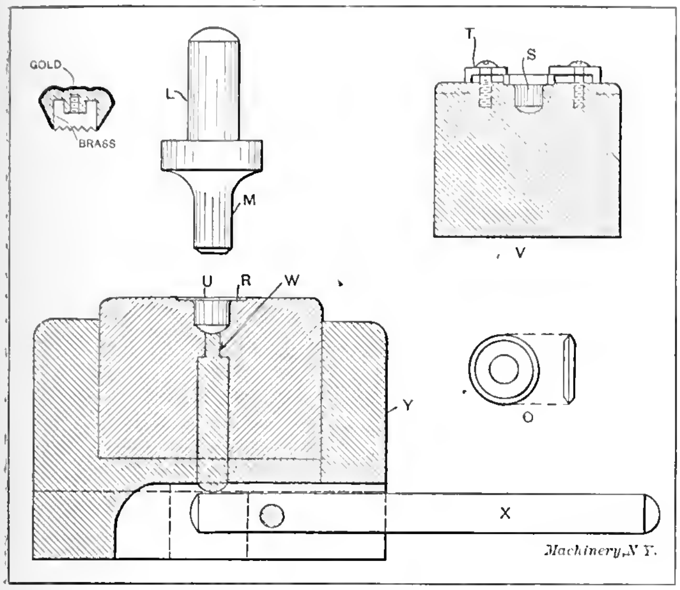


Fig. 1. Dies used in making Watch Crowns

The stem-winding, and finally the stem-setting watch was improved so as to render the key unnecessary, and with this improvement came the watch crown. In the beginning, it was globular, or nearly so in shape, but in recent years the style known as the antique crown has almost completely superseded the old form, particularly on American watches.

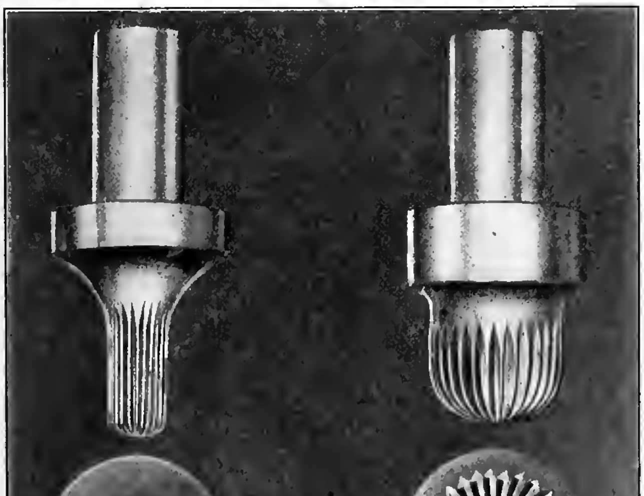


Fig. 2. Two Punches used for Forming the Gold-plated Outer Shell

There are numerous sizes made which are numbered from 0 to 24 or larger. The small sizes are used mainly on ladies' watches, while those for men seldom range above size 18.

Such a thing as a solid gold crown is unusual, the practice being to make a central hub or core of brass, over which is drawn a filled or solid gold shell, as shown in the sectional view in the upper left-hand corner of Fig. 1. Manufacturers at the present time seem to be unanimous in two particulars: First, the brass hub is made just as large and heavy as possible; and second, the shell over the brass is made just as thin as the trade will allow. The reasons for this are obvious. Thus it will be understood that when one has what he fondly imagines is a solid gold watch in his pocket, it is composed, in reality, mainly of brass and steel.

The machinery required in the making of tools for watch crowns, is a screw press, lathe, and a small universal milling machine. In making the dies, the punch for the gold shell is the first thing to make. A punch of hard tool steel such as is used for one of the final operations is shown in Fig. 1, and also at the left in Fig. 2. It has a shank *L*, and point *M* which is fluted on the milling machine with the correct number of divisions for its size. These divisions are standard for the different sizes, and must be very smoothly cut by a small V-shaped 60-degree milling cutter such as shown at *O*. The fluting of the punch necessitates not only a keen cutter, but such an exercise of skill on the part of the toolmaker as will produce a surface on the flute free from chatter marks or blemishes of any kind. The perfection of the punch in this respect should be followed by a die that is also perfect. After the flutes are cut in the punch both on the sides and

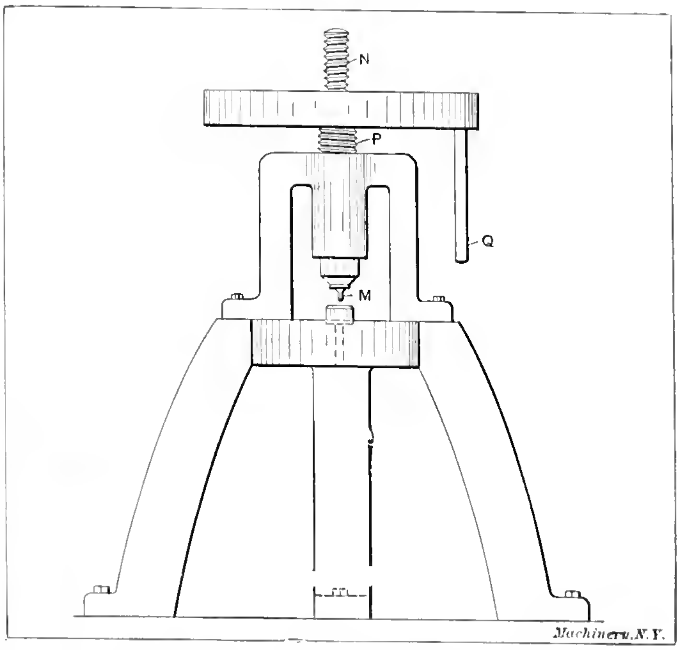


Fig 3 Screw Press in which Dies and Crowns are made

end to the center, the part that forms the crown top is turned (usually by hand) to a gage, as shown in the end view in Fig. 2. I will state here that the top of a watch crown is the small central hub on the top where the flutes end. The bottom or point of the punch is turned to this shape, as shown, and to the exact diameter that the body of the hub on the finished crown is to be.

The punches, when ready to be hardened, are packed in a cast iron box with a mixture of powdered charcoal and bone-dust. The cover is then luted with fire-clay so as to make it air tight, and the box with its contents is heated long enough to bring the punches to the right temperature for hardening. They are then taken out one by one, and dipped vertically in lukewarm water. Care is taken to keep those that are in the box covered with the charcoal, for an exposure to the air even for a few seconds will cause them to scale so as to render it impossible to get them of the necessary smoothness again. Before packing the punches they should be slightly warmed and dipped in the following solution: Boracic acid, 1½ ounce; aqua ammonia, 2 ounces; powdered borax, 1 ounce; potassium cyanide, ½ ounce. This solution is dissolved by boiling it in ½ gallon of rain water. It forms a protection to the finished surface of the punch, and assists in keeping it from scaling. If it is used, the punches will come out bright, and nearly as smooth as when put in the fire, which is a very essential thing to consider in work of this class. After hardening, the punches are scratch-brushed (not buffed), and then put into a muffler and drawn to a clear straw color all over. When cold, the

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point M is dipped in water, and with a gas blow-pipe, the shank L and the enlarged part of the punch is drawn to a dark blue, while the point as far as it is in the water will remain a straw color.

The die is usually about $2\frac{1}{2}$ inches in diameter by $1\frac{1}{2}$ inch thick, and the blank is turned all over so as to be round, and parallel on the top, and bottom. For the smaller sizes, the spot where the punch will strike in sinking, should be smoothly polished. The die is set in a recess on the bed of the screw-press, as indicated in Fig. 3, and the punch M is brought gently down on it. The screw-press is made with a compound screw N and P which, together with a heavy fly-wheel actuated by the handle Q, gives it great power. Before beginning the operation of sinking the die, the punch should be wet with the following mixture, which seems to have a softening effect on the steel of the die, causing it to give away with greater ease before the punch; in addition, the sunk surface will remain smooth in service longer than when oil is used: sulphuric ether, 6 drams; pulverized camphor, 2 ounces; enough oil of turpentine to fill a 6-ounce bottle.

In sinking the die, it should be held down in the recess in the bed-plate of the press with the right hand, while with the left the wheel is swung so as to move the plunger of the press with the punch up and down. Too much force must not be applied at first, but the blows should be struck gently, until the point of the punch has entered the die far enough so that the flutes on the sides of the punch are well supported by the wall of the die. The greatest danger of breaking the punch is when the operation of sinking is first started, but by observing the above precaution, breakage may be reduced to a minimum. The punch should be kept wet with the solution (which is applied with a small brush) and driven a little at a time down into the die. Care should be taken to prevent dirt, bristles from the brush or other foreign matter from getting into the pit as it is being sunk, and after every two or three blows the die should be turned around. In doing this, it should be lifted by the hand from the recess in the press bed, and placed on the punch, after which the press is carefully brought down, and the die located in the recess, when the sinking may be continued. As the punch travels down, the force of the blows may be increased with safety, until the required depth is nearly reached, when they should be again moderated, and at the finish the die should only be tapped gently. The reason for this is that a large number of gently delivered blows towards the finish will make a much more durable die, and one that is less liable to crack in hardening.

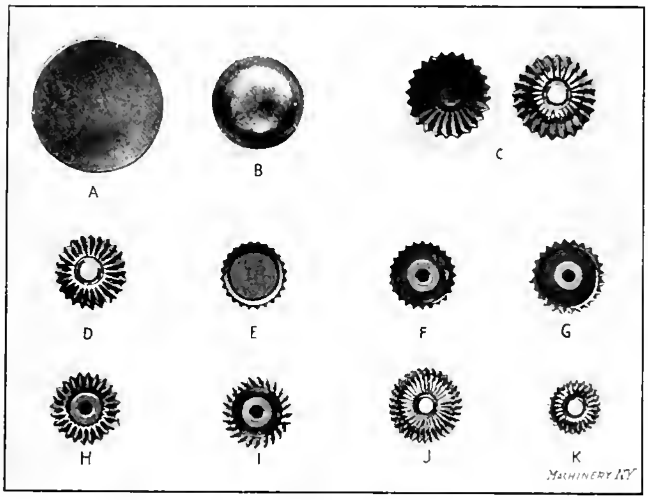

Fig 4. The Evolution of a Watch Crown

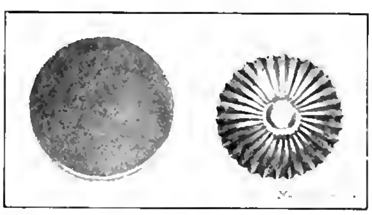

Fig. 5. Gold-filled Blank for 18-size Crown, and Shape after Second Operation

If by any means one of the flutes of the punch should break in the sinking (and it sometimes happens with the most careful management) see that no small pieces of the splinter are in the die, and then, by the method of turning heretofore described, it may still be saved, or if the splinter has injured it only slightly it may be used for a larger size. The old method of sinking, especially with the large sizes, was to heat the die red hot, and then bring the punch down on it, a proceeding that was almost sure to ruin the punch, and produce a die more or less rough and pitted. With the sinking fluid mentioned, however, dies of any size can be sunk cold with ease, and the hot method is no longer used by up-to-date toolmakers.

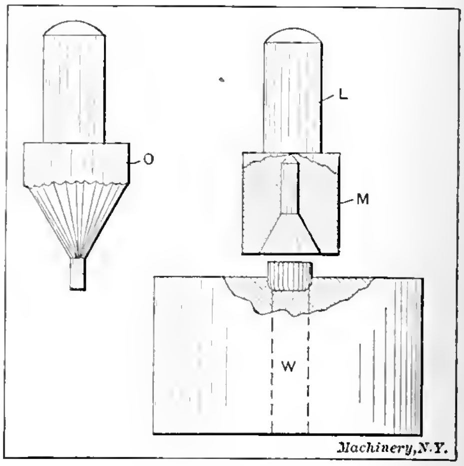

Fig. 6. Punch and Die for Closing Crowns as at H, Fig. 4

After the die is sunk, it is put on the face-plate of a lathe, and indicated until the pit in the die comes central, and then a recess R (Fig. 1) is turned concentric with the pit to receive the round blank A (Fig. 4) which is to form the shell of the crown. The stock from which the shells are made varies in thickness for different sizes, but for an 18 size it would be 0.012 of an inch thick for filled stock. In some cases instead of the recess R, a nest S is made to hold the blank. Holes are then drilled and tapped in the top of the die as shown, and the nest is held in place by the straps T. I regard these holes as objectionable, however, and always use the recess R in preference, where it is permissible. In turning out the recess, the sharp corner U of the pit in the die is slightly rounded and highly polished. If this is not done the gold will be scratched or even cut by the sharp corners of the flutes which are now, of course, exact duplicates of the flutes on the punch.

In making the larger sizes of crown dies it becomes necessary to turn out a pit in the top of the die, removing most of the metal in the way of the punch before beginning the operation of sinking so that the punch has only to draw up the flutes. This hole should be turned as smooth as possible, and polished. I have known a small ring made in the turning which was hardly discernible with the naked eye, to irretrievably ruin a die, for no matter to what extent the sinking was carried, that ring would still appear on the flutes, and of necessity on the finished crown. Filled gold plate consists of a very thin sheet of gold (10 or 12 carat) laid on a sheet of copper, and united by pressure alone, no solder or other adhesive being used. It will be seen, however, that all the work on a crown die using this stock must be perfect, for the slightest scratch through the thin gold will quickly show on the darker colored copper beneath, which will eventually turn a dark brown while the uninjured part of the gold will remain bright. A flute on the punch that has been slightly distorted in hardening, will sometimes draw the gold so that it will not cover the copper after the slight buffing the crowns receive as a finish, and a dark spot on the crown will soon develop in use.

Dies for small sizes of crowns are commonly made solid at the bottom of the pit, as in the die V, Fig. 1, but the larger sizes require some means of pushing the drawn shell out of the die. A rod W is used for this purpose which has a small end or shoulder as shown, which is of such a length that when the shoulder strikes the bottom of the counterbored hole in the die, and the shell is forced down into the die, the top of the crown is drawn into shape by the top end of the rod, instead of the bottom of the pit as in the small sizes. In making dies of this class, it should never be attempted to drill the central hole for the rod W after the die is sunk. It is my practice to drill the hole while the die is on the face-plate, and after the clearance hole is made for the punch. It should be a few drill sizes smaller than the correct finish size for the small end of the rod. The punch in sinking will fol-

low this hole very accurately if everything else is correct, and after the die is sunk, the hole may be enlarged to the proper size for lapping to an exact fit on the rod after hardening. In the smaller sizes, the shell will come out of the die on the punch from which it may be removed with the fingers, but in the large sizes a blow from a mallet on the lever *X* is often required to force the shell out of the die. This lever is fulcrumed in the shoe *Y* which is strapped to the bed of the press, and holds the die in position under the punch. A slight tap on the lever will, through the agency of the rod *W*, drive the shell out of the die after the punch has been withdrawn.

After the die has been completed, a second working punch for drawing the shells must be made. It is in all respects like the first or sinking punch in shape, but is made smaller in diameter by twice the thickness of the stock used. This applies to both the body, and the hub which forms the top of the crown. In addition to this, a small clearance must be allowed which varies from a fraction of a thousandth of an inch to one or more thousandths, according to the size of the crown to be made. This allowance is for distortions in hardening, and other small differences between the punch, die, and stock, although the latter is usually very uniform in thickness. The round blanks are found in the market, of the correct diameters for the various sizes, and are generally bought by the manufacturers ready for use, so that the toolmaker is chiefly concerned with the various drawing processes.

The first drawing operation is to make the round blank into a shallow cup as at *B*, Fig. 4, where a cup for a 16 size crown is shown. This is done in a die that is easily made, but must, of course, be correct in size and smooth. This die is made with its punch, in the same manner as described for the fluted ones, but a little more latitude may be allowed between the punch and die so as to treat the gold blank as gently as possible. Heating between the drawing processes is never necessary if the preliminary tools are made right, as the stock will harden but slightly, before the shell reaches the fluting stage.

The second operation, *C*, puts the primary flutes in, as well as the top in a rudimentary form. The blank for an 18 size and also its shape after the second operation, is shown in Fig. 5. The punch used in forming the blank to this shape is shown to the right in Fig. 2. The third operation, *D*, brings the sides up parallel or nearly so, and to the correct diameter of the finished crown. The punch for this operation is shown to the left in Fig. 2. In small work, operation number two is omitted, and the shell is drawn directly from a plain shallow cup to the shape shown at *D*.

After the third operation, the shell is ready to receive the hub in which is tapped the thread for the stem. This hub is made from a chunk of soft brass which is chopped off in almost any old way. It is thrown into a die that forms it as shown at *E*, with the same number of flutes as the shell. The top is smaller than the top of the shell, but exactly fills it. The making of the punch for sinking this die is the same as for the other fluted punches, but it is slightly smaller than the inside diameter of the shell so that the hub may be pushed into the shell without stretching it. After the die is finished, a second punch is made with a blunt end somewhat smaller than the inside of the die at the top. This outfit is used commonly on a foot-press that is operated with great spirit by one of the small jokers of the establishment, who turns the hubs out by the thousand at so much per.

After the hub is struck up, it is put into a spring chuck, counterbored, drilled, and tapped for the stem of the watch as at *F*. It is then pushed into the shell by the aforesaid small joker, as at *G*, and it is then ready to close in, which requires a special punch and die, as shown in Fig. 6. This die is made so that by changing the rod *W*, a number of different sizes may be closed by the same die. The punch as well as the die is sunk, which is done as follows: The shank *L* having been duly turned, the body *M* is bored out to the proper taper and a smaller straight hole is bored as shown. The sinking punch *O* has the same number of flutes in it, and is as carefully made as the shell punch so that the flutes in the taper will be absolutely smooth, and of a high polish. At its point it is provided with a pilot that fits the straight hole in the punch *M*. The punch *M* is placed in an inverted position in a special shoe on the screw-press, and the flutes sunk in it by the punch *O*, which is attached to the press plunger.

After both punch and die are finished, the shell of the crown containing the brass hub is placed top side down in the die, and the punch *M* is brought down on it until it strikes the die. This action draws the top together, as shown at *H* (Fig. 4), and brings the crown to the shape required for frazing, which consists essentially in counterboring the ragged edges where the brass hub and shell come together, to the correct size to fit the watch case. Samples of the completed crowns, antique style, are shown at *I*, *J* and *K*, the first two being number 16 in size and the last number 12.

After the dies are made, and are ready to be hardened, the pit is filled with a stiff paste of lampblack mixed with the non-scaling solution mentioned in this article. The die is now luted into a hardening box, and brought to a low red heat, and allowed to cool off over night. Unless this precaution is taken, the great molecular strain set up in the top of the die blank by the sinking, is liable to cause it to split in the hardening. When the die is finally ready to be hardened the pit is again filled with the lampblack mixture, and the die is packed in the same manner as heretofore described for hardening the punches, and then heated to the proper temperature to dip.

The hardening bath is sometimes of oil, but I prefer clean rain water which has been made lukewarm. The die is taken quickly from the box, and dipped face down into the cup *C* (Fig. 7) of the hardening tank. Holes are cored out in this cup so as to allow a free circulation of the water, and to permit the steam to escape readily. Water is let into the cup until it is about half full, and then the die is placed therein; the water which is supplied by a pump at about 15 pounds pressure, is then turned on full.

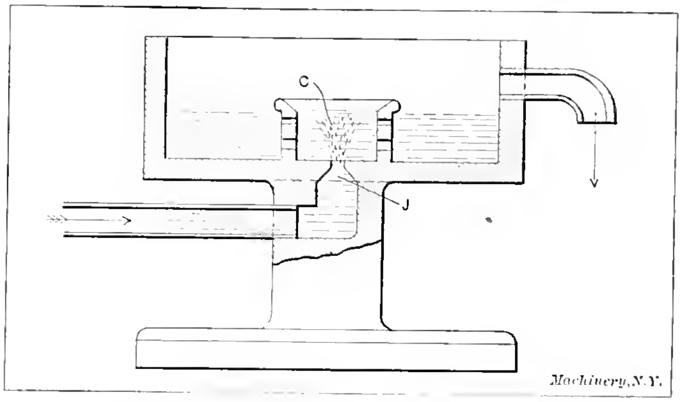

Fig. 7. Tank in which the Crown Dies are hardened

The jet *J* comes directly under the sunk pit in the die, and quickly washes out the lampblack, driving it with the steam through the holes in the side of the cup. If the dies are of the proper temperature, it will be found that the flutes and bottom of the pit that forms the top of the crown, are perfectly hardened, smooth, and almost as bright as when put in the hardening box.

Both the punches and dies for making watch crowns, should be so smooth and bright as to reflect any article brought near them like a mirror, and if in this condition they will turn out perfect work.

* * *

EXPLODED BOILER PROJECTED TO GREAT HEIGHT

A 400 H. P. vertical water-tube boiler of the type having water and steam drums connected by the water tubes, exploded in the Denver Gas & Electric Co.'s power plant in Denver, Col., last June. The bottom head of the lower drum ruptured at the rivet holes where connected to the shell, and the boiler "sky-rocketed" to a calculated height of over 1,600 feet; it fell into the engine room 175 feet from its starting point and demolished a Hamilton-Corliss engine and two large direct-connected generators. The explosion caused the immediate death of four persons and serious injuries to four others. The estimate of the damage to property ranged from $60,000 to $200,000. The explosion and calculations of the height to which the boiler projected itself were the subjects of an interesting article in the July number of the *Locomotive*.

ACCURATE SETTING OF THE BEVEL GEAR CUTTER*

WARREN E. THOMPSON†

This article deals exclusively with the formed bevel gear rotary cutter, and introduces a method of mathematically finding the correct setting of the bevel gear cutter in relation to the axis of the gear; also the amount of rotation of the gear blank required for the correct thickness of the teeth.

Bevel gear cutting with a formed cutter is but a compromise process, the teeth having to be shaped, to a certain extent, after cutting by filing or other means. The customary practice is to cut the large end of the tooth to the correct form as nearly as possible and then finish the small end addendum by rounding, either with a file or by running it in mesh with a hardened master gear. Another method is to cut the large end of the tooth slightly more rounding than necessary and the small end of the space deeper than regularly figured. The latter method saves considerable of the after finishing work and if the teeth are cut somewhat thin, an amount varying with the pitch, they may be run with no other labor on them, but will be noisy at high speed. These two methods of producing bevel gears with rotary cutters are the most economical of the many available, but the first produces the most nearly correct tooth form of any.

The following methods of obtaining settings are applicable to all methods of cutting with rotary cutters whether in the milling machine or gear cutter, but, of course, allowances must be made in the formulas for conditions other than those described:

The Choice of the Cutter

The choice of the cutter is perhaps the most important item of any, as the smoothness of the tooth action is entirely dependent upon the shape of the formed cutter. The best method for selection of the cutter, in the writer's opinion, is to figure or measure the back cone radius of the gear, and multiply it by twice the given diametral pitch. This gives the number of teeth of an equivalent spur gear having the correct tooth form. The position of the cutter in relation to the axis of the gear is variable with each case, and this is what makes the selection of the cutter a rather difficult proposition. Select a spur gear cutter for the calculated spur gear, and scribe the outline of the tooth form on a piece of blackened zinc or other sheet metal. Select a bevel gear cutter having the same or slightly less concave form. This method has been used by the writer and found more satisfactory than any other coming within his experience. [Of course the tooth faces of the spur cutter and bevel cutter must be ground exactly radial and parallel with the cutter axis, as they should properly be, in order to make the comparison effective.—EDITOR.]

The Setting of the Cutter

The setting of the cutter has been a matter of cut-and-try and a rather unsatisfactory operation as well as costly in high-grade labor. The following method overcomes these difficulties to a marked degree; it enables the draftsman to put the figures for the shop on the gear drawings the same as other shop data:

Fig. 1 represents the layout of the middle section of a gear tooth lying in the same plane as the axis of the gear. BT is the pitch radius; BP the front cone radius; and BR the back cone radius. AB and A_1B_1 are the addenda; BC and B_1C_1, the working depths; and BD and B_1D_1 the whole depths of space below the pitch line, called the $S + F$ and $s + F$ of the large and small ends of the tooth respectively. BB_1 is the length of the tooth, called the "face." B_1D_1, or the $s + F$ of the small end equals $\frac{PB_1}{PB} BC + F$. Clearance is constant.

By referring to Fig. 3, which is a section of a bevel gear cutter, it can readily be seen that every different $S + F$ or height from the bottom has its definite corresponding thickness, and the accompanying table of proportions comprises a series of measurements taken from large standard layouts. This table has correct figures for 1 diametral pitch

BEVEL GEAR CUTTER PROPORTIONS, 1 DIAMETRAL PITCH

Cutter No. 1, 135 Teeth		Cutter No. 2, 55 Teeth		Cutter No. 3, 35 Teeth		Cutter No. 4, 26 Teeth		Cutter No. 5, 21 Teeth		Cutter No. 6, 17 Teeth		Cutter No. 7, 14 Teeth		Cutter No. 8, 12 Teeth	
$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t	$s+F$	t
1.152	.000	1.146	.000	1.1395	.000	1.133	.000	1.128	.000	1.121	.000	1.113	.000	1.106	.000
1.145	.006	1.139	.006	1.132	.008	1.126	.008	1.121	.008	1.114	.010	1.106	.012	1.099	.013
1.138	.010	1.132	.009	1.125	.013	1.119	.013	1.114	.010	1.107	.017	1.099	.017	1.092	.019
1.131	.014	1.125	.012	1.118	.019	1.112	.018	1.107	.014	1.100	.022	1.092	.021	1.085	.025
1.124	.018	1.118	.016	1.111	.022	1.105	.022	1.100	.023	1.093	.027	1.085	.025	1.078	.031
1.117	.022	1.111	.022	1.104	.026	1.098	.027	1.093	.027	1.086	.032	1.078	.030	1.071	.037
1.110	.026	1.104	.026	1.097	.029	1.091	.032	1.086	.030	1.079	.040	1.071	.035	1.064	.042
1.103	.030	1.097	.029	1.090	.033	1.084	.036	1.079	.036	1.072	.045	1.064	.040	1.057	.047
1.096	.034	1.090	.034	1.083	.040	1.077	.040	1.072	.040	1.065	.048	1.057	.045	1.050	.052
1.089	.040	1.083	.038	1.076	.042	1.070	.044	1.065	.044	1.058	.050	1.050	.050	1.043	.056
1.082	.044	1.076	.042	1.069	.044	1.063	.048	1.058	.048	1.051	.057	1.043	.053	1.036	.060
1.075	.048	1.069	.044	1.062	.047	1.056	.052	1.051	.052	1.044	.060	1.036	.057	1.029	.064
1.068	.052	1.062	.048	1.055	.050	1.049	.055	1.044	.058	1.037	.065	1.029	.062	1.022	.067
1.061	.056	1.055	.052	1.048	.056	1.042	.058	1.037	.064	1.030	.068	1.022	.068	1.015	.070
1.054	.059	1.048	.056	1.041	.060	1.035	.062	1.030	.068	1.023	.070	1.015	.070	1.008	.074
1.047	.062	1.041	.059	1.034	.065	1.028	.066	1.023	.070	1.016	.075	1.008	.075	1.001	.077
1.040	.066	1.034	.062	1.027	.068	1.021	.071	1.016	.074	1.009	.080	1.001	.080	.994	.080
1.033	.070	1.027	.068	1.020	.072	1.014	.075	1.009	.078	1.002	.085	.994	.085	.987	.083
1.026	.074	1.020	.072	1.013	.076	1.007	.079	1.002	.084	.995	.090	.987	.090	.980	.089
1.019	.076	1.013	.074	1.006	.079	1.000	.082	.995	.086	.988	.093	.980	.093	.973	.094
1.012	.080	1.006	.078	.999	.082	.993	.085	.988	.090	.981	.098	.973	.098	.966	.097
1.005	.084	.999	.082	.992	.086	.986	.089	.981	.094	.974	.100	.966	.100	.959	.100
.998	.088	.992	.086	.985	.089	.979	.092	.974	.100	.967	.103	.959	.105	.952	.103
.991	.092	.985	.090	.978	.092	.972	.096	.967	.104	.960	.108	.952	.110	.945	.106
.984	.094	.978	.094	.971	.096	.965	.100	.960	.108	.953	.113	.945	.115	.938	.109
.977	.098	.971	.098	.964	.100	.958	.104	.953	.112	.946	.115	.938	.116	.931	.112
.970	.100	.964	.100	.957	.104	.951	.107	.946	.116	.939	.118	.931	.117	.924	.115
.963	.104	.957	.104	.950	.108	.944	.111	.939	.118	.932	.120	.924	.122	.917	.118
.956	.110	.950	.108	.943	.111	.937	.115	.932	.122	.925	.123	.917	.125	.910	.121
.949	.114	.943	.112	.936	.115	.930	.118	.925	.124	.918	.125	.910	.126	.903	.124
.942	.116	.936	.116	.929	.120	.923	.121	.918	.126	.911	.128	.903	.127	.896	.127
.935	.120	.929	.120	.922	.124	.916	.126	.911	.130	.904	.129	.896	.130	.889	.130
.928	.124	.922	.124	.915	.128	.909	.130	.904	.132	.897	.131	.889	.135	.882	.131
.921	.128	.915	.128	.908	.132	.902	.133	.897	.136	.890	.133	.882	.136	.875	.132
.914	.130	.908	.130	.901	.135	.895	.136	.890	.140	.883	.136	.875	.137	.868	.133
.907	.132	.901	.133	.894	.137	.888	.140	.883	.144	.876	.140	.868	.139	.861	.134
.900	.136	.894	.136	.887	.140	.881	.144	.876	.148	.869	.143	.861	.140	.854	.135
.893	.139	.887	.139	.880	.144	.874	.148	.869	.150	.862	.145	.854	.142	.847	.137
.886	.144	.880	.142	.873	.149	.867	.152	.862	.152	.855	.146	.847	.145	.840	.139
.879	.149	.873	.146	.866	.153	.860	.154	.855	.154	.848	.147	.840	.147	.833	.140
.872	.153	.866	.149	.859	.156	.853	.156	.848	.160	.841	.148	.833	.150	.826	.142
.865	.156	.859	.152	.852	.158	.846	.159	.841	.164	.834	.150	.826	.151	.819	.145
.858	.160	.852	.157	.845	.160	.839	.162	.834	.166	.827	.153	.819	.153	.812	.147
.851	.162	.845	.161	.838	.164	.832	166	.827	.168	.820	.155	.812	.155	.805	.150
.844	.166	.838	.165	.831	.167	.825	.169	.820	.170	.813	.157	.805	.158	.798	.154
.837	.170	.831	.169	.824	.170	.818	.172	.813	.174	.806	.158	.798	.159	.791	.156
.830	.174	.824	.172	.817	.174	.811	.174	.806	.186	.799	.160	.791	.160	.784	.157
.823	.176	.817	.174	.810	.177	.804	.176	.798	.178	.792	.161	.784	.161	.777	.158
.816	.178	.810	.176	.803	.180	.797	.179	.791	.180	.785	.163	.777	.163	.770	.160
.809	.182	.803	.180	.796	.184	.790	.182	.784	.182	.778	.164	.770	.165	.763	.162
.802	.186	.796	.185	.789	.185	.783	.186	.777	.184	.771	.165	.763	.166	.756	.163
.795	.190	.789	.188	.782	.188	.776	.190	.770	.186	.764	.167	.756	.169	.749	.165
.788	.194	.782	.190	.775	.190	.769	.194	.763	.188	.757	.168	.749	.170	.740	.167
.781	.196	.775	.192	.768	.194	.762	.196	.756	.190	.750	.170	.740	.172	.733	.168
.774	.198	.768	.196	.761	.196	.755	.198	.749	.192	.743	.171	.733	.174	.726	.170
.767	.200	.761	.199	.754	.198	.748	.200	.742	.193	.736	.173	.726	.175	.719	.171
.760	.204	.754	.202	.747	.200	.741	.202	.735	.194	.729	.174	.719	.176	.710	.172
.753	.210	.747	.206	.740	.204	.734	.204	.728	.194	.722	.175	.710	178	.703	.173
.746	.214	.740	.210	.733	.210	.727	.206	.721	.195	.715	.176	.703	.180	.696	.174

* For further information on this subject, see "Cutting Bevel Gears with a Rotary Cutter," October, 1907, and "Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-over," in this issue.

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cutter only, and starts at T_c or the pitch line of the cutter; hence the $S + F$ of the actual case must be multiplied by the stipulated diametral pitch before referring to the table. Under the number of the standard cutter chosen by the method just described the given $s + F$ will be found with its corresponding t, or loss in thickness. This number must be divided by the given diametral pitch to get the actual loss in thickness from the large to the small end of the actual tooth space on the cone pitch line PR.

Now a bevel gear cutter set central with the axis of the gear will cut some such lines as DE, Fig. 2, passing outside of the gear center. The finishing face of the cutter must be moved until it cuts cone pitch lines passing through the center as FO. The angle subtended by the pitch points of the

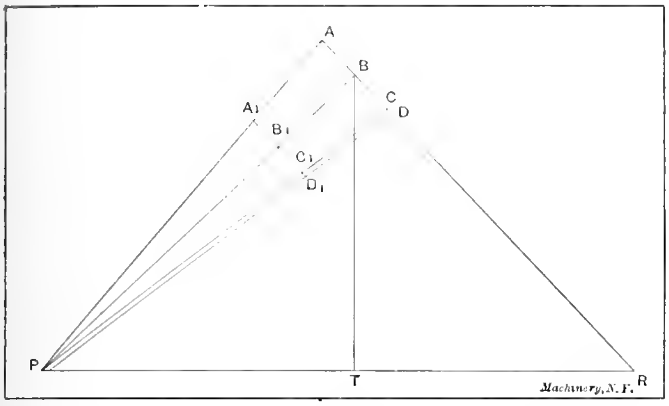

Fig. 1

cutter when it is set in its central position, measured from a line passing through the cone center parallel to the center line of the form of the cutter, is called the "cutter angle." The tangent of this angle equals $\dfrac{t}{2\text{ face}}$, or the t of the table divided by twice the length of face.

The front cone pitch line of the gear multiplied by the sine of the cutter angle equals the distance to set the pitch points of the finishing faces of cutter out of center. Call this distance D_c. To determine the required distance to move the cutter, after setting it central, the thickness of the cutter at

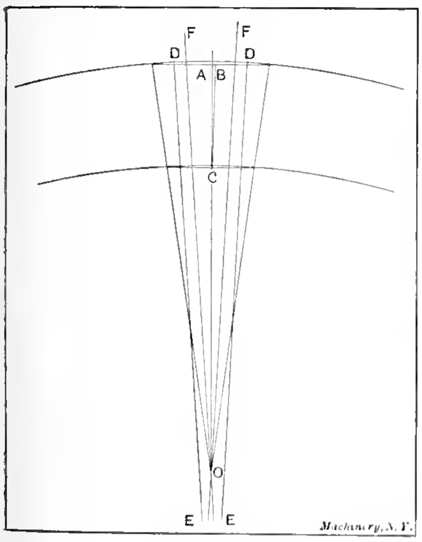

Fig. 2. Angle A C B is the "Cutter Angle"

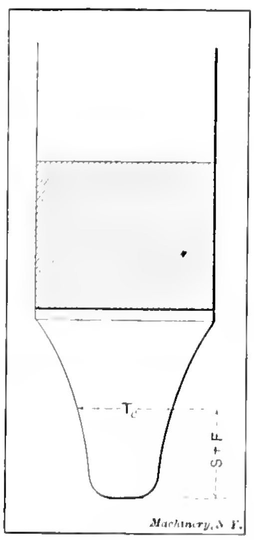

Fig. 3

the $S + F$ of the large end of space must be measured with the Brown & Sharpe vernier gear tooth caliper, because the cutters vary in practice. Call this thickness T_c. Subtract D_c from $\dfrac{T_c}{2}$, and move the finishing face of the cutter toward the center line of the blank an amount equal to the remainder, for cutting each side of the tooth.

The table gives, in the columns headed $s + F$, the depths to which the cutter is sunk below the pitch line of the gear at the small ends of the teeth, and begins with the $S + F$ at the large ends which is measured to the pitch line T_c, Fig. 3. These depths, of course, are proportional to the length of tooth face plus the constant clearance.

$$B_1D_1 = \frac{\text{cosec. center angle} \times \tfrac{1}{2}\text{ pitch diam.}-\text{face}}{\text{cosec. center angle} \times \tfrac{1}{2}\text{ pitch diam.}} S + F$$

The values in the columns t are the differences in width of the cutter at the respective $s + F$ points, corresponding to the depth of the cutter at the cone pitch line at small end of the tooth space and the width T_c on the normal pitch line. The table being for 1 diametral pitch, the values must be divided by the diametral pitch to obtain t for other pitches.

The various operations of finding the setting may be formulated thus:

1. Find $\left(\dfrac{\tfrac{1}{2}\text{ pitch diam.} \times \text{cosec. center angle}-\text{face}}{\tfrac{1}{2}\text{ pitch diam.} \times \text{cosec. center angle}} S+F\right)$ $\times$ diam. pitch. $F = 0.157 \div$ diam. pitch.

2. Refer to the table and find the corresponding t.

3. $\dfrac{t}{\text{diam. pitch} \times 2\text{ face}} =$ tangent of cutter angle.

4. Measure the thickness of the cutter at the $S + F$ of large end of tooth space to obtain T_c

5. $\dfrac{T_c}{2} -$ (cone pitch line $\times$ sine cutter angle) $=$ the required distance to set the cutter each side of the center.

The center angle is the angle included between the axis of the gear and the front cone pitch line.

These formulas are correct for both methods of cutting set forth in this article, but where the tooth is cut deeper at the small end, the $s + F$ must be figured accordingly, and this will give a small cutter angle, making the setting distance greater.

The Rotation of the Blank

The rotation of the blank may be figured by the following formula. This formula is not exact, but is very nearly so, and is used in preference to the actual true formula on account of the complications arising from the latter, making it impracticable. The vernier tooth caliper should be used to size the teeth and the blank revolved more than the formula calls for, if necessary. On small pitch gears no change from the figured rotation will be necessary unless the teeth are desired thin.

Subtract the product of twice the cone pitch line of the gear and the sine of the cutter angle from the width of the tooth space on the pitch line and divide the difference by the pitch radius to get the tangent of the angle of rotation, or,

6. $\dfrac{T_s - (2\text{ cone pitch line} \times \text{sine cutter angle})}{\text{pitch radius}} =$ tangent of angle of rotation.

Example from Practice

Bevel Gear:—16 pitch, 12 teeth, 0.75 inch pitch diameter, 0.25 inch face, 9 degrees 30 minutes, center angle, 2.272 inches cone pitch line, No. 6 cutter, $S + F = 0.069$ inch.

1. $\left(\dfrac{0.375 \times 6.0588 - 0.25}{0.375 \times 6.0588} 0.059 + 0.10\right) \times 16 = 1.0000$

2. t, from table $= 0.086$

3. $\dfrac{0.086}{16 \times 0.5} = 0.01075$ tan cutter angle; cutter angle $= 37$ minutes.

4. T_c measured $= 0.065$ inch.

5. $\dfrac{T_c}{2} - 2.272 \times 0.01076 = 0.0081$ inch.

Set the cutter central, then move the finishing face 0.0081 inch toward center. Cut once around and move cutter back 0.0162 inch for the opposite side of the tooth.

6. $\dfrac{0.098 - (2 \times 2.272 \times 0.01076)}{0.375} = 0.13066$ tangent.

Angle to revolve $= 7$ degrees 27 minutes.

If a dividing head having a 54-hole plate is used the blank would be given one-fortieth of a turn (one turn of the index handle) plus nine holes on the 54 circle as each hole on the circle equals 1/6 of one degree, or 10 minutes.

CLAMPING DEVICES*

LUCIEN L. HAAS†

If the reader will carefully go over the twenty illustrations of different clamping devices found in the accompanying Data Sheet, he will find that some of them are very similar; yet the mechanic will be able to cite many instances where one, and only one, of these types can be used to advantage. Of course, it will be understood that these illustrations are diagrammatical and are intended to indicate the principles of various clamping methods rather than the actual design and construction of the clamp itself. In order to make each illustration more complete, the work itself has been represented in each case by sections shown in solid black.

Figs. 1 and 2 represent the every-day method of clamping work to the table of a milling machine or to the face-plate of a lathe. The type of clamp shown in Fig. 3 is commonly used for holding work in a drill jig when one bolt or screw is sufficient, especially when it is desired to have an open end jig. Fig. 4 illustrates a scheme which is not often found in use. This type of clamp is adapted to box jigs; it has the advantage of being easily removed, which is accomplished by sliding it longitudinally. By glancing at the detailed view to the right, which shows the end of the clamping bar and its retaining grooves, the way in which it is held in place and removed will be clearly understood. Figs. 5 and 6 show clamps which are very much alike, but as a great many mechanics use the design shown in Fig. 5, I added that of Fig. 6, as it is both simpler and two-to-one quicker, when it comes to removal. It will be noted that when the clamp is slotted as shown in the plan view of Fig. 6, that fixed studs may be used instead of the swinging bolts. As there are a great many mechanics who prefer the cam as a means of clamping, the illustration Fig. 7 is presented as a reminder of the application of this principle. As is well known a cam can be used in possibly a hundred different ways. The type shown in Fig. 8 is often found in machine shops, on milling fixtures, drill jigs, lathe fixtures, etc. The clamp and bolts can be removed by loosening the nuts and pulling out the slip washers which allow the nuts to pass through the large holes. Fig. 9 illustrates a scheme which is commonly used on milling fixtures when light milling is to be done. The design of clamp shown in Fig. 10 is not frequently seen in use as it is a scheme which a mechanic will not use if he can see another way out of it; but at times it is found almost impossible to use a clamp of any other type. Fig. 11 shows the style of clamp that is used in connection with box drill jigs when it is desired to support a part to be drilled on two points. As will be seen, these two bearing points are self-adjusting. The design of Fig. 12 is generally used when it is desired to support the work in two places in an open-end drill jig. Figs. 13 and 14 show types which are quite similar, but, as before stated, there are many cases where one type can be used to advantage and not the other. For instance, the clamp, Fig. 13, is intended for box jigs and one would not think of using the type of Fig. 14 in such a jig, because the latter is altogether too slow. However, its advantages over Fig. 13, in case it is desired to have an open end jig, are apparent. The relation of the first cost of a jig to the quantity of work to be done, is a factor which sometimes makes a jig which is not perfect from a purely mechanical standpoint, more desirable than one which represents better design but greatly increased cost. Fig. 15 shows the old hook-bolt scheme, a clamp which is found in use almost as often as that of Fig. 1. The type shown in Fig. 16 answers practically the same purpose as that of Fig. 11, and it is used on, I dare say, one-third of the drill jigs now in use. A style of clamp that is somewhat similar to the one illustrated in Fig. 4, is shown in Fig. 17. In this case, however, two clamping bolts are used and the clamp is removed from the end of the jig. This is a good, as well as a quick method, of clamping work in open-end drill jigs. Fig. 18 illustrates the use of bolts only, for holding down work. The illustration is self-explanatory. Fig. 19 shows a good design of clamp for holding work in a milling fixture. It binds the work both horizontally and vertically and "has it all over" any other type when it can be used. The last but not the least of the clamping devices is shown in Fig. 20, which illustrates the wedge method. This is found in use in about every machine shop in the world, and its application is familiar to all mechanics.

* With Data Sheet Supplement.

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* * *

HELICAL TIMING GEARS FOR AUTOMOBILE MOTORS

ERNEST L. SMITH*

It is a fact, becoming better known each succeeding year, that correctly cut helical gearing will run with less noise than equally well cut spur gearing. That this knowledge is not wider spread, or in fact universal at present, is due naturally to the fact that the high development of hobbing machinery and the hobbing process is comparatively recent, as it is only by this process that perfect helical teeth can be machined at low cost.

The reason that the helical tooth is quieter in action than that of the spur gear is that the angle at which this tooth is cut permits only of its gradual engagement, and as this angle is usually great enough to permit the following tooth to enter contact before the first has quite passed out of mesh, we derive what may be characterized as practically a continuous contact.

The field in which these gears have been found especially desirable is that of the timing gears for a gasoline motor, *i. e.*, the gears that drive the cam-shaft and the magneto. The service of these gears is not arduous but it is imperative that they be quiet in action at either high or low speeds, and this quality the helical tooth possesses as does no other.

Regarding the specific points to be taken care of in adopting helical gears for motor timing, the Grant-Lees Machine Co., Cleveland, Ohio, suggests as an ideal outfit the following: Crank-shaft gear, of 20-point carbon steel, with no recessing; magneto gear, carbon steel, with no hubs; idler gear, of cast iron, with no hubs; cam-shaft gear of cast iron or 20-point carbon steel.

It is suggested that no recessing be done in the steel gears, because, while lightening the motor is of undoubted importance, the amount of lightening possible here is really negligible, but the increase in cost for such recessing is not. Hubs should be avoided where possible, for the same reason of cost, as they prevent ganging the gears for cutting.

An important point, then, that should be held in mind by the engineer when designing helical gears is to produce blanks that can either be made automatically from the bar or, in case the blanks are of cast iron, a simplicity in construction should be carried out so as to allow ganging of gears and the smallest number of settings of the machine for hobbing and facing them.

Cast iron is recommended in place of the once customary bronze as it is cheaper than bronze, and for this service in no way inferior. In fact, it has this one advantage, which is of higher value than at first might appear. If a bronze gear is dropped or struck accidentally, it is liable to be harmed to an extent not noticeable on inspection, but will show up later in action. If a cast iron gear is not broken by a similar accident, it will be found as good as before.

Almost any angle of the teeth from 12 to 20 degrees will give satisfaction, as the end thrust resulting from an angle within these limits will for this service (timing gears) be slight enough to be negligible. A diametral pitch from 9 to 12 is usually employed, and approximately a one-inch face on the gear.

Although the use of helical timing gears was practically unknown four years ago, the designers of automobiles have already come to regard them highly as is shown by the fact that the Grant-Lees Machine Company will in 1909-10 cut timing gears of this type for something over 20 per cent of the American automobile manufacturers, this percentage practically covering the field.

* * *

Pure winter strained lard oil is the best lubricant for tapping, reaming and boring steel castings, and for cutting threads on wrought iron pipe.

* Address: 6901 Quincy Ave., Cleveland, Ohio.

ELECTRIC DRIVE OF TURBINE PUMPS*

It is becoming a well-recognized fact that the electrical engineer, in order to successfully solve the problems of his particular science, must give earnest study and work to many other branches of engineering. The peculiarities of electrical rotating machinery make it desirable, and often essential, to obtain a thorough knowledge of the mode of operation, variation of load, and nature of product, of the mechanical apparatus that it will be applied to. The point of view of the electrical engineer is in this study so different from that of the mechanical engineer in designing his part of the combination that it should cause no surprise if the investigations of the former must run along entirely original lines. Such has most prominently been the case in introducing the electric motor in steel, cotton and paper mills, or when applying gas engines to the driving of electric generators. The turbine pump, to which this paper will be devoted, has been comparatively neglected, and yet the erratic conditions found in many pump installations show the unquestionable necessity for a better understanding of the problem involved in electric drive of turbine pumps.

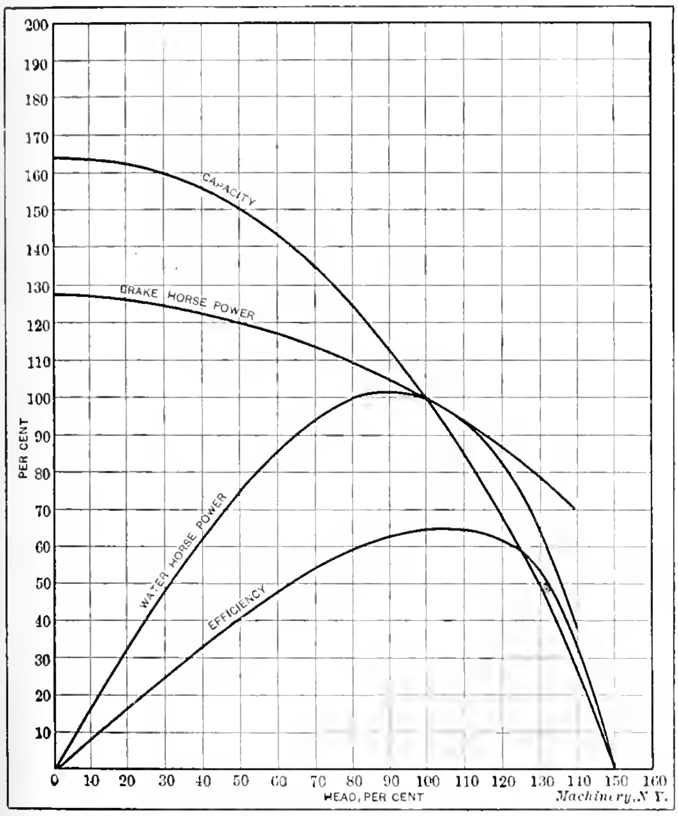


Diagram showing the Relation between Capacity, Brake Horse-power, Water Horse-power, and Efficiency of Centrifugal Pumps running at Constant Speed

The troubles experienced indicate that there are two principal questions, the correct solution of which insure successful electrical operation of turbine pumps. First, the selection of the proper size of motor to take care of varying load conditions; second, the selection of the proper type of motor to meet different starting requirements.

Taking these questions in the order just mentioned, it first becomes necessary to investigate how the load on a turbine pump running at constant speed or nearly so, varies with varying capacity and head. The variation of the load with different speeds is less important and less involved. It is less important, because at each speed that may be desired our reasoning for constant speed is applicable. It is less involved, because the behavior of the turbine pump in this respect is well known, and all necessary information is voluntarily and fairly accurately supplied by the pump manufacturer. The self-evident necessity of allowing margin in the motor for different speeds has caused this condition to be well taken care of. The most frequent speed variation desired is one speed for so-called domestic service pressure and another for fire service pressure. In the case of multipolar alternating current motors, this variation is generally accomplished by using a different number of poles for the two speeds.

* Abstract of a paper by Mr. J. E. Fries, read before the American Society of Swedish Engineers, at Brooklyn, N. Y., October 16, 1909.

At each constant speed, however, it will be found that most pump manufacturers are by no means certain as to how the load on any particular pump varies with varying head. Neither do they seem to think accurate information in this respect of special value. A glance at the accompanying diagram, which shows a typical relation between head, capacity, efficiency and brake horse-power in ordinary commercial turbine pumps demonstrates the great importance to the electrical engineer of obtaining a similar diagram or equivalent information wherever he undertakes to prescribe the size of the motor. In this diagram an efficiency of 65 per cent is assumed, but the relations given will be approximately correct for all efficiencies between 50 and 80 per cent.

The pump ought to be adapted for an average head corresponding to its maximum efficiency. This head, however, will nearly always vary considerably; the water level will, for instance, rise and fall in the source of supply and in the tank or reservoir into which the water is pumped, or if the water is forced directly into a distribution system, the varying demand will frequently cause the discharge pressure to vary over a wide range. The emptying of dry-docks through turbine pumps presents a particularly interesting problem of this nature. In such cases it will be found that when the *head falls off*, the capacity generally increases, and as the efficiency at the same time goes down rapidly, *the load* in most turbine pumps *increases*. It becomes imperative, therefore, that the electrical engineer should know what this overload amounts to, within the range of abnormally low head liable to occur, and the duration of such overloads.

It is true that the pump manufacturers are beginning to realize that this characteristic of the turbine pump makes it unsuitable for electric motor drive, and that they, therefore, have endeavored, and partially succeeded, in "flattening" the capacity curve over a considerable range, thereby making the horse-power required fairly constant between the same limits; but the electrical engineer will as yet seldom meet this condition, and in any case it is safe to remember that the size of the motor is governed by capacity at low rather than at high head. Where no information in this respect is obtainable, it is safe to assume the relations shown in the diagram. On account of the efficiency in all motors, and the power factor in induction motors, being lower at lighter loads, electrical engineers should use every opportunity to impress upon pump builders the desirability of designing pumps with a horse-power curve as flat as possible.

Official test records of pumps recently furnished the U. S. Government for dry-dock purposes will soon be published, and will show that the desired constancy in load has been reached almost to perfection. In these pumps the vanes of the impellers act themselves as automatic throttles, so to speak, restricting the capacity with decreasing head so that the energy consumed is kept constant.

It is often left to the electrical engineer to determine the horse-power required by a certain pump from the capacity in gallons per minute, total head in feet or pounds pressure per square inch, and the efficiency of the pump. Frequently, however, the head given in the specifications does not include friction in the water pipes. It is necessary, of course, to make allowance for this factor when calculating the horse-power of the motor. For the convenience of the electrical engineer who meets this problem, the accompanying table is here given, showing the friction head in feet per hundred feet commercial pipe sizes and for different capacities. The number of U. S. gallons delivered per minute multiplied by 8.3 gives the pounds of water handled per minute. This product multiplied by the sum of the total vertical head and total friction head taken from the table gives foot-pounds work done per minute. If the head is stated as composed of suction lift and pounds of pressure delivered by the pump, it is only necessary to remember that each pound corresponds to 2.3 feet static head. As one horse-power is equivalent to raising 33,000 pounds one foot in one minute against the force of gravity, we obtain the work done in the pump expressed in horse-power by dividing the foot-pounds just calculated by 33,000. This

result is often called "water horse-power." A final division by the efficiency of the pump gives effective horse-power required from the motor. The suction lift and the friction head in the suction pipe added together must, of course, be kept as far below the theoretical limit of 32 feet as possible.

The second consideration that must be given serious thought when attempting electric drive of turbine pumps is that of starting. The direct-current motors possess such remarkable qualities in this respect that little difficulties are to be anticipated in their application to turbine pumps, provided they have the proper capacity to handle the load under all other conditions. The great majority of electrically-driven centrifugal pumps are, however, supplied with alternating current. An induction motor of sufficient capacity to handle the expected load will also start the pump successfully, provided the current rush is tolerated. A synchronous motor, on the other hand, may or may not start the pump, the torque of the motor, especially with certain designs, being very small until synchronism is reached, while the torque required by the pump grows with the square of the velocity. Just before synchronism, therefore, is the critical point in starting turbine pumps. The best remedy for this trouble, as well as for excessive starting currents, is to start the pump empty and prime it after full speed has been reached. Where water is not delivered to the pump under pressure, this may be accomplished either by an auxiliary pump of the rotary type, or an ejector where steam is available, in both cases forcing the supply of water up the suction pipe into the pump.

The electrical engineer is often told that although the pump is filled with water, it will start under very light load, because a check valve will be closed either in the suction or in the discharge pipe, and the writer has seen similar statements in specifications issued by consulting engineers of very good standing. The truth is, however, that neither of these expedients improve starting conditions at all. With the valve closed in the suction line, the pump supports the ordinary water column just the same, and with the valve closed in the discharge line, the pump creates a pressure behind the valve, so that in either case the load is practically normal, and the energy consumed is transformed into heat, which soon makes the water boiling hot. The only way to partially relieve the load from a primed pump is to close a valve in the discharge pipe and open an outlet between this valve and the pump, thus discharging close to the pump and letting the water go to waste during the period of starting. In the case of a single-stage pump, however, the capacity is much greater at the lower head, and the load may even be more than normal, as pointed out before, but with multi-stage pumps the water passages through the pump do not allow such great increase of water flow as would correspond to the extremely low head, and although it might be thought that the excess energy would be converted into heat, practice shows that the load on the motor is in this way partly relieved.

It is evident from the foregoing that the synchronous motor of ordinary design when applied to turbine pumps may fail to pull into synchronism. As the starting torque in a synchronous motor is due to eddy currents and hysteresis, and more to the former than to the latter, it follows that every means to increase the eddy currents improve the possibility of starting a turbine pump. Thus solid steel poles are far superior to laminated ones. Some manufacturers provide copper rings around the pole tips for the same purpose. A radical, although expensive, method of improving the laminated pole motor, is to provide it with a squirrel-cage winding in the pole faces, thus approximating induction motor starting characteristics. Owing to the big air gap and consequent leakage and also to the uneven distribution of this secondary winding, the torque is far from that of an induction motor.

It seems that where synchronous motors are desired the best solution is to prime after starting. It would also seem, however, that where high starting currents are not objectionable, sufficient starting torque may be obtained in synchronous motors with inherent low starting torque, without the highly expensive squirrel-cage winding, by supplying a starting compensator capable of producing about 25 per cent excess voltage. As the torque increases with the square of the voltage, this means should in most cases prove sufficient. Precautions must be taken, however, to make the change from one voltage to another gradual and not sudden, so as not to overstrain the windings.

FRICTION OF WATER IN PIPES

Friction loss in feet static head, for each 100 feet of length in different sizes of clean iron pipes discharging given quantities of water per minute

Gals. per Min.	Size of Pipe, Inside Diameter, in Inches														
	3/4	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	18
5	7.6	1.94	0.72	0.28											
10	30.0	7.3	2.42	1.09	0.28										
15	66.3	16.1	5.5	2.24	0.44										
20	116.0	28.4	9.4	3.8	0.97										
25	180.0	44.0	28.6	6.1	1.48	0.49	0.23								
30		63.5	37.2	8.7	2.1	0.69	0.32								
35		85.5	46.7	11.7	2.9	0.78	0.35								
40		111.0	57.5	15.1	3.7	1.21	0.53								
45			130.0	18.8	4.6	1.52	0.66								
50				23.1	5.6	1.87	0.81	0.21							
75				51.8	12.3	4.15	1.71	0.37							
100				90.0	21.9	7.4	3.03	0.76	0.12						
125					34.5	11.3	4.6	1.14	0.17						
150					49.0	16.2	6.6	1.60	0.23						
175					65.0	21.9	8.9	2.16	0.30						
200					86.7	28.8	11.6	2.82	0.39						
250						45.4	17.9	4.37	0.60	0.16	0.07	0.02			
300						64.8	25.9	6.37	0.86	0.21	0.09	0.03			
350							35.2	8.43	1.15	0.28	0.12	0.05			
400							45.0	11.0	1.50	0.37	0.14	0.06			
450							57.8	13.9	1.87	0.46	0.16	0.07			
500							71.2	17.2	2.22	0.58	0.25	0.09	0.039	0.021	0.012
750									5.10	1.23	0.42	0.19	0.068	0.039	0.035
1000									8.95	2.17	0.74	0.30	0.14	0.083	0.093
1250										3.37	1.13	0.46	0.22	0.12	0.11
1500										4.83	1.62	0.67	0.31	0.16	0.13
1750											2.20	0.88	0.41	0.21	0.14
2000											2.84	1.13	0.54	0.28	0.16
2250												1.45	0.68	0.36	0.20
2500												1.78	0.84	0.44	0.25
3000												2.56	1.19	0.62	0.35
3500													1.61	0.85	0.47
4000													2.10	1.09	0.61
4500														1.27	0.77
5000														1.69	0.95

METHODS AND TOOLS USED IN METAL SPINNING

C. TUELLS

Metal spinning, that process of sheet metal goods manufacturing which deals with the forming of sheet metal into circular shapes of great variety by means of the lathe, forms and hand-tools, is full of kinks and schemes peculiar to itself. It is the purpose of this article to give a description of spinning in general, and to outline some of the methods and tools used in spinning for rapid production.

The products of metal spinning are used in a great many lines of manufacture. Examples of this work are chandelier parts, cooking utensils, silver and brittania hollow-ware, automobile lamps, cane-heads and many other sheet metal specialties. Brass, copper, zinc, aluminum, iron, soft steel, and, in fact nearly all metals yield readily to the spinner's skill. At best spinning is physically hard work, and the softer the stock, the easier and quicker the spinner can transform it into the required product.

There are but two practical ways of forming pieces of sheet metal into hollow circular articles: by dies and by spinning. By far the cheapest and best method of producing quantities of this class of work is by the use of dies, but there are many cases where it is impractical or impossible to follow this course. Dies are expensive and there is constant danger of breakage, whereas spinning forms are easily and cheaply made and are almost never damaged by use beyond a reasonable amount of wear. Thus it will be seen that when the production is small, it does not pay to make costly dies. Again, the styles or designs of many articles that are spun are constantly being changed; if made by dies each change would necessitate a new die, while in spinning merely a new wooden form is required—and sometimes the old form can be altered, costing practically nothing. Still other advantages of spinning are that in working soft steel, a much cheaper grade may be spun than can be drawn with dies; beads may be rolled at the edges of shells at little expense; experimental pieces may be made quickly, and, added to these features, comes the fact that very difficult work that cannot possibly be made with dies can be spun with comparative ease. It must not be construed from the above that spinning is to be preferred to die work in all or even in the majority of cases, because, on the contrary, die work is a more economical method of manufacture, and should always be used when possible on production work. The cases already cited are merely given to point out some of the instances in which, for economical reasons, spinning is to be preferred to die work.

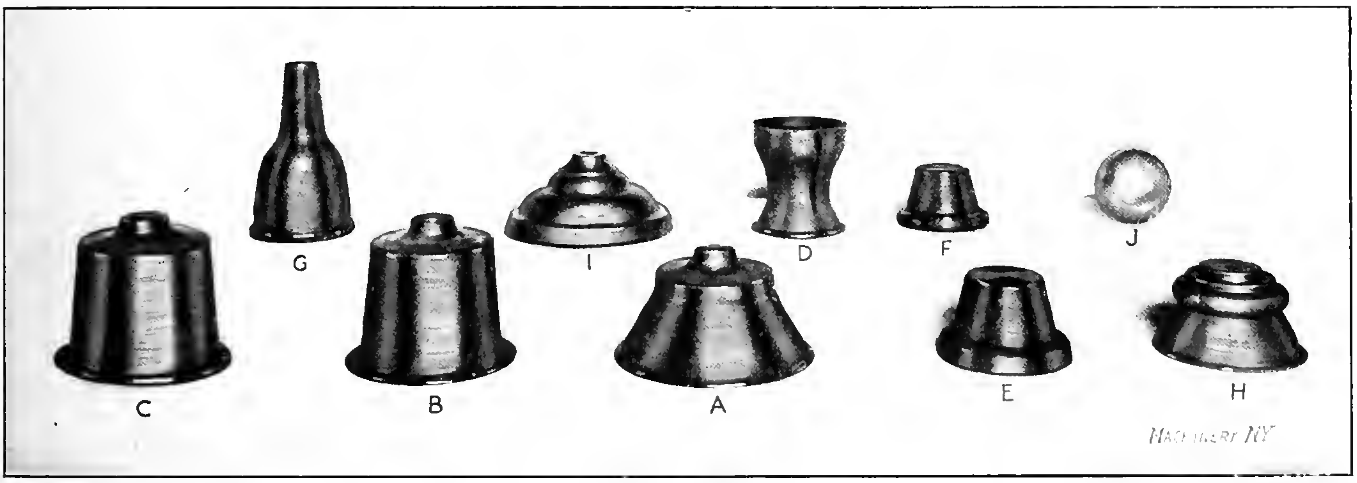


Fig. 1. Specimens of Metal Spinning

The Spinning Lathe

The principal tool used in the operation of spinning is the spinning lathe, shown in Fig. 2. While in many respects this machine is similar to any other lathe, it is built without back-gears, carriage or lead-screw, is very rigid in construction, and, on the whole, very much resembles a speed lathe. Like other lathes, the spinning lathe is fitted with a cone pulley (preferably of wood, because of its lightness and gripping qualities), allowing the use of four or five different speeds. Speed is an important factor in spinning. Arbitrary rules for spinning speeds cannot be given, as the thicker the stock the slower must be the speed; thus while 1/32-inch iron can be readily spun at 600 revolutions, 1/16-inch iron would necessitate reducing the speed to 400 revolutions per minute. Zinc spins best at from 1,000 to 1,400 revolutions; copper works well at 800 to 1,000; brass and aluminum require practically the same speed, from 800 to 1,200; while the comparatively slow speed of 300 to 600 revolutions is effective on iron and soft steel. Brittania and silver spin best at speeds from 800 to 1,000 revolutions.

One of the essential parts of the spinning lathe is the T-rest. The base of this rest is movable on the ways of the lathe, and it has at the side nearest the operator, a stud about four inches in diameter and six inches high, through which is swiveled the T-rest proper. As the illustration shows, provision is made for raising and lowering the rest, and the entire rest may be clamped in any desired position by means of the hand-wheel shown beneath the ways. The rest proper consists of an arm, 12 to 15 inches long, similar to a wood turner's rest, and through the face of this arm are from twelve to sixteen closely spaced $\frac{3}{8}$-inch holes. These holes are to receive the pin against which the hand tools are held while spinning. The pin is three inches long and of $\frac{3}{4}$-inch steel, turned down on one end to loosely fit the holes in the rest.

Another important part of the spinning lathe is the tail-center. This center is sometimes the ordinary dead center that is in general machine shop use, but nearly all spinners use the revolving center, shown in Fig. 3. The revolving center is $\frac{3}{4}$ inch diameter (without taper) and about six inches long, and is fitted into the socket in which it runs; this socket is, in turn, fitted to the taper hole in the tailstock. At the bottom of the hole in the socket are two steel buttons, hardened and ground convex on their faces. These buttons act as ball bearings and reduce friction to a minimum.

Forms and Chucks for Spinning

The shape of a shell made by spinning is dependent on the form or chuck upon which the metal is spun. Forms are used for plain spinning where the shape of the shell will permit of its being readily taken from the form after the spinning has been completed; but when the shape of the shell is such that it will not "draw," as the molders say, it becomes necessary to employ sectional chucks, similar to the one shown in Fig. 5. Generally speaking, spinning forms are made of kiln dried maple. After being bored and threaded to fit the lathe spindle, the spinner turns the maple block to agree with a templet shaped in outline to the sample shell. When no sample is furnished, the templet must be laid out from the sketch or drawing; in either case proper allowance is made for the thickness of the stock. When large quantities of shells are to be spun, all alike, the form is sometimes made of lignum vitae. Another method is to turn the maple form small enough so that one shell may be spun and cemented to it and then this metal-cased form is used to spin the balance of the shells

For continuous spinning, forms are made of cast iron or steel, which of course makes a most satisfactory surface to spin on and gives indefinite service.

A sectional or "split" chuck, as it is sometimes called, is, as the name implies, a spinning chuck or form which may be taken apart in sections after the shell has been spun over it. As before stated, this class of spinning chuck is only used when the finished shell could not be removed from an ordinary form after spinning. After a shell has been spun over a sectional chuck, the shell and the sections of the chuck are together pulled lengthwise from the core of the chuck. Then, starting with the key section, it is an easy matter to remove each section from the inside of the shell. As the sections are removed, they are replaced upon the core, slipped under the

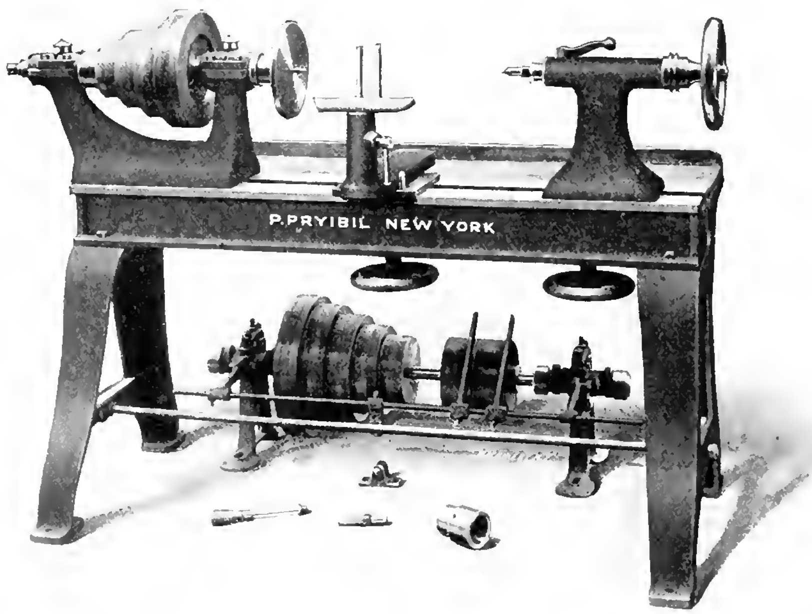


Fig. 2. Spinning Lathe

retaining flange and the chuck is ready for spinning a new shell. The whole operation of removing and replacing the sections of a chuck takes less time than it does to tell it, and, as the sections are of different sizes, it is easy to replace them in the proper order. Like other forms, sectional chucks are made of wood or metal, according to the requirements of the job. The core and retaining ring are first made from one piece and then the sections are turned in a continuous ring and split with a fine saw. In some cases it is necessary to add a small piece to the last section to make up for the stock lost in splitting the sections.

Another kind of sectional chuck, known to the trade as a "plug" (shown in Fig. 7) is used extensively in some shops in cases where the shell must have projections or shoulders at both ends, and no bottom to the shell is required. In making the plug, which is always in two parts, the first half is turned to take the shell from one end to the center of the smallest diameter. Into the end of this part is bored a hole to which is fitted the end of the second part, which is afterwards turned to fit the shell. Over this two-part plug the shell is spun; then the bottom of the shell is cut out and the first half of the plug removed thus allowing the shell to be withdrawn. The first part is then replaced and the plug is ready for use again. Fig. 6 shows a method of spinning difficult shells that ordinarily would require a sectional chuck. The shell shown at the left of Fig. 6 is first spun as far as the bulged part on an ordinary form that ends at this point. Then after annealing, it is replaced on the form and while another operator holds the wooden arm, supported with a pin in the T-rest, the spinner forms the metal around the bulge-shaped end of the arm. The arm, being stationary on the inside of the shell, acts as a continuation of the spinning form, and by this method as good a shell is obtained as could be spun with a sectional chuck.

For spinning operations upon tubing or press-drawn tubes, steel arbors are generally used. Tubing may be readily spun upon an arbor and it can be reduced or expanded to comply with the shape of shell required much more quickly than the shell could be spun from the blank.

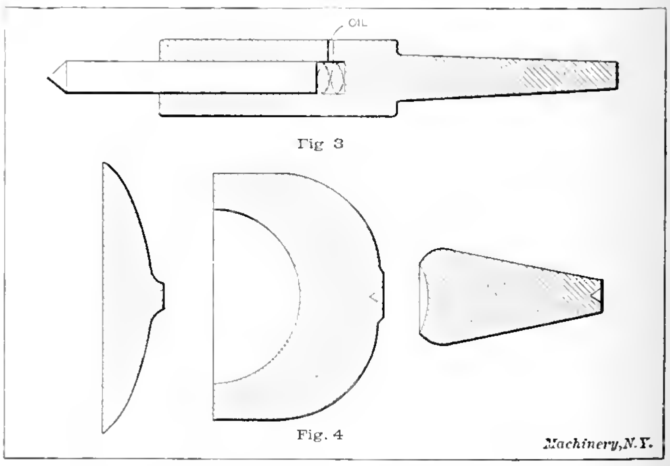
Followers

For holding the sheet metal blank to the spinning form, a block of wood known as the follower, is used (see Fig. 4). Followers are made to suit the shape of the work with which they are to be employed, always being made with the largest possible bearing on the work; thus a shell with a flat bottom twelve inches in diameter would be turned with the aid of a follower having an 11¾-inch face; while a shell with a 4-inch face would take a follower with a 3⅞-inch face. All shells do not have flat bottoms, consequently, in spinning such as do not, it becomes necessary to employ hollow followers. Hollow followers have their bearing surfaces turned out to fit the ends of the forms with which they are to be used. In practice, the blank is held against the end of the spherical form with a small flat follower until enough of the shell has been spun to admit of the hollow follower being used. All followers are made with a large center hole in one end to receive the revolving tail-center.

In starting to spin a difficult shell it sometimes happens that the necessarily small follower will not hold the blank. To prevent this slipping, the face of the follower is covered with emery cloth. Often, however, on rough work, the spinner will not stop to face the follower, but will make a large shallow dent at the center of the blank; the extra pressure required to force the metal against the form will usually overcome the slipping tendency.

Hand Tools

Hand tools, in great variety, form the principal asset of the spinner's kit. Spinning tools are made of tool steel forged to the required shapes, and are hardened and polished on the "business" end. The round steel from which they are made varies from ½ inch to 1½ inch in diameter, according to the class of work upon which they are to be used. The length of a spinning tool is about 2 feet, and it is fitted into a wooden handle 2 inches diameter and 18 inches long, making the total length of the handled tool about 3 feet, as shown in Fig. 8. As the spinner holds this handle under the right armpit, he



Figs. 3 and 4. Revolving Center and Three Types of Followers

secures a great leverage upon the work and is better able to supply the physical power required to bring the metal to the desired shape.

The commonest and by far the most useful of the spinning tools is the combination "point and ball" which together with a number of other tools, is shown in Fig. 10. This tool is used in doing the bulk of the spinning operations—for starting the work and bringing it approximately to the shape of the form. Its range of usefulness is large on account of the many differ-

ent shapes that may be utilized by merely turning the tool in a different direction. Next in importance comes the flat or smoothing tool which, as the name implies, is for smoothing the shell and finishing any rough surfaces left by the point and ball tool. The fishtail tool, so named from its shape, is used principally in flaring the end of a shell from the inside, "spinning on air" as it is sometimes termed. This tool is used to good advantage in any place where it is necessary to stretch the metal to any extent, and its thin rounding edge proves useful in setting the metal into corners and narrow grooves. Other tools are the ball tool which is adapted to finishing curves; the hook tool, used on inside work; and the beading tool which is needed in rolling over a bead at the edge of a shell when extra strength or a better finish is desired.

When much beading of one kind is being done, a large heavy pair of round-nose pliers (Fig. 11) with the jaws bent around

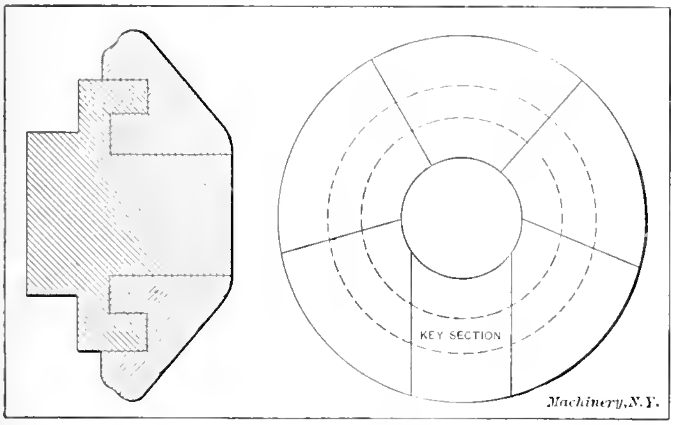
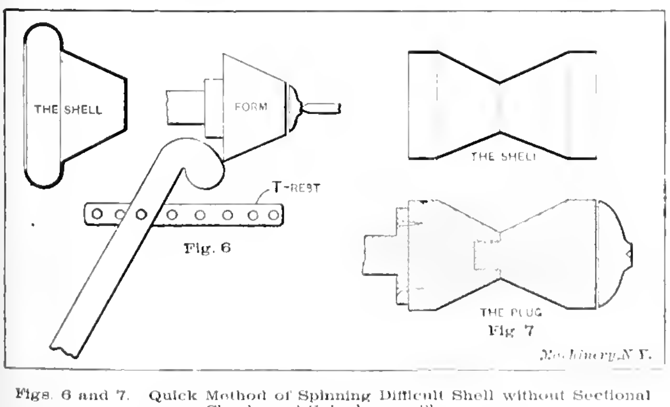


Fig. 5. Sectional Spinning Chuck

in a curve and sprung apart enough to allow for the thickness of the metal proves to be a handy tool. After the edge of the shell has been flared out to start the bead, the pliers are opened enough to admit the metal and then closed and the stock guided around to form the bead as far as possible. In this way the larger part of a bead is rapidly formed; one jaw of the plier acting as a spinning tool and the other corresponding to the back-stick. During this operation, the pliers are, of course, supported by being held against the T-rest.

Closely allied with these spinning tools are two other tools (also shown in Fig. 10) known as the diamond point and the skimmer. The diamond point is for trimming the edges of the shell during the spinning operation and for cutting out centers or other parts of the work. The skimmer is for cleaning up the surface of a shell, removing a small amount of metal in doing so, the amount depending upon the skill the spinner used in the spinning proper.

When the bottoms are to be cut from a large number of shells and it is necessary that they be cut exactly alike, a tool



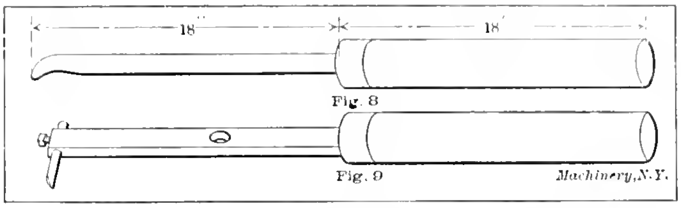
Figs. 6 and 7. Quick Method of Spinning Difficult Shell without Sectional Chuck, and Spinning on Plugs

known as a swivel cutter is used. This tool (see Fig. 9) is simply an iron bar with a cutter on one end, which swivels near the center around a pin in the T-rest; thus by a slight movement of the arm the cutter is brought up to the work, cutting a piece from the shell of exactly the same size each time.

The Spinning Operation

In order to make clear the successive steps in spinning, let us briefly consider the making of a copper head-light reflector, and the way the work is handled when a few hundred pieces are to be made.

By trial spinning, the size of the blank required for one of the reflectors is determined, and with the square shears the



Figs. 8 and 9. Handled Spinning Tool and Swivel Cutter

copper sheets are cut into pieces an eighth of an inch larger each way. These squares are then taken to the circular shears and cut to round shapes ready for the spinning lathe. The spinning form, of kiln dried maple, is screwed to the spindle and the belt thrown to that step of the cone pulley which will bring the speed nearest to 1,200 revolutions. From the stock room a follower is selected whose face will nearly cover the bottom of the form. It is now "up to" the spinner. Holding a blank and also the follower against the end of the form, he runs the tail-center up to the center in the follower just hard enough to hold the blank in place. Then, starting the lathe, he centers the blank by lightly pressing against its edge a hard wood stick. As soon as it "lines up" he runs the center up a little harder and clamps it in place. Some spinners will "hop in" a blank with the lathe running, but this is dangerous

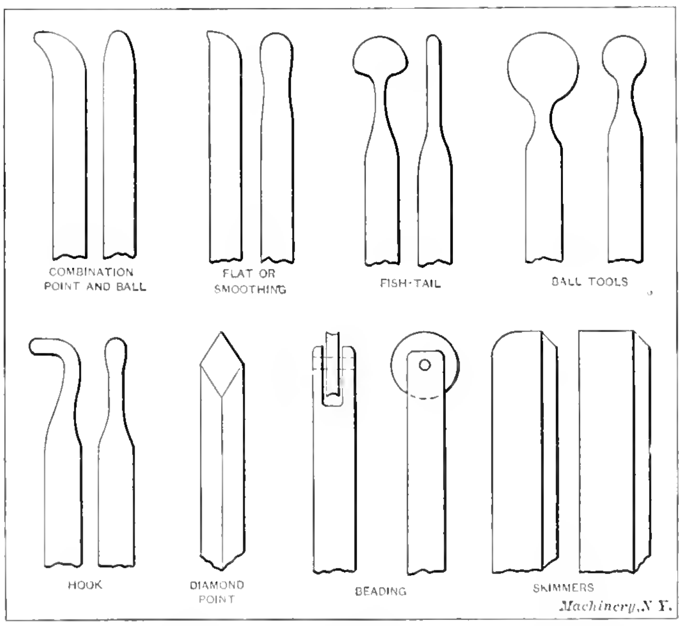


Fig. 10. Hand Tools of Various Forms used in Spinning

practice and sometimes the blank will go sailing across the room. Often this happens in truing up the blank and for this reason it is considered advisable to have a wire grating at the further side of the lathe to prevent serious accidents; for a sheet metal blank is a dangerous missile traveling at the high rate of speed which is imparted to it by the lathe.

With a piece of beeswax (soap is sometimes used for economical reasons) the spinner lightly rubs the rapidly revolving blank and then adjusts the pin in the T-rest to a point near enough to the blank to obtain a good leverage with the spinning tool. Holding the handle of his point and ball tool under his right armpit and using the tool as a lever and the pin on the rest as a fulcrum, he slowly forces the metal disk back in the direction of the body of the form; never allowing the tool to rest in one spot, but constantly working it in and out, applying the pressure on the way out to the edge of the disk and letting up as he comes back for a new stroke. In the meantime his left hand is busy holding a short piece of hard wood (called the back-stick), firmly against the reverse

side of the metal at a constantly changing point opposite the tool. The object of the back-stick is to keep the stock from wrinkling as it is stretched toward the edge of the disk. Wrinkles cause the metal to crack at the edges and for this reason they must be kept from the stock as much as possible.

After a few strokes of the spinning tool have been taken, the shell will appear about as shown at *B*, Fig. 12, and at this point, it is necessary to trim the shell at the edges with the diamond-point tool. Trimming is required because spinning stretches the stock and the resulting uneven edge will cause splits in the metal if it is not trimmed occasionally. As a carpenter is known by his chips, so a spinner is known by the way his work stretches. While the even pressure of a good spinner will stretch the stock very little, the uneven pressure of the inexperienced man will lead him into all sorts of trouble

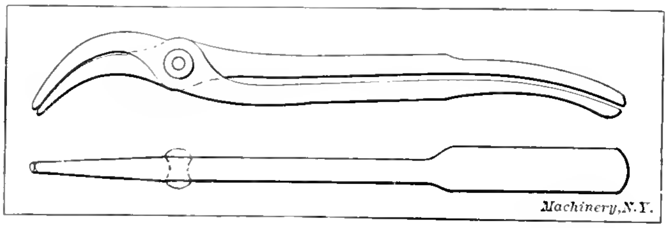


Fig. 11. Spinner's Pliers

on account of the way the stock will go. In either case the metal always stretches least in the direction in which the sheet stock was originally rolled, consequently giving the edge a slight oval shape. In trimming zinc, the spinner holds a "swab" of cloth just above the diamond point, to prevent the chips from flying into his face and eyes—or those of his neighbors. With other metals the swab is unnecessary.

The reflector is now taking shape. With each successive stroke the spinner sets a little more of the metal against the form. Not only does spinning stretch the metal, but it hardens it as well; therefore, at the stage *C* it becomes necessary to anneal the partially completed reflector, which is done by heating it to a low red in a gas furnace. In running through a lot of shells, the common practice is to spin them all as far as possible without annealing and after annealing the whole lot, to complete the spinning.

After replacing the shell upon the form, it is trimmed and worked further along the form, gradually assuming the ap-

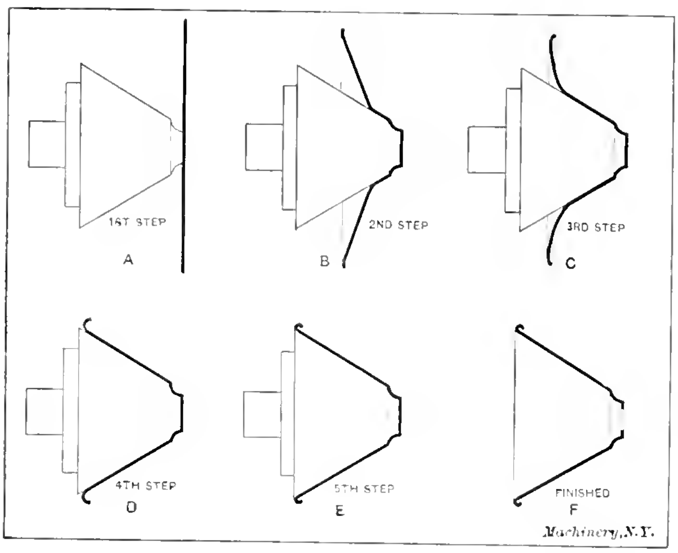


Fig. 12. Successive Steps in Spinning a Reflector

pearance shown at *D*. At this time, the spinner goes back to the small radius at the front end of the shell and with a ball tool he closes the annealed metal hard down against the form, for the spinning has tended to pull the stock slightly from the form at this point. The body of the reflector is now practically completed and the spinner directs his attention to rolling the bead at the outside edge. Slowly he begins to roll the edge of the shell back, using his hook tool to complete the bead as far as possible and exercising care to keep the back-stick firmly against the metal so as to keep the wrinkles out.

Now, with the diamond point, he gives the edges a final trim and with the beading tool closes down the bead snugly against the rest of the shell, as shown at *E*. Lastly, the swivel cutter is placed in the proper hole of the T-rest and a turn of the tool cuts out the center to the exact size, and the reflector is completed. If any burrs or rough places remain they are easily removed at this time with the skimmer or diamond point and a little emery cloth gives the shell a finished appearance.

Referring to the illustration Fig. 1, *A*, *B* and *C* represent the three most important stages of spinning a shell like that shown at *C*. Annealing is necessary between steps *A* and *B*. *D* is a shell spun upon a form of the plug variety, and *E* and *F* are two views of a shell spun after the method shown in Fig. 6, *F* being the completed shell. *G* illustrates a very difficult shell to spin, on account of the small follower that must be used; the length of the small diameter also adds to the difficulty. *H* shows a shell that must be spun upon a sectional chuck, while *I* is a plain easy job of ornamental spinning. The ball shown at *J* was spun from one piece of aluminum and it is more of a curiosity than a specimen of practical spinning. It was first spun over a form that would leave one-half of the ball complete and the stock for the other half straight out like a short tube. Next a wooden split chuck was made, hollowed out to receive the finished end of the ball and the open end was gradually spun down and in until the ball was complete with but a 1/16-inch hole at the finish. This hole was plugged and the hollow ball was done.

While the operation of spinning is a comparatively simple one to describe, it is not easily learned, and to-day good all-around spinners are hard to find. The limits of accuracy are not as closely defined as in straight machine work, but there are times when good fits are absolutely necessary, as in cases where two shells must slip snugly together. In this article we have taken up only the plain every-day kind of spinning, and were we to follow its work in the gold and silversmith's trade, we would see it evolve into a fine art. In order to insure really good work coming from the spinning lathe, there is a wide range of knowledge that the spinner must have. That knowledge may be brought together and summed up by a single word—*judgment*.

* * *

A STEAM BOILER INCIDENT

Seventeen years ago an enterprising farmer living near Boston purchased a portable steam pump to water his farm. Every summer he has had one of the young men in the neighborhood run it, under the supervision of Mike, the foreman, whose word was law. This summer the boiler leaked so badly that the facts came to my attention. The boiler tubes became so overheated and loosened that there was not a single one which was tight. In former years when they leaked badly, Mike, with a hammer and chisel, would calk them until they were fairly tight. Several years ago the steam gage was stolen, and since that time the "engineer" estimated the pressure by the rate the pump worked with the throttle wide open. How he estimated it when the pump was not working was not made clear to me. The water used in the boiler was the same as that used in the pump, and it came from a dirty frog pond. Small fish and eel grass were continually thrown out of the discharge nozzle of the pump and the natural inference was that they were just as frequently thrown into the boiler. The water glass was so dirty that even if there had been any water in it it could not have been seen; as Mike explained, "It was so stuck up with mud that you couldn't ever depend on it."

Once (long ago) Mike opened a hand hole to clean out the boiler, but as he said, "there was such a mess in there that it would have taken a whole day to clean it out, and what was the use, since it was running all right as it was"—and the mud stayed in there. In all these seventeen years no repairs have been made to the boiler, it has never been inspected, the inside has never been cleaned, its safety valve and steam gage (when it had one) have never been tested, and it has never had anyone with a license to run it. In spite of all this, the owner refuses to have any repairs made, saying that "It isn't worth it, and as long as it will pump water, let it alone and don't fool with it." E. M. S.

MANUFACTURING AUTOMOBILE EQUALIZING GEARS*

A TYPICAL EXAMPLE OF GOOD DESIGN AND SHOP PRACTICE

RALPH E. FLANDERS†

There is always some question in the mind of the editor as to the interest of his readers in descriptions of typical shop operations. There are occasional operations of particular interest owing to the accuracy required, the novel principles employed, or unusual difficulties to be overcome; about such material there is no doubt. This present article, on the other hand, deals with operations which do not present these unusual or spectacular features, yet the writer feels that they have a value derived from the fact that they are closely related to the operations which produce the bulk of the product of the machine shops of the country; for that reason they should attract the attention of mechanics interested in accurate and economical work. In the particular case with which this article deals, we are able to describe and adequately illustrate the operations from beginning to end, for making a complete, compact machine unit—a differential or equalizing gear for automobile use. The completeness of the job gives it a suggestive value that would not be offered by a series of miscellaneous operations, however interesting. The value of this description, however, does not depend on its completeness

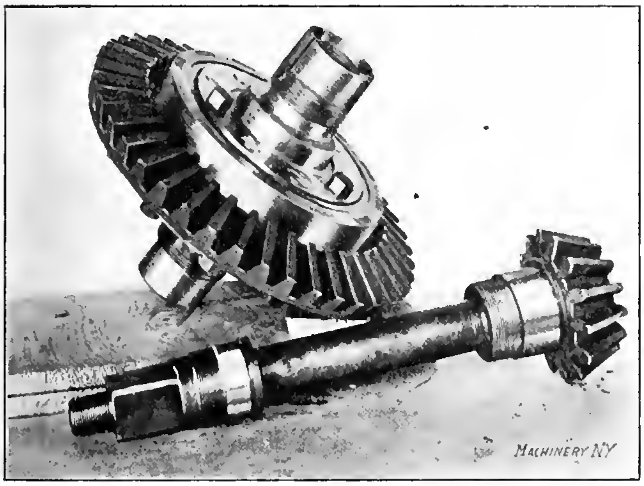


Fig. 1. The Equalizing Gear Complete, with Bevel Gear and Pinion, as used in the Stevens-Duryea Automobile

alone, as many of the specific shop operations give evidence of a high degree of manufacturing ability.

Description of the Equalizing Gear

Figs. 1, 2 and 3 show assembled, dismantled and detail views, respectively, of an equalizing or differential gear, designed by Mr. A. A. Fuller, of the Providence Engineering Works, Providence, R. I. The determining feature of this design is the necessity for getting a maximum of strength and effectiveness in a minimum of space—coupled, of course, with reasonable cost of manufacture. This problem was attacked by scientific analysis. It was possible, without great difficulty, to obtain reasonable strength in the casing which contains the equalizing gearing. The crucial point was in the design of the equalizing gears themselves. In determining the proportions of the gears, curves were drawn showing the strength of the teeth for lay-outs of varying pitch and number of teeth, arranged to be contained within a casing of a given diameter. The strength and bearing area of the pivots, and the strength of the pinions as limited by the thickness of the shell between the bottom of the tooth and the bore, had also to be reckoned with. The tooth shapes were not confined to standard forms, but various pressure angles and heights of addendum were investigated. By comparing the curves for various possible designs, a certain pitch, number of teeth and shape of tooth for the various gears were found for each diameter of casing, so proportioned that if any of the dimensions were changed, the mechanism became weaker instead of stronger. These proportions, worked into a design satisfactory in other particulars, have been adopted as standard, and the makers feel confident that it is impossible to enclose in the same space gears of greater strength than they are offering in the design illustrated herewith. As this confidence is based on mathematical calculations and has been further tested by many months of experience, it seems reasonable that they should hold to it.

Referring particularly to Fig. 3, the mechanism is contained within case *B* and covers *A* and *A'*. It revolves in the rear

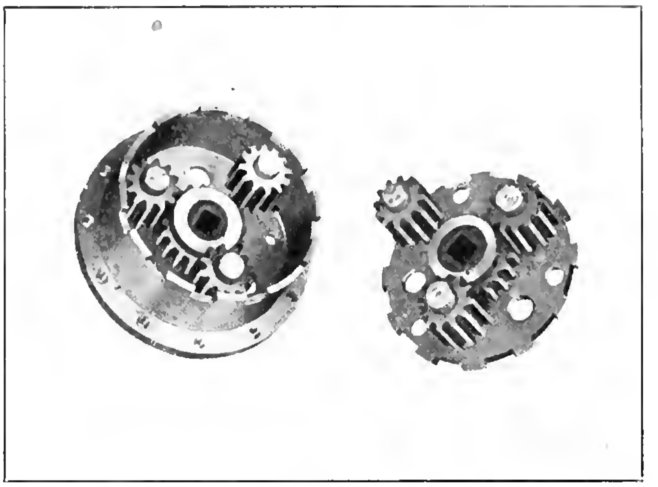


Fig. 2. A Small Size of Equalizing Gear Dismantled to show Construction

axle gear casing on ball bearings, mounted at the ends of casings *A* and *A'*, and the driving bevel gear is carried on the periphery of case *B*, to which it is clamped by hex-head screws *H*. The pivots *E* are riveted into the flanges of covers *A* and *A'*, three in one side and three in the other. These pivots carry pinions *F* and *F'* meshing with gears *C* and *C'*; the latter run in bronze bushings *D* and *D'* forced into the two covers, and are provided with broached square holes by which the floating wheel shafts are driven. As will be seen in Fig. 2 in connection with Fig. 3, gear *C* meshes with pinion *F'*, which also meshes with pinion *F*, the latter in turn engaging gear *C'*. Thus, when gear *C* is turned, gear *C'* is revolved in the opposite direction, and *vice versa*, thus forming a spur gear differential mechanism.

Attention may be called to some of the features which make for strength in this design. It will be seen, for instance, that

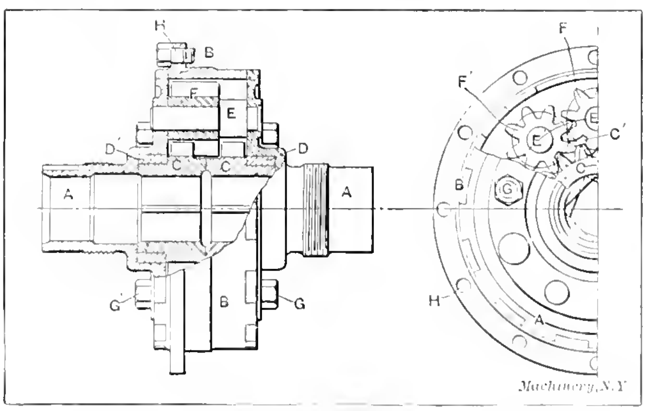


Fig 3 Details of Construction of the 7-inch Equalizing Gear

the gears have teeth of special shape and of very coarse pitch and few numbers of teeth. The pinions have eight teeth and the gears sixteen each. In designing the mechanism by analysis, as described, it was found that this construction was necessary for strength. Older designs of this kind, more commonly met with, in which the pinions are smaller in proportion to the gears, have repeatedly proved their weakness by breakage.

Mention should also be made of the solid way in which the parts composing the casing are fastened together. The casing *B* is provided with tongues locking into the grooves cut in covers *A*, so that the strain of transmission is taken on these interlocking members and does not depend on the bolts, dowel pins or similar parts. So far as this torsional strain is con-

* For further description of this type of differential gearing, see October number of MACHINERY, page 84, engineering edition.

† Associate Editor of MACHINERY.

cerned, the casing is as strong as if it were made of solid metal—an impossible construction, of course. Through bolts and nuts G and G' clamp the whole casing firmly together.

The proper meshing of the bevel gears can be controlled by shifting the whole casing axially in its bearings. Nuts are mounted, for this purpose, one on the threaded diameter of A and the other at the same point on A'. By loosening one and tightening the other the teeth of the gears can be brought more closely into contact, or *vice versa*.

The provisions for oiling should be noted. The casing in the rear axle is provided with a bath of oil in which the bevel gears run. Three holes cut in the exterior of B (not shown in Fig. 2, but visible in the detail views of the operations in Fig. 4, and at the right of Fig. 5, where these holes are being drilled) admit oil from this bath into the interior spur gears. Pivots E and pinions F are grooved, as are also gears C and C', permitting a flow of oil through the whole structure, kept in constant motion through the revolving of the parts.

In describing the manufacture of this device we will take up each part in turn. The manufacture of the bevel gears will not be described in detail, as their design is determined

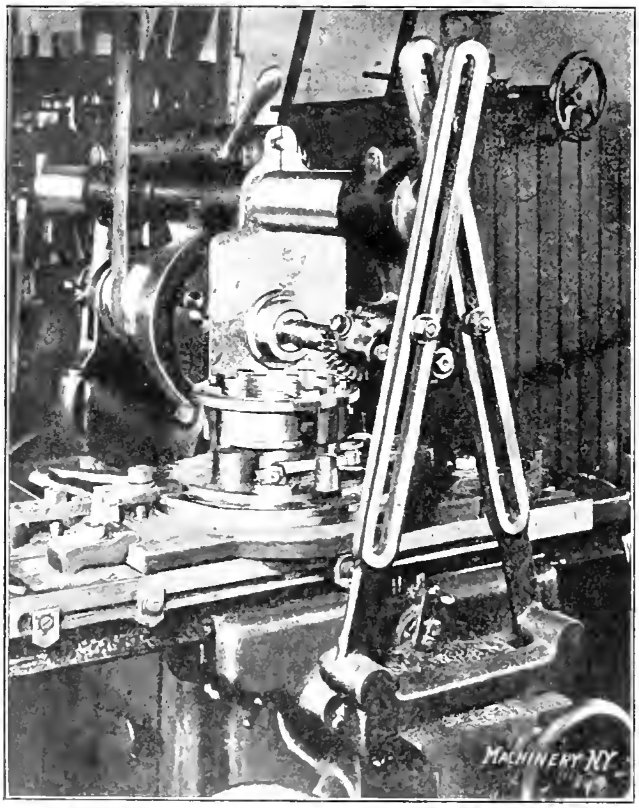


Fig. 4. Milling the Driving Tongues in the Gear Case—Second Operation

by the maker of the car in which the device is to be installed. The first part to be considered will be the gear case, shown at B in Fig. 3.

Operations in the Manufacture of the Gear Case

The case is made from a malleable iron casting on which the first operation, naturally, is that of snagging to remove fins, gates, etc. The second operation is performed in the Jones & Lamson flat turret lathe, of which large use is made in this shop. The casting is placed in the chuck of the machine with the flange outward. In this operation the hole is finished to size, the flange is turned, and the projecting end is faced. The regular equipment is used for this purpose, the only special tools being gages for the inside diameter of the hole and the outside diameter of the flange.

In the third operation, performed in the same machine, the part is grasped by the finished flange in special soft chuck jaws, which have been turned in place to fit the diameter they are to receive. This gives assurance that the work done in this operation will be true, within reasonable limits, with the cuts previously taken. Regular flat turret lathe equipment is used for this operation as well, suitable gages of simple construction being provided. The next operation, shown at the right of Fig. 5, is drilling the three holes which admit oil to the interior of the case. This jig is of the simplest possible construction, consisting of a knee with a turned seat on which the work is placed, and an overhanging lug carrying a drill bushing. A clamp provides for holding the work, and a plug, entering a suitably located hole in the seat, provides means for indexing the second and third holes drilled, from the one previously completed. The other operation shown in this engraving will be described later on.

The tongues which interlock with the grooves in covers A, A' (see Fig. 3) have next to be milled. The fixture for doing this is shown in use in Fig. 4. It consists of a base provided with an index plate and a revolving table, by means of which

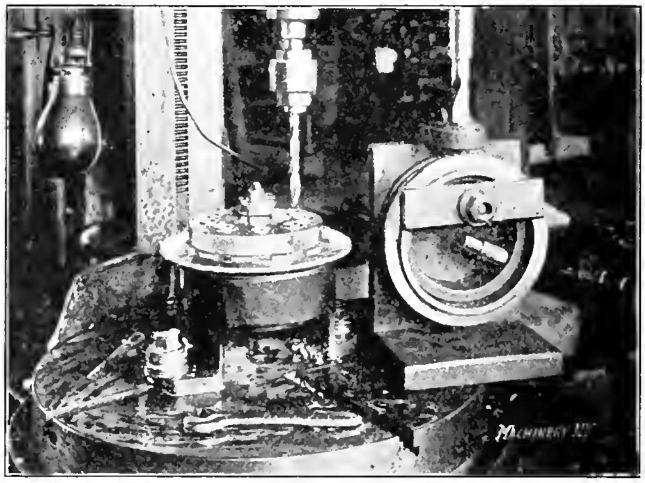


Fig. 5. Drilling the Three Oil Supply Holes in the Case (see Fixture at the Right), and Drilling the Bolt and Pivot Holes in the Cover

the work may be indexed step by step to cut the various tongues. These are shaped by straddle mills which form the opposite sides of the tongues parallel, so that they fit into corresponding grooves milled into the covers by a straight-sided cutter. In the operation illustrated, tongues have been cut on one side of the casing, which is located in its seat in the fixture by the interlocking of these tongues with grooves provided to receive them as shown. This assures alignment of the cuts on each edge of the case. In the first operation the uncut edge of the work is simply set down onto this seat. It is held down by three clamps, provided with noses which enter

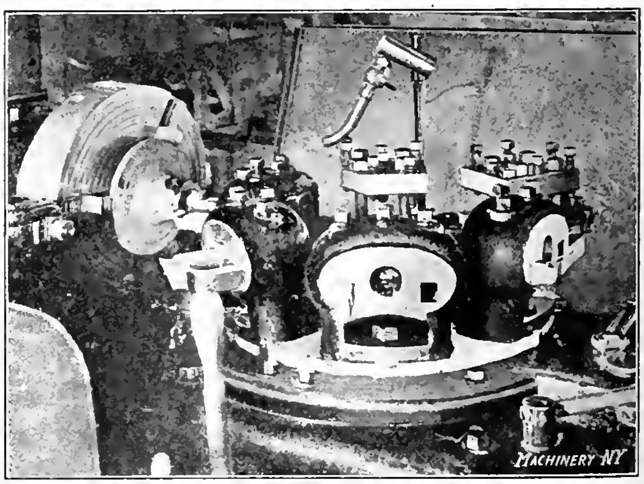


Fig. 6. The First Turret Lathe Operation in Finishing the Gear Case Covers

the three holes drilled to admit oil to the interior of the mechanism.

It is interesting to see the expertness with which the operator cuts out these tongues. The automatic feed is set at the highest point practicable when cutting the full depth. As this would be less than the maximum possible when the cutter is entering the work, he begins with a hand-feed at a considerably higher rate, throwing in the automatic feed when the cutter gets down to work. Although the machine is of modern construction, the workman was feeding it all the belt could handle, and was evidently then not satisfied with its performance, as he was engaged in tightening up both the countershaft and driving belts during the time of the writer's visit.

The gear casing is now complete except for certain operations performed on it in assembling, as described later.

Operations on the Gear Case Cover

The gear case covers are made from machine steel drop forgings. After the snagging, the first operation is the simple one of putting a 1½-inch hole through the center of the forgings. This is a drill press operation and is merely done to remove stock, it being, of course, impracticable to form the hole in the forging. It is next clamped by the rim with the hub projecting, in the chuck of the flat turret lathe. This first turret lathe operation is shown in Figs. 6 and 7, the latter diagram indicating the arrangement of the tools.

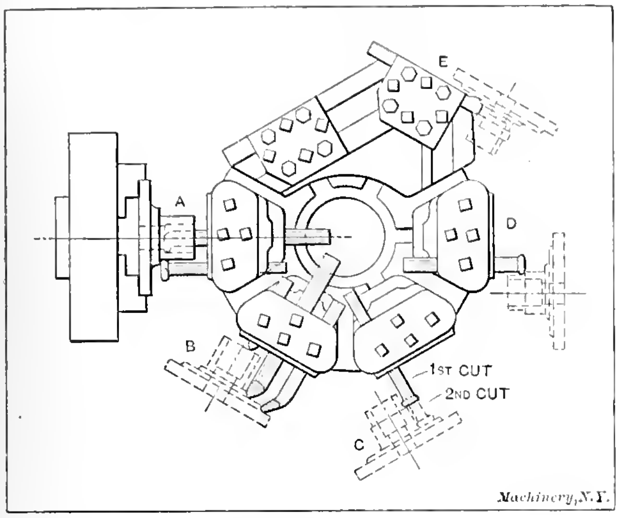


Fig. 7. Lay-out of Tools on the Flat Turret Lathe for the Operation shown in Fig. 6

The first cut is shown at *A*. An outside turning and boring tool, acting in conjunction, rough turns the hub and rough bores the hole. At the next station, *B*, three tools simultaneously face the end of the hub and the two surfaces of the flange. Two cuts are taken with these, one for roughing and one for finishing. A third cut is taken with the same tools fed axially against the work to form the two grooves in the face of the flange, as most plainly shown in Fig. 3. At the third station *C*, another turning tool removes the stock on two diameters of the hub, two cuts being taken. At *D* a finishing cut is taken over the smaller diameter, while at *E* a form tool shapes that portion of the hub extending from the threaded diameter to the flange. This operation is completed in about 18 minutes.

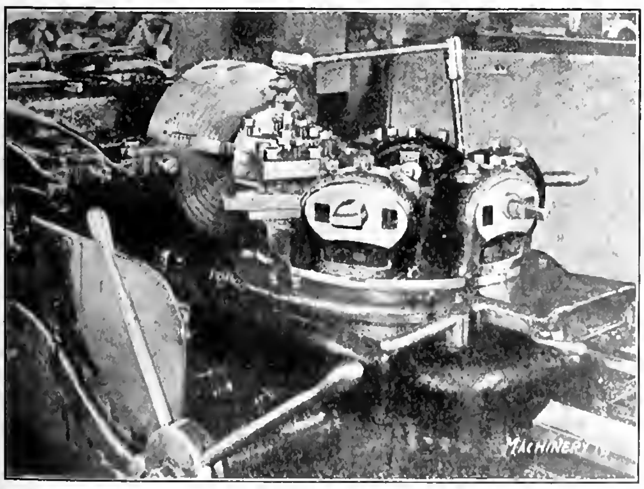


Fig. 8. Second Operation on the Flat Turret Lathe, using Special Jaws

In the second operation (see Figs. 8 and 9) the completed end of the piece is grasped in soft jaws turned to fit the surface they grasp, assuring true running of the surfaces made in the two operations. The tool at *A* bores out the large diameter of the hole, which is for clearance only. The reamer at *B* finishes the small diameter to size. The tool at *C* faces the flange, taking two cuts, one to rough out stock and the second to bring it to size. A flat-nosed tool at *D* finishes the flange. The tool at *E* roughs out the counterbore, while that at *F* finishes it. This latter tool is fed directly in, boring the diameter of the counterbore to size until the bottom is reached, when the sliding head is fed outward, so that the same tool faces the bottom of the counterbore. The finishing is thus done by turning cuts instead of forming cuts, giving a higher degree of accuracy. Work of this kind shows the flat turret lathe to very good advantage. In the lay-out of tools shown in Figs. 7 and 9, there were probably no special tools of any kind required, with the exception of the form tool *E*, the rest being stock turning tools of the kind which forms the regular equipment of the machine. It may, have been necessary in some cases to give the tool a knock of the hammer on the blacksmith's anvil to crook it in one direction or the other, but nothing more would be needed. The cross sliding head and the multiple stops come into play in such operations as those at *B* and *C* in Fig. 7, and *F* in Fig. 9, giving each separate tool a wide range of usefulness, especially when it is so made that it can be used for both turning and facing jobs.

Hand vs. Automatic Machines

Of course there are all sorts of opinions about such matters, but in the question of hand versus automatic machines, this company believes that the conditions favor the use of the hand turret lathe in its work. The simplicity of the tooling is an important factor on contract work. The management can never be sure of the long continuance of any job, so that anything approaching costliness or elaboration is prohibited. Furthermore, it is reasonably certain that one hand machine will turn out more work than one automatic, particularly when, as in this shop, there is an inducement, such as the premium system, for the workman to get the most possible out of his machine. He is constantly changing his feeds and speeds as the varying diameters, depths of the cut and condition of the tool require. He is thus able to take heavier cuts without injuring his cutting edges than would be possible without constant personal supervision. Probably three or four changes are made in each operation to one that would be made by an automatic machine. As another advantage, this greater production of the machine means a much less capital outlay per dollar of output.

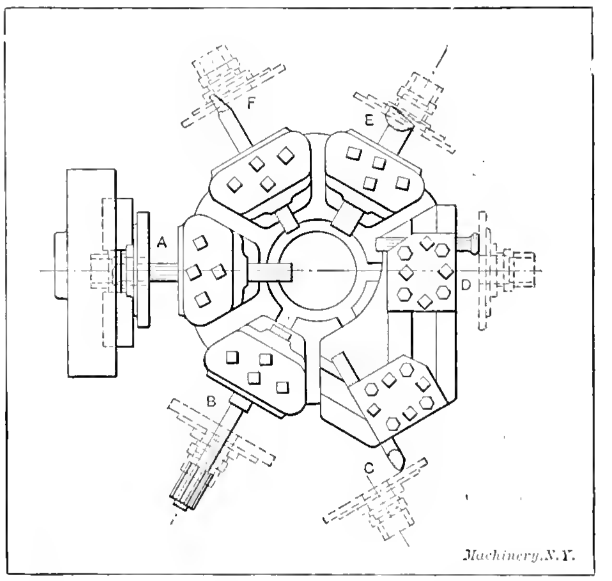


Fig. 9. Lay-out of Tools in the Operation shown in Fig. 8

It certainly does keep the operator busy to get the most out of one of these lathes. There is no possibility of his running more than one machine, on this particular work at least. Cuts are taken very rapidly and changes of feed and speed follow each other in constant succession. There is a line of demarkation at the point where the intensity of production on the part of the hand machine and the lower capital charge on machines, buildings, stock, etc., balance the higher output per man and the consequent lessened labor cost for the automatic machines. In accordance with their judgment, some shop managers will draw the line at one point and some at another. It is fortunate for the builders of both types that all men do not come to the same conclusion when reasoning from the same premises.

Gear Case Covers—Continued

In Fig. 10 the milling machine is shown rigged up to cut the driving slots in a pair of the gear case covers. The two are mounted together face to face on a special iron arbor, having a driving tail cast integrally with it in place of the usual separate dog. A formed cutter is used which shapes the bottom of the slot to the true radius of the inside diameter of the casing B (see Figs. 3 and 4) assuring a tight fit. This operation and that shown in Fig. 4 have to be done to close limits with good indexing plates, only 0.001 inch variation being allowed on the thickness of the slot and the tongue. This means that in order to make a good fit the dividing must be very accurate. In the cases the writer saw assembled, these parts drove together with a very little gentle urging from a lead hammer. Not much of anything else seemed to be required. In Fig. 11 is shown a jig for drilling the bolt and pivot holes in the gear covers. It is of simple construction, the cover being supported on four legs and located by a central spindle over which it is dropped and by which it is clamped, an open side collar and nut being used as shown. The bushing plate set over the work is located to bring the

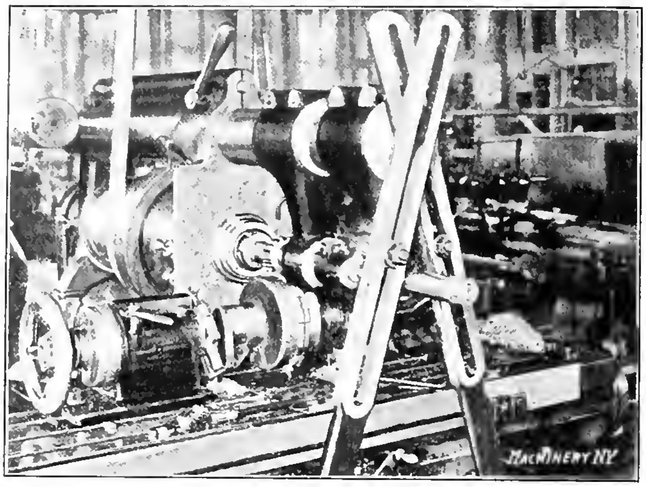


Fig 10. Milling the Driving Slots in a Pair of Gear Case Covers

holes in right relation with the slots, by a tongue entering the latter. In the next operation the covers are mounted on a special face-plate, as shown in Fig. 12. This face-plate is surfaced true in place and is provided with an expansion mandrel centered integrally with it. The gear case is slipped on over this mandrel and tightened in place by turning on a wedge screw. While thus held the countersink in the outer end of the hub, the seat for the ball bearing, and the threaded diameter are turned. The thread is also cut. This is done by the Rivett-Dock threading tool, shown in operation. These

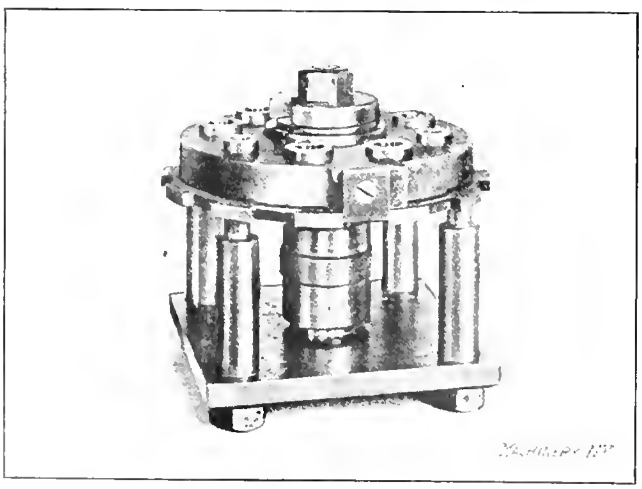


Fig 11. Jig for Drilling the Bolt and Pivot Holes in the Gear Case Covers. Another Jig for the Same Operation is shown at the Left of Fig 5

operations of countersinking, turning and threading, altogether, average about eight minutes time for each piece. When the turning was in progress, the writer timed the lathe and found it was making 250 revolutions per minute, which gives about 150 surface feet per minute for the cutting speed.

A fixture and mill of obvious construction are used for cutting the keyway by which the inner race of the ball bearing is made fast to the hub.

Equalizing Pinions, Studs and Gears

The studs E are made on the Gridley automatic turret lathe with the regular tools and equipment, the job being, of course, one of the everyday variety for this machine. Oil grooves are milled, and then the burrs are removed by hand. The

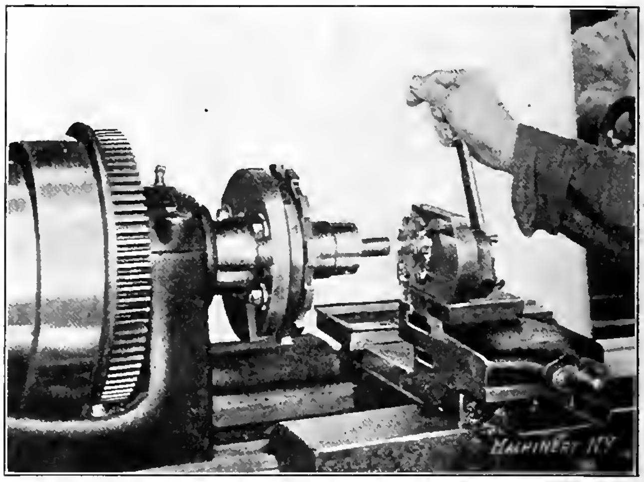


Fig. 12. Threading the Gear Case Covers with a Rivett-Dock Threading Tool

equalizing pinions are drilled, reamed and turned on the flat turret lathe. The ends are squared accurately to length in the engine lathe.

The equalizing gears are cut off to length from the bar stock (all gears and pinions are made of chrome nickel steel) and are bored, reamed, faced and filleted at the large end in the Jones & Lamson machine. The hole is reamed accurately to size so as to furnish a guide for the broach in forming a square hole. This is done on the La Pointe machine at a

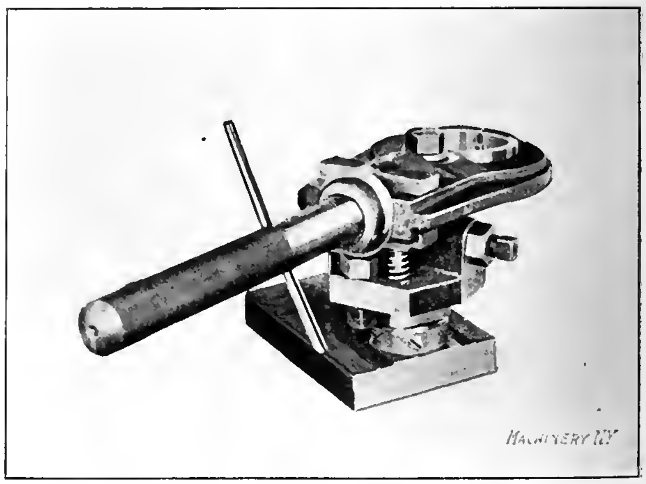


Fig. 13. A Special Fixture for Cutting Oil Grooves in the Equalizing Gear Bushing

single pass of the broach, which is a long one, having some 24 inches or thereabouts of cutting length. The outside surfaces of the gear are then rough turned on a square expansion chuck somewhat similar to that shown in Fig. 12 for the gear case cover, except, of course, that it is mounted on a square surface instead of a round one. In the next operation it is finish turned all over.

The spur gears and pinions are cut in a triple head indexing device which is one of the standard attachments on the Brown & Sharpe milling machine. Three cutters operate on three gangs of work simultaneously. By giving special shapes to the gears and by being very careful both in centering the cutters and setting them to the proper depth, first-class results have been obtained—better than are needed in fact, since normally these gears are stationary or nearly so, being in operation only when rounding corners, in the case of a deflated tire on one side, or the slipping of a wheel in the mud. After removing the burrs by file and reamer, the gears and pinions are hardened by the regular process recommended by the makers of the steel (the Carpenter Steel Co.), with

such modifications as the blacksmith of the shop has found advisable.

The equalizing gear bushings *D* and *D'* are cut out from a bronze bar in the flat turret lathe, being turned and bored complete to size. A stack of them are placed on the Mitts & Merrill keyseater for cutting the internal oil grooves. The radial oil groove is cut on the interesting tool shown in Fig. 13. This device is a modification of the principle used in attachments for slotting screws with a saw held in the speed lathe. The knurled handle shown controls three motions. By screwing it in or out the bushing is tightened or released in the jaws by which it is held. Tripping it up or down drops the bushing away from or brings it up toward the revolving cutter, while springing it to one side brings the bushing out from under the cutter where it can be removed without interference. A wire finger locates the work with relation to the internal groove previously cut.

Assembling

The operation of assembling the parts to make the complete mechanism includes some operations worthy of notice. In Fig. 14 is a case assembled with its two covers and dropped into a cast-iron reaming stand, where it is held from revolving by the projecting pin shown, which enters one of the three

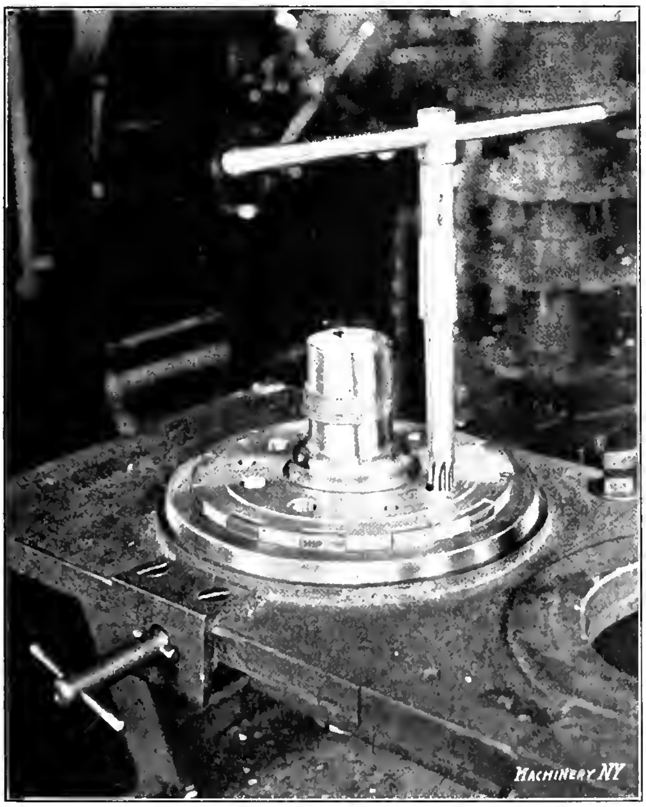


Fig. 14. Line-reaming the Pivot Holes in the Assembled Gear Cases and Covers

holes in its periphery. A line reamer is used, giving assurance that the two bearings in each cover will be true with each other. After this line reaming the covers are marked, numbered and burred so that the same parts will be reassembled together.

Studs *E* are next riveted to the covers, three on one side and three on the other, a hand hammer being used for this purpose. The ends of the rivets are cupped to facilitate this operation. The pinions are assembled on the studs, three on each side. The bushings are pressed into the covers under the arbor press, and burred. The equalizing gears *C* and *C'* are dropped into place and the whole structure is then assembled. A square wrench inserted through the bore into the squared hole in *C*, permits the gears to turn until they are all engaged. Three bolts and nuts *G* and *G'* are now passed through, binding the whole solidly together.

It is of extreme importance in the quiet running of an automobile that the bevel gears run true. For this purpose the bevel gear seat on the outside diameter of the casing is not finish turned until it has been assembled as described. To do this, the mechanism is mounted on the lathe on large centers, bearing on the countersinks in *A* and *A'*. These countersinks, being formed in the same operation with the ball bearing seats and the threads, are true with them. After this turning and facing, a jig fitting on this accurate seat is used for drilling the flange holes through which screws *H* pass to fasten the bevel gear to the casing.

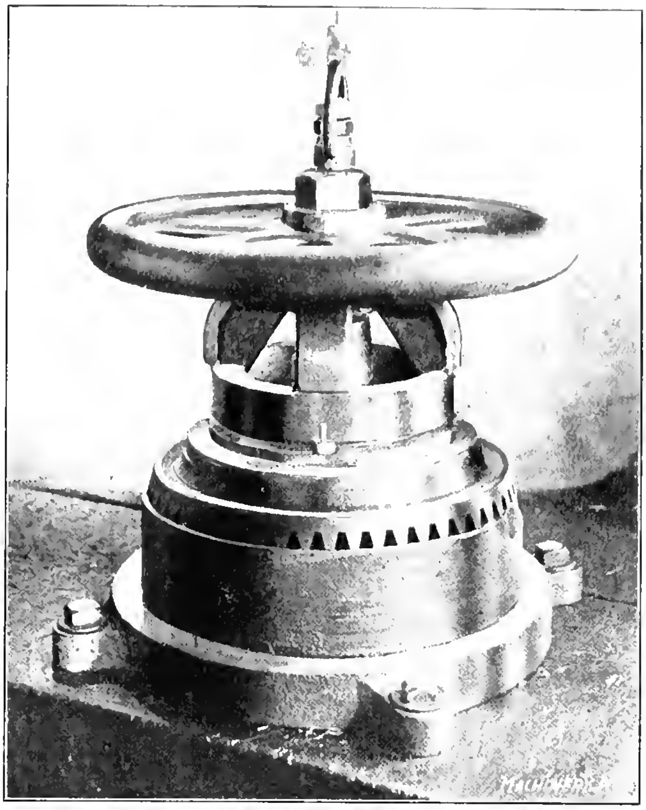


Fig. 15. A Convenient Fixture for Assembling the Gears on the Gear Case

The gear is pressed into place in its seat by a simple contrivance which illustrates the demand for conveniences created by the premium system. On the bench in front of the

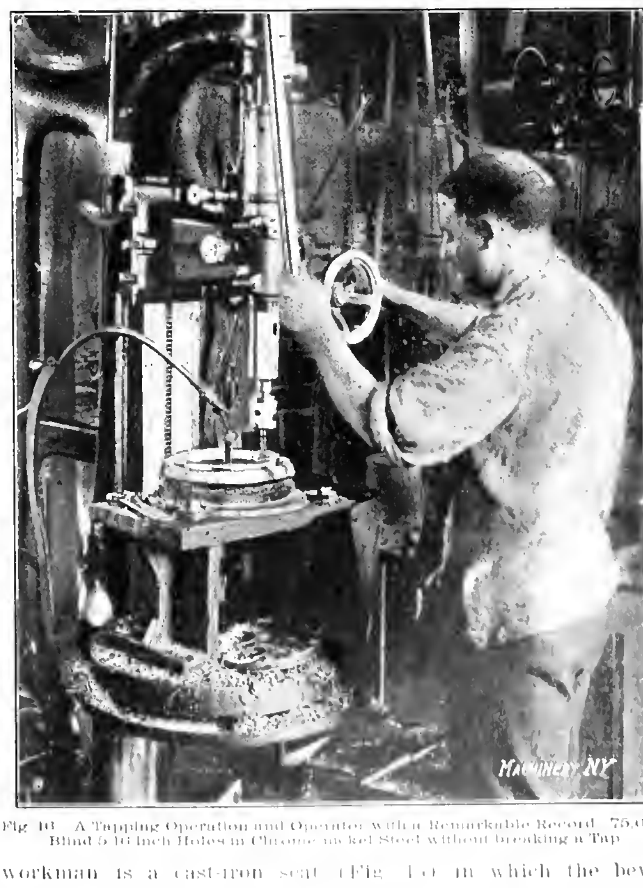


Fig. 16. A Tapping Operation and Operator with a Remarkable Record: 75,000 Blind 5/16 Inch Holes in Chrome-nickel Steel without breaking a Tap

workman is a cast-iron seat (Fig. 15) in which the bevel gear is placed face downward. The complete differential mechanism is then placed over the gear in a position to be forced down into it. The workman now reaches up above his head and brings down the hand wheel, clamping screw and clamp

shown, which is suspended by a counterweight so as to move freely up and down and remain stationary in any position. Entering the screw in the nut in the base of the device and turning the hand-wheel, forces the casing down into the gear and thus completes the assembling. The tap bolts are now put in and are wired through holes drilled through their heads, to prevent them from turning. This completes the making of the equalizing gear.

A Good Tapping Record

While the making of the bevel gear has not been described, it will not do to pass over one of the operations met with. This is the operation of tapping the holes by which the gear is held to the flange. These holes are 5/16 inch in diameter and 13/16 inch deep and are blind, being tapped to a bottom and not through. The tapping is done in a Cincinnati drill press (Fig. 16), using an Errington friction chuck. Tapping in chrome-nickel steel by power is, it will be agreed, no "fool of a job." One of the difficulties met with is the tendency of the metal to seize the tap and break it when backing out.

The operator shown broke many taps in becoming familiar with his job, but since he has gotten into the swing of it, he has tapped 75,000 of these blind holes in chrome-nickel steel without breaking a tap. The credit for this record must be divided between the man, the machine, the chuck and the tap, but there is enough to make a respectable showing for all four. It may be remarked that, in accordance with the well-known total depravity of inanimate things, the workman had the misfortune to break a tap a few minutes after the conversation in which I learned his record. His increase of effectiveness was obtained with practically no change in the tools or methods, being due simply to the training of his judgment in the feeling of the tap, and in the use of excellent tools. It might be said that a firm of the highest reputation for accuracy and for skill in manufacturing, had asked ten cents a hole for the job. This operator runs two taps in each of the twelve holes in a gear, twenty-four holes in all, in from 15 to 18 minutes.

Tests on the Finished Casings

Of course, the object that was aimed at in designing these equalizing gears for sale to manufacturers of automobiles, was to give them such strength that some other part of the machine would break first. In order to find out whether or no this result had been obtained a number of tests were made in the laboratory of the engineering school of Brown University.

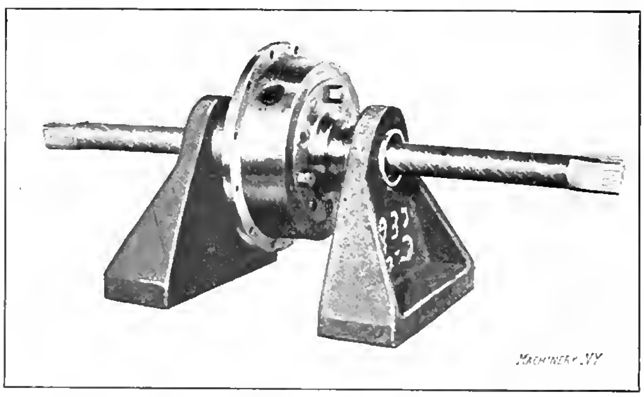


Fig. 17. A Completed Equalizing Gear, Set up for Testing to Destruction by Torsional Stress

In Fig. 17 the casing is shown as mounted in brackets for a torsion test, the power being applied through 1-inch, 3½ per cent nickel steel shafts specially treated. These failed at 20,300 inch-pounds, twisting through 800 degrees before rupture. Samples of broken shafts are shown in Fig. 18, and give some idea, in combination with the figures just given, of the excellence of the material used in these shafts. No damage of any kind was found inside the gear casing, the mechanism being unbroken and running as easily and smoothly as before.

The Providence Engineering Works feels perfectly confident in offering these equalizing gears to automobile manufacturers, after its experience with them in the laboratory, and their trial in the road conditions met with by the thousands which have been placed on the market.

EXPERIENCES OF A YOUNG TOOL-MAKER

T. COVEY

After Jim had completed his end mills ready for the hardening operation (as described in the August number), he turned them in and was given stock for some spiral surfacing mills, with instructions to make them like a sample given him, and to ream the holes 0.005 inch small so as to leave stock to grind out after the mills were hardened. He proceeded to chuck the pieces in a lathe and face one end and bore the holes. When a 1⅛-inch hole had been bored about an inch deep in the first piece, Jim began to have trouble. The steel was hard and tough, and the drill, which was somewhat worn, though apparently sharp, would not cut. Instead it would screech and stick until it stopped the lathe. After many efforts in grinding the drill and trying different speeds, he finally remarked to a man by the name of Anderson who was working on a machine near him, that that was the worst stuff he had ever tried to drill.

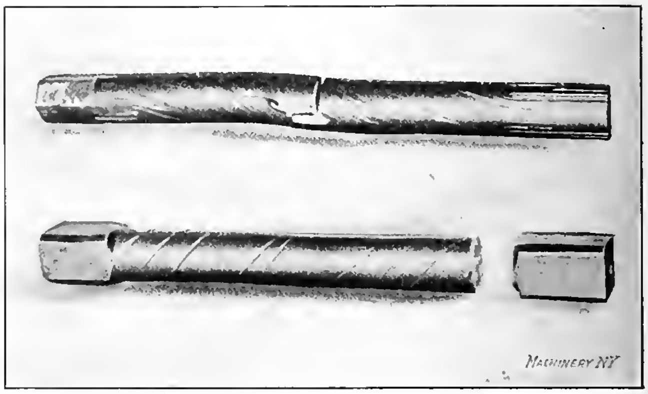


Fig 18. Condition of Shafts Broken in Tests shown in Fig. 17; the Gears were Uninjured

"What is the matter with it?" Anderson asked.

"That's what I would like to know; I can't get a drill to cut it," said Jim.

"Let's see your drill. Is that the best one you could get?"

"Yes. The boy at the window said the rest of that size were out. I guess he thought that was good enough for a kid to use anyway."

"Well, the clearance is gone for an inch at least. Do you know that you can grind a drill so that it will cut a hole larger than itself?"

"I never noticed it in particular."

"Well you can. You just grind one cutting edge longer than the other, so that the point is off center and the drill will cut large.

"I ground it on the drill-grinder and supposed it was all right."

"It probably would be if it was a good drill. Get a boring tool and bore out that hole as far as you have gone with the drill, at least a thirty-second of an inch larger and I will fix this drill so that it will work."

Jim got a tool and bored out the hole. When Anderson came back and handed Jim the drill he said, "There, that will cut large, and in that way it will have clearance on one side. Of course it can't bind much unless both sides rub. I think you will have no trouble in getting it to drill those pieces. I don't say that it is good practice to grind drills that way; a drill properly made and in good condition will clear itself and drill a hole to size, but when a drill is worn out it is no good, and for that reason you could not spoil it. It is a question, however, whether grinding a good drill off center would spoil it or not. Now if you are not accustomed to working tool steel, I can give you a pointer that may save you trouble. When you wish to ream a hole in tool steel, leave more stock for the reamer to cut than you would for cast iron or soft steel; a good thirty-second of an inch will not be too much. If possible use one of the special reamers that we have made for this work as they have more teeth and more clearance or reversed taper. The ordinary commercial reamer, while probably the best for general shop use, will ream too close to size for this job, and it also tends to stick in tool steel."

"I am glad you told me about it," said Jim. "I was of the opinion that the less stock left for the reamer to cut the

better, and I thought one kind of reamer as good as another. This drill is working all right now, and I guess I'll get a hole through *this* piece anyway."

Jim got his first piece bored and reamed without further mishap, but in making a starting hole for the drill in the next piece, he broke his tool by pushing it into the work before he got it central. George happened along about that time and Jim asked him for the loan of his centering tool until he could get his re-forged.

"A centering tool is something that I do not have, and very seldom use," said George. "What do you want to do? Start your drill? I'll show you how to start it without a centering tool. The first thing you want to do is to face the work off square so that the shape of it will not crowd the drill off the center; then place the drill in the chuck so that its cutting edges are in a horizontal position, and start it into the work, so!"

"But it is not running true," said Jim.

"We'll fix that; we will take this lathe tool, which is pretty square across the back end, and put it in the tool-post with the back end forward and clamp it fast, and then bring it up so that it bears against the drill close to the work; then feed the drill in a little, and crowd the tool against it until it looks as if it were central. When the tool is backed away, if the drill still looks central, go ahead; if not, repeat the operation until it is central. You see it saves the time and trouble of grinding and setting a centering tool and for ordinary purposes it is just as good."

As Jim was finishing up his lathe work, Mr. Corbin came along and picking up the sample mill said, "Jim, I want those mills for heavy roughing work and this sample mill has too many teeth; don't cut them like that but cut them about ⅝ pitch." Just then his attention was called to something else and he gave Jim no further directions. Jim was at a loss to know just what he meant but he did not like to let him know it. As Anderson was working near, he told him that he had been instructed to cut the teeth on his mills ⅝ pitch, but did not understand just what Mr. Corbin wanted.

"Well," said Anderson, "in this case ⅝ pitch means ⅝ of an inch from one tooth to the next."

"But why didn't he tell me how many teeth he wanted? How am I to know how many teeth he wants?"

"He would have to calculate the number before he could tell you, and be left that for you to do."

"I suppose it appears like an easy matter to you but I don't know how to go about it."

"Multiply 3.1416 by the diameter of your blank and divide the result by ⅝. That will give you the number of teeth. What is the diameter of your mills?"

"About four inches."

"Well, 3.1416×4 is 12.5664, and $12.5664 \div ⅝$, or 0.625 is a little over 20. Twenty teeth is what you want."

"Where did you get the 3.1416 from?"

"Why, 3.1416 is the ratio of the circumference to the diameter. That is, the circumference of a circle whose diameter is 1 would be 3.1416 and the circumference of a circle whose diameter is 4 inches would be 4×3.1416. If you want to demonstrate the truth of this take a piece of cord, pass it around one of your blanks and cut it off so that it goes around once with the ends just touching; take it off and measure it and you will find that it is very nearly 12½ inches long. Then if you wish to carry it further, cut the cord up in pieces ⅝ of an inch long, count the pieces and you will find 20.

"That is rather interesting, but is a machinist or toolmaker expected to have a knowledge of all such things?"

"I can only answer that in this way. I have noticed that the amount of a man's pay generally depends on his ability, and that toolmakers with a good knowledge of geometry and trigonometry combined with ability to do good accurate work are nearly always paid the best rate of wages."

With that Anderson went to grind a tool and Jim looked around for a milling machine to finish his job in. He found a small one idle and started to set it up when Mr. Corbin saw him and said, "That job of yours is too heavy for that machine; cutting spirals is pretty hard on any machine and you would be apt to strain this little fellow and impair its accuracy. Use that No. 1 over there—it may be more awkward to handle but it is suitable for the work."

Jim set the machine up for cutting the spiral according to the instructions on the table with the machine, and then as George was working near, he asked him to look it over to see if he had it right. George looked at the gears and referring to the table said they were all right; also the angle was right. Taking hold of the handle that moves the table he tried to turn it but it would not move. "You have not unlocked the index plate so that it can turn," he said. "You should always work the table back and forth once or twice to make sure that everything is free and working properly before starting the machine on a job of this kind."

"What angle cutter would you use for these?" Jim asked.

"Use a regular spiral mill cutter; they have a 12-degree angle on one side and an angle of 40, 48, or 53 degrees on the other. You want a right-hand cutter."

Jim obtained a cutter, a 1¼-inch mandrel, and a dog. On trying the mandrel into one of the blanks, he found, of course, that it was too large, and he went to Mr. Corbin and asked him what to do about it.

"We have hardened and ground mandrels 0.005 inch under size," said Mr. Corbin, "also reamers and expanding arbors of 1-inch, 1¼-inch, and 1½-inch sizes for work that is to be hardened. A great many shops ream mills and such work to size and depend on the hardening operation to close the holes sufficiently to allow them to be finished by lapping, but we make a great variety of mills that are of irregular shape and unless there is an equal amount of stock around a hole throughout its length it is apt to come back from hardening with one end of the hole larger than the other, making it a difficult and long operation to lap out the hole; and sometimes there is not enough stock to finish. For this reason we leave 0.005 inch stock in the holes of all work that is to be hardened, except the smaller sizes and special cases, and grind them out to size."

Jim took the mandrel back and asked for one 0.005 inch small, which he found fitted all right. When he got his cutter on the arbor and the work in position he began to realize that it was going to be a difficult matter for him to start a cut in the proper place for the simple reason that he did not know how. After thinking about it for awhile he came to the conclusion that it was beyond him. Looking around to see whom he could get to help him out of his difficulty, he saw a man by the name of Joe Waters who was working on a shaper near by and seemed to have lots of time at his disposal as he had just started a cut. Jim went to him and asked him if he would show him how to start a cut properly on one of those blanks.

"I'll try to," said Joe. "A good many fellows put a mill on a mandrel, put it between the centers and set their cutter to that, and I am afraid that there are some men that have laid claim to the title of toolmaker for a good many years that could do it no other way. I sometimes wonder what they would do if they had no sample to go by. You have your cutter on wrong; the side with the 12-degree angle should be next to the machine. Now get a surface gage and set the scriber to the height of the centers of the machine. Generally you will find a line on the footstock center that indicates this height, but where there is none, put the work between the centers and set the surface gage scriber as near to the center as you can guess and scribe a line on both sides of the work, index the work half around and scribe another with the gage at the same height; the center will then be just half way between the first and last lines. The gage is then set as near this point as possible and the operation repeated. When the gage is at the right height, you will be able to make only one line with the scriber on turning the index head half around. Now get some of that acid and rub it on the ends of your blanks so that you can see the lines that you scribe—use a little piece of waste moistened with it."

"Say! that is funny stuff," said Jim; "what is it?"

"It is nothing but water with bluestone, which is the same as sulphate of copper, dissolved in it, with a very small amount of nitric acid added. When it is applied to iron or steel it deposits a thin coat of copper on it. Now move the table of

the machine along until the end of the work next the footstock center is just half under the arbor on which the cutter is mounted and let it stay in this position for the present. How many teeth are you to cut?"

"Twenty," said Jim.

"That means just two turns of the index handle for each tooth, and we will put the index pin in the 21 hole circle. Now scribe a line across the end of your blank next the footstock center, index for one tooth and scribe another, and so on until you have gone clear around the blank. This may seem unnecessary, and it is, so far as starting the cut is concerned, but we need two and the rest serve as a check on the indexing and also would show if the work should at any time slip on the mandrel. When you scribe the last line mark it with a pencil or piece of chalk and turn the index handle 10 turns bringing this line on top. Now the edges of the teeth you are going to cut should be perfectly radial the same as the lines you have just scribed, and the side of the cutter that is to make these edges is to be at an angle of 12 degrees with a vertical line. Let the line that you have marked and turned to the top represent the first one of these edges that you are going to make; now what we want to do is to set this line in position so that the 12-degree side of the cutter is parallel to it, and as the 12-degree side is next to the machine, the line on top must be turned toward the machine 12 degrees; 360 ÷ 12 is 30, so we must turn the index head 1/30 of a turn, and to do this the index handle must be turned 1 1/3 turn, or one turn and seven holes in the 21 hole circle. There! Now the line you have marked is parallel to the 12-degree side of the cutter, and as your cutter is just half over the end of the blank that has the lines on it you have only to move the saddle in or out until the cutter is over the space between the line you have marked and the one next it at the top. Start the machine and raise the work up under the cutter until the 12-degree side cuts up to the line you marked and the other side comes about 3/64 inch from the next line. If you wish, you can keep away from both lines until you have taken a cut to see how it looks and satisfy yourself that it is coming all right. You should note the reading on the dial of the handle that operates the knee, and every time you finish a cut drop the work down away from the cutter before you run the table back for another cut, then raise it up again, after running it back, until the dial reads the same as it did before it was disturbed. If you don't lower the work, the backlash in the gears will allow the cutter to cut up the sides of the teeth and make a bad job. You will not need to set up your machine but once for this lot of mills as they are all of the same size and have the same number of teeth. It would be well, though to index each blank and lay out each tooth with the surface gage, and when you have scribed the lines all around move the index handle 1 1/3 turn and one of the lines will come in the proper place providing your blank sets with the end next the footstock center just half under the cutter when you are laying out the teeth. Very few toolmakers bother to lay out the teeth before milling, but it is a good idea for a beginner to do so as it gives an opportunity to watch the cutter when it is starting into the blank on each tooth, and if a mistake is made in indexing, or if the blank slips on the mandrel, it will be readily noticed and may be remedied before much, if any, damage is done."

"Thank you for the information," said Jim. "It's a good thing for me that I don't have to cut teeth on the ends of these mills or I would be in trouble again."

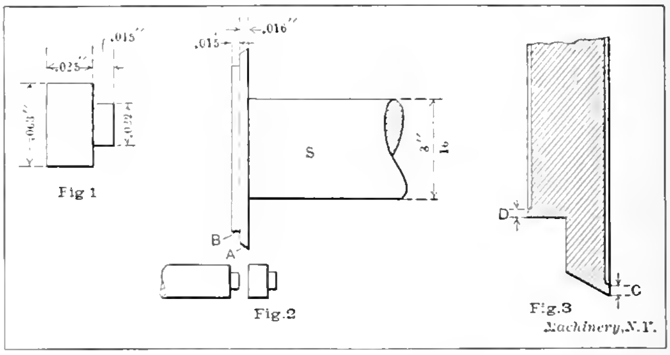
"That is not such a difficult job," replied Joe. "We have cutters in the tool-room that have a 12-degree angle on one side and 65 degrees on the other, which will generally cut the teeth in the ends that have a negative rake, and we usually cut the teeth in the end that would be undercut if the form of the spiral were followed, with a regular 65-degree cutter, not bothering to carry out the form of the spiral on this end, although it may be done quite easily where the index head can be lowered enough from the horizontal to bring the lands equal, by swinging the table around enough to bring the spiral in a position at right angles to the cutter (which would be to the same angle as given for cutting the spiral) and feeding the work in a vertical direction past the cutter. Well my cut is over and I will have to get busy."

MAKING PINS FOR IRIS DIAPHRAGM LEAVES

WALTER GRIBBEN*

The brass pin shown in Fig. 1 is used in the iris diaphragm of a camera, one pin being used in each end of each leaf of the iris. A few of these were wanted by a repair shop, or "camera hospital," to use in repairing diaphragms where a few of the leaves were damaged. On account of the limited number wanted, the job would not admit of very much rigging up. The teat left on the end for riveting in the hole in the leaf should be cupped out a little to facilitate riveting, but permission was asked to omit this cup, as by so doing the pins would be cheapened somewhat, and a solid teat was considered plenty good enough for repair jobs, although it might not do when manufacturing.

The pins were made of brass wire 0.063 inch diameter and were to be 0.035 inch long in the body, while the teat was to be 0.032 inch diameter and 0.015 inch long. No screw machine



Figs. 1, 2 and 3 Small Pin used in the Iris Diaphragm of a Camera, and Disk Tool used for Turning it

was available for this job, so it was done on a bench lathe. The details of the fixtures used are shown in the line cuts, but they are not all drawn to the same scale.

A disk tool, Fig. 2, was made of 3/8-inch drill rod. The shank *S* by which it is held, is in one piece with the disk. The part *A* is the cut-off, while the part *B* forms the teat on the next pin to be made. Fig. 3 is an enlarged section through part of the disk tool, showing how the sides were cupped out a few thousandths to make the cutting parts *C* and *D* quite narrow, with the object of making the tool cut more freely and thus throw up less burr on the work.

The halftone engraving, Fig. 4, shows the general arrangement of the improvised apparatus for getting out this job. The iron casting *E* was fastened to the top of the slide rest, and a hole bored in place which eventually held the hard steel bushing that guided the stock. This bushing is held by the set-screw *F*. The rock-shaft *G* is mounted between pointed screws, the one on the left being screwed clear up to the head, while the screw on the right-hand end has a check-nut by which to adjust for a close-running fit without shake. The arm *H*, shown in detail in Fig. 5, is tight on shaft *G*, while arms *K* and *L*, shown in detail in Figs. 6 and 7, are both loose on *G*. The two screws *M* and *N* hold *H* and *K* together, and serve to adjust the disk tool *A* for depth of cut, and thus produce the proper size of the teat on the end of the work, *M* being tapped into *K*, while *N* is tapped into *H*. When *M* and *N* are both tight, *H* and *K* act as one piece. The crank-shaft *O* was made of 1/8-inch Bessemer rod, and it carries two eccentrics *P* and *R*, made of 5/16-inch Bessemer rod with the hole bored off center. Eccentric *P* works in the open slot in the end of lever *K*, and causes the disk tool *A* to alternately move to and from the stock wire. Eccentric *R* works in the closed slot in the end of lever *L*, and causes the upper slide of the slide-rest to feed along after each cut has been made. The feed is accomplished by means of the pawl *U*, the bell-crank *V*, and the stationary rack ratchet *T*, clamped to the lower slide, the regular feed screw of the top slide being temporarily removed. The bell-crank is pivoted to *E* by a shouldered screw *W*, while another shouldered screw *X*, connects its horizontal arm with the end of lever *L*. Screw *X* had to be a rather loose fit in the end of the bell-crank arm, as *V* and *L* vibrated in different planes, but as the vibration was only

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over an arc of a few degrees, no trouble from binding was apparent. The rack T was cut on one of the edges of a piece of angle brass, the pitch of the teeth being equal to the total length of the finished pin plus the width of the cut-off part of the disk tool, or 0.066 inch altogether. The bell-crank was made of two pieces of sheet brass taken from the scrap box and soft soldered together. This may look like a slovenly way of making a bell-crank, but it was quickly made, and held together long enough to do the job, besides having the advantage that the vertical arm could be made longer or shorter by simply melting the solder. The arm carrying the pawl was adjusted in this way until the pawl moved a little more than one tooth of the rack, but not as much as two teeth. As the movement of the top slide is governed entirely by the pitch of the rack teeth and not by the amount of movement of the pawl, any lost motion in the feed works does not affect the length of the pins, unless it amounts to as much as the distance between two consecutive teeth of the rack. The two eccentrics P and R were adjusted around on the crank-shaft until the two movements were correctly timed relative to one another; that is, so the feed did not start until after the disk tool had been withdrawn from the work, and also so that the feed was completed before the disk tool started to cut.

As this work is so small in diameter, it was realized that a high speed of rotation was desirable, both to prevent the formation of much of a burr on the edges of the work, and also to reduce to a minimum the little teat left by the cut-off tool. With this object in view, the high-speed drive shown in Fig. 4, which was originally made to drive an internal grinding device, was changed a little to adapt it to present needs. The drive is shown in section in Fig. 8. It consists of the brass casting A, the upper end of which is slotted and carries the adjustable stud B, on which runs the double wooden pulley C, the large part of which is for a flat belt, and the small part for a round belt from the countershaft. This pulley has screwed fast to it a brass flange and hub D, into which are forced two hard steel bushings, one in each end, leaving on oil chamber between them. The end of the

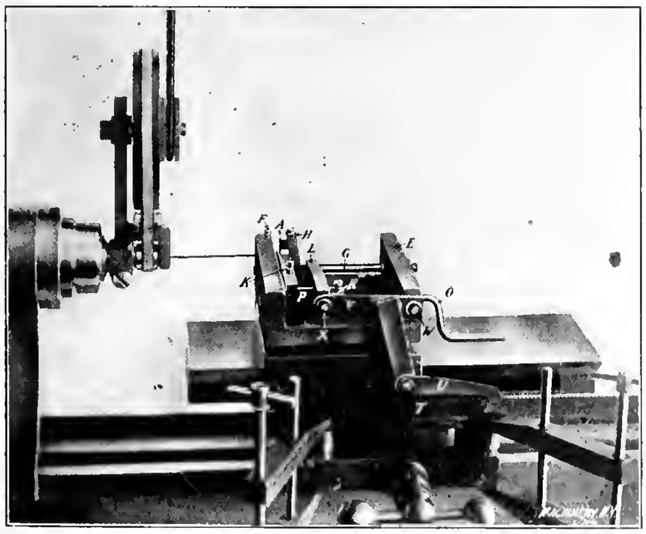
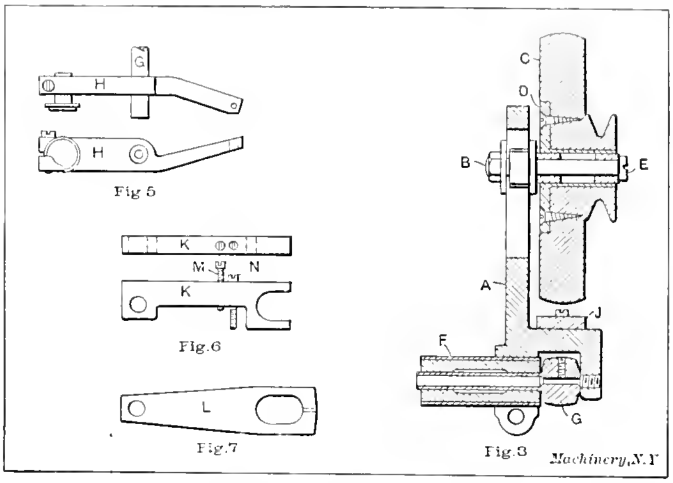


Fig. 4. Bench Lathe Attachment for Turning the Small Pins shown in Fig. 1, at the Rate of Sixty per Minute

stud is tapped, and the large-headed screw E is screwed in tight, which prevents the pulley from coming off. The lower part of A is bored 1/2 inch diameter, and has a saw cut and pinching screw to clamp it on the piece of 1/2-inch brass tubing F, which was tinned with soft solder on the inside and then poured full of babbitt metal. After cooling, it was bored 3/16 inch clear through and the ends faced. The middle of this hole was bored a trifle larger than the ends, in order to form an oil chamber. The pulley G also performed the office of a chuck to hold the brass wire of which the pins were made. It is made of 1/2-inch cold-rolled steel, with a long stem on one side 3/16 inch diameter, this stem being bored 1/8 inch as far as the pulley, and 0.063 inch the rest of the way. A small headless set-screw in G holds the work in place. The part of F that projects to the left is grasped in a 1/2-inch draw-chuck, and the lathe spindle locked to prevent it from rotating. An ordinary flat rubber band did duty as a belt to connect C and G, but it had this peculiarity, that considerable crowning on the pulleys seemed to have very little effect on keeping the belt in the middle of the pulley face, so a guiding fork J of sheet brass was attached. There seemed to be some structural irregularity in the rubber itself, as there was a tendency for it to crawl to the right when one side of the rubber was next the pulley, but to crawl to the left when the rubber band was turned over.

The mode of operation was to lift the feed pawl and draw the top slide as far to the right as it would go. Then a three-foot length of wire was passed through the lathe spindle and into the hardened guide bushing, in E (Fig. 4), after



Figs. 5 to 8. Details of the Attachment shown in Fig. 4

which the small set-screw in pulley G (Fig. 8) was tightened and the countershaft started. This gave an estimated speed of 10,000 revolutions per minute to G, providing the belt did not slip. Then the crank on the end of O was turned by hand, a finished pin dropping off for each turn, until the top slide reached the left-hand end of its travel, when the power was shut off, the slide moved to the right again, the stock wire released and pulled through until it was in the guide bushing once more. After tightening the set-screw and starting the power, a few dozen more pins could be made at the rate of about 60 per minute, when the stopping and returning to the right had to be repeated. The handle O could be turned much faster than this, but in that case the momentum of the top slide would be apt to carry it a little too far, and thus make the pins of varying lengths, so it was thought advisable not to exceed the rate mentioned. This fixture left the pins with practically no burr on them, and they were all ready for immediate use.

* * *

At the present time when we are prone to assume that everything undertaken in the mechanical field surpasses in magnitude or difficulty of production anything made in past centuries, it is of interest to recall that the so-called Great Bell of Moscow, made in Russia in 1734, is, according to the *Brass World*, not only the largest bell ever cast, but is also the largest casting of any kind ever made. The making of a casting of the size of this bell would startle the world even to-day. A great Chinese bell weighing 120,000 pounds is another example of ancient casting. As far as is known, these bells were cast from metal melted in close proximity to the mold. One or more furnaces capable of melting the required quantity of metal were so arranged that a trough connected the tap hole with the mold, for tapping the metal directly from the furnace into it. As a matter of fact, this method would, even to-day, be the only practicable one for casting a piece of similar size.

* * *

That the gasoline or alcohol engine is destined to be the farmers' future source of power in preference to the horse, seems to be reasonably sure. It now drives his automobile, shells his corn, grinds his cattle feed, pumps his water, threshes his grain and plows his land. Kansas farmers are using traction gasoline engines to haul their plows, and it is claimed that four men with a traction gasoline engine can do as much plowing as twenty men with horses

DIE SINKING AND SHOP PRACTICE IN THE ARMSTRONG BROS. PLANT

ETHAN VIALL*

The business of the Armstrong Bros. Tool Co., "The Tool-holder People" of Chicago, has grown from the almost insignificant product of a very small shop to the immense output of a factory that is second to none in equipment and which holds its own in size with those far in the front rank. This last statement means something, for as a rule, the business of a shop making small tool specialties does not require a large plant. The growth has not been of the mushroom kind, but has been a strong, steady increase, the result of good sound business management pushing a line of tools that were needed and which were made in a first-class manner. The Armstrong brothers have always been good, steady advertisers, but no amount of advertising could have built up the business that they have to-day, had the tools, the material and the workmanship not been right.

Besides the regular line of lathe and planer tools, the company now makes drop forgings and machine shop specialties

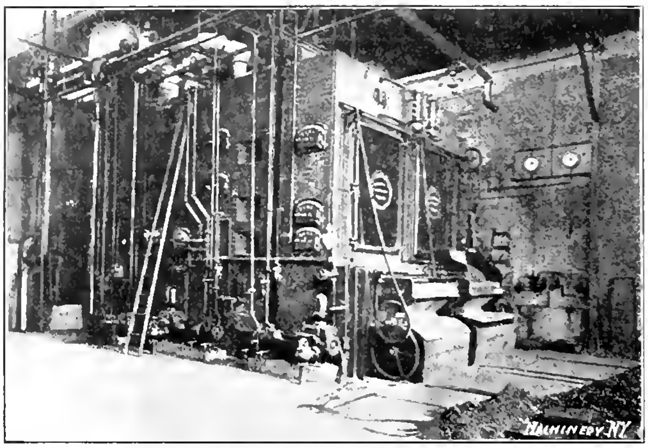


Fig. 1 View of the Boiler Room at the Armstrong Bros. Shop

of several kinds. The factory has its own power and light plant, and the boiler room, a partial view of which is shown in Fig. 1, is a model of neatness and careful planning; it is light, well drained and amply large enough for future expansion. Automatic stokers are used, and the condition in which the place is habitually kept is plainly shown in the engraving, the picture having been obtained one noon when no one knew that it was to be taken, so that no cleaning up for the occasion was possible.

The forge room is partially shown in Fig. 2. The arrangement of alternate steam hammer and trimming press is good. The heating furnaces are also well located, but, unfortunately,

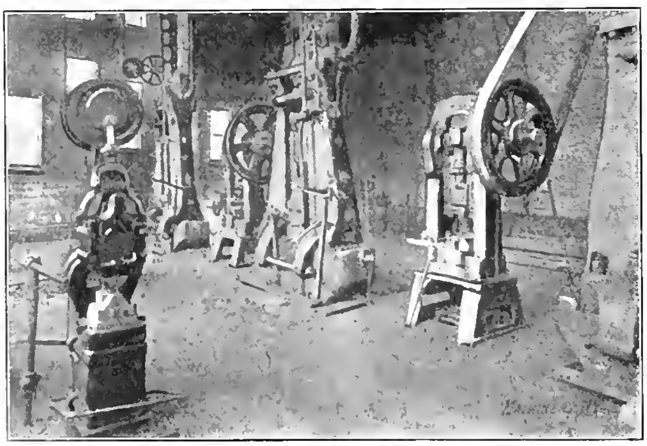


Fig 2. Arrangement of Steam Hammers and Trimming Presses in the Forge Room

the position from which the picture was taken, would not allow of their being shown. This department, as well as all the others, has been planned with an eye to both present and future needs.

A great many of the articles manufactured, especially the tool-holders, are case-hardened by being packed in large iron boxes with raw bone and charcoal, and heated in furnaces in the usual way. The method of handling the iron boxes is not, however, as common as it might be. These boxes are made with grooves or corrugations on each side, extending the entire length of the box, and a large iron fork, the prongs of which just fit these grooves, and which is swung from a

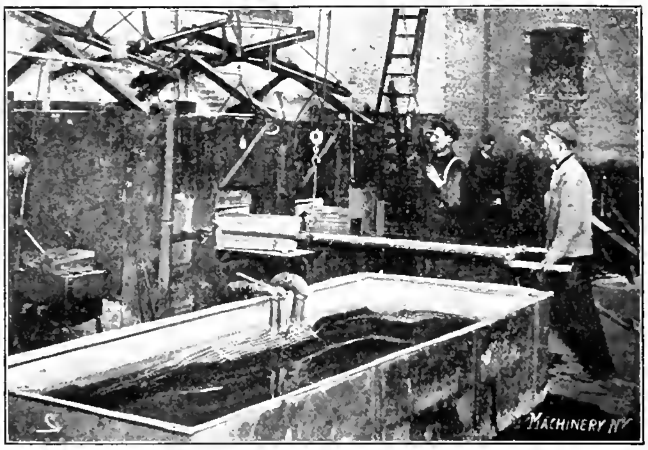


Fig 3 Case-hardening Furnace and Cooling Tank

traveling tackle, is used to put the boxes into the furnace and to remove them when they are sufficiently heated. When the boxes are removed the contents are dumped into the cooling tank, which is fitted with a screen to keep the parts off the bottom and insure more even and thorough cooling, all of which may be seen by referring to Fig. 3. The screen just referred to, can be easily removed to clean the burnt bone out of the bottom of the tank. When the picture was taken the water was purposely lowered to show the position of the big screen in the tank.

The tool holder set-screws, which are made of tool steel, are heated in a special furnace that heats only the points and

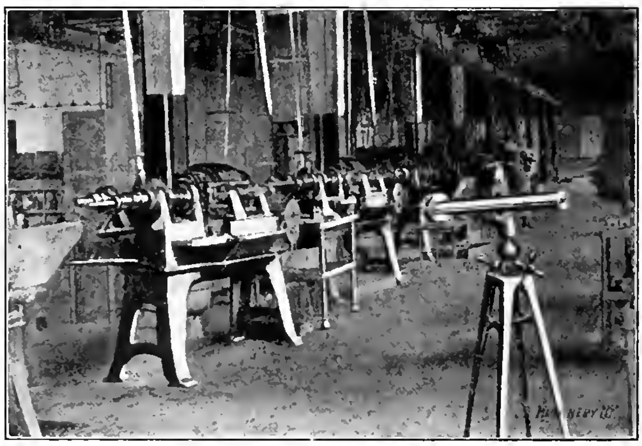


Fig. 4. Battery of Automatic Screw Machines which make the Tool-holder Set-screws

drops them into the hardening bath as fast as the operator can feed them in. The burner of this furnace is the same as that used on a bicycle brazer, and, in fact, the furnace is principally made from the parts of an old brazing stand.

The set-screws just referred to are made by the battery of automatic screw machines shown in Fig. 4. In the foreground is an old universal bicycle vise that is used to hold the big quills while taking out or putting in the spring collets used for feeding the stock. Anyone who has ever run this class of automatics will see the convenience of the old vise, for something of the kind is very frequently needed.

The system used for detailing the dimensions of parts for different sizes of tools of the same class, will be of interest to many, as it saves a great deal of work in the drafting room by making one print do for all sizes. A sample drawing for the six different sizes of spindle and feed sleeves manufactured, is shown in Fig. 5, and for those not already familiar with this method, it will be a revelation in simplicity.

Naturally in a shop depending so much upon drop-forge work, the die making department is one of the most important in the works and is well equipped. This department is in charge of a man of long experience on this class of work,

* Associate Editor of MACHINERY.

though a comparatively young man. One of his remarks hits the drop-forging die problem squarely on the head, and it is that the great difficulty in drop-forge work is not so much in making the die, but in making the metal go into it, meaning, of course, that the breaking down, roughing or bending operations are really the most important and the most difficult to plan out properly. Almost any toolmaker can sink a finishing be judged from it. For very large forgings such as the C-clamp just mentioned, cast-iron roughing and forming dies are used. The piece is first broken down, bent and rough formed in these dies and then reheated and finished in the tool steel finishing die. Fig. 8 shows a set of wooden patterns for a pair of cast-iron dies weighing 1,600 pounds, or 800 pounds apiece.

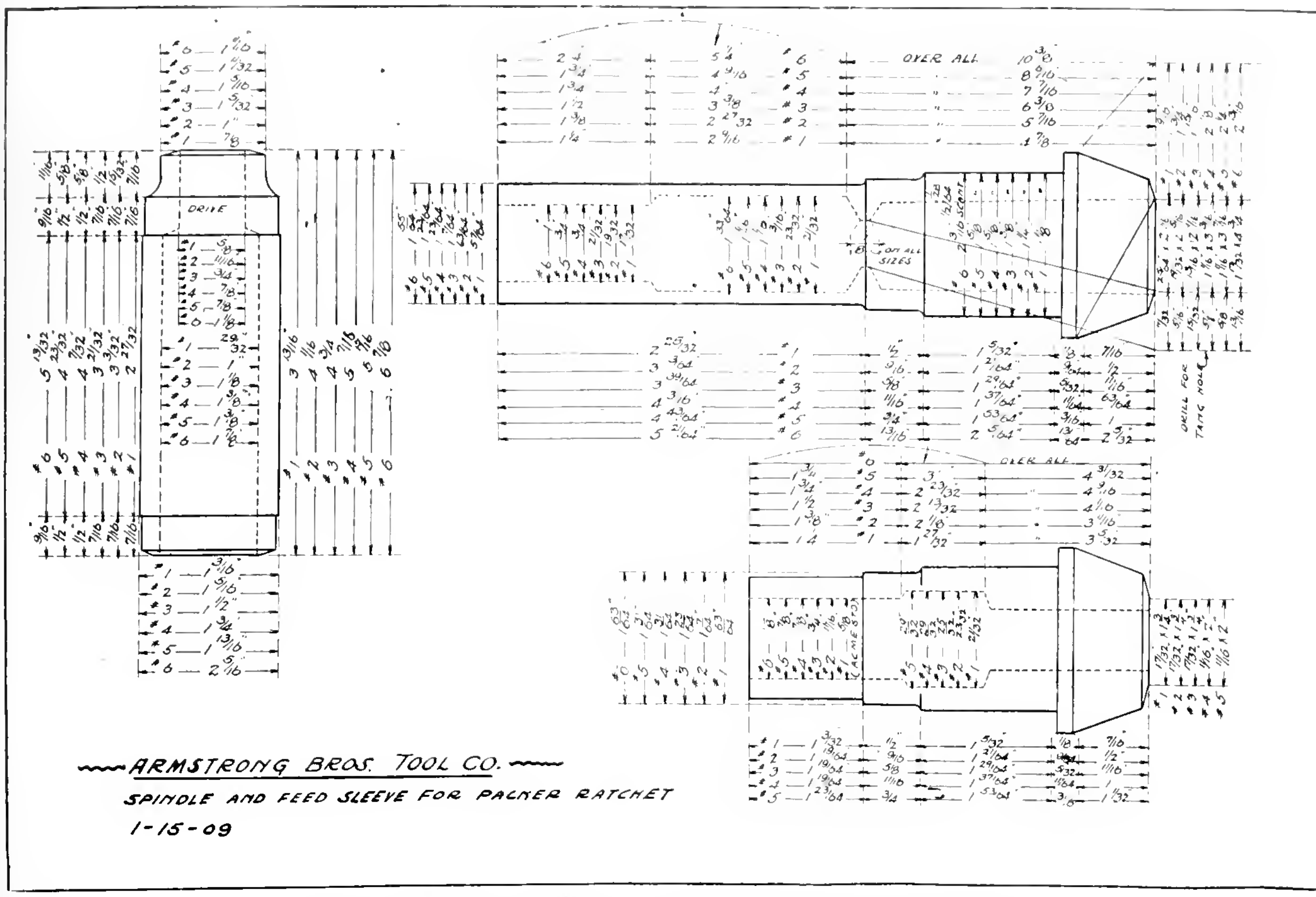


Fig. 5. Drawing giving Dimensions of Six Different Sizes of Spindle and Feed Sleeves

die from a model, but it takes brains and experience to plan and work out the other parts of the die so that it will work satisfactorily without unnecessary waste of time or material. In planning dies or die parts of especially difficult shapes, plaster of Paris models are often used in order to find the best shape or position for the part to lie in; this is especially important in so planning a die as to get that great desideratum of the drop-forge shop—the finishing at one heat.

Many small pieces are forged in "pony dies," which are made of a shoe of tool steel two or three inches thick, which is keyed into a heavy cast-iron or cast-steel block. These pony dies are very economical, as one set of shanks can be made to do duty for a large number of shoes, the shoes all being located by dowel pins and keyed in with a taper key, in the same way that the shanks are keyed into the steam hammer anvil and head.

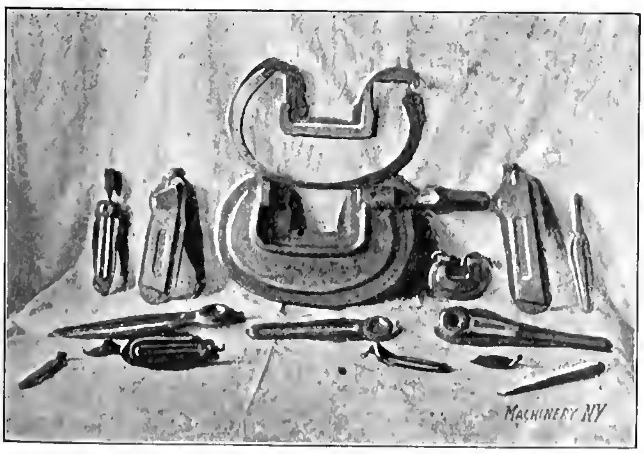


Fig. 6. View of Drop Forgings as they appear when taken from the Dies

Fig. 7. Lead Proofs of Various Parts which are to be drop forged

Fig. 6 shows a number of drop-forgings, including toolholders, wrenches, drifts and a C-clamp with the flash still in place. These forgings are just as they came from the steam hammer. A trimmed-off flash is shown on top of the large C-clamp in the middle of the group. Fig. 7 shows a lot of lead proofs of dies for making various sizes of drop-forgings from the smallest to the largest. The big C-clamp shown is 18 inches long and the sizes of the other parts can

For working out difficult dies on the profiler, the universal angle-plate or profiling-block, shown in Fig. 9, is used. In this engraving, *A* is the die and *B* is the top of the block, which may be swung around in a complete circle, while the part *C* can be tilted about 45 degrees each way and clamped at any point on the base *D*. These adjustments give almost any angle required in die sinking, that cannot be obtained in the regular profiler vise.

A special center-bracket used to steady small mill arbors held in the spindle chuck of the profiling machine while working out cylindrical cavities, is shown in Fig. 10. The

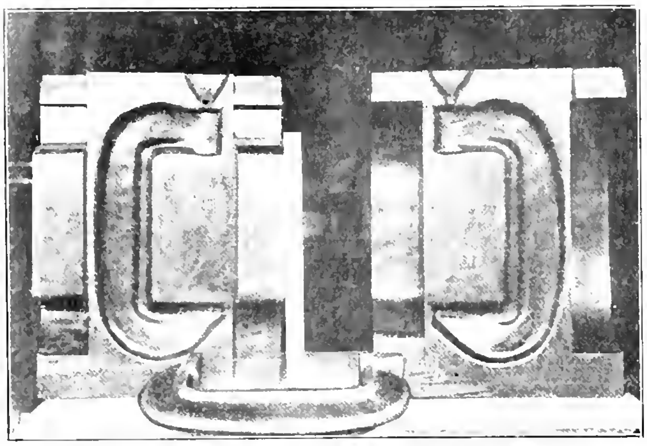


Fig. 8. Wooden Patterns for a Pair of Heavy Cast-iron Dies

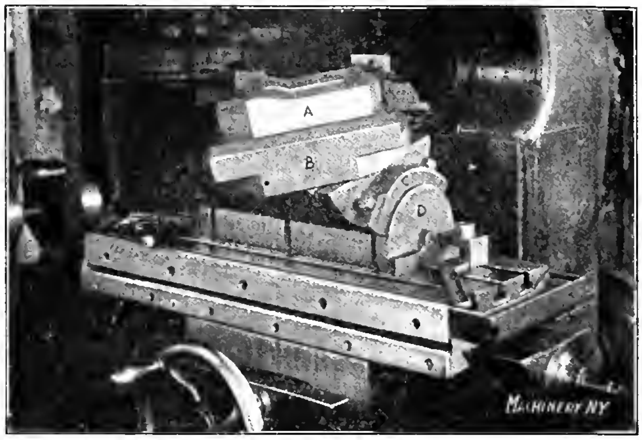


Fig. 9. Universal Angle-plate or Profiling Block used in Die Sinking

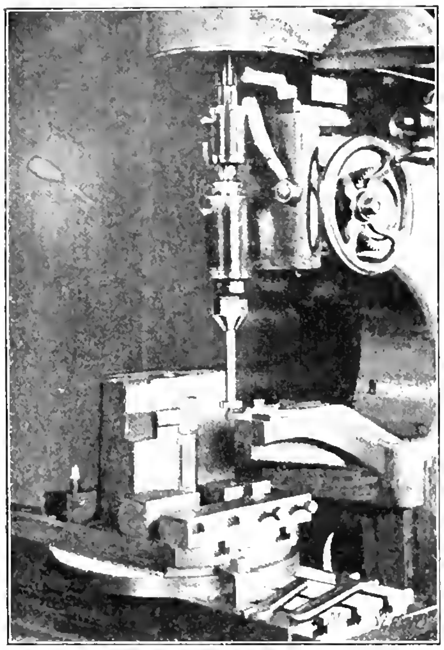


Fig. 10. Special Center Bracket used to Support Small Mill Arbors

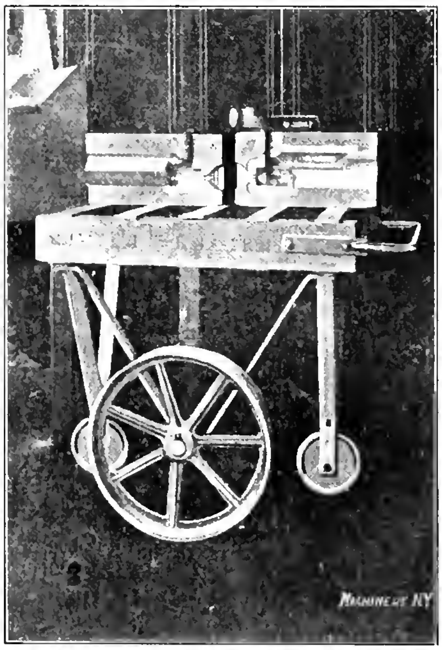


Fig. 11. Dies in which a Boring Tool Shank is forged, and a Convenient Form of Shop Truck

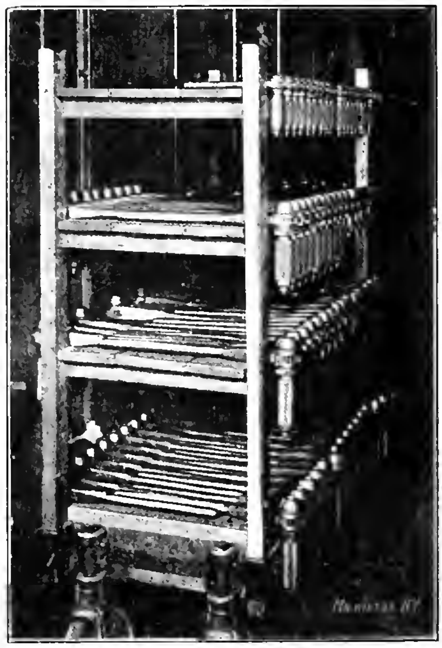
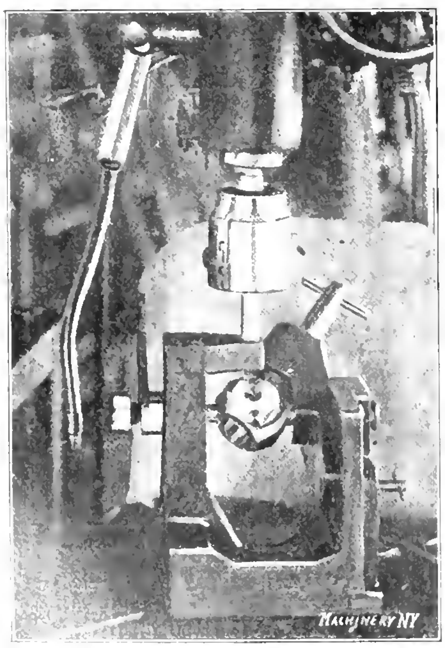


Fig. 12. Shop Truck with Shelves the Same Height as those in the Store-room



[illegible] Holding Hubs of Universal [illegible]

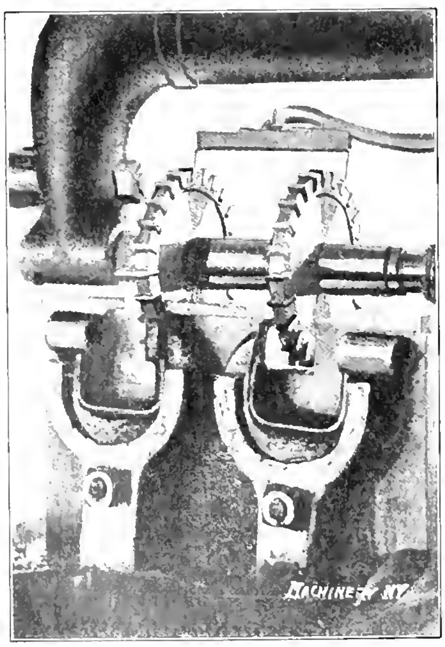


Fig. 14. Fixture which holds Two C-clamps while Faces are being milled

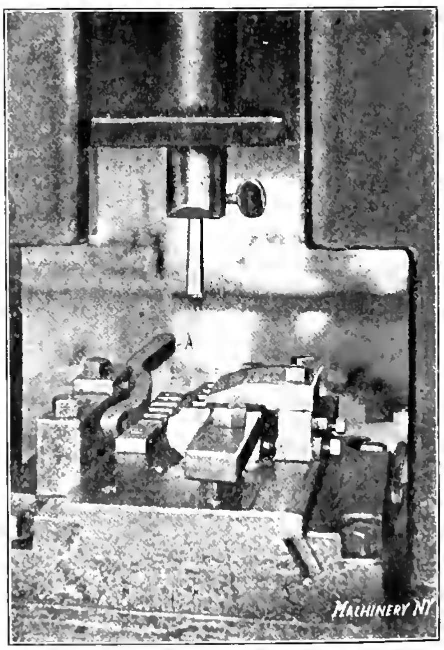


Fig. 15. The Way in which Planer Tool-holders of the Gang Type are broached in a Punch-press

[illegible] same diameter as the cavity wanted, and [illegible] way of getting a perfect cavity of the

The making of dies for the Armstrong boring tool, so that the metal would come out of the die, was quite a difficult problem. This was one of the few cases where getting the metal *into* the die was not the most important thing. It was easy enough to make a die that would forge up the shape required, but owing to the peculiar shape of the boring tool.

the metal would be wedged in too tight to be easily removed. This problem was worked out by using plaster of Paris in the way previously referred to, and the die as it was finally successfully made is shown in Fig. 11. One of the boring tool holders is shown lying on top of the die. The truck shown in this engraving is very useful, as it is just the height of the work benches and a heavy die can be easily pushed from one to the other. Another very handy truck used to carry finished tools from the assembling benches or shop to the storage shelves, is shown in Fig. 12. This truck is also used to carry tools packed in boxes to the shelves, and as the shelves of the truck are made the same height as the four lower shelves of the store-room, the boxes can be easily slipped into place.

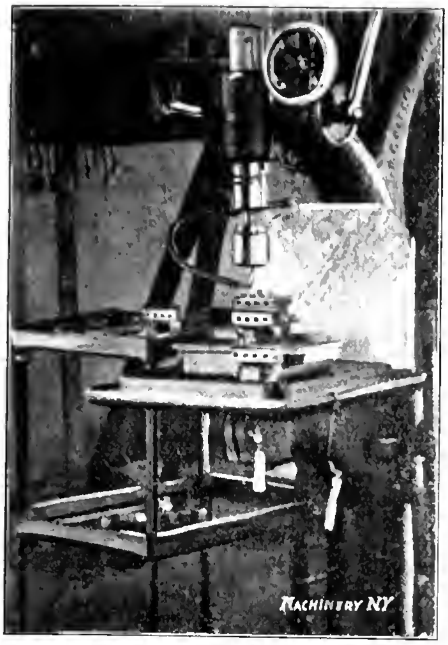


Fig. 16. Drilling Set-screw Holes in the Gang Tool-holders


Fig. 17. Cutting High-speed Steel with rapidly-revolving Plain Tool Steel Disk

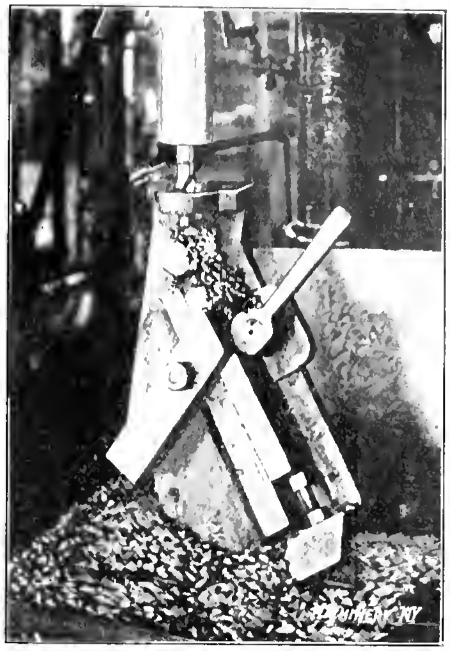


Fig. 18. Simple Form of Chuck for Drilling the Cutter Hole in Off-set Tool-holders

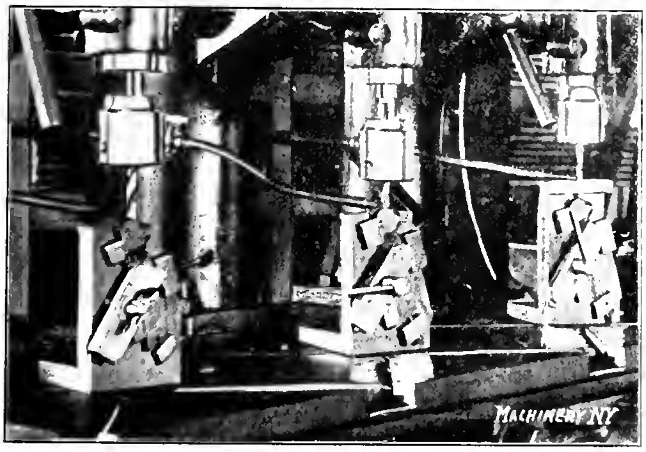


Fig. 19. Drilling the Cutter Holes in the Straight Lathe Tool-holder

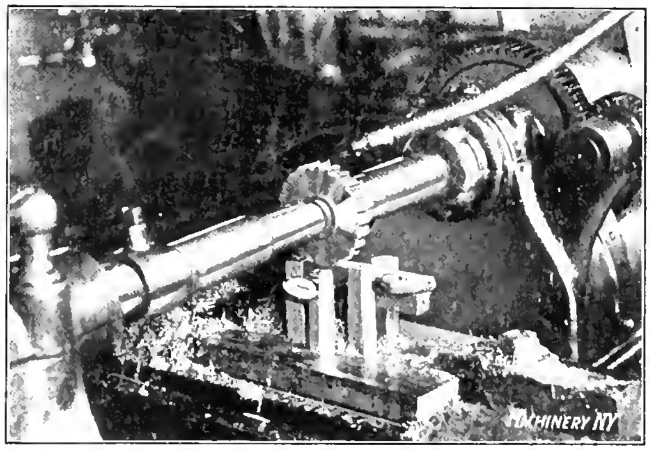


Fig. 20. Milling the Slots for the Blades in Cutting-off Tools

Fig. 13 shows an indexing jig used to hold the hubs of the universal ratchet drills, the construction of which is too plainly shown to need explanation.

In Fig. 14 is shown the milling jig used to hold two C-clamps at once while machining the faces.

Gang planer tool-holders are broached out in a punch press as in Fig. 15. The fixture used to hold the gang tool-holder, is mounted on a slide which is fed under the broach one hole at a time, by lifting the dog-lever *A* and pushing the fixture along until the dog engages the next notch. The view shown was taken from the back of the press. The gang tool-holders are next placed in a very similar fixture, shown in Fig. 16, and the set-screw holes drilled.

Many employers and foremen complain about their men grinding away the tool-holder when sharpening the cutters; consequently a set of special holders has been made for customers, in which to place the steel while grinding. A set of these holders is shown in the rack on the grinder column in Fig. 17, and the man at the left is using one, holding it at the proper angle by pressing it down on the adjustable grinder rest. At the right in this engraving is shown a man cutting high-speed steel into suitable tool-holder lengths with a metal wheel. This wheel is 16 inches in diameter and runs at 2,500 revolutions per minute. It is simply a thin tool steel disk clamped between two big soft-steel washers. The steel bars are not cut off entirely but are just cut into slightly on the four sides and snapped off, the cuts on the sides being as clean as if made by a milling saw in soft metal. No teeth or anything of the kind are used on the cutting disk and the hard high-speed steel does not quickly wear the softer metal, as a "saw" lasts for a long time.

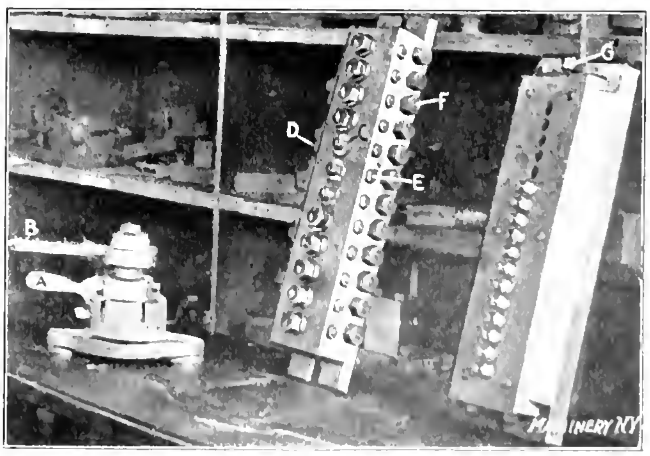


Fig. 21. Interesting Types of [illegible] Shoulder Nuts and Collar Head-screws. A[illegible]

One of the simplest possible drilling jigs for holding offset tool-holders while drilling the cutter hole, is shown in Fig. 18, while in Fig. 19 is shown a set of three jigs used for the progressive drilling of the long cutter hole in the straight lathe tool-holder. After the cutter holes have been drilled as shown, they are broached out square in special turret broaching machines.

Slots for the blades of cutting-off tools are milled in the holder, as shown in Fig. 20. A close inspection of this jig will show that the tool-holder is pressed from below up against stops. This method makes all slots the same depth regardless of any slight difference in the thicknesses of the forgings. The pushing up of the clamping-block is done by a cap-screw underneath which is turned with an end wrench.

Three very interesting milling fixtures are shown in Fig. 21. The tool at the left is an indexing fixture for milling large hexagon shoulder-nuts, using either one or two mills at a time. The indexing is done by the lever *A*, the nut being held in the chuck which is operated by the lever *B*. The fixture in the center is for holding twelve shoulder-nuts while

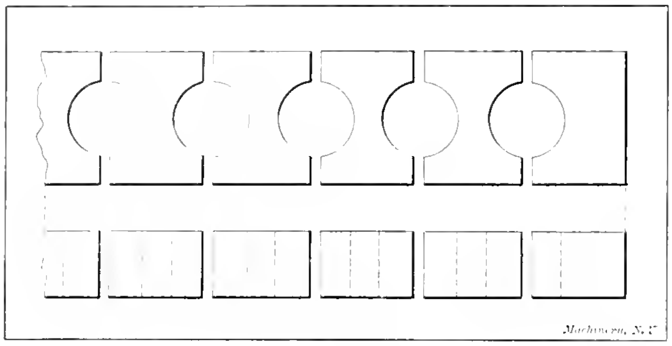


Fig. 22. Detail of the Clamping Blocks used in one of the Fixtures shown in Fig. 21

milling them hexagon, using straddle mills. The blanks are first faced and threaded and then screwed tightly down on the studs *C*, which are kept from turning by tightening the screws *D*. These screws are so arranged as to tighten two studs at a time. The nuts and screws *E* are simply lock nuts and pointed retaining screws, the ends of which fit into a groove turned in the stud shank. At *F* are the spring-actuated indexing stop-pins which are made to engage six notches in the stud shank, so that by simply loosening the lock screws *D* the nuts may be easily indexed with the fingers. Square-headed collar-screws are milled seventeen at a time, in the jig shown to the right. This jig is simple and easily operated. The screws to be milled are held by a series of clamping blocks, shown in detail in Fig. 22, which are set into a channel in the cast iron base of the jig, held in place by an iron top plate and tightened or loosened by the single set-screw *G*. No indexing device is used, but after the first straddle mill cut is taken the set-screw is loosened and the screws are turned a quarter way around by hand and lined up by using a gage with teeth in it like a big comb. The set-screw is again tightened and the final cut taken.

* * *

THE SMALLEST STEEL HAND STAMP

The engraving of the Lord's prayer on one side of a ten-cent piece and other feats of expert engravers even more remarkable have interested and astonished the public from time to time. The letters in these examples are of a microscopic size, and can be read only with the aid of a magnifying glass, but the difficulty of cutting them in copper or silver is small compared to cutting tool steel in relief, as is required for a stamping die. An interesting example of very small steel stamp work is now on exhibition at the New York store of William Dixon, Inc., 39 John St., which is said to be the smallest ever made. The die, which is of the common hand form hardened and tempered, stamps the name WILLIAM HOWARD TAFT in letters one two-hundredth (0.005) inch high, the seventeen letters making a line only 11/64 inch long. The name even when printed by the stamp on white paper with black ink cannot be read, without the aid of a magnifying glass, by any but the very sharpest eyes. The letters are all capitals, clean-cut and well-shaped. A page of MACHINERY on the same scale would be about 1/2 inch x 1 inch.

WATER REQUIRED TO COOL A GAS ENGINE

S. H. SWEET*

The water pump for a gas engine is generally designed to carry off one-half the heat produced by combustion. At times one-quarter would be sufficient but one-half is the amount that should be figured on. If the heat per minute generated by an engine is represented by q, then for a thermal efficiency of 12½ per cent, $q = 339.2 \times$ I. H. P., and $q \times 0.5 =$ the heat to be carried off by the water.

The constant 339.2 is obtained from the formula $q = \frac{\text{I. H. P.}}{E} \times \frac{33{,}000}{778}$. $E =$ the thermal efficiency, which for gasoline is taken as 12½ per cent. Hence, $q = \frac{\text{I. H. P.}}{0.125} \times \frac{33{,}000}{778} = 339.2 \times$ I. H. P. Other constants may be obtained by substituting the thermal efficiency expected or known. So far as I know the maximum efficiency of gasoline is 19 per cent, and a number of very good engines have shown about 15 per cent efficiency, but for the general run, the safe figure to use is 12½ per cent.

Let

$t - t_1 =$ allowable rise in temperature.

$t =$ maximum temperature of water in degrees F. (About 180 degrees should be the maximum temperature allowed.)

$t_1 =$ normal temperature of water in degrees F.

$W =$ the number of pounds of water required per minute,

then

$$W = \frac{169.6 \times \text{I.H.P.}}{t - t_1}$$

$t - t_1 =$ the number of B. T. U. absorbed per pound of water.

As the pump is generally attached to the engine shaft, it will have the same number of revolutions as the engine. Let p equal pounds of water required per revolution, then

TABLE GIVING PART OF A GALLON PER STROKE FOR VARIOUS SIZES OF SINGLE-ACTING PUMPS

Diam.	Area	Stroke 1	1½	2	3	4	5	6
½	0.196	0.0008	0.001	0.002	0.0025	0.003	0.004	0.005
5/8	0.307	0.001	0.002	0.003	0.004	0.005	0.007	0.008
¾	0.442	0.002	0.003	0.004	0.006	0.008	0.010	0.012
7/8	0.601	0.0025	0.004	0.005	0.008	0.010	0.013	0.016
1	0.785	0.003	0.005	0.007	0.011	0.014	0.017	0.020
1¼	1.227	0.005	0.007	0.010	0.016	0.021	0.026	0.032
1½	1.767	0.007	0.011	0.015	0.022	0.030	0.038	0.045
1¾	2.405	0.010	0.015	0.021	0.031	0.041	0.051	0.062
2	3.142	0.014	0.021	0.027	0.041	0.054	0.068	0.082

$$p = \frac{W}{\text{R. P. M.}}$$

As one gallon of water weighs 8.33 pounds,

$\frac{p}{8.33} =$ number of gallons required per revolution.

Let us take an example and assume that we wish to design a pump for a 20 I. H. P. gas engine which turns at 300 R. P. M.

$$q = 339.2 \times 20 = 6{,}784 \text{ B. T. U.}$$

$q \times 0.5 = 6{,}784 \times 0.5 = 3{,}392$ B. T. U., which is the amount of heat the water is to carry off.

$t = 180$, $t_1 = 60$, $180 - 60 = 120$.

$$W = \frac{169.6 \times 20}{120} = 28.267 \text{ pounds.}$$

$$p = \frac{28.267}{300} = 0.0942 \text{ pound per revolution.}$$

$$\frac{0.0942}{8.33} = 0.0113 \text{ gallon per revolution.}$$

By referring to the accompanying table we see that a pump 1½ inch bore by 1½ inch stroke will answer. The number

* Address: 190 Orchard St., Bridgeport, Conn.

of gallons pumped per minute is equal to the number of R. P. M. of a single acting pump multiplied by the number of gallons per revolution as given in the table.

[If the thermal efficiency of a gas engine were 100 per cent, that is if all the heat were converted into work, there would be no rejection of heat into the cylinder walls, and consequently no need for cooling water. Again, if the thermal efficiency were 50 per cent, one-half the heat would be rejected into the walls and exhaust while the other half was converted into work. The formula, therefore, is not strictly correct, as it does not take into consideration the percentage of heat converted into energy and which thus disappears.

Using the same notation, the formula should properly be:

$$q = \left(\frac{\text{I. H. P.}}{E} \times \frac{33{,}000}{778}\right) - \left(\frac{33{,}000 \times \text{I. H. P.}}{778}\right)$$

$$= \frac{(33{,}000 \text{ I.H.P.} \times 778) - (33{,}000 \text{ I.H.P.} \times 778\,E)}{778\,E \times 778}$$

$$= \frac{25{,}674{,}000 - 25{,}674{,}000\,E}{605{,}284\,E}$$

If $E = 12\frac{1}{2}$ per cent, then:

$$q = \frac{25{,}674{,}000 - 3{,}209{,}250}{75{,}660.5}$$

$$= 296.8$$

The thermal efficiency of gas engines being rarely more than 20 per cent the error in Mr. Sweet's method is not important and for practical purposes it is to be preferred because of its simplicity.—EDITOR.]

* * *

HOW BILLY CENTERED SHAFTS

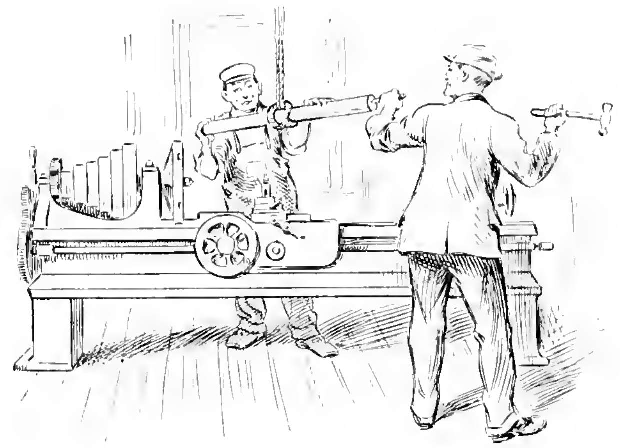
H. A. D.

Mr. William Collis, affectionately known amongst the boys as "Billy," was the foreman of the turning shop some twenty years or so ago. He was a working foreman too—not one of the kind who was afraid to dirty his hands—and to fill in his time between Monday morning and Saturday noon, when he was not giving out work or looking after his men he ran the shafting lathe—or rather the shafting lathe ran itself even when he was looking after the men, or when he was dozing on the top of his tool-chest, for in that shop there was no tool-room and each man kept his own special fancies in the way of tools, etc., under lock and key. High-speed steel was in the dim and distant future, and a cut over a shaft lasted a long time.

Now Billy's method of centering was as primitive as could be, the usual tools consisting of a center punch and hammer only. A square center was used sometimes, but this gave trouble in changing centers, putting something in the tool-post to press the shaft, and other little worries which could be avoided; therefore, by placing the center punch where he guessed the center of the shaft should be, and hitting it several good smart blows the thing was done—except, of course, when he had miscalculated as to the exact position of the center. It was then necessary to try the shaft in the lathe, and if too much eccentricity was found he would mark the "high side" with chalk, remove the shaft and "draw" the center by means of the punch, the shaft being swung in and out of the lathe by means of pulley blocks.

His assistant on the operation was generally one of the newer lads knocking around, and for the particular shaft in the story the services of Harry had been secured. Now Harry's sense of humor (?) was strongly developed, and he hated this particular job just as much as he was afraid of Billy, but his love of a joke overcame his fears one day, and here is the story:

Billy had made a particularly bad guess as to the position of the center of the shaft and had followed his usual practice up to the point of swinging the shaft out of the lathe, when he was called away to attend to some other duty. As Harry lolled around waiting for the work to proceed again, the little chalk mark persistently stared him in the face in such a manner that finally an idea struck him, that it would be funny if he rubbed it out and placed another on the *opposite side*. Of course, as in most things of importance, the main thing was to have the idea, the rest was easy and was soon accomplished. It was too good a joke to be enjoyed alone and several others soon knew what had been done, amongst them being one of Billy's own particular cronies. Billy returned soon afterwards, and resuming operations, drew the center towards the mark. His surprise was very pronounced when he saw the result of his latest efforts and the remarks he made about shafts in general and this one in particular are unprintable, but he fairly lost his temper when he caught sight of someone smiling, apparently at him.



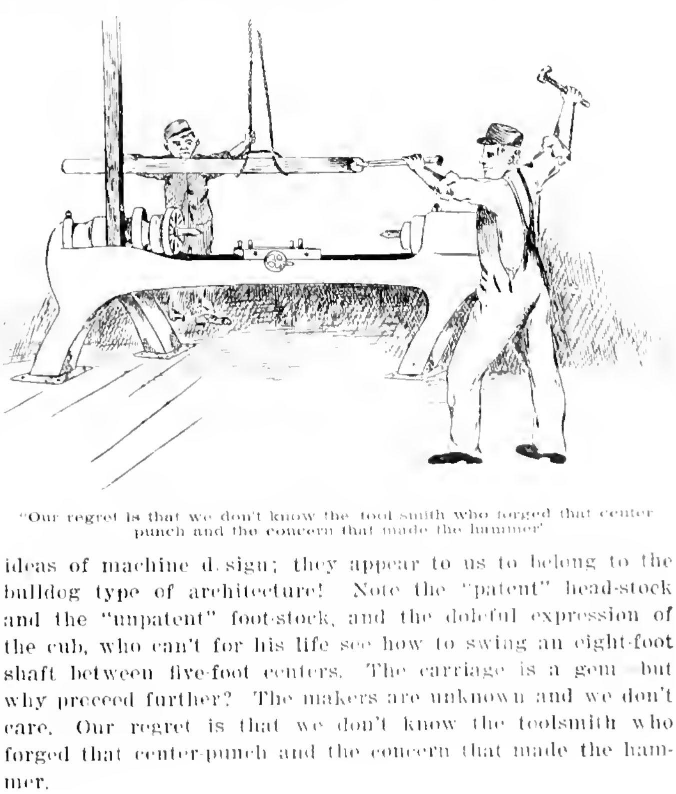
"Now Billy's method of centering shafts was primitive"

Poor Harry wanted to laugh, too, but dared not, so offered what consolation he thought would meet the case, suggesting that Billy had perhaps made a mistake, and should have drawn the center *away* from the mark, but Billy said he might do that when he started his second apprenticeship and knew no better. From his manner towards his assistant the next day it was clear he had learned over night what had occurred, but he was not vindictive, and afterward enjoyed the joke as much as anyone.

* * *

HOW BILLY DIDN'T CENTER SHAFTS

This startling sketch illustrates an amateur artist's weird conception of a shafting lathe and a machinist's way of handling centering tools. He was asked to make a drawing for "How Billy Centered Shafts," and the result exceeded our wildest expectations. We are impressed particularly with the lathe legs. How well they don't harmonize with modern



"Our regret is that we don't know the tool smith who forged that center punch and the concern that made the hammer"

ideas of machine design; they appear to us to belong to the bulldog type of architecture! Note the "patent" head-stock and the "unpatent" foot-stock, and the doleful expression of the cub, who can't for his life see how to swing an eight-foot shaft between five-foot centers. The carriage is a gem—but why proceed further? The makers are unknown and we don't care. Our regret is that we don't know the toolsmith who forged that center-punch and the concern that made the hammer.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

CHINESE METHODS IN DESIGN

One of the most delightful of Charles Lamb's "Essays of Elia," deals with the alleged discovery of roast pig by the Chinese. As the story goes, a Chinaman's house was burned up and his pig lost in the flames. While poking around in the ruins the Chinaman came upon the body of the unfortunate beast, and in the handling found it necessary to cool his fingers, which he did by putting them in his mouth, when he tasted for the first time in the history of mankind the sweet and delicate flavor of roast pig. The narrative goes on to state that for some time thereafter Chinamen's houses were burned down regularly and frequently, and roasted pigs were always found in the ruins, until an inspired genius discovered a shorter and less expensive method of producing the same result.

It sometimes seems as though there are very few machine designers who have gotten out of what may be called the "house burning stage" in machine design. Why is it that nine times out of ten the first design of a new machine is too light, the second design a little heavier, the next heavier still; and only in the course of years is the tool designed so as to be strong enough for its work? Instead of wasting time and money all around in repeated strengthening, why not make the machine strong enough in the first place—or even too strong? It would be a welcome change to see a machine pared down a little in weight in successive developments, instead of having it corrected repeatedly in the opposite direction.

* * *

ELECTRIC DRIVE IN THE MACHINE SHOP

When electric drive was first being introduced into machine shops and factory equipment, claims were made for the power saved by elimination of line-shaft and belt losses, and the more important but not obvious economies were not pointed out, either because of ignorance or lack of appreciation. In the machine shop the greatest advantage of electric drive doubtless lies in the increase of product made possible by constantly adjusting the speed of the work to the full capacity of the cutter and thus working the machine always at its maximum rating, pre-supposing that variable speed motors are used to drive the machines. In a paper on the economy of electric drive in machine shops, to be presented before the A. S. M. E. in December, Mr. De Leeuw lays stress on this element of advantage, it being of much greater importance than the mere saving of power. In fact we may conclude that if it were simply a matter of saving power it is doubtful if it would pay in many cases to make the change from line-shaft drive to motor drive.

To illustrate, the conditions in a shop are quoted where an average of nine tons of metal is machined daily. The metal is, for the greater part, cast iron with a small percentage of steel, bronze and other metals. The chips removed amount to about 2,700 pounds of metal in a nine-hour day, making 300 pounds per hour or five pounds per minute. The power required is about 225 H.P. which, with a production of 5 pounds of chips per minute means that 45 H.P. per minute for each pound of chips removed is consumed. The power costs about $40 per H.P. per year or $9,000 per year including the steam for heating the building. Now, if one-half the amount spent for power could be saved by another mode of drive, the total possible gain would be only $4,500 per year. The shop employs about 500 men, and the gain per man would be $9 per year. The yearly product per man is about $2,000 from which it becomes evident that the small gain of 5 per cent in productive capacity would be much greater than the saving in power, and this is a large consideration in the economy of electric drive in the machine shop.

The importance of increasing the product by the substitution of electric drive for line-shafts and belts is greatest in the matter of capital investment when a plant is working practically to its limit, and any increase of capacity in the direction of new building and new machinery means perhaps a prohibitive cost, to say nothing of the delay in getting the equipment into shape. The substitution of electric drive to increase the capacity may make an increase in the number of machines unnecessary, and thus save making a large investment, much greater than the cost of the change. There are other advantages than those of electric drive that may be enumerated, but the increase in efficiency of machine and man made possible by the variable speed motor is the chief consideration for the machine shop manager.

* * *

STRESSES IN CURVED MACHINE MEMBERS

The A. S. M. E. paper on stresses in curved machine members, abstracted in another part of this number, engineering edition, is a valuable contribution to the society's proceedings, being one that can be studied with profit by designers of hooks, punch and shear frames, C-frame riveters and other similar structures in which the loads induce combined tensile and bending stress. The familiar formula $f_c = \frac{W}{A} + \frac{Wle}{I}$ found in text-books on machine design is based on the assumption that curved machine members under load act as do beams originally straight, but this supposition has been known for some time to be erroneous, the calculated factor of safety being much more than that known to actually exist. The results of tests on hooks of cast steel and wrought iron at Columbia University show conclusively that the old formula is very seriously at fault, the actual load at the elastic limit being, roughly, one-half, or less, of the calculated load.

So serious a discrepancy between the results of calculations and actual tests, and on the wrong side at that, cannot be tolerated. Future treatment of the subject in works on machine design must take into account the newer theory from which Andrews and Pearson have deduced a formula that appears to agree well with the results of tests. In fact, there is a surprisingly close agreement of the test loads and the calculated loads in the Columbia experiments when figured by this formula. Unfortunately it is not readily handled by a designer unfamiliar with higher analysis, but by the use of constants that have been derived for the common hook section, the use of the resulting modified expression is made comparatively easy.

It is cases like this that have given cause for the not uncommon belief that theory and practice do not agree, and it is not strange that the hard-headed practical man has some contempt for the purely theoretical designer, when machine members fall with no apparent reason in theory. But, theory and practice will agree when the theory takes into consideration all the factors affecting the problem and the mathematical formulas are correctly deduced. Effort to fit a fact to an untenable theory must necessarily fail, and when it fails, as in this case, in producing results that are tolerable, we must change the theory to fit the fact.

* * *

TURBINE PUMP MOTOR DRIVE

The turbine pump has come to be recognized as a practical pumping machine peculiarly well suited to certain conditions, the same as the steam turbine prime mover. It has been used for pumping against very high heads with success, but notwithstanding its essential simplicity, some peculiar problems have been met in its design and construction that have baffled the designers. One of these problems concerns the matter of drive. When a turbine pump is driven by an electric motor, the motor conditions become very bad if the head fluctuates. There is great danger of over-loading the motor with a low head, strange as it may seem at first thought. The natural inference is that with a low head the load would become less than with a high head, but the contrary is the case. A turbine pump designed to deliver a certain quantity of water against a head, say, of 100 feet will operate smoothly when driven by an electric motor so long as the water approximates the given head, but should the head fall to 75 or 50 feet, the chances are that the motor would be over-loaded. A larger quantity of water than normal is pumped at lower efficiency, the work done increasing rapidly with decrease of head.

The reason for this action is that the turbine pump operates under conditions analogons to those affecting the electric generator. A generator carries its normal load so long as the resistance in its circuit is that for which it is designed. But, should a short circuit or reduction of resistance through other means occur, the generator at once becomes over-loaded, and will break down or burn out if continued in operation. In the case of a turbine pump, the head corresponds to the ohmic resistance and the quantity of water pumped to the amperes of current. When the head under which a motor-driven turbine pump is working decreases, the pressure or resistance is decreased and the quantity of water handled is increased, the consequence being that the pump is over-loaded while working at a low efficiency, the same as the generator. The over-load must be carried by the motor and unless the motor has good over-load capacity it will not stand up under the service. However, the characteristics of the best turbine pumps have been improved so that considerable fluctuation of head will not greatly increase the load or decrease the pump efficiency.

* * *

GASOLINE AND ALCOHOL MOTORS COMPARED

The United States Geological Survey, has just issued a bulletin on "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines," by Robert M. Strong. The tests, which were under the technical direction of R. H. Fernald, engineer in charge of the producer-gas section of the technologic branch, were conducted at the fuel-testing plant in St. Louis, Mo., and at Norfolk, Va. The tests dealt primarily with gasoline, forming part of the investigation of mineral fuels provided for by acts of Congress. To determine the relative economy and efficiency of gasoline it was compared with denatured alcohol. When the series of tests was started, it was found that it took from one and one-half to two times as much alcohol as gasoline to produce a given power. With special alcohol engines, entirely suited to the use of alcohol, the latter fuel has been made to do as much work, gallon for gallon, as the gasoline.

By using alcohol in an alcohol engine with a high degree of compression (about 180 pounds per square inch above atmospheric pressure—much higher than can be used for gasoline on account of pre-ignition from the high temperatures produced by compression) the fuel consumption rate in gallons per horse-power per hour can be reduced to practically the same as the rate of consumption of gasoline for a gasoline engine of the same size and speed. The indications are that this possible 1-to-1 fuel consumption, ratio by volume, for gasoline and alcohol engines, will hold true for any size or speed, if the cylinder dimensions and revolutions per minute of the two engines are the same.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average 19,200 British thermal units per pound, or 115,800 British thermal units per gallon. Thus the low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires about twice the weight of air for complete combustion as a pound of alcohol.

A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horse-power about ten per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal advantage, the maximum available horse-power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed.

Alcohol diluted with water in any proportion, from denatured alcohol which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol, can be used in gasoline and alcohol engines if they are properly equipped and adjusted.

When used in an engine having a constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse-power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease respectively is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has but little effect upon the performance of the engine; so that if 80 per cent alcohol can be had for 15 per cent less cost than 90 per cent alcohol and could be sold without tax when denatured, it would be more economical to use the 80 per cent alcohol.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels for marine and factory engines and engines to be placed in the basements of office buildings, in coast defense fortifications, or in like places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply, or where the forming of explosive or inflammable mixtures of the fuel vapors and air in the immediate vicinity would be hazardous. It is indicated by statistics and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been definitely established. Considerable work has been done on this phase of the investigation and a series of tests that will be of assistance in determining the relative hazard involved in the use of these fuels is in progress at the testing station of the Survey in Pittsburg.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene as a fuel. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and, it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward mak-

ing them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine, and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is, in general, relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low or lower than the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

When used as a fuel, denatured alcohol is not always so classed as to be exempt from restrictions placed on the use of gasoline by the rules of insurance and transportation companies or city ordinances. The restrictions that are placed on the use of denatured alcohol are, however, never greater than those placed on the use of gasoline. In some places, they are such that the use of an alcohol engine is permitted where the use of a gasoline engine is prohibited. For instance, alcohol motor trucks and automobiles are admitted to many steamer piers that are not open to gasoline machines.

When the restrictions placed upon the use of denatured alcohol are less than those placed on the use of gasoline or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in fuel expense, especially if the cost of a fuel is but a small portion of the total expense involved, as is often the case. Denatured alcohol will, however, probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to ability to service required and quantity of fuel consumed per brake horse-power, which has been demonstrated to be possible, becomes more generally realized.

A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleums may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come, but as yet comparatively few data pertaining to this phase of the general investigation are available.

* * *

AUTOMOBILE SPRINGS

The development of the automobile has proved that the ordinary carriage spring is inadequate to meet the severe requirements of automobile service. Manufacturers have experimented with many grades of foreign and domestic steels including chrome-nickel, tungsten, vanadium and other special alloys with results more or less satisfactory depending largely on the heat treatment. The experience of some makers, members of the A. L. A. M., appears to indicate that silico-manganese springs endure longer than high carbon steel, but whatever steel is used, it must be made to certain specified analyses and heat treated in an approved manner to yield satisfaction. It is necessary to have the furnaces under pyrometer control, and so closely regulated that there is but very slight variation in temperature. The most commonly used heat treatments are annealing, hardening, tempering, hardening and annealing, double annealing, and double hardening. A long flat spring is preferable to a spring with considerable arch as the fiber stress is lower for the same load and deflection. The deflection should not be more than one-fourth inch per hundred pounds. The reason leaf springs are preferable to coil springs is the greater dampening effect of the leaf springs, because of the friction between the component parts of the spring. A leaf spring does not return to its normal position so quickly and forcibly as a coil spring of the same capacity, hence its easier effect upon the car and its occupants.

THE DESIGN OF CURVED MACHINE MEMBERS UNDER ECCENTRIC LOAD*

Machine members, such as frames for punches, shears and riveters, hooks and the like, when subjected to load, are generally supposed to behave like beams originally straight and subjected to the same conditions. The usual analysis applied to such beams in determining the proportions required to withstand safely a given stress assumes that the maximum tensile stress equals the load considered as uniformly distributed over the section plus the stress due to the eccentricity of the load. Symbolically expressed

$$f_t = \frac{W}{A} + \frac{Wlc}{I}$$

f_t = maximum intensity of tensile stress,
W = load on beam,
A = area of section,

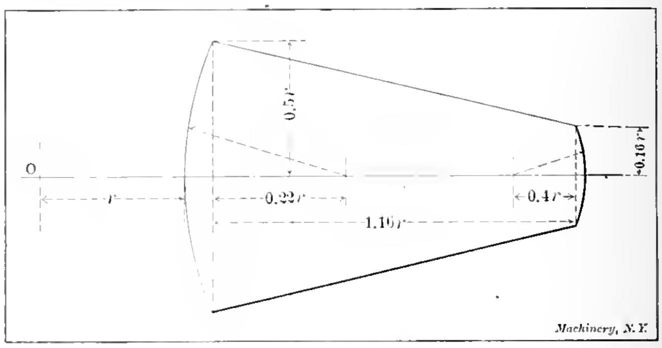

Fig. 1 Section of Crane Hook

l = eccentricity of loading,
c = distance from gravity axis of section to point under stress f_t
I = moment of inertia.

This analysis is unfortunately prevalent in textbooks on the design of machine elements and strength of materials, and has been accepted generally because of long standing. However, it does not agree with the results of experiment on members of this kind; in fact such experimental results are so different from results calculated by this formula that no confidence whatever can be placed in it, and safe proportions can be obtained only by the use of a large factor of safety.

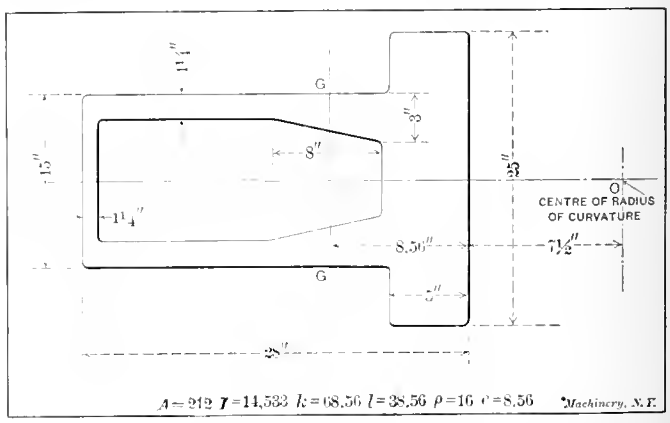

Fig. 2. Section of Punch and Riveter Frame

The results of a series of experiments which are remarkable in their disagreement with the results obtained by the formula are given in the accompanying table. The crane hook was taken as an example of a beam of this sort and experiments were conducted on ten hooks ranging from two to thirty tons rated capacity.

It is very evident that the assumptions on which the conventional formula is based are not correct, and that machine members designed on this basis have a much smaller factor of safety than is generally supposed. While this has been known in some quarters and attempts have been made to bring about an adjustment, no theory which has been developed seems to fit the case better than that evolved by E. S. Andrews and

* Abstract of paper by Prof. Walter Rautenstrauch, read before the November, 1909, meeting of the American Society of Mechanical Engineers.

Prof. Karl Pearson of London University. Their investigation gives the following expression for the tensile stress at the most strained point in the principal section of beam:

$$f_t = \frac{W}{A}\left[\frac{l}{\rho\gamma_2}\left(\frac{1}{\left(1-\frac{e}{\rho}\right)^{\gamma_1}}-\gamma_1\right)+1\right]$$

f_t = tensile stress at most strained point of section, pounds per square inch,
W = load on hook, pounds,
A = area of section, square inches,
l = distance from load line to gravity axis of section,
ρ = radius of curvature of belly of hook at gravity axis,
e = distance from gravity axis to point of maximum tensile stress,
γ_1 and γ_2 are functions the values of which are determined for each section by means of rather complicated higher analysis; approximate values are given in the following.

This formula was applied to each of the hooks tested, with the results recorded in the third line of the accompanying table. An inspection of this table will show how nearly the analysis of Mr. Andrews and Professor Pearson fits the case.

ANALYSIS OF HOOKS TESTED

Load at Elastic Limit, Pounds

Rated Capacity	30-ton Cast Steel	20-ton Cast Steel	15-ton Cast Steel	15-ton Wrought Iron	10-ton Cast Steel	10-ton Wrought Iron	5-ton Cast Steel	5-ton Wrought Iron	3-ton Cast Steel	2-ton Cast Steel
By test	56,000	30,000	48,000	16,000	18,000	16,000	18,000	14,000	8,500	4,700
By standard formula	115,000	70,000	145,000	73,000	43,000	26,000	52,300	20,800	11,900	14,900
By new formula	55,080	29,925	50 570	15,000	16,500	15,000	18,950	14,100	8,600	4,400

In its present form it is a rather unwieldy instrument in the hands of a designer, but it may be made more applicable to design than might be thought at first. The functions γ_1 and γ_2 are constants for all sections of similar form, that is, for all sections the proportions of which may be expressed as a function of some unit of dimension, for example, the radius of curvature. Under the same circumstances the entire expression within the brackets is a constant. The equation for a series of sizes and sections may therefore be written $f_t = \frac{W}{A}K$, or $A = \frac{W}{f_t}K$. The area is a function of the unit squared and therefore we may write $A = C'r^2$, or

$$r = \sqrt{\frac{K}{C'} \times \frac{W}{f_t}} = C\sqrt{\frac{W}{f_t}}$$

Applying this to the case of a series of hooks ranging from the minimum to the maximum to be manufactured, a standard form of section may be laid out as in Fig. 1, and the constant established. For the hooks tested by the writer the following values for the constant were found:

30-ton hook, cast steel	3.00
30-ton hook, cast steel	3.10
15-ton hook, cast steel	3.23
15-ton hook, wrought iron	4.29
10-ton hook, cast steel	3.49
10-ton hook, wrought iron	3.42
5-ton hook, cast steel	3.12
5-ton hook, wrought iron	3.12
3-ton hook, cast steel	3.78
2-ton hook, cast steel	3.74
Average	3.43

To make the case representative of present practice let such ratio of proportions be assigned to the section shown in Fig. 1 that $C = 3.4$. The design of a series of wrought iron hooks to sustain loads of from 2 to 40 tons with a limiting intensity of tensile stress of 30,000 pounds per square inch will require the following computations:

$$\text{40-ton hook, } r = 3.4\sqrt{\frac{80000}{30000}} = 5.54$$

$$\text{30-ton hook, } r = 3.4\sqrt{\frac{60000}{30000}} = 4.7$$

$$\text{20-ton hook, } r = 3.4\sqrt{\frac{40000}{30000}} = 3.94$$

$$\text{10-ton hook, } r = 3.4\sqrt{\frac{20000}{30000}} = 2.76$$

$$\text{5-ton hook, } r = 3.4\sqrt{\frac{10000}{30000}} = 1.95$$

$$\text{2-ton hook, } r = 3.4\sqrt{\frac{4000}{30000}} = 1.23$$

The proportions obtained above will be for loads giving a maximum stress at the elastic limit of the material. For cast steel different values will necessarily be obtained. The establishment of such a standard would lead to a very simple process for the determination of the principal section of a hook for any capacity; the proportions of the shank and other parts of the hook may readily be established on the same basis. The bottom of the hook, being subjected to much wear, cannot of course be proportioned on the basis of the stress analysis. The above standard section selected as an average representative of present practice is not, however, the most economic form of section from the standpoint of equal maximum tensile and compressive stresses. It has been pointed out by Professor Pearson that a section with such proportions is approximately an isosceles triangle with a radius of curvature of 1.75 of the height. The more nearly this form could be approached, the less would be the weight of hook.

Professor Goodman points out that for hook sections the functions γ_1 and γ_2 are expressed approximately as follows:

$$\gamma_2 = \frac{ke}{1.2\,\rho^2}$$

$$\gamma_1 = 1 + 1.1\,\gamma_2$$

where k = radius of gyration of the sections, the other symbols being as before noted.

In applying these empirical formulas to punch and riveter frame sections the writer has found that the results are not accurate, but that the values are better expressed as follows:

$$\gamma_2 = \frac{ke}{0.7\,\rho^2}$$

$$\gamma_1 = 1 + 1.1\,\gamma_2$$

For example, consider the design for a punch frame shown in Fig. 2. Computing the values for the functions γ_1 and γ_2 by the empirical formula, $\gamma_1 = 1.44$, $\gamma_2 = 0.4$. Whereupon the intensity of stress according to the new method of analysis for a force of 90,000 pounds at the punch will be

$$f_t = \frac{W}{A}\left[\frac{l}{\rho\gamma_2}\left(\frac{1}{\left(1-\frac{e}{\rho}\right)^{\gamma_1}}-\gamma_1\right)+1\right] = \text{8500 pounds per square inch, approximately}$$

According to the old formula used almost exclusively in text books, the value of f_t is expressed by $\frac{W}{A} + \frac{Wle}{I}$, whence $f_t = 2,450$. It may be clearly seen that were the punch in question designed for a limiting intensity of stress of 2,450 by the old formula, there would actually be a maximum stress of 8,500 pounds per square inch, which is hardly a safe value for cast iron and particularly for a large casting.

The above empirical formulas are derived from the results of computation of two sections and may not work out as correctly in all cases.

ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER*—1

ALFRED SPANGENBERG†

In planer erection, the principal points to be observed are that the housings must be parallel with each other and square with the bed; accuracy is essential in the fit of all sliding members and in the truth of all plane bearing surfaces; the gears should mesh properly and run smoothly; and the system must be such as to permit the various parts to be easily and quickly assembled, and avoid the necessity of fitting the members together for the laying-out operations. This, of course, presupposes the employment of jigs and gages, but, owing to the fact that planers of the 48-inch size and upwards are seldom built in large numbers at a time, and further, that there are many different types of drive, it is impracticable to indulge very freely in the use of elaborate jigs for duplicating the larger parts. However, many of the members used in the construction of planers are common to several different sizes and different types of drive, so that with a few very simple jigs and gages, the standard members can be made interchangeable, and in this way much expensive handling in laying out, and the consequent lost time, is avoided.

This article will deal principally with the erecting process on the bed, since the methods and processes employed in assembling the smaller units do not differ greatly from the practice used in assembling those of other machine tools. All the principles involved in the erection of a small planer are encountered in the case of a large machine, and many other complicating factors are added; hence, the erection a planer of the latter class will be described in detail. For this purpose a 48-inch motor-driven planer is selected, the general features of which are immediately apparent from a study of the half-tone Fig. 1.

As the machining processes are so intimately correlated with those of assembling, and as the methods employed in the latter are controlled to a great extent by the former, a brief description of the points to be observed in machining, together with the gages used for testing the larger members, will be illustrated and described. Referring to Fig. 2, A indicates a gage for testing the V-surfaces on both the bed and table, it being shown in position on the latter. The surfaces B, which support the gage, are finished first, and in this way the gage is always kept in a horizontal plane and both tracks are the same width, so that when the table is placed in position on the bed, the top of the table will be square with the housings. Another advantage of this gage over the usual form having a bearing on both sides of the V, is that only two parallel surfaces are finished and tested at a time, which often saves changing the planing tools and resetting the toolheads. The gage is squared by trying a 0.001-inch feeler on both sides of the gage as at C and C_1. To determine the width of the V tracks on the bed and table, measurements are taken at D and D_1, respectively.

The gage just described is not adapted for measuring the rack seat, however, and therefore another gage is provided which fits both sides of the V's, and is represented by the dotted lines. This gage carries a slide E which measures the rack seat. At F is shown a sheet iron support which fits either gage and prevents it from tipping over.

In the same illustration, at G, is shown the method of testing the table on surfaces H and H_1, which have a clearance of 0.005 inch between corresponding surfaces on the bed. As will be seen, the cast iron gage block I fits the V on the table and is provided with two surfaces, one, J, for setting the planer tool, and another, K, for testing surface H after the finishing cut is taken. To the right, at L, is shown another cast iron gage, this being used for setting the tools and testing the surfaces M and N; at L_1 the gage is shown in position in the V track of the bed. As will be pointed out later, the object of finishing the surface N last is to provide a locating surface for the jig for boring the bed. In this way, the rack gear shaft hole is bored the correct distance from the V tracks, so that when the table is in position, the table rack will mesh properly with its gears. Length gages O, P, Q, and R are for testing the measurements indicated, the latter also

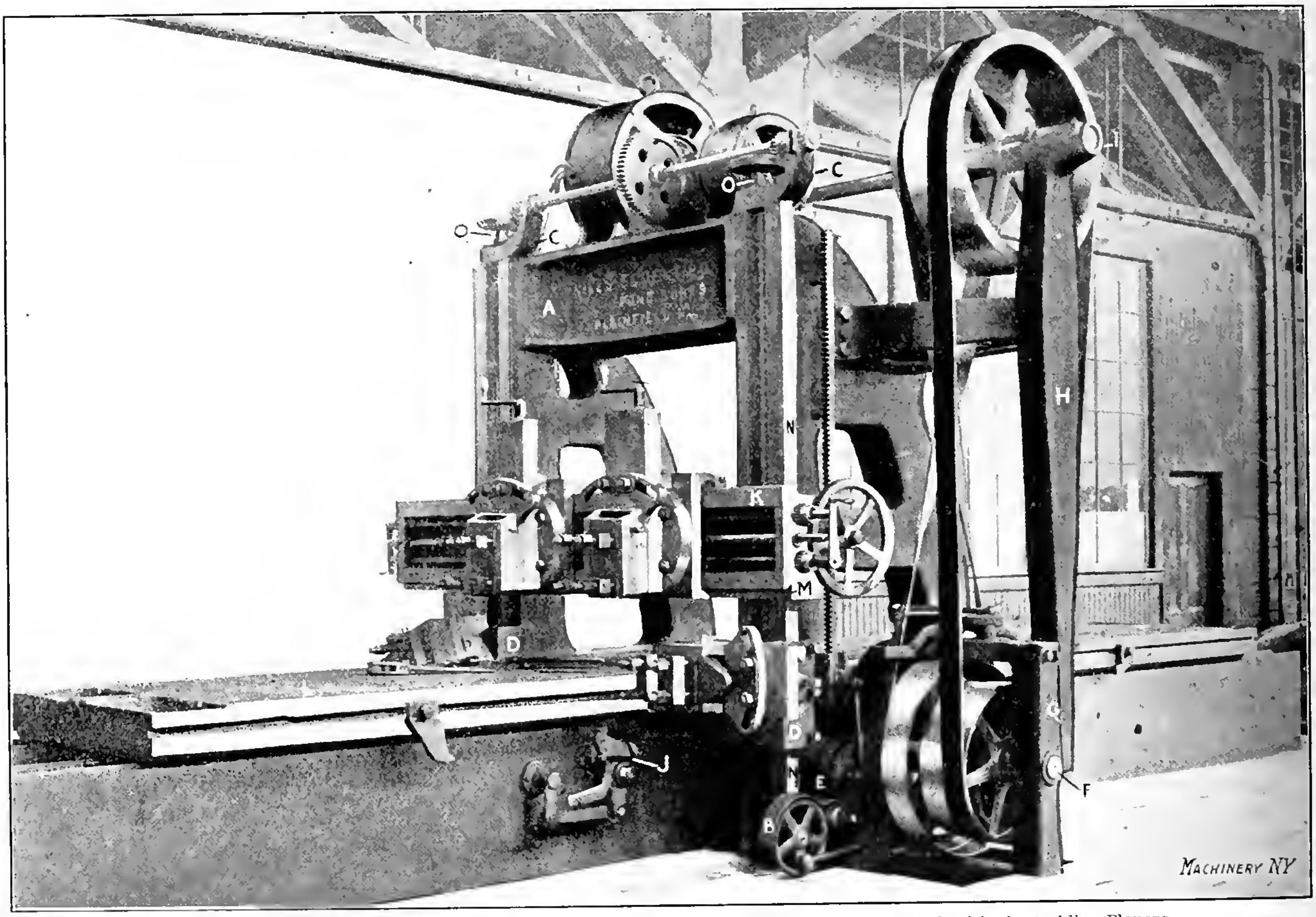

Fig. 1. Forty-eight-inch Motor-driven Planer, used as Example for Illustrating Principles Involved in Assembling Planers

* For additional information on this and kindred subjects, see "Assembling a 24-inch Engine Lathe," in the November, 1909, issue of MACHINERY, and articles there referred to.

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being used for taking the length of the arch *A*, Fig. 1.

It is essential, of course, that the housing cheeks on the bed be perfectly square with the V-tracks and parallel with each other. To accomplish this, the sweep *S*, carrying the Starrett indicator *T*, is used in connection with the straight-edge *U*, which reaches across the bed and extends a sufficient amount beyond one side to accommodate the swing of the indicator. By this means very accurate results are obtained. The operator holds the bar *V* in contact with the bed, and the flanged bearing *W*, being of ample diameter and ground true with the bar, keeps the bar in a vertical plane.

Boring and Drilling the Bed

The bed, having passed inspection with regard to the accuracy of the planing operations, is now sent to the horizontal boring and drilling machine where all the boring, drilling, and tapping operations are completed; one setting only is required, as the machine is provided with two separate columns carrying spindle heads, both working on each side of the bed simultaneously. In the line-engraving Fig. 3 the bed is seen resting on parallels *A* with the jig *B* in position ready for the operations just mentioned. As will be observed from the top view, the jig consists of three main castings *C*, *D*, and *E*, respectively, which are bolted to the three cast iron tie bars *F*; this construction permits adjustment of members *D* and *E* to compensate for beds having different widths over the housing cheeks. The jig rests on the top of the bed, and is located endwise with reference to the jig members *D* and *E* matching the bed casting, so that when the housings, which have been drilled by a separate jig, are bolted onto the bed, the castings will match properly. Set-screws *G* square the jig with the bed by holding the jig against surface *H*. Suitable stops, straps and bolts secure the jig and bed to the base-plate during these operations.

For boring and reaming the shaft holes *I*, *J*, *K*, *L*, and *M*, two boring bars having suitable cutters and reamers are used, similar to those shown in an article on Jigs and Fixtures, in MACHINERY, March, 1909, issue, Figs. 137 and 142, except that in the present case a middle support enables each bar to carry two cutters and two reamers. The jig is provided with removable hardened steel drill bushings for the housing bolt holes *N*, the tapping being accomplished at the same setting of the spindle. Drill and reamer bushings are used at *O* and *P*, while a fixed drill bushing *Q* permits a small hole to be drilled for the taper dowel pin, ample stock being left for reaming after the housings are bolted on and properly located. After the boring and drilling operations are completed, the bed is moved over to the erecting foundation where the erecting process proper begins.

Drilling the Housings

In Fig. 4, the front housing is shown at *A*, with jigs *B* and *C* in position for

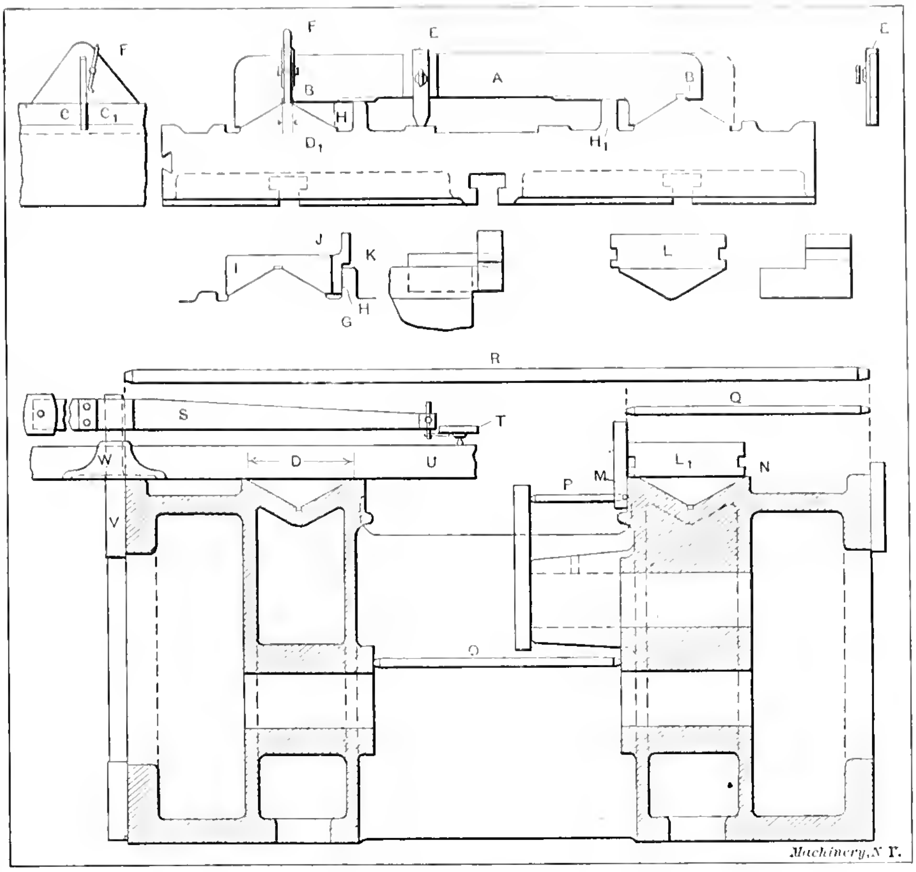


Fig. 2. Gages used for Testing Planing of Bed and Table

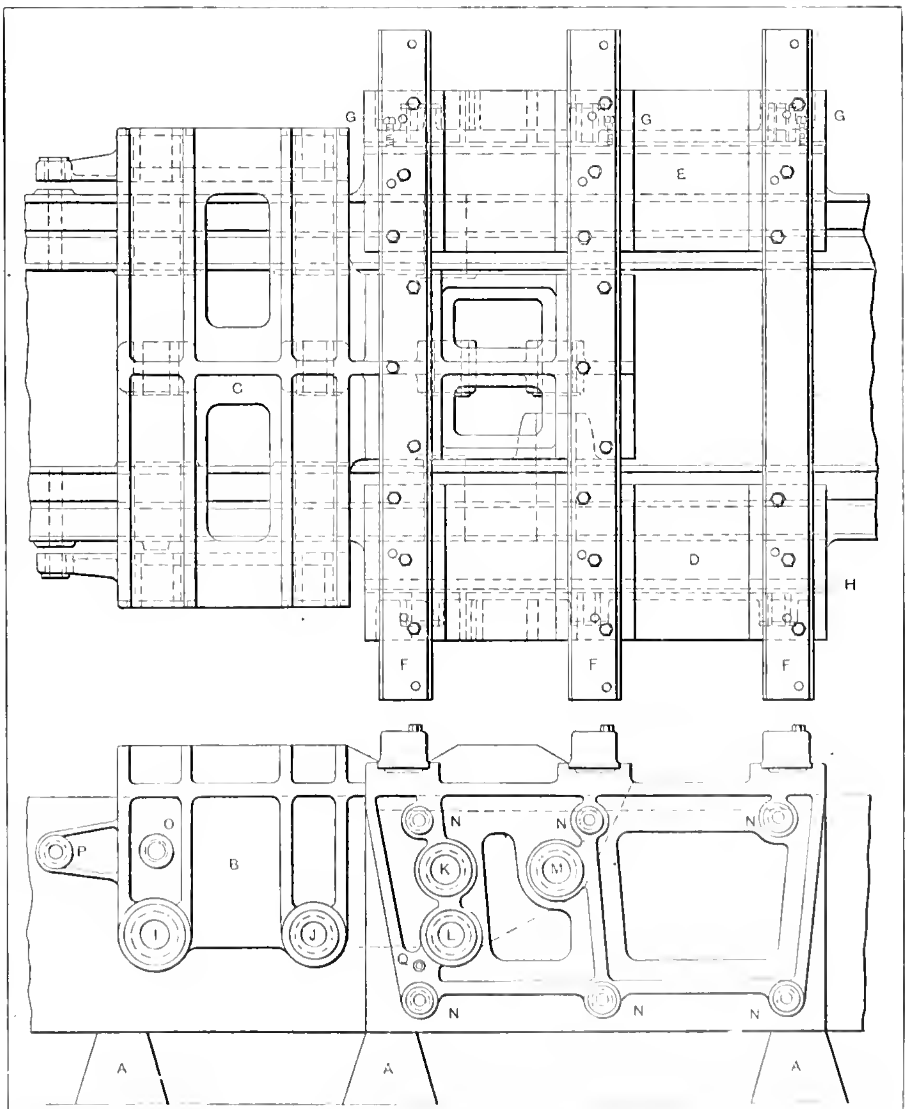


Fig. 3. Combination Boring and Drilling Jig in Position on the Bed

drilling the cheek bolt holes and the arch seat tap holes, respectively; the same jigs are used for the back housing, and jig *C* is also used for drilling the arch casting. The locating points and method of clamping the jigs are indicated in the engraving; as a matter of precaution, after the first hole is drilled in each case, a pin is inserted through the jig bushing into the drilled hole, thus preventing the jig from moving.

All drilling and tapping on this side of the housing being completed, jig *C* is removed, while *B* is secured by four bolts *D* having round heads fitting in place of the drill bushing collars, after which the housing is turned over in the position shown in Fig. 7. The drilling operations are performed on a cast iron base plate provided with a portable motor-driven radial drill, this base also serving the purpose of a surface plate for laying out the work. It is important that the driving shaft bracket hole *A* and feed box shaft hole *C* line up nicely with corresponding holes in the bed, so that the shafts will run perfectly free when assembled. In order to accomplish this without having to assemble the members and housing on the bed, jig *B* is provided with flanged bearings, as at *D*, which support arbors located in the exact center position of the respective driving and feed shafts. The location of the bearings in this jig, and also of the bolt holes *E* is found by clamping the jig to the bed jig member *D*, Fig. 3, and boring the former in this position, so that the two jigs are identical with respect to the locating points and center distances of the various holes.

Referring again to Fig. 7, driving shaft bracket *F* is first centered by the bushing *G* being pushed down into the hole; then the outboard bearing *H* and its member *I* are set approximately correct by means of shaft *J* and jig *K*, and held in this position by C-clamps, after which the truth of bearing *H* with respect to its being square is tested by means of sweep *L*, indicator *M* and test block *N*, as shown in the engraving. When it is determined that bearing *H* is square and properly set, so that bushing *O* enters the hole in jig *K* without springing the shaft, all the clamping bolt holes are marked off, the brackets removed, and the holes drilled and tapped; then the brackets are bolted on, reset in the same manner, and the dowel pins fitted. In setting and testing these bearing brackets, particular care is exercised to insure the accuracy of the work, thereby saving much time when assembling the parts. As was stated at the outset, the fact that these driving works generally are of a special nature, is the reason jigs are not provided for each individual member.

The cam operating lever bracket *P* is marked off after being set lengthways to the correct dimension *Q*, and sideways so that the center line of its shaft will coincide with a line laid off on the housing the right distance from surface *R*. A simple jig for drilling the feed rack casing holes is shown at *S*, the method of locating and clamping it being immediately apparent. Jig *T* is for drilling the feed-box clamping bolt holes; the jig consists of a flat plate centered by means of an arbor the same as at *D*, and located by a pin fitting into housing dowel pin hole *U*. A jig of similar construction and

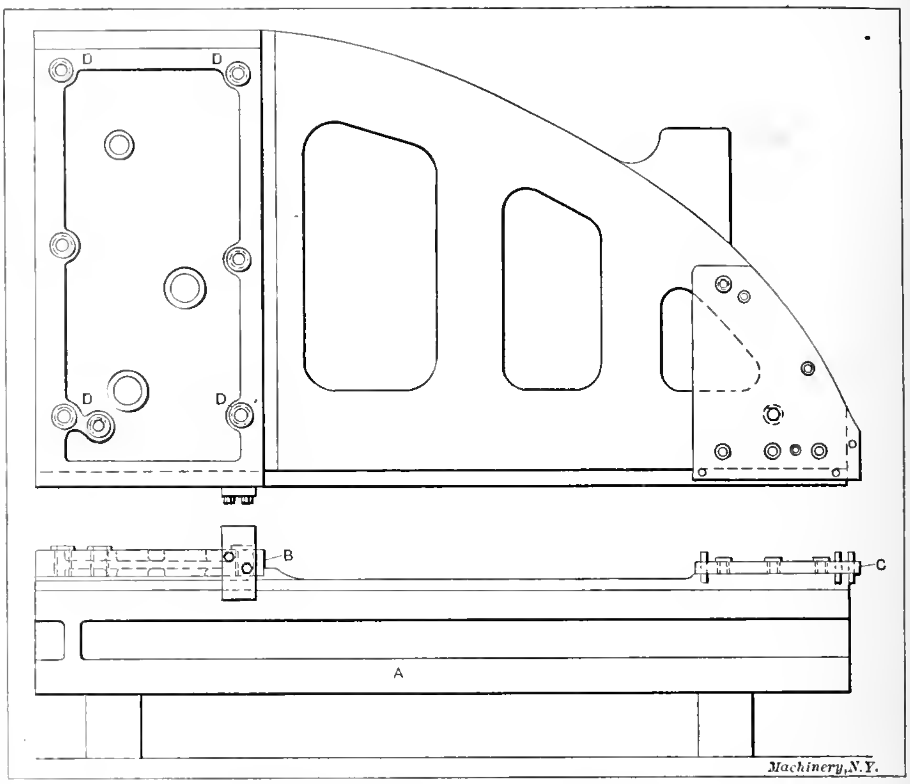


Fig. 4. Front Housing with Jigs in Position for Drilling Clamping Bolt Holes. Same Jigs are used for Similar Operations on the Back Housing

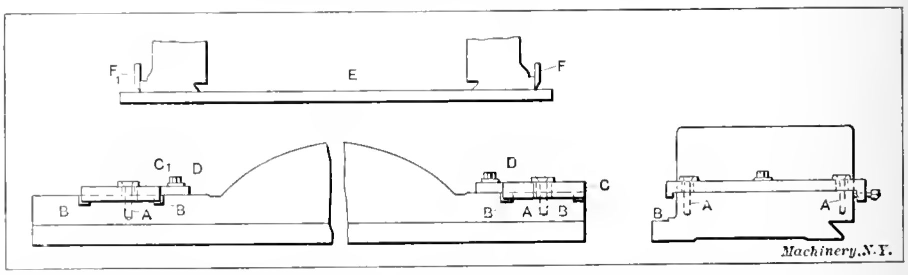


Fig. 5. Jigs for Drilling Stud Holes in Back of Cross-rail. Setting of Jig C_1 Endwise, is accomplished by transferring Measurement from Housings by Means of Wooden Straightedge E

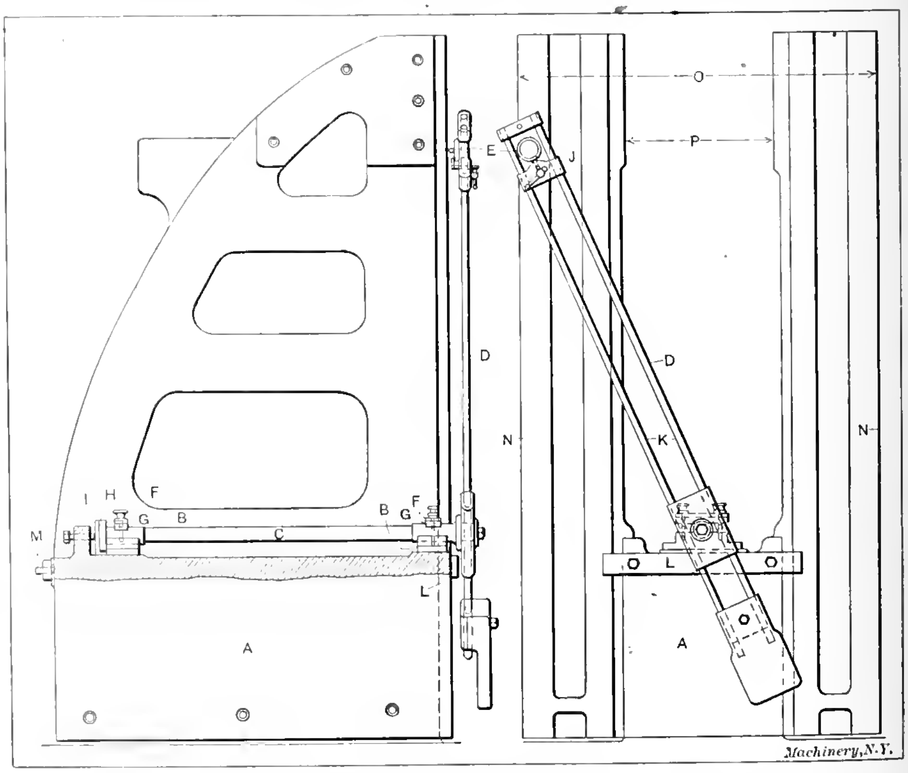


Fig. 6. Special Fixture used for Testing Alignment of Housing Faces and provided with Sweep for Carrying Starrett Indicator

centered in the same manner, is illustrated at *V*; this jig drills the clamping bolt holes for a bracket that carries the side-head feed shaft. Simple jigs, not shown, are provided for drilling for the feed bracket *B* and elevating screw brackets *C*, Fig. 1, these two operations being performed on a horizontal drill. This completes the drilling on the front housing, and after the necessary drilling is performed on the back housing, using the same jigs as previously explained, the housings are tested to determine the accuracy of the planing.

Testing the Housings

One of the essential requirements of a first-class planer is that it must produce accurate work when using the side-heads, and this means that the ways on the housings be perfectly true and parallel. When making this test, as shown in Fig. 6, the housings occupy the same position as when assembled

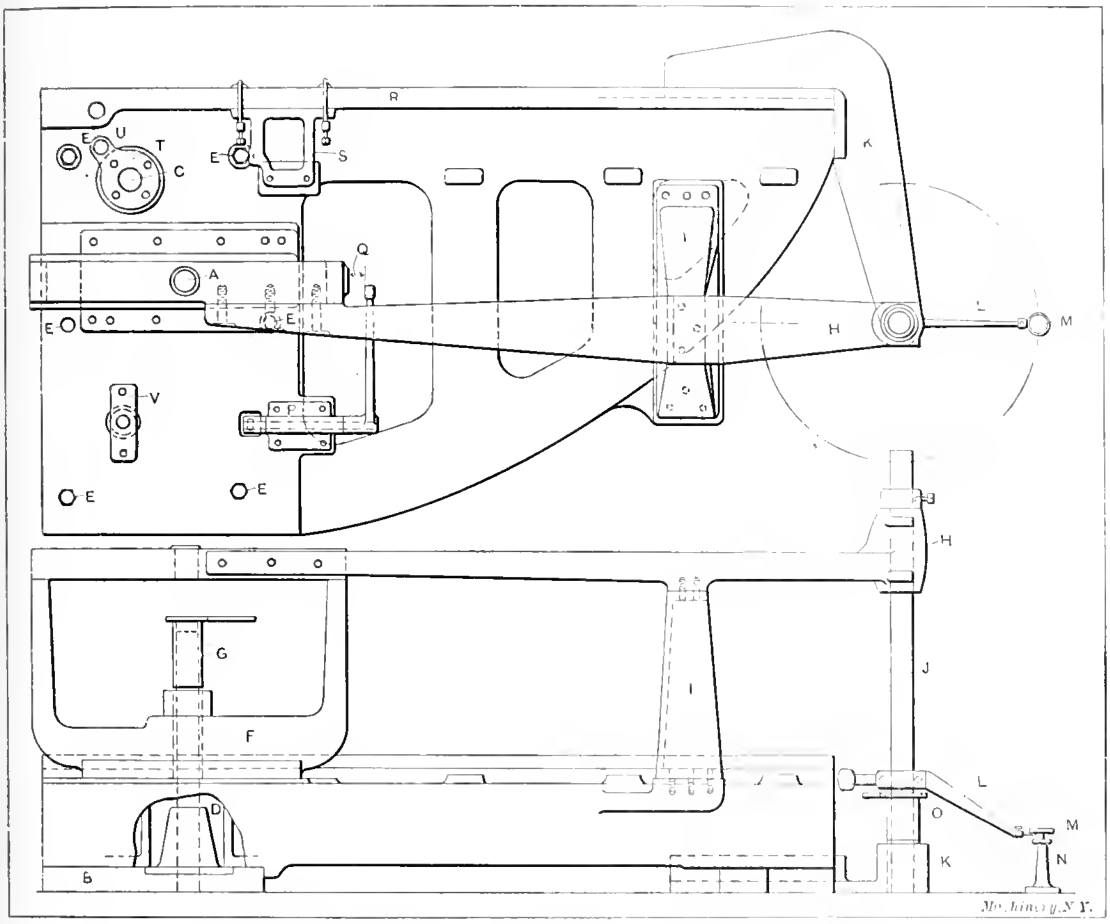


Fig. 7. Method of Setting and Laying out Holes for the Driving and Feed Members on the Front Housing

on their bed, and it is at once apparent that whether or not the front faces stand perfectly plumb, is a matter of little consequence, so long as the faces lie in the same plane. With respect to the side faces and angles, however, the conditions are different; these must be square with the bed. Casting *A* which corresponds to the cheeks on the planer bed, is bolted to a suitable concrete foundation and carries two V-blocks *B*, forming bearings for the sweep bar *C* which in turn supports sweep *D* and indicator *E*. The bar is held in the V-blocks by straps *F* and wooden blocks *G*, while collar *H* and its thrust bearing *I* take up all lateral motion. The construction of sweep proper, *D*, is such that clamp *J*, carrying the indicator, may be secured in any position of its travel between the two seamless steel tubes *K*, which enables readings to be taken at various points.

After being bolted onto the jig, the housings are located against strap *L* by means of screws as at *M*. It is desirable that the front faces show about 0.001 inch low at their outer edges, as at *N*, so that when the cross-rail is in position it will surely have a bearing across the entire face of each housing. Measurements are also taken across *O* at various heights, and between the arch seats *P*, to determine the parallelism of these surfaces. It should be explained that, in the side view, the front housing only is shown for the purpose of more clearly illustrating the sweep bearings. The housings having passed inspection in this test, are next turned face uppermost in a suitable pit for convenience in scraping on the side-head shoes *D*, Fig. 1, after which the housings are ready to be placed in position on the bed.

* * *

MODERN CONDENSER PERFORMANCE

Steam engineers in the past have generally considered that from the standpoints of coal consumption and plant operation, the reciprocating engine gained little from a vacuum above 26 inches of mercury. This opinion was in part due, especially in marine circles, to the practice of driving the auxiliaries from the main engine, so that, there being no auxiliary exhaust to heat the feed, a lower vacuum meant hotter feed water. The steam turbine, however, because of its ability to deal efficiently with steam in large volumes, easily shows a gain of from 5 to 10 per cent in steam economy for every additional inch of vacuum above 26 inches, and the heating of the feed water is properly left to the economizers or to heaters utilizing the exhaust of auxiliaries. The premium thus put upon condenser performance has resulted in a closer scrutiny of the several processes which go on in a condenser.

The activity of the several groups of tubes in a surface condenser can be quite accurately inferred from the rise in temperature of the water passing through them. By inserting thermometers in the water-boxes it has thus been discovered that in the ordinary surface condenser most of the heat is absorbed—that is, most of the steam is condensed—in the first few rows at the top. The transmission of heat through condenser tubes may be affected by the flooding of the lower tubes by the water descending from those above or by the tubes being immersed in air. The velocity of the steam and of the circulating water, and the cleanliness of the tubes, are also governing factors.

While much scientific investigation has been devoted to the effects of water velocity and of steam velocity, the possibilities of improvement in this direction are limited by the fact that excessively high steam velocities mean back pressure while high water velocities involve the consumption of an excessive amount of power in the circulating pumps. The avoidance of air-drowning and of the flooding of the tubes has, however, resulted in greatly reducing the amount of condenser tube surface for a given amount and temperature of circulating water; that is, with the same surface, less, or water of a higher temperature, will maintain the same vacuum.

Air-drowning is prevented by avoidance of air leaks, provision of sufficient air pump capacity and arrangements for removing the air at the lowest possible temperature and hence at the greatest density. The flooding of tubes has been met in various ways. To avoid this flooding effect, the four "Dry Tube" condensers, installed by the Wheeler Condenser and Engineering Co. in the Williamsburg power station of the Transit Development Co. of Brooklyn, are equipped with horizontal baffle plates which are interposed between the sev-

eral banks of tubes. The exhaust steam from the double-flow Westinghouse turbines installed on the floor above, enters the condensers at the top and upon condensing falls upon these baffle or rain plates, which catch the water and carry it to the outside against the shell, down which it flows to the hot well without coming in contact with other tubes. To permit the passage of the steam past these rain plates there are openings, around the edge of which the plate is turned up to form a vertical lip, preventing an overflow of water. These openings are so staggered that the steam will reach all parts of the tubes, insuring complete utilization of all the surface. Simple as this expedient appears, the results obtained by means of it have been remarkable, as will be apparent from a consideration of the rate of heat transfer developed in this condenser under working conditions. It was formerly customary to assume the rate of heat transfer through surface condenser tubes, closed feed water heaters, and similar appliances as between 200 and 300 British thermal units per square foot per hour per degree difference of temperature between the water inside the tubes and the steam outside.

After a series of tests of one of the condensers in the plant referred to, which was designed to handle 180,000 pounds of steam per hour and to give a vacuum equivalent to 2 inches absolute pressure with 70 degrees F. circulating water, the transmission of heat per square foot per hour per degree difference of temperature was found to be between 800 and 900 British thermal units which is two to three times greater than is obtained from the ordinary surface condenser. During the tests the rate of condensation varied from 164,586 pounds to 220,200 pounds of steam per hour. These results show that the guaranteed vacuum could have been maintained with even less condensing surface than was actually installed, although the latter is considerably below usual practice. That is, while the ordinary condenser would contain 2 or 3 square feet of surface per rated horse-power, this condenser contains only 1.5 square foot per rated electrical horse-power.

With the jet condenser, it is not so much a question of improving the rate of heat transmission as of insuring thoroughness of intermixture, that is, of bringing each particle of water so intimately in contact with the steam that it will be heated to the steam temperature and its full capacity for absorbing heat realized. This is desirable in order to reduce the amount of circulating water and to prevent loss of temperature in the hot well. By reducing the amount of circulating water, the power required for pumping it is minimized and less air is brought into the condenser. At first thought it would seem an easier and simpler matter to secure high temperature in the circulating water leaving a jet condenser than in that leaving a surface condenser, since in the jet condenser the water and steam come into actual immediate contact; nevertheless, the fact remains that the water discharged from most jet condensers does not rise nearer than to within 10 to 20 degrees F. of the temperature of the steam.

The results of tests of a Wheeler "Rain Type" jet condenser connected with a Westinghouse-Parsons 1,000-kilowatt steam turbine are given in the accompanying table.

Vacuum, inches	Absolute Pressure, Ins. Mer.	Corresponding Temp.* of Exh. Steam	Injection Temperature In	Injection Temperature Out	Difference in Temp. of Steam and Cir. Water
28.65	1.25	85.5	44	85	0.5
28.7	1.2	85.	44	85	0.0
28.7	1.2	85.	44	83	2.0
28.75	1.15	83.5	44	80	3.5
28.75	1.15	83.5	44	81	2.5
28.55	1.35	88.5	44	87	1.5
28.75	1.15	83.5	43	79	4.5
28.75	1.15	83.5	43	76	7.5

* Temperatures given in degrees Fahrenheit

As will be seen, the outgoing circulating water kept within from ½ to 7½ degrees of the temperature corresponding to that of the exhaust steam. This condenser is of a new design and is so constructed that the steam enters through an opening at the left, passes horizontally across through a shower of water, ascends to the second level, passes to the left through an upper shower, and finally all that is left of the steam vapor together with the air, and other gases, passes horizontally to the right, and over the entering and coldest water at the top to the dry vacuum pump suction opening in the uppermost part of the shell. The water is introduced at the upper right hand corner into an extended trough or pan, from which it overflows through numerous short tubes, falling into a second and similar pan provided with similar overflow pipes and weir, and finally falling into the lower part of the shell, and overflowing thence to the barometric column or to the centrifugal or other type of pump serving to overcome the atmospheric pressure. The water is finely divided by small baffle plates hung below the tubes.

On the day of the test, the barometer stood at 29.9 inches, while the street railway load on the turbine varied from full load to 10 per cent overload. Temperature readings were taken by thermometers placed in the exhaust pipe and in the hot well, while the vacuum readings were taken from a mercury column connected directly to the condenser. The number of pounds of circulating water required to condense 1 pound of steam was found by calculation to be 24.3. As a matter of fact, the amount would be less than this, since not all of the exhaust is steam when it arrives at the condenser, some of it having already condensed in the turbine and in the exhaust pipe, due to work performed and to radiation.

* * *

LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

The accompanying table has been compiled with a view of giving at a glance the length of recess in the bore of milling cutters, including cutters from one-half inch width of face up to cutters six inches long. It will be seen, by studying the figures in the table, that, in general, the length of the recess is about half of the total length or width of the face of the cutter, and the length of the bearing at each end is about one-quarter of the total length. A.

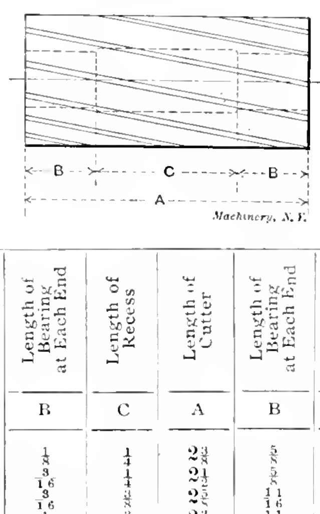


TABLE GIVING LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

Length of Cutter	Length of Bearing at Each End	Length of Recess	Length of Cutter	Length of Bearing at Each End	Length of Recess	Length of Cutter	Length of Bearing at Each End	Length of Recess
A	B	C	A	B	C	A	B	C
1/2	1/8	1/4	2 3/8	5/8	1 1/8	4 1/4	1 1/16	2 1/8
5/8	3/16	1/4	2 1/2	5/8	1 1/4	4 3/8	1 1/16	2 1/4
3/4	3/16	3/8	2 5/8	11/16	1 1/4	4 1/2	1 1/8	2 1/4
7/8	1/4	3/8	2 3/4	11/16	1 3/8	4 5/8	1 1/8	2 3/8
1	1/4	1/2	2 7/8	3/4	1 3/8	4 3/4	1 3/16	2 3/8
1 1/8	5/16	1/2	3	3/4	1 1/2	4 7/8	1 3/16	2 1/2
1 1/4	5/16	5/8	3 1/8	3/4	1 1/2	5	1 3/16	2 5/8
1 3/8	3/8	5/8	3 1/4	13/16	1 5/8	5 1/8	1 1/4	2 5/8
1 1/2	3/8	3/4	3 3/8	13/16	1 3/4	5 1/4	1 1/4	2 3/4
1 5/8	7/16	3/4	3 1/2	7/8	1 3/4	5 3/8	1 5/16	2 3/4
1 3/4	7/16	7/8	3 5/8	7/8	1 7/8	5 1/2	1 5/16	2 7/8
1 7/8	1/2	7/8	3 3/4	7/8	2	5 5/8	1 5/16	3
2	1/2	1	3 7/8	15/16	2	5 3/4	1 7/16	2 7/8
2 1/8	9/16	1	4	15/16	2 1/8	5 7/8	1 7/16	3
2 1/4	9/16	1 1/8	4 1/8	1 1/16	2	6	1 1/2	3

* * *

A remarkable demonstration of the possibilities of gas producers and producer gas engines for boat propulsion was described in the August issue of the *International Marine Engineering*. A boat 40 feet long over-all, 9 feet beam, driven by a four-cylinder 35 horse-power gas engine, covered between 800 and 900 miles at an average speed of from 8 to 9 miles an hour on one ton of pea anthracite coal, used for producing the gas in a small gas producer installed on the boat. In addition to the greater safety, it is stated that the cost of operation is about one-tenth that of a gasoline engine using gasoline at fifteen cents a gallon.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—2

THE LODGE & SHIPLEY MACHINE TOOL COMPANY

ETHAN VIALL*

The names of Spring Grove and Colerain Avenues become very familiar to the man who visits the Cincinnati tool and machine tool shops—more so perhaps than the names of any

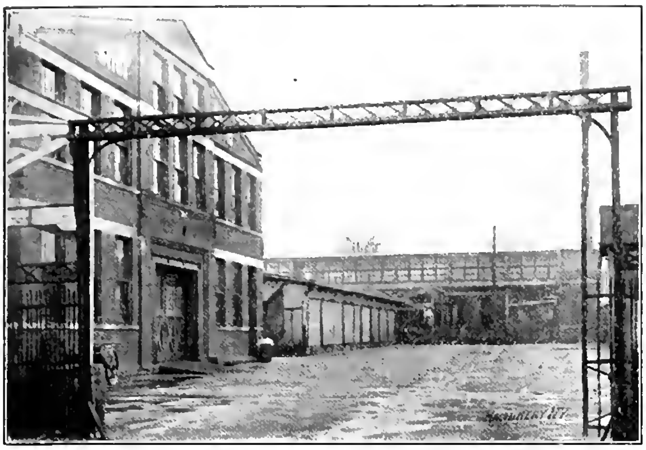


Fig. 1. Paved Court at the Lodge & Shipley Plant for Teaming Purposes

other streets there, for some of the best-known machine tool building shops in the world are easily reached by taking the cars that run from Fountain Square in the heart of the city

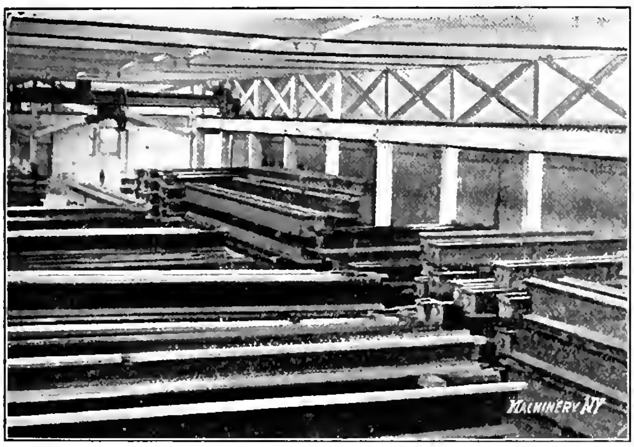


Fig. 2. Lathe Bed Storage House with Traveling Crane and Sliding Doors along the Side

out along these two avenues. It is worth while for any mechanic who can possibly do so to take the time to go through a few of these shops at least, and all of them if he can, and naturally, even if only a few were selected, he would not overlook as large and well-known a plant as that of the Lodge & Shipley Machine Tool Co., at 3055-3065 Colerain Ave., which makes nothing but lathes and lathe attachments or fittings, and where he will be given a hearty welcome and a guide who will show and explain everything to him that is worth while. In a trip through this plant, a reader of MACHINERY would see many old mechanical acquaintances in the line of tools and methods that have been introduced to him from time to time through these columns, yet there are many things to be seen which have never been described and many things impossible to describe—adequately at least. The present article does not aim to go very deeply into descriptions of shop methods or practice, but simply to present a few of the "high spots" touched here and there in a recent tour of inspection.

System and neatness prevail everywhere and many time- and labor-saving devices are to be found on every hand. The old way for a workman to get the big traveling crane, by going out in the runway, waving his arms like a windmill and yelling until he was hoarse, at the sleepy crane operator two or three hundred feet away, has all been done away with, and now the workman presses one of the buttons set at convenient distances along the shop runway, a red light is flashed in plain view of the crane man and unless already employed, he at once runs his crane to where it is needed. Then, too, there is a messenger system in use that obviates the necessity of a machinist leaving his work to get a new jig or tool, as he has only to press a button close to his machine and an annunciator near the tool room indicates to a waiting messenger boy where he is wanted, as all machines are numbered; he then goes at once and finds out what is wanted, gets it for the man and returns to his place ready for another call.

The traveling crane system is unusually complete and is so arranged that castings can be removed from a wagon by the yard crane and stored, or carried within reach of one of the shop cranes. New machines are loaded with the same ease. The court into which the heavy wagons are driven for loading or unloading is shown in Fig. 1. This is well paved and drained and is large enough for several teams to maneuver in at once. In this engraving the main shop is partially shown in the background; shop Number 2 is at the left and one of the storage sheds is in between the two.

In Fig. 2 is shown the way lathe beds are stored, some of these being in the rough, while others are partly finished and left here to "season." Lathe carriages are stored close to the assembling floor in upright racks, as shown at the right in Fig. 3, and compound rests on the iron shelves covered with cloth, shown at the left.

A satisfactory and economical way to stack quantities of round bars of various sizes and lengths, is often a puzzle to the man in charge of stock, but the problem has here been very happily solved, as shown in Fig. 4, by using short lengths of square iron bars curved up at each end and placing them

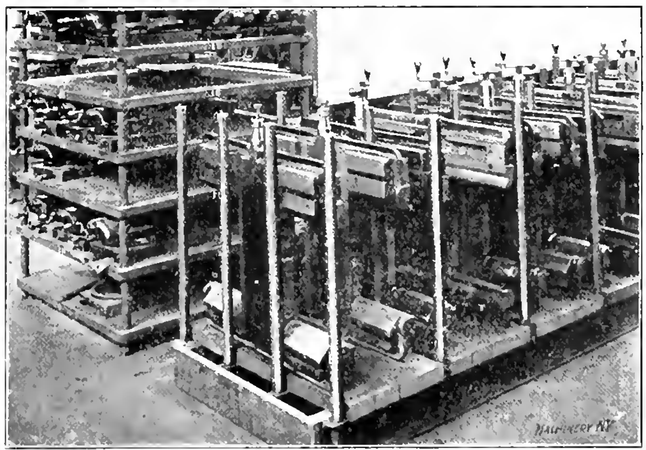


Fig. 3. Racks and Shelves for Holding Carriages and Compound Rests

as shown. Where a rack of some kind is wanted for storing large amounts of stock, a very good type is shown in Fig. 5. This rack has adjustable supports for the cross-pieces, so that

Fig. 4. Method of Piling Round Stock, which is both Convenient and Economical as to Space

compartments, to suit the different sizes or amounts of stock, can be readily arranged.

In the machine shop, a portable motor-driven variable speed countershaft, shown in Fig. 6, is used to run lathes that are being assembled or tested. A planer equipped with a regular Lodge & Shipley variable-speed lathe countershaft (Fig.

* Associate Editor of MACHINERY.

7) is something unusual, but it ought to be very handy for some classes of work.

The hand scrapers used by the assemblers and fitters are sharpened on the portable oil-stones shown in Fig. 8. These stones are motor-driven and may be set in any convenient place close to the machine or machines upon which a group of men may be working.

After the gears and parts of a lathe head are in place, the shift-gear lever-lock holes *A*, Fig. 9, are drilled in the head-casting so that they will line up properly with the correct position of the lever and gears. This is done by removing the locking pin from the lever, meshing the gears, spotting each hole to be drilled in turn through the locking pin hole, and then finishing the holes, using the electric drill and adjustable stand shown. Braces and locks to hold the drill to the work for this and other jobs are shown lying on the floor.

Large lathe beds are placed on the four-wheeled trucks, Fig. 10, while the different holes are drilled with a big radial drill, and in this way the huge castings may be moved along with comparative ease. The ends of these large beds are faced off with the portable milling machine shown in Fig. 11.

Hand-wheels of all kinds have the rims ground on the special machine shown in Fig. 12, which does splendid work and is very conveniently and rigidly built. The emery wheel spindle is run with a belt in the usual way, but the spindle carrying the work is driven by a universal jointed shaft and set of bevel gears, connected to the countershaft, in the same way that drills in a screw machine turret are independently driven. The work is fed up to the grinding wheel by means of the ball-crank *A*; a rotary movement is given to the table by turning the hand-wheel *B*. The wheel to be ground is fastened on the end of the work spindle by a nut and it is kept from turning by a pin in the face-plate which engages one of the spokes.

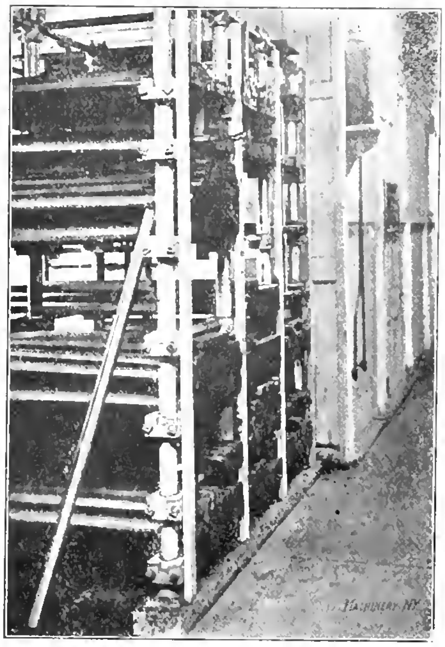


Fig. 5. An Adjustable Storage Rack for the Stock-room

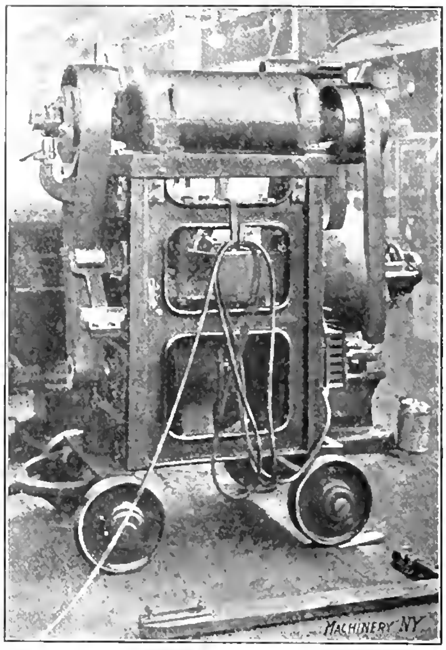


Fig. 6. Movable Variable-speed Countershaft for Testing Purposes

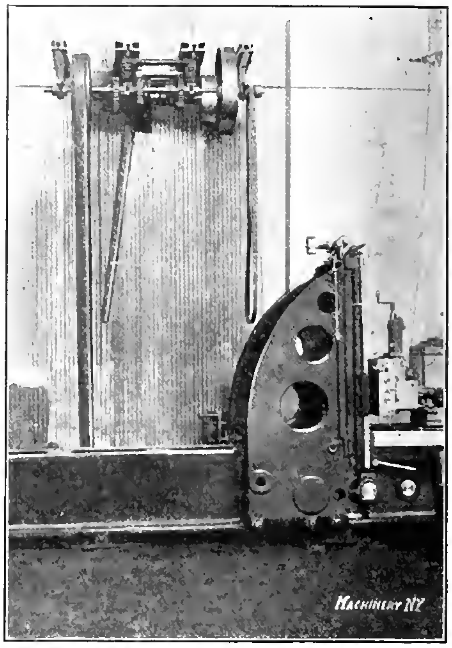


Fig. 7. Planer equipped with a Lodge & Shipley Variable-speed Lathe Countershaft

The small straightening block or screw-press (Fig. 13) is made considerably lighter than usual by bracing the top with an eye-bolt as shown, which makes it just as good for most purposes. It is also easier to handle because of the decreased weight.

Bushings like *A*, Fig. 14, are screwed into the lathe aprons by taking advantage of the oil groove in them and using it for a wrench-hold, the wrench-plugs *B* being made with a corresponding ridge.

Small reverse-plate gear-bushings are held while turning the outside, as shown in Fig. 15. The mandrel used is fastened securely in the lathe spindle and has a pin or key in it which fits into the oil notch in the bore of the gear-bushing and keeps it from turning. The outer end of the mandrel is supported by the tailstock spindle of the lathe which has been fitted with a bushing for the purpose. This spindle also has

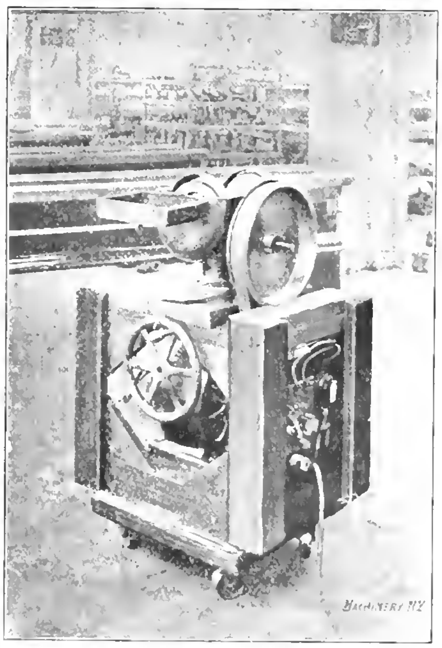


Fig. 8. Portable Scraper Grinder

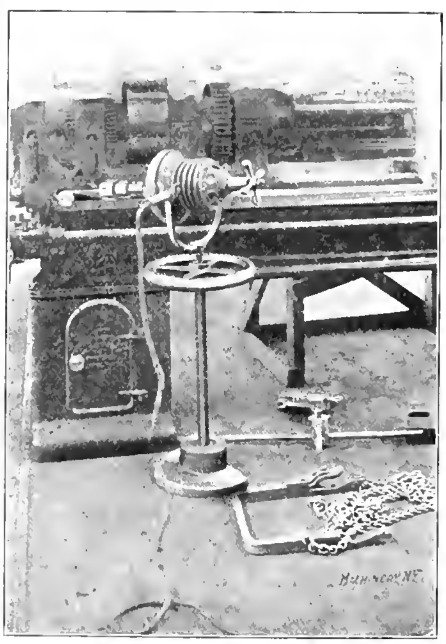


Fig. 9. Adjustable Electric Drill and Brackets

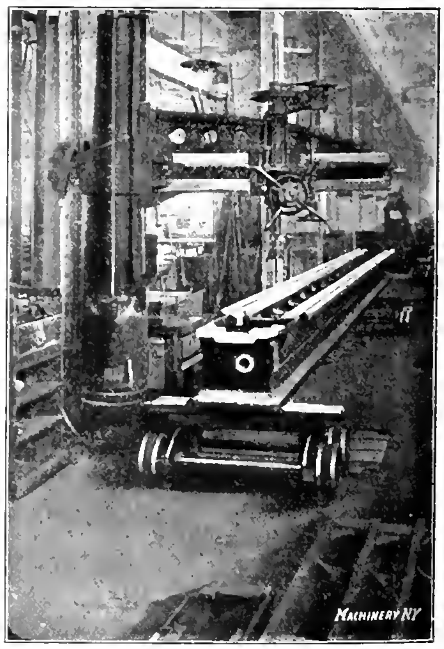


Fig. 10. Drilling Large Lathe Beds

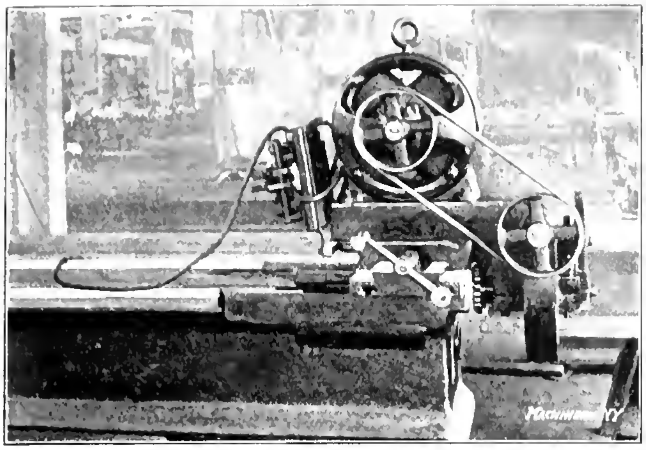


Fig. 11. Portable Milling Machine for Facing Ends of Large Lathe Beds

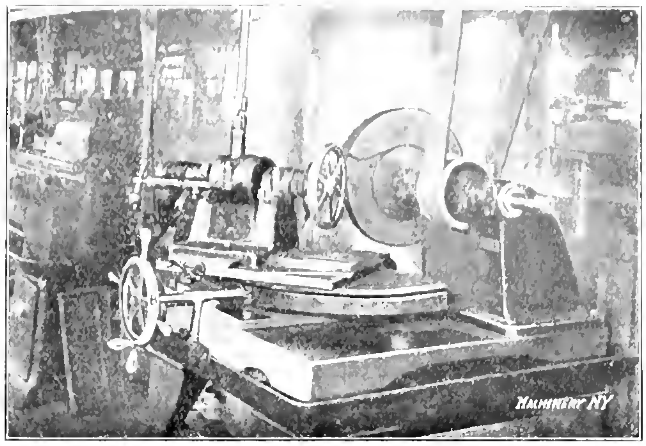


Fig. 12. Special Machine for Grinding Rims of Hand-wheels

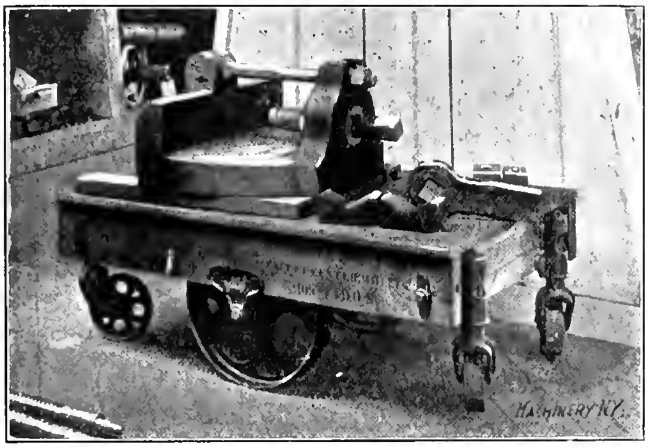


Fig. 13. Straightening Block with Top Brace

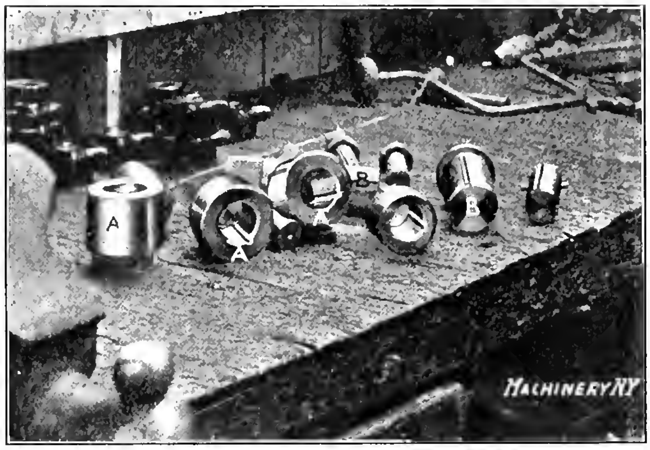


Fig. 14. Apron Bushings and Plugs used for Screwing them in.

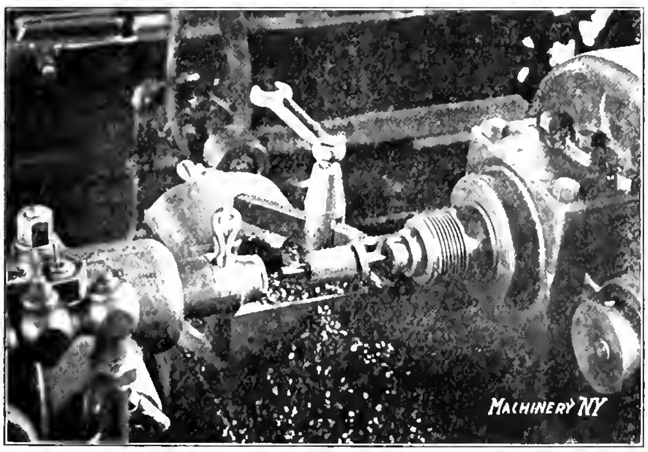


Fig. 15. Special Mandrel used to hold Reverse Plate Gear Bushing

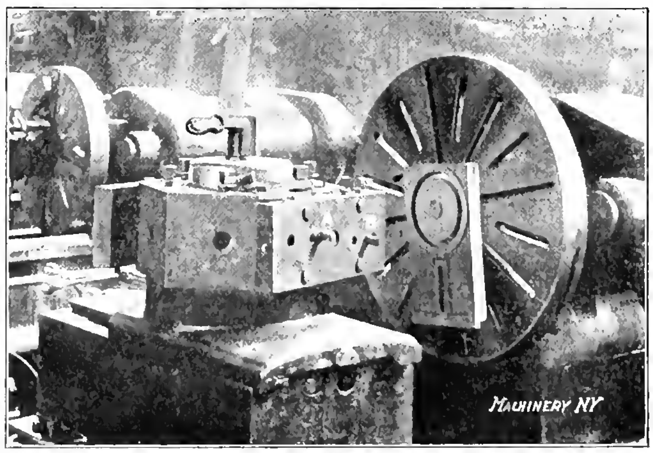


Fig. 16. Cutting T-slots in Lower Compound Slide

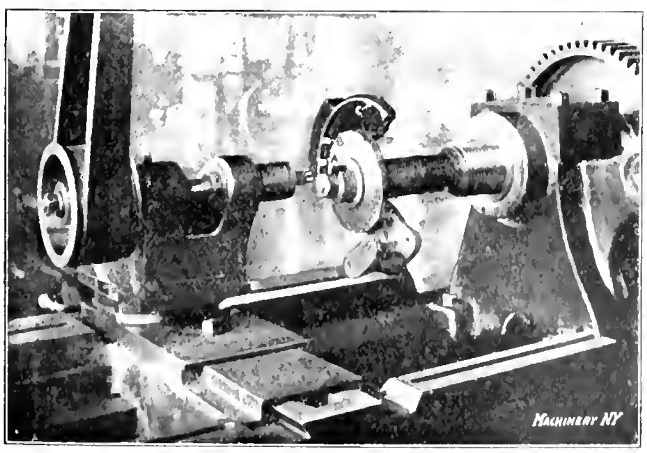


Fig. 17. Milling Contact Spots on Countershaft Friction Parts

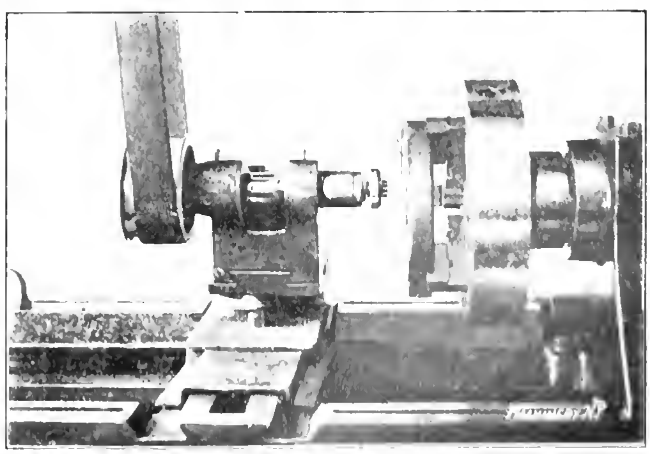


Fig. 18. Milling Friction Bands for Countershafts in the Lathe

a handle attached so that it can be shifted out or in easier while taking off or putting work on the mandrel.

Fig. 16 shows how the circular T-slots are cut in the compound rest bottom slides. They are located on the face-plate by means of a plug mandrel in the lathe spindle, which fits the hole bored in the casting. The circular slot is cut out by using the two cutters A and B, shown in the turret, and feeding them straight in. The slot is then made T-shape by

using two L-shaped tools set in the turret in a way similar to *A* and *B*. These tools are run in flush with the bottom of the slot which is finished by cross feeding the turret the desired amount.

The "spots" *A*, *B* and *C*, Fig. 17, on the countershaft friction parts, are milled on a lathe, to the carriage of which has been fitted the fixture shown. The friction band is milled at *D*, *E* and *F*, Fig. 18, using the same fixture, with another cutter which machines both the face and outside of the contacts at once while the casting is held in a regular lathe chuck.

Fig. 22 shows the series of jigs used to hold lathe heads on the planer, and Fig. 23 shows a lot of lathe carriages being planed up for the cross-slides.

This article would not be complete without a brief description of a few of the many things that are provided for the comfort and welfare of the employes. In Fig. 24 is given a partial view of the neat washroom with its individual wash basins, and along the walls are shown dust-proof individual lockers for the men's clothing and lunch boxes. Ample space is also provided elsewhere for bicycle storage.

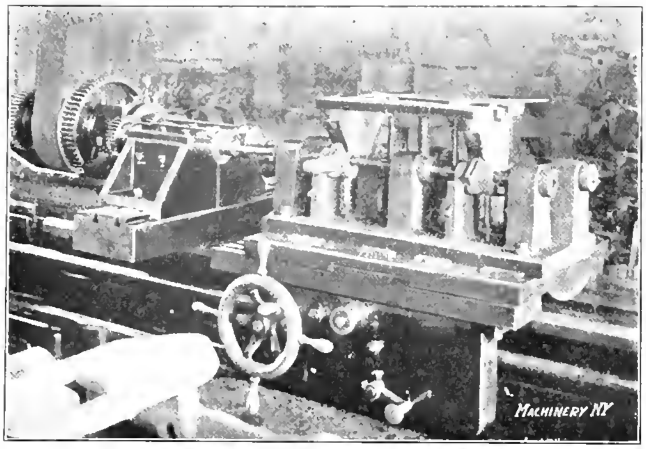


Fig 19 Jig for boring Countershaft Brackets

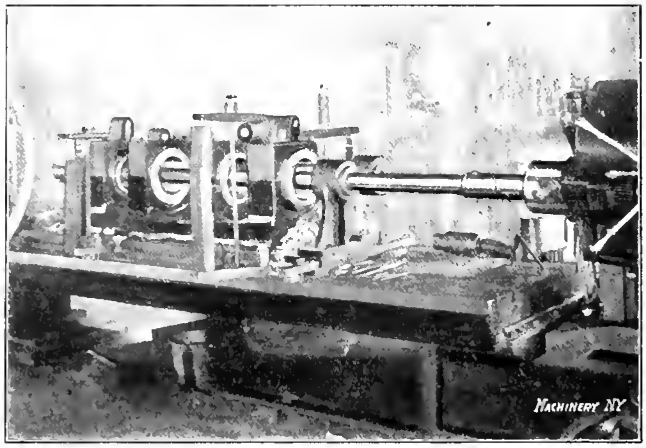


Fig 20 Boring Lathe Heads

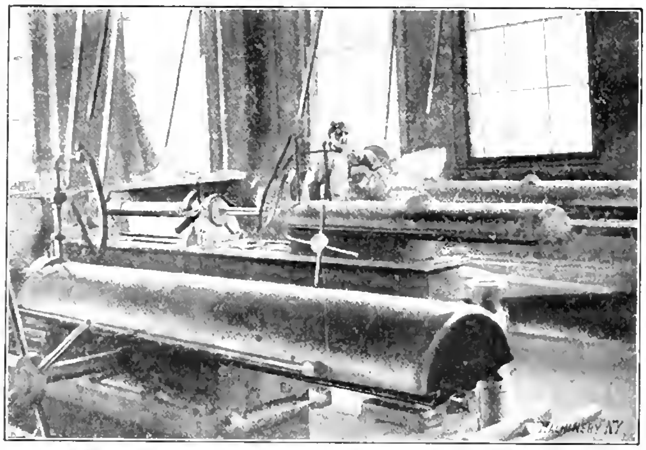


Fig 21 Group of Special Spindle-drilling Machines

Fig 22 Fixture for Head-stock Planing

Fig 23 Planing Lathe Carriages

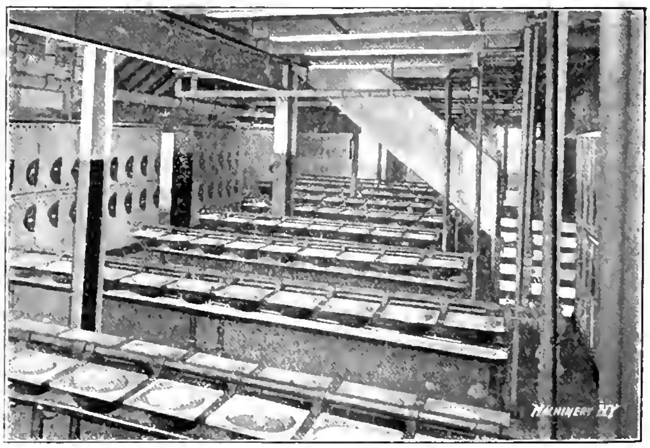


Fig 24 Employes' Locker and Wash-room

Countershaft brackets are bored out while held on a lathe in the jig shown in Fig. 19, using a double-headed boring fixture operating two boring-bars at once.

Lathe heads are bored out as shown in Fig. 20. All lathe spindles used in this shop are drilled out of solid metal on the machines shown in Fig. 21. The standard method of rotating the work and feeding in the drill is used in these machines. Lodge & Shipley also makes a motor-driven lathe attachment for deep drilling.*

The employes have a mutual benefit association, which for a small sum provides a fair amount of protection for members who are sick or injured.

* * *

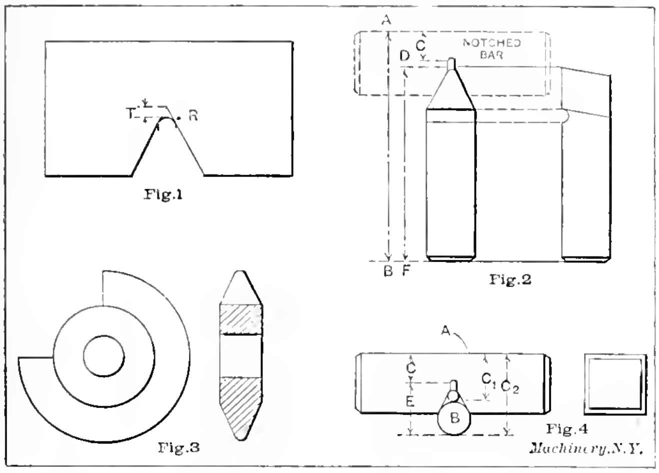
The electrification of a street railway line in London has been brought to a standstill on account of possible disturbances to the delicate instruments at the Greenwich observatory. The Astronomer Royal has the power to pass upon any undertaking within three miles of the observatory that is liable to affect the instruments, and the railroad company must obtain his consent before proceeding with the electrification.

* Complete information on this subject will be found in MACHINERY'S Reference Series No. 25 on Deep Hole Drilling. A description of the Lodge & Shipley deep hole drilling attachment will also be found in this pamphlet.

MAKING WHITWORTH THREAD TOOLS*

In order to produce interchangeability in screw threads, the tools for the screw cutting operations require very careful consideration. Even with accurate tools, the form of thread cut by any threading device depends considerably on the material in which the thread is cut. For instance, a tap used to cut a thread in cast iron is withdrawn with ease, but when the same tap is used in machinery steel it is not as easily withdrawn, the cause evidently being that the threads in the cast iron are thinner and that the pitch diameter of the screw thread is correspondingly increased. This being the case, it is very evident that it is necessary to have the original thread cutting tool as nearly perfect as possible, in order that the subsequent deviations may be minimized. A method is briefly described for generating and measuring thread tools for cutting threads with rounded top and bottom, such as the Whitworth and British Association standard threads.

In the specifications of these standards the radius of curvature, R in Fig. 1, at the top and bottom is given. In originating tools for these thread forms templets are usually made



Figs. 1 to 4. Whitworth Thread Tools and Methods used for Making

by drilling a round hole of the required radius and cutting an angular notch with sides running tangentially into the hole as shown. Fairly accurate work can be done in this way, but a method originated by Mr. W. Taylor permits of greater accuracy in gaging the angle of the thread tool, this being of more importance than the exact curvature of top and bottom.

In shaping the original thread tool as shown in Fig. 2, a notched bar of hardened steel, as shown in Fig. 4, is used for measuring. The face A of this bar is lapped flat, the V-notch is lapped so that its center is perpendicular to A and apex of the V-notch. Anyone familiar with trigonometry can easily calculate the dimensions C and E when C_1, C_2, the angle of the notch, and the diameters of the cylindrical gages are known. This notched bar is applied to the tool as shown by the dotted lines in Fig. 2, the angular faces of the tool having been previously ground. The total distance AB is measured, and from this we subtract the constant dimension C of the bar and the distance T, Fig. 1, from the rounded surface of the thread to the true apex of the V-point of the tool. We then obtain the required finished length DF, Fig. 2, to which the tool must be shortened by rounding its extreme point.*

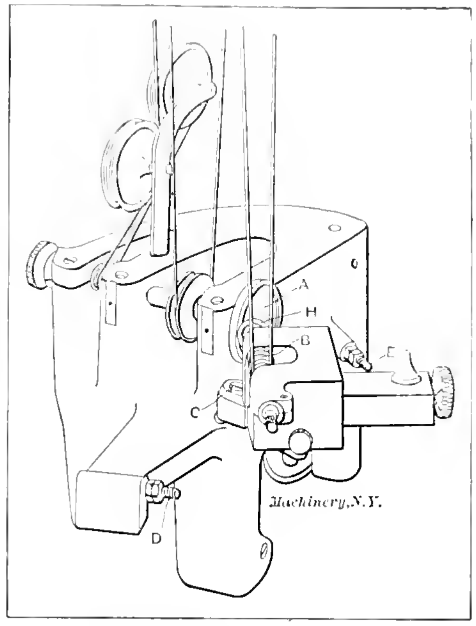
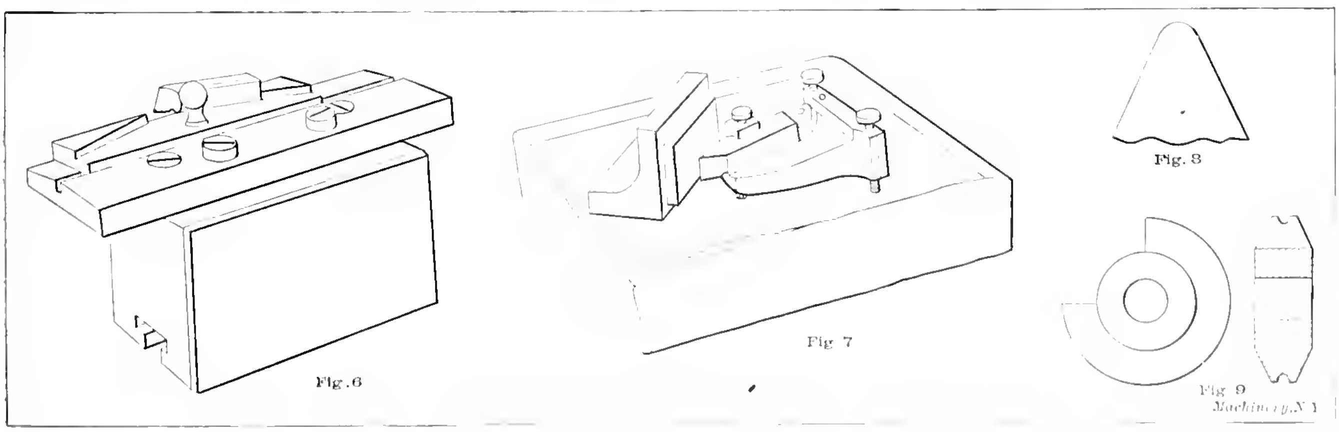


Fig. 5. Machine for Grinding Circular Formed Thread Tools

In rounding the tool point the radius of the curvature is not directly measured. It is sufficient that the curve be circular, that the angular sides of the tool join it tangentially, and that the distance from the top of the curve to the apex of the tool angle be obtained correctly by measurements as described. The first two conditions above are most easily obtained in circular formed threading tools of the shape shown in Fig. 3, which can be sharpened without losing their form. Cutters of this form are invaluable for constant use, but cutters shaped as shown in Fig. 2 can be made by simple means.

The grinding machine shown in Fig. 5 is used for forming correctly the circular tool. In this the previously shaped and hardened cutter is finished by grinding with a cup-shaped wheel A, which, while rotating, moves in an eccentric circular orbit so it wears truly flat. The cutter H is mounted and rotated on the horizontal spindle B, and while rotating can be swung around a vertical axis C as far as permitted by the stops D and E, which are set so as to limit the movement to the angle of the tool (55 degrees for the Whitworth thread), so that it has the thread angle required. Its apex is cut away entirely, as shown, and by means of two or more small cylindrical gages placed at B, the measurements C_1 and C_2 are taken, by which the accuracy of the angle may be verified and from which is found the distance C between the face A and the true



Figs. 6 and 7. Appliances for Making a Tool with Rounded Nose or Cutting Point and with the required Clearance Angle, as shown in Fig. 2

Fig. 8. Enlarged View of Tool Point made by the Process described. Fig. 9. Tool for Forming Top of Thread

The tool, when ground, is again tested by the notched bar in Figs. 2 and 4.

In Fig. 6 is shown a simple holder with guides mounted on a slide, which serves to support the tool shown in Fig. 2, and

* From a paper entitled Interchangeability and Methods of Securing It in Screw Threads, read before the Institution of Mechanical Engineers of Great Britain, by Mr. H. F. Donaldson.

* A description of a method used for measuring, by the micrometer, the amount to be removed from a Whitworth tool having front clearance was included in an article entitled "Measuring Width of Flat on U. S. Standard Thread Tools," MACHINERY, April, 1907.

present it accurately to a flat-faced rotating metal lap so as to grind the angular sides of the tool point. In Fig. 7 is shown a holder with adjustable feet and with a stop against which the tool may be clamped. This is placed upon a piece of plate glass and worked against a small angle plate faced with an Arkansas oil-stone. With these simple appliances, and with the exercise of a little skill, it is possible to round the tool point so accurately that when magnified 100 to 200 diameters and compared with the circular field of a microscope, no error is perceptible. In Fig. 8 is shown a tool point of a British Association standard thread No. 6 rounded in this way, magnified 30 diameters, and correctly copied. In Fig. 9 is shown the form of the tool used to round the top of the threads, the groove not being as deep as that of a full half circle.

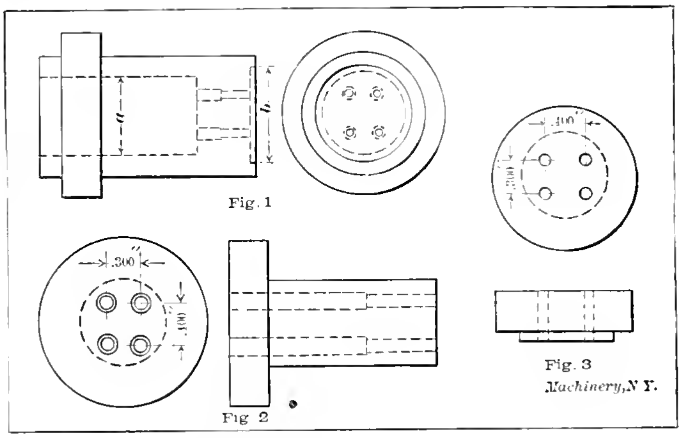
* * *

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE—2

A. L. MONRAD†

Those who read the first installment of this article in the November number will recall that the method of making two small jigs to be used in connection with drilling four holes in the die shown in Fig. 1 was explained. We shall now consider the drilling of this hardened die with a hollow diamond drill, and also the way in which the holes are ground in a bench lathe. Of course, drilling into hardened steel is a



Figs. 1, 2 and 3 Die and Jigs for Drilling

very unusual operation. It was resorted to in this case because of changes in the die, which made it necessary to either drill holes or make a new die. As less time would be required for drilling, this was done, and while the operation is one rarely performed, it will doubtless be of interest to those not familiar with it.

It was first necessary to locate the jigs (shown in Figs. 2 and 3), which had been previously fitted to the die, so that the holes in each jig were in alignment. This was accomplished as follows: First, the jigs were placed in each end of the die which rested in a V-block, one being in hole *a* and the other in recess *b*. This block, in turn, was on an accurate surface plate. Two close-fitting plugs were next inserted in the two upper holes in each jig, and these plugs were then tested with a surface gage until they were all parallel with the surface plate, the necesssary adjustments being made, of course, by turning the jigs with relation to the die. When the jigs were correctly set, they were clamped together and then fastened to the die temporarily with a little solder, after which the clamp was removed.

The drilling was done in a sensitive drill press. The die with the attached jigs is shown on the drill press table in Fig. 2. As the work was hardened, the drilling operation was performed with a hollow drill *D*, the end of which was charged with number 4 diamond dust and number 80 alundum. The drill was first charged with diamond dust mixed in sperm oil, by having the diamond on a hardened and ground parallel block and by dropping the drill onto it about a dozen times by a movement of the handle *A*. This pounded the diamond into the end of the drill. While the drill was being charged, the drill press remained stationary. The drilling operation was performed by dropping a little alundum and then a drop of sperm oil in the hole, and pounding the drill, which was run at a high speed, against the work. The drill was recharged with diamond about every ten minutes. The large or counterbored part of the holes was first drilled to the proper depth with jig *B* guiding the drill. The work was then inverted and the small part of each hole drilled in until it met the larger part, when the small plug *E* in the center dropped down and left a clean counterbored hole.

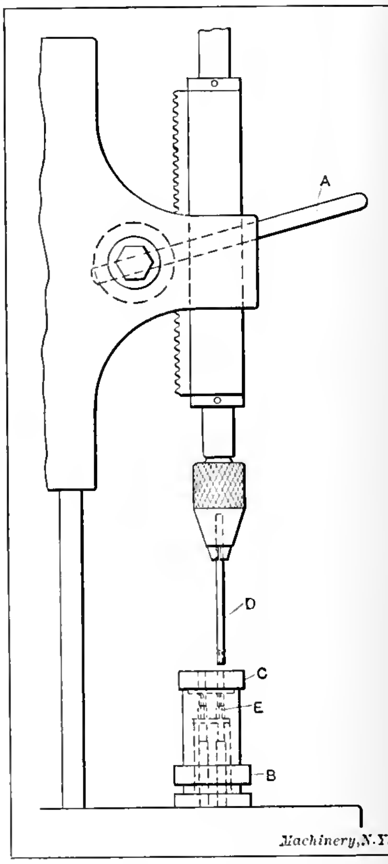


Fig. 4. Sensitive Drill Press with Hollow Diamond Drill and Work in Place

As the hollow drill will cut a hole a little large, it was made 0.010 inch smaller than the diameter of the small holes (which were 0.052 inch) and this gave sufficient allowance for grinding in the bench lathe, which was the next operation performed. The master-plate *M* with the brass disk *G* attached to it was strapped to the faceplate *F* with the locating plug in the spindle inserted in the central hole in the master plate. A recess was then turned in disk *G* to fit the end of the die as shown in Fig. 5. The die was then inserted in this disk and located so that the four holes in it were approximately in alignment with those in the master-plate. The die was then soldered to disk *G*, which, it will be remembered, was provided with elongated slots for the clamping screws. A diamond lap was used when grinding the small holes. This lap *N* was made of tool steel and was charged with number 2 diamond dust and sperm oil by being rolled between two hardened and ground blocks.

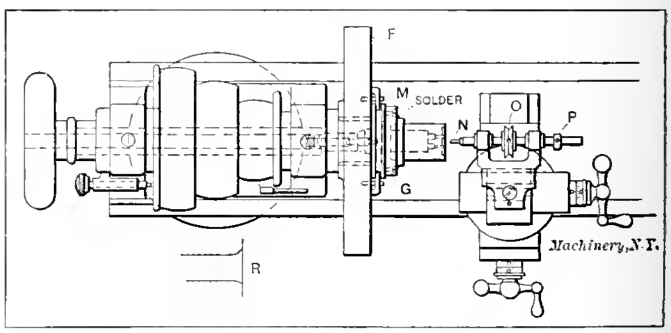


Fig. 5. Finishing the Hole in a Bench Lathe with a Diamond Lap

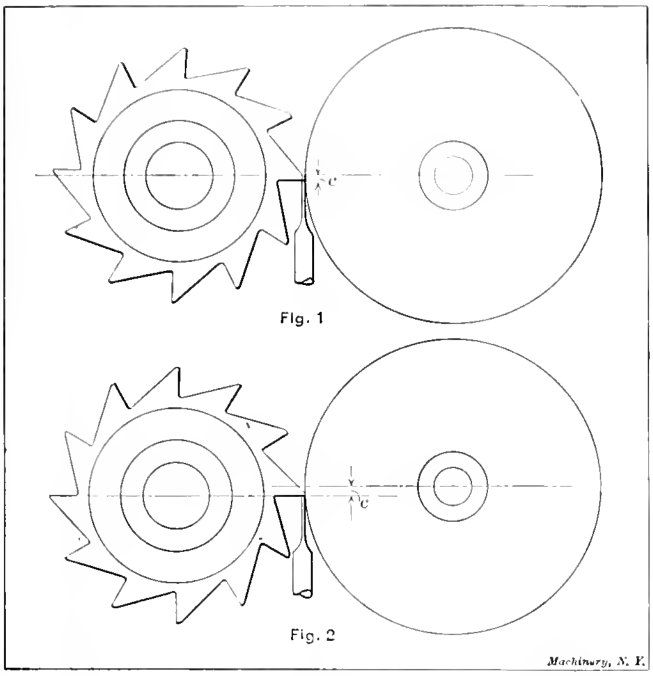
When grinding holes in this way, the lap should run at the highest speed that can be obtained and the die at the slowest. The feed may be obtained by placing the forefinger and thumb on the sides of the wheel *O* and pushing the grinder spindle back and forth at a moderate speed. Care should be taken to prevent the ends of the holes in the die from being ground "bell-mouthed," that is, rounding at the end as shown enlarged at *R*. This will not occur if the stop *P* and the wheel *O* are located so that the lap cannot move clear of the hole. It will be seen that if the lap were to leave the hole at the end of the stroke, there would be more or less springing action on the part of the lap, which, when it entered the work on the return stroke, would tend to grind the end of the hole rounding.

* With Shop Operation Sheet Supplement.
† Address: 58 Connecticut Boulevard, East Hartford, Conn.

ERRORS IN GRINDING TAPERED REAMERS AND MILLING CUTTERS

H. A. S. HOWARTH*

There are two distinct methods that are commonly used for grinding the clearance on reamers and milling cutters. These methods involve the relative positions of the axis of the reamer, the grinding wheel spindle, and the guide finger. The first method is shown in Fig. 1, with the axes of the reamer and the wheel spindle in the same horizontal plane. The



Figs. 1 and 2. Common Methods used for Grinding Clearance on Reamers and Milling Cutters

finger is set so that the cutting edge of the reamer lies at sufficient distance below this plane to give proper clearance or backing off. The amount of clearance is decreased by raising and increased by lowering the finger.

The second method is shown in Fig. 2 with the axis of the reamer in the same horizontal plane with the cutting edge, *i. e.*, with the end of the guide finger; but the wheel spindle is above this plane a variable amount governed by the clearance desired. As the wheel is raised the clearance is increased and *vice versa*. Cylindrical reamers or cutters can be accurately ground by either of these methods, whether the flutes are straight or spiral; but tapered reamers or cutters *cannot* be ground accurately by the first method; they *can*,

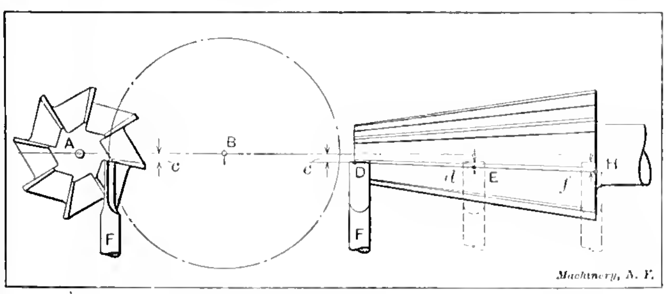


Fig. 3. Illustration showing Conditions when Grinding a Taper Reamer by Method shown in Fig. 1

however, be so ground by the second method. Because of the extensive use of the first method it is the purpose of this article to prove its inaccuracy and to discuss the errors introduced in grinding tapered reamers and cutters. The actual error will be calculated for a number of sizes and the reader can then form some idea of the probable error in cases under his observation.

By reference to Fig. 3, it will be clearly seen what takes place when a tapered reamer is ground by the method in Fig. 1. The finger F is set at a distance c below the plane of centers AB, and, being fastened to the frame of the grinder, it does not change its position relative to the wheel. The reamer, mounted on centers, is moved back and forth in front of the wheel with its cutting face resting on the finger. When the wheel is grinding at the small end, the cutting edge at point D rests on the finger a distance c below AB; but the points E and H on the same cutting edge are lower down by distances d and f, respectively. This is due to the conical form of the reamer. When the point E reaches the wheel and finger, it has been lifted the distance d and is ground also at distance c below plane AB. The same thing is true of the point H. It seems on the face of it that this method would produce a truly conical reamer. Hence it is that so many have fallen into the error of using it. However, by a formula which is derived below, the error is seen to be considerable in some cases while negligible in others.

The construction from which the formula is derived is shown in Fig. 4, which represents the method shown in Fig. 1. The end D of the finger is shown at a distance $GD = c$ below the horizontal plane of the axes of the reamer and the spindle. The end view shows a heavy line AHK which represents the cutting edge actually ground by this method.

Suppose the exact diameters of the ends of the reamer are known; A is a point on the circumference at the small end while K is a corresponding point on the large end. In setting up for grinding, the centers are set over so that as the edge AHK passes over the finger, the wheel will grind OA and OK to the proper radii. When A rests on the point of the finger, H and K will be below it, as shown; but as H reaches the finger A passes above it, and K still remains below it. Finally when K reaches the finger, the whole cutting edge except point K will be above it, and nearer the horizontal plane of the reamer axis.

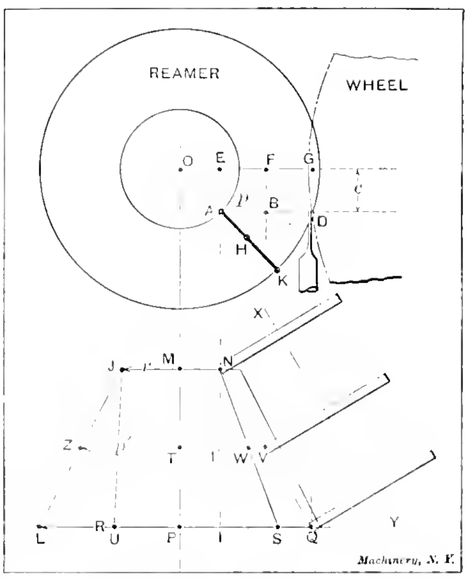


Fig. 4. Diagram for Calculating the Error Involved when grinding a Taper Reamer by Method shown in Fig. 1.

In order better to understand what takes place, the line XY, which represents the wheel spindle axis, is shown in the bottom view. The wheel is shown in three positions. The points N, V and Q are bottom views of the points ground in the three positions shown. These points will lie in a straight line, parallel to XY, and at distance c below the horizontal plane of the centers. This line NVQ is the line ABD in the end view. All points of the cutting edge AHK swing up into this line ABD to be ground. Since NWS is the bottom view of AHK, all of its points swing over into the line NVQ.

Let a point W be taken at a perpendicular distance MT below the end of the reamer so that $\frac{MT}{MP} = m$ which can have any value from zero to one. When W is ground, it is at point V and we have the further geometric relation that

$$\frac{TV - MN}{PQ - MN} = \frac{MT}{MP} = m \qquad (1)$$

This is taken from the triangles NPQ and NTV. Taking now the equivalents of TV, MN, and PQ in the end view we have $TV = OF$, $MN = OE$, $PQ = OG$. By substituting these values in Equation (1) we have

$$\frac{OG - OE}{OF - OE} = m \qquad (2)$$

It is from this equation that we must get the value of the radius $OH = OB \pm p$, which will be the actual radius ground

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by the wheel at W. Let $OA = r$, and $OK = R$, being, respectively, the radii of the small and large ends of the reamer. Then from Equation (2) OF is solved and squared as follows:

$$OF = m\,(OG - OE) + OE$$
$$OF^2 = [m\,(OG - OE) + OE]^2$$
$$p = \sqrt{(OF^2 + FB^2)}$$
$$FB^2 = c^2,\ OG = \sqrt{(R^2 - c^2)},\ OE = \sqrt{(r^2 - c^2)}.$$

Then by substituting in (3) and simplifying we have the following value:

$$p = \sqrt{\{m^2\,[R^2 + r^2 - 2c^2 - 2\sqrt{(R^2 - c^2)\,(r^2 - c^2)}\,] - 2m\,[r^2 - c^2 - \sqrt{(R^2 - c^2)\,(r^2 - c^2)}\,] + r^2\}} \qquad (4)$$

While the above equation gives the value of p actually ground, it is necessary for us to know what the valne should be if the point W were on a true cone. This is shown by the

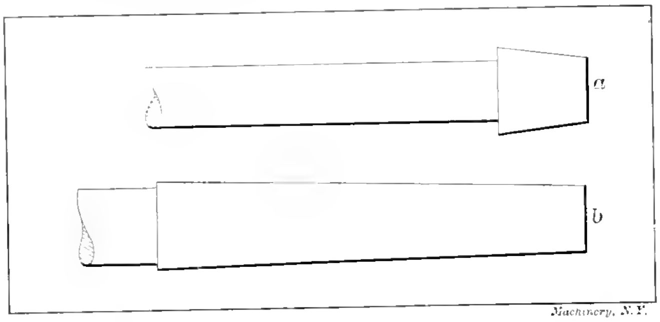


Fig. 5 Taper Reamers of Proportions given in Example 1

line ZT. The point Z is on an element of the cone and at a distance MT below the small end of the reamer. Hence we have the proportion following:

$$\frac{ZT - JM}{LP - JM} = \frac{MT}{MP} = m \qquad (5)$$

ZT is our true radius which we will call p', while $JM = r$ and $LP = R$. Then by rearrangement and substitution we have

$$p' = r + m\,(R - r) \qquad (6)$$

The error which we are seeking will be the difference between p and p'. Hence

$p' - p =$ error in radius.

$2\,(p' - p) =$ error in diameter.

The error will vary in amount from zero at either end to a maximum near the middle of the cutting edge. Hence m may be assumed at some value such as 0.4 or 0.5.

Example 1.—Take a reamer whose diameters are 1 inch and 1.2 inch at the small and large ends, respectively. Then $R = 0.6$ and $r = 0.5$ inch. We will assume in our calculations that c is one-fifth of r. Hence $c = 0.1$ inch. Then m will be taken at different values in order to show about what it should be in this case. The errors in diameters will be as follows:

m	$2\,(p' - p)$
0.35	0.000152
0.40	0.000154
0.45	0.000157
0.50	0.000157

It is evident that the greatest error in this case occurs when m is about 0.5. This is so because the taper is slight compared with the diameters. This also accounts for the very small error, which is a little over one and one-half ten-thousandths inch. Fig. 5 shows two reamers *a* and *b*, which have the proportions used above. The length of the flutes does not influence the result, because it does not appear in the formulas. The error depends on the value of the ratio $\frac{R}{r}$ and on the size of r.

Example 2.—Take the smallest or No. 1 B. & S. reamer; $r = 0.1$, $R = 0.16$, $c = 0.02$ inch; $m = 0.4$. Error in diameter is 0.000054 inch, which is very small.

Because the error in the above cases is relatively insignificant, it is not to be supposed that it is negligible in all instances. The following examples show errors of from 0.002 inch to 0.011 inch.

Example 3.—$R = 1.0$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00176 inch.

Example 4.—$R = 1.5$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00355 inch.

Example 5.—Use the same values as in Example 3, but give greater clearance by increasing the value of c to 0.15. Then $R = 1.0$, $r = 0.5$, $c = 0.15$, $m = 0.4$.

Error in diameter is 0.00408 inch, *i. e.*, more than twice as great as the error in Example 3. This shows how great an effect the amount of clearance has on the error.

Now assume some sizes that would be typical of milling cutters.

Example 6.—Use a value of c that is less than one-fifth of r, say about one-seventh. $R = 3$, $r = 2$, $c = 0.3$, $m = 0.4$. Error in diameter is 0.0016 inch which is smaller than expected because of the reduced ratio of r to c.

Example 7.—$R = 4$, $r = 2$, $c = 0.4$, $m = 0.4$.

Error in diameter is 0.00704 inch, which is four times the error in Example 3. This was to be expected because the dimensions were taken four times as great.

Example 8.—Take the same sizes as in Example 7 except increase the clearance by making $c = 0.5$ inch instead of 0.4.

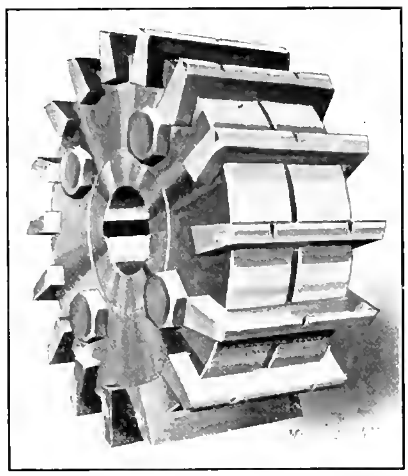
Error in diameter is 0.0112 inch.

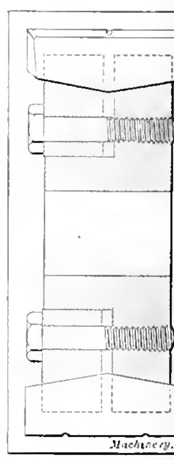
The errors shown above will explain many things that happen in connection with the making and the use of tapered reamers and milling cutters. Many persons have probably noticed that when grinding the clearance on a new tapered reamer or cutter the center will come up sharp before the ends do. The reason for this is now plain. When fitting an arbor into a tapered hole it seems frequently to bear hard in the middle. This may be due to the reaming of the hole in the first place by an improperly ground reamer. It is difficult even with a perfect reamer to avoid reaming the ends of the hole larger than the reamer itself. Hence any inaccuracy will tend to increase the trouble. The conclusion from the above discussion is obvious. Tapered reamers and milling cutters should be ground by the method shown in Fig. 2, *i. e.*, with the cutting edge and the point of the finger in the horizontal plane of the axis of the reamer. Then the proper amount of clearance can be obtained by lowering the reamer and finger together, or by raising the wheel.

* * *

MILLING CUTTER WITH INSERTED TEETH

An inserted tooth milling cutter of a design radically different from those commonly in use has been brought out by Messrs. Modes Eadon & Sons, Ltd., of President Works, Sheffield, England. The body of the cutter is made in two parts



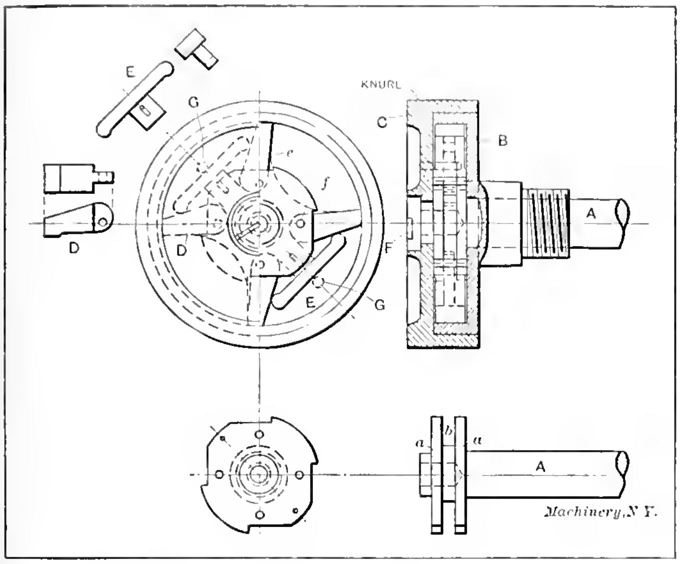


Figs. 1 and 2. Inserted-tooth Milling Cutter of English Design

as shown in the accompanying illustrations, the two parts being drawn together either by a central nut, or, preferably, by a number of screws. The teeth are made of dove-tail section, and the bottom of the tooth is made of a V-shape as shown in the line-engraving. The body, of course, is slotted to fit this shape of the teeth. When the teeth are placed in position and the two halves of the cutter body drawn together, the teeth are forced tightly into the upper portions of the dove-tail, thus providing for an extremely firm hold of the cutter teeth. Being held by a wedge grip in two directions, it is evident that any movement whatever is impossible. It is claimed that a single tooth cannot become loose, and that breakage of one tooth does not loosen the other teeth.

LOCKING DEVICE FOR ADJUSTING SCREWS

An automatic locking device is shown in the accompanying sketch, which is constructed as follows: Part A is the screw or shaft to be held rigid at any point that may be required. The hub parts a are turned solid on the shaft and far enough from the end to allow a bearing for the wheel C. The slot b is cut deep enough so that the lugs on pawls D and the pawl-releasing bars E have sufficient clearance to work freely. The pawls should be put in position as shown in the assembled view, and held rigidly while turning them to the inside diameter of the friction cup B; they are then relieved at the shoulders until their face edges come back almost on a line with the center, when the friction cup is removed. This friction cup is screwed or bolted to the casting carrying the shaft; the parts are then assembled. The pawls D are held in place by pins f and are forced outward by springs c. The pawl releasing-bars are put in position as shown, and the shaft is put in place with the releasing wheel C mounted on the end and secured by a screw F adjusted to allow the wheel to work freely. The pins G of the releasing wheel are in contact with the pawl-releasing bars E. By turning the wheel either to the right or left, these pins force the releasing bars inward, bringing the pawls away from the walls of the friction cup; the shaft is then readily moved in the required direction. It will be seen that when the wheel is released the springs c will force the pawls outward against the walls of the friction cup, and any attempt to turn the shaft will meet with a stubborn resistance at these points of contact. This little wheel is thoroughly practical and it relieves one of the dread of having an adjustment altered by the jarring of a machine.



A Device for Locking an Adjusting Screw in any Position

Baltimore, Md. ROBERT O'NEAL.

MAKING PRESS FITS

Making a press fit is looked upon by a great many machinists as a very difficult job, and undoubtedly this is true in cases where the machinist has no micrometer calipers and depends entirely upon his sense of feeling. Without the micrometer, it is impossible to know just what has been allowed in difference between the diameter of the plug and hole, and, consequently, the pressure required to force in the plug cannot be even approximately ascertained. Of course in manufacturing shops where one man does all the press fitting, does it continually, and calipers with gages made by the tool-maker, with the allowance calculated for him, he cannot be expected to do other than a good job. On the other hand, in contract or repair shops it is too expensive to make gages, as the jobs vary too often; consequently, making a press fit in such shops requires considerable skill.

It is only necessary to use an inside caliper with micrometer adjustment for this work, as this tool may first be set to the exact size of the bore and then to the required number of thousandths larger than the bore. A regular pair of outside calipers may then be set to the inside caliper. I have kept a record of press fits recording the kind of metal, allowance, area of fitting, and the pressure required to force the plug in the hole. This record has proved valuable to refer to when making press fits, but the handiest and most accurate data I have found is that given in MACHINERY'S Data Sheet for August, 1903. I have used this Data Sheet for some time, and find it to be so accurate that I can place absolute confidence in it; thereby removing that lump in my chest that used to settle there every time I made a press fit. If you want to do good work, buy or borrow a good inside micrometer caliper of good make, get this Data Sheet, study it until you understand it thoroughly, and you will soon be up-to-date. By taking the formula $P = \frac{A\,D\,(P\,F)}{2}$ and transposing it thus $D = \frac{2\,P}{A\,(P\,F)}$ the allowance when the number of tons pressure is known, is easily determined. In these formulas,

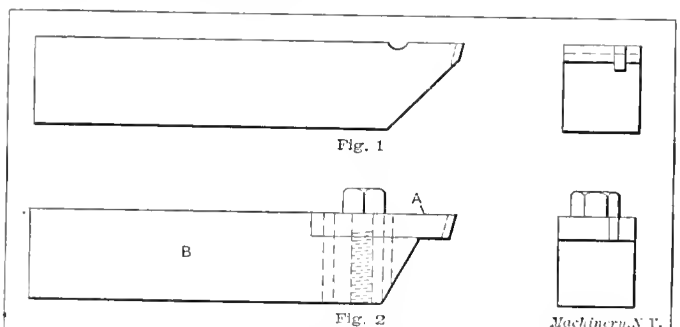
P = pressure required in tons,
D = difference in diameter between plug and bore,
$P\,F$ = pressure factor taken from Data Sheet,
A = area of fitting in square inches.

By using the last formula, and then calipering as described, one will be surprised at the accurate results obtained. A good lubricant to use when pressing the plug into a hole, consists of white lead and machine oil, just enough of the oil being added to make a paste of about twice the consistency of paint.

Augusta, Ga. J. S. VAN PELT.

MASTER FORM TOOLS

The extensive use of circular forming tools, brought about by the introduction of the automatic screw machine, has led to more or less experimenting to obtain an inexpensive method of making the master tools with which the tool used to form the circular cutter is made. In some shops this tool is made



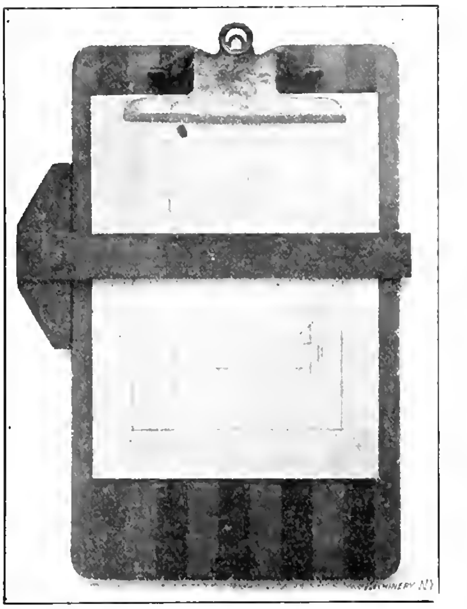
Master Tools for Making Circular Cutters

in the shape shown in Fig. 1, being a solid bar of steel. The outline is laid out on the cutting end and the tool is milled out and finished by filing. This type of tool is often annealed and recut for other forms after the completion of the forming tool. The blanks, of different widths desired, are carried in stock ready for use, and a minimum amount of labor is left for the form-tool maker, as the roughing out is all done with cheaper help. In other shops the master tool is always saved and filed away, in a cabinet, with the form tool, and when this is the case the design shown in Fig. 2 is superior because it occupies less space than Fig. 1, and it is also much easier and less costly to make. In Fig. 2, A is the tool proper which is fastened to the holder B by a hexagon head screw and two dowel pins. Both screw hole and dowel pin holes are drilled and reamed in a simple jig, so as to get the correct location from the back edge of the tool. In making these tools, much costly experimenting has led to the

adoption of "Intra" steel for the master tool, while the circular tool is made from several different brands of high-speed steel, depending on the material to be operated on and other considerations. F. CHAS. SCRIBNER.

Greenfield, Mass.

CONVENIENT DRAWING OUTFIT



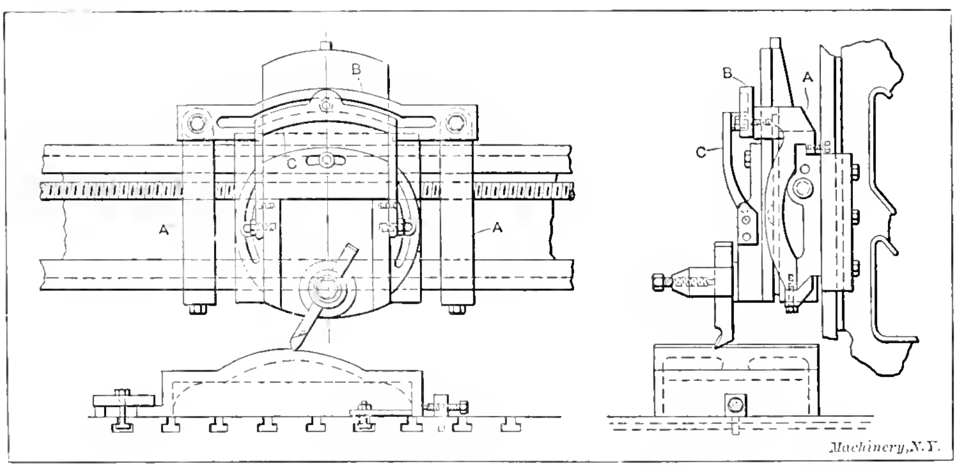
Filing Board used for Drawing

A very convenient drawing outfit for making sketches on small sheets of paper or calculating sheets, that has recently come into quite extensive use, is shown in the accompanying engraving. The outfit consists of an ordinary letter filing board, the left-hand edge of which is planed true, and a small T-square, both of which may be obtained in any stationery or drawing material store. The drawing paper is held by the spring clip as shown. MARTIN JOACHIMSON.

New York City.

PLANER ATTACHMENT FOR MACHINING CURVED SURFACES

An attachment for planing work of a convex or concave shape is shown in the accompanying engraving. The attachment consists of four parts all of which are of cast iron. These castings comprise the two side pieces or brackets *A*, the templet *B*, and the double-armed "leader" *C*, which is attached to the tool slide. Of course, different templets have to be used for different jobs, the shape of each being governed by the special requirements of the work in hand. The side brackets must be cast with bosses to allow the templet to clear the planer head, so that the latter can move along the rail. As shown, the brackets fit over the top guide on the rail and any slack is taken up by the set-screw shown in the end view. Separate pieces are fitted to the bottom of

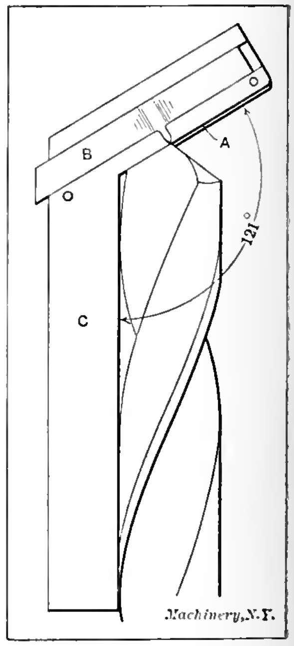


Planer Attachment which automatically guides the Tool when machining Curved Surfaces

each bracket which are put in place after the fixture is put on the rail. These brackets are at all times stationary. The templet is worked out on a profiler or slotter, and it is attached to the brackets *A* by bolts. It should be machined carefully to the required shape, for, obviously, when it is made it will produce any number of pieces which will be exact duplicates. Attached to the double-armed leader *C* is a stud upon which is mounted a loose sleeve which travels in, and fits the slot of the templet. As the head is driven along the rail the tool is automatically raised or lowered according to the formation of the guiding slot in the templet. Of course, when this attachment is in use, the screw of the slide is removed. The fixture is entirely automatic, and when it is in use the cross-feed may be put on, and the planer will take care of the work. This fixture is not new, but there are doubtless many who are not familiar with it. J. B. M.

GAGE FOR DRILL GRINDING

A gage to be used when grinding either flat or twist drills, in order to obtain the proper lip and clearance angles as well as equal lengths for the cutting edges, is shown in the accompanying line engraving. This gage is a great deal handier and more convenient to use than a protractor and scale, and, besides, it can be carried in the pocket. The surface *A* of the head forms an angle of 121 degrees with the shank *C*, which gives a lip angle to the drill of 59 degrees. Fitted to the head is a piece *B*, which slides in a dove-tailed slot and which has attached to it a pointer, as shown, which is used for measuring the lengths of the cutting edges. This is accomplished by setting the pointer as shown in the illustration, and then without moving it, turning the drill over so that the length of the other cutting edge may be measured. If the lengths of the cutting edges are unequal, the short one is, of course, ground off until the pointer coincides with the upper end of each edge. The surface *A* of the gage is beveled to an angle of 12 degrees so that the clearance angle may be tested when the drill is being ground.



Drill Gage for Testing the Lip and Clearance Angles and the Lengths of the Cutting Edges

Lestershire, N. Y. L. B. MINGES.

MILLING FLUTES IN REAMERS WITH IRREGULAR WIDTHS AND DEPTHS

For the purpose of eliminating the chatter marks sometimes found in holes finished with reamers having equally spaced teeth, a good method is adopted by most reamer manufacturers, which is perhaps known to all reamer users, of making flutes of irregular widths and depths. Having had the opportunity to cut reamers of this type, I have tried the following method which has proved quite satisfactory.

Suppose we want to cut a reamer with 6, 8, 10, 12, or any regular number of teeth. Knowing, as we do, that a circumference contains 360 degrees, and bearing in mind that opposite teeth are to be cut to the same depth (to facilitate measuring), it will readily be understood that instead of dividing 360 degrees into irregular spaces, we divide 180 degrees into one-half as many spaces as flutes required. Let us take for example a reamer to have 12 flutes; this gives us 180 degrees to be divided into six irregular spaces. We first divide 180 degrees by 6, obtaining 30 degrees, which would be the angular distance between the teeth for regular spacing. In order to get irregular spaces we must find six numbers that will total 180. In this case, we

have 26, 28, 30, 31, 32, and 33 degrees. The next move is to transfer the degrees to turns and holes for indexing. Nearly all milling machine dividing heads have worm-wheels of 40 teeth, making 40 turns equal 360 degrees or one revolution. This will make one turn equal 9 degrees, and by using a 27-hole circle, 3 holes will equal one degree. Going back to our irregular divisions, we first come to 26 degrees. It is not necessary to index for the first cut. The indexing for the remaining divisions is found as follows:

28 degrees ÷ 9 degrees = 3 1/9 = 3 turns and 3 holes
30 degrees ÷ 9 degrees = 3 3/9 = 3 turns and 9 holes
31 degrees ÷ 9 degrees = 3 4/9 = 3 turns and 12 holes
32 degrees ÷ 9 degrees = 3 5/9 = 3 turns and 15 holes
33 degrees ÷ 9 degrees = 3 6/9 = 3 turns and 18 holes

Having the degrees changed to turns and parts of a turn for the indexing crank, we now go ahead with the first cut, being careful not to go too deep, so that the required width of land can be obtained. It will now be seen that as the angle between the teeth changes, the depth must also be changed if the lands are to be made uniform. This depth is found more readily by practice than by figures. When large reamers are to be cut, instead of dividing 180 degrees, 90 degrees may be used, and in that case four teeth instead of two can be cut to the same depth. JAMES FRASER.

New Haven, Conn.

REMOVING BROKEN DEEP-WELL PUMP-ROD

An A. D. Cook deep-well pump-rod separated far down in the casing, part being pulled out at the top and the remainder staying at the bottom. In order to secure the lower part, a

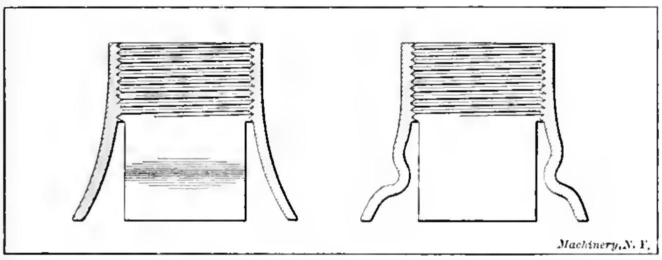


Fig. 1. Special Sleeve for Gripping the End of the Broken Rod

piece of iron pipe was split at one end into four leaves, as shown in Fig. 1, and the solid end tapped out and bushed down to fit the thread upon the pump-rod taken out. Two of these leaves were beaded to form a snap hook after all four of them had been bent out at the lower end to completely fill the well casing. These two beaded leaves were intended to form a hook smaller than the upper head of the lost pump-rod C (Fig. 2), so that when part B was lowered into the casing and forced down over the upper end of C, the leaves would spring back over the shoulder and grip the rod C, thereby enabling it to be pulled out. The device worked very satisfactorily. It was attached to the lower end of the upper section A of the broken pump-rod and lowered until C was gripped.

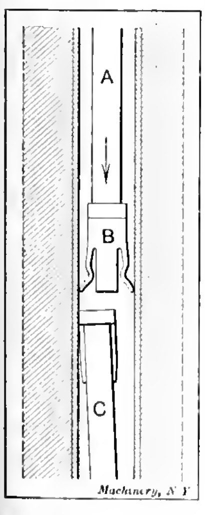
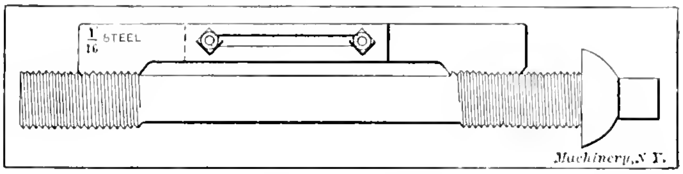


Fig. 2. Method of Removing Broken Pump-rod

Wadsworth, Ohio. HOWARD D. YODER.

THREAD GAGE FOR STAY-BOLTS

Radial stays are a hard thing to fit into place, according to some boilermakers, because the threads in the boiler plates and the threads on the stay-bolt will not mesh in both sheets at the same time. I knew of one case where a boilermaker spent two days putting in five stays, and these were obtained by sorting over about one hundred stay-bolts. Schemes are tried of having the tap so made that the threads in both plates will be as on a continuous rod, and this helps a lot; in fact, it is necessary to have the holes exactly in line. But another trouble often comes from the fact that the stay-bolts are turned up in a lathe which is so worn that in a foot or two of length the pitch is a little off which changes the position of the threads so that they cross when the bolt is screwed into place in the boiler plates. It will pass through the outside sheet all right, but will not fit into the inner sheet. Now if



Thread Gage applied to a Stay-bolt

this stay-bolt is lengthened a little, by hammering, so that the threads are moved a little ahead until they will exactly fit into the threads of both sheets, everything works smoothly.

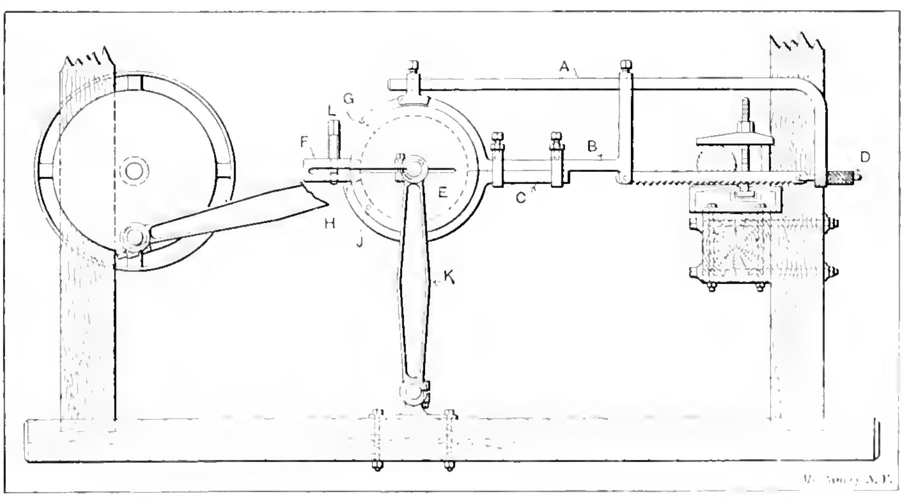
The illustration shows an adjustable gage that can be used in spacing these threads. This gage can be set by the tap that was used in making the threads in the plates, or it can even be placed in the holes and set to the actual threads in the sheets. Then the bolts can be drawn out with a hammer to fit the gage, and a lot of hard work will be eliminated.

Two Harbors, Minn. A. G. JOHNSON.

MULTIPLE POWER-DRIVEN HACK-SAW

Old, rejected street car axles were being cut into short lengths to be used for drop-forging stock, and other purposes for which this steel is suitable, but the work of sawing them on a single reciprocating saw proved too slow. A gang saw, a view of which is shown in the accompanying engraving, was built, which will cut simultaneously the whole length of an axle into any number of pieces required. The construction of the saw is simple, yet it is rigid, and will stand up under very heavy sawing.

The saw frame is composed of three pieces, A, B and C. The first is a machine steel bar 1¼ inch in diameter, the end of which is enlarged to receive an adjusting screw D. The two halves, B and C of the remainder of the frame are hand-forged from machine steel stock 1½ inch wide and ½ inch thick. The vertical part of B is slotted at the lower end to receive the saw, and the upper end is enlarged to provide for a hole through which passes bar A. The circular ends of B and C fit into a groove which is turned in the circumference of the cast-iron disk E 10 inches in diameter. To allow clamping this disk in any position on the shaft, a slot is milled partway through it as shown, and also in the clamping block F, which is attached by pins, to the disk on each side of the slot. It will be noted that the end of the saw frame is not a complete circle, as it terminates at G and H. This serves two purposes: After the saw has finished its cut, the end H



Elevation of a Multiple Hack-saw for Sawing Stock into a Number of Lengths, simultaneously

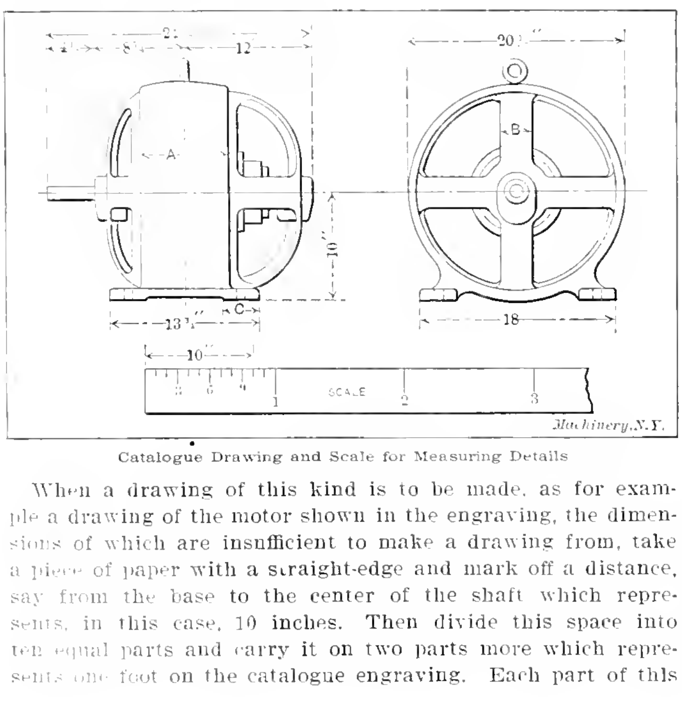
prevents it from cutting into the chucking table, by coming in contact with stop F, while the space between end G and the stop permits lifting the saw to take in any stock within the capacity of the machine. When it is desired to put one or more saws out of service, the frame is raised until the end H drops down past the hole J through which a stop-pin is inserted, thus securing the frame in an elevated position. The shaft upon which the disks are mounted, is turned down at each end to receive the vertical supporting rods K and also the connecting-rods. The latter are connected to the two crank disks mounted on either end of the driving shaft, which runs in bearings attached to wooden uprights. At the opposite end of the frame there are other uprights across which is secured a timber to which is attached a cast-iron plate with a T-slot which permits strapping down the stock at any place along the table. Any of the saw frames can be removed from their disk in five minutes, or replaced in the same time, and pieces of any length may be cut by simply shifting the disks to the proper position on the shaft. A key in the shaft prevents the disks from turning, and when they are properly located they are clamped by the screw L.

In forging the circular parts of the frame they are first formed as near the required shape as possible. After machining the joints between the two halves they are held together by the clamps shown, and the circular ends are tested on a surface plate, to see that the sides are flat, and that the vertical part of B is in a plane parallel with them. These ends can be faced on a disk grinder; if available, a double disk grinder is preferable. Just enough stock is removed to give a fair amount of trued surface. If no other means is at hand the inside of the strap can be machined in the drill press. By fitting the groove in the disk E to the strap, the latter may be ground without reference to any particular width. With a machine of this type it is possible to saw a number of pieces in about the same time as required for one; and obviously, the machine may be designed for any desired number of saws.

M. E. DAWSON.

A KINK FOR DRAFTSMEN

Very often a draftsman in laying out work, finds that he has to refer to outline drawings in catalogues where not enough dimensions are given to make a drawing from and have it to any kind of scale.



Catalogue Drawing and Scale for Measuring Details

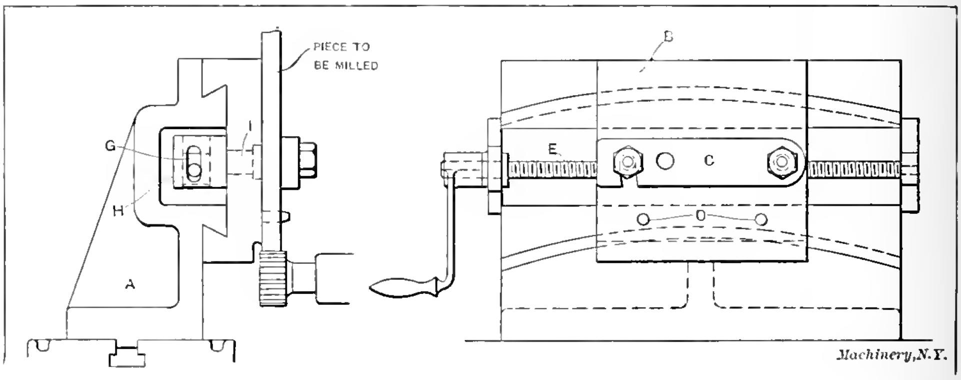
When a drawing of this kind is to be made, as for example a drawing of the motor shown in the engraving, the dimensions of which are insufficient to make a drawing from, take a piece of paper with a straight-edge and mark off a distance, say from the base to the center of the shaft which represents, in this case, 10 inches. Then divide this space into ten equal parts and carry it on two parts more which represents one foot on the catalogue engraving. Each part of this space represents one inch, and each division may be subdivided as required. The scale may be made any length by stepping off spaces equal to one foot, as shown in the engraving. By using such a scale, the dimensions of A, B, C, etc., may be easily found.

This is a very simple method and one which I find helps a great deal at times. A new scale has to be made for each different engraving, the proper proportions being obtained from some one of the dimensions given.

New Haven, Conn. J. H. SCHULTHEISS.

MILLING ATTACHMENT FOR MACHINING A CURVE OF LARGE RADIUS

Some time ago we had a large quantity of parts that had a finished surface on a radius of about five feet, and this surface had to be an exact distance from two holes in the piece. The radius was far too large for any lathe we had available, but the length of the surface to be finished was only a few



Milling Attachment for Machining a Curve of Large Radius

inches, so the device shown in the accompanying engraving was made. An angle casting A was made with a dovetail slide of suitable radius, to which a sliding block B was fitted. A feed-screw E engaged with a nut G attached to the back of B. To allow for the variations in height and angle as B moved across on the curved slide, the nut G could slide up and down in a slot in holder H, and H could swivel on its axle I. Two pins were put in block B in the proper position to take the holes in the piece to be milled, and a clamp-bar C arranged to hold the work in place. The attachment was put on a milling machine and the table adjusted vertically until the cutter was at the proper height. It worked satisfactorily, and we were able to make good time on what had been a troublesome job.

W. ALTON.

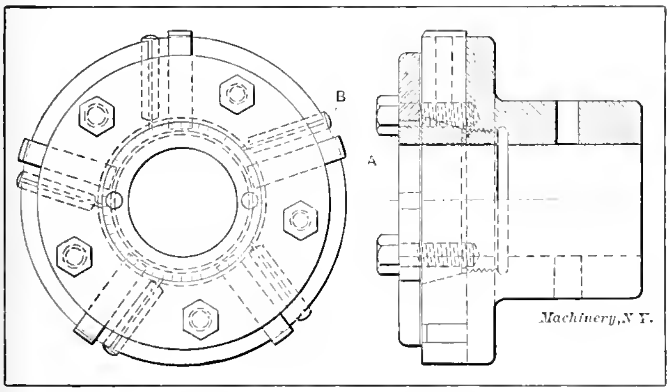
HOW WE GOT ELECTRIC LIGHTS

The shop where I learned the trade was a small one, and although the place was turning out a very good class of work and considerable of it, the "boss" was rather inclined to be a bit slow in putting in improvements for the benefit of the workmen. One of the improvements needed was electric lights, and many were the cuss-words which were fired at the measly old gas jets which were always in the wrong place and never gave sufficient light. One dark, dismal day one of the boys was working at the bench, and he had the gas jet down near the vise; he felt a warm sensation around the top of his head and when he put his hand up to find out what the trouble was he found that his cap and a good share of his "thatch" had gone up in smoke. Of course immediately there was added to the already pungent smell in the air, a distinctly sulphurous strata, which brought the boss post-haste to find out the cause of it all, and when Jack had finished telling of his misfortune and also consigned all such things as gas jets and behind-the-times employers to regions where we have reason to believe there is no need of gas, the boss said, "Well, Jack, that is too bad; those old gas jets are sort of a nuisance and don't give very good light anyway—I think that I'll have to get the electricity put in." Jack told him that he had just about the same sort of idea about it himself, and furthermore, that it had better be done P. D. Q. or there wouldn't be many of the boys working there.

Well, time went on into days, weeks, and months, and still we had no electricity, when one day another of the boys, Eli by name, came over to my lathe and said "Say, George, just keep a weather eye on the shipper handle of my machine. I am going over on the other side of the shop and there is going to be something doing around here in a few minutes. If things get too fierce, why stop them, but don't do it before the "old man" sees it, if you can help." I looked over to Eli's lathe and saw that he had carefully placed the gas jet so that the flame was just under the shipper handle, and in a couple of minutes the handle began to smoke and finally a bit of flame started creeping up it; just about when the flame was up to the ceiling and I was thinking it time to stop it, the "old man" came tearing down the line, jumped up on the lathe and swiped his hands down the handle and put out the fire. Of course Eli showed up on the scene about then and innocently wanted to know what the trouble was. He told the boss that he thought he had that bloody gas far enough away so that there was no danger of the handle catching fire, but it had always been a mystery to him that such things did not occur oftener. The old man did not say much except that we ought to be more careful, but I guess it started something going in his "think tank," for when, a few days later, another of the boys working at that same lathe accidentally (?) allowed the same thing to happen and the fire had even started in on the ceiling, the boss said: "Well, boys, this won't happen again—I've ordered the electricity put in this week." And sure enough, a couple of days later the men were down there wiring the shop, and the day of gas was over in that place. M. A. Chenist.

AN ADJUSTABLE REAMER

The reamer shown in the accompanying engraving differs in construction in some respects from any that the writer has ever seen, and it is such a good tool that it seemed worth



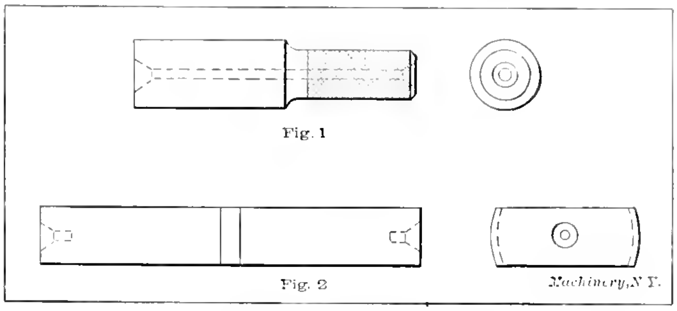
Reamer with Graduated Adjustment

while offering a description of it for publication. The means of adjustment is clearly shown in the sectioned part of the elevation. The cutters are beveled to fit the taper of the sleeve *A* at their inner ends, and are forced out by the inward movement of this sleeve, which is threaded 12 threads per inch. The taper part is turned to an angle of 16 degrees 40 minutes with the axis, and the end of the sleeve has 50 graduations, as shown in the end view, which makes each graduation equal 0.001 inch increase in diameter across the cutters. A spanner wrench is used to turn the sleeves. The cutters are brought to a snug fit in the sockets by means of tapered pins *B*, which are driven into split holes in the cutter head. The reamer chosen for this description is used for reaming 7½-inch holes. C. W. Hebert.

Nashua, N. H.

PROVISION FOR THE ESCAPE OF AIR IN PLUG GAGES

While reading an article in the September number of Machinery about plug and ring gages, I noticed that the importance of lightness was especially treated; this is indeed very important. Another important feature in connection with gage construction, which applies only to plug gages, is the provision for the escape of air when such gages are to be used in blind holes or those having closed ends. Of course, in most cases where plugs are used such provision is not necesssary, as the hole to be tested passes through the work, and therefore gives the air plenty of chance to escape; but once in awhile a hole has to be tested which is closed at one end. In this case the solid plug is rendered absolutely useless, and inside micrometers or calipers have to be used, as it is almost impossible to insert the plug before the hole is about 0.001 inch or more too large. This is because the air cannot escape, and I have been wondering why makers of plugs do not put a hole through the center, as shown in Fig. 1, so that the air could pass through it. It need not be large, but should, of course, increase in size with the size of the plug.



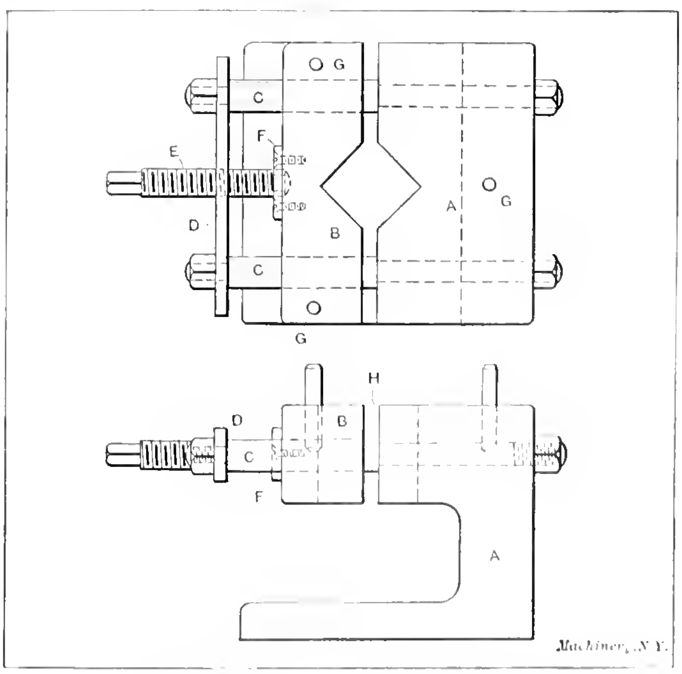
Figs 1 and 2. Plug Gage with Hole for the Escape of Air, and Form for Large Gages

Fig. 2 shows a good way of making large plug gages. They may be made in this style for sizes from one inch and up. Gages made in this way are light, which, as stated, is an important feature, and besides, it is possible to tell with this form of gage if a hole is round or not, which may be impossible with a solid one. It is good practice to make one side of the gage with about 0.005 inch taper, especially when it is used for grinding, as it gives the user a chance to tell when he is near to the gage size. After a little practice, one will know just how much to take off by observing how far the taper part goes in the hole. A. Nielsen.

Cleveland, Ohio.

DRILL PRESS CHUCK FOR ROUND OR FLAT STOCK

A simple chuck for the drill press is shown in the accompanying engraving. It is intended for holding round and square stock that is to be drilled, reamed or countersunk, and also for flat plates which are either round or irregular in shape. The round stock is held in the V's and the flat stock between the pins *G*. Bar stock may be clamped between the jaws at *H*. The cast-iron base *A* is machined on the bottom and top, as are the faces *H* and the V's. The part *B* is also



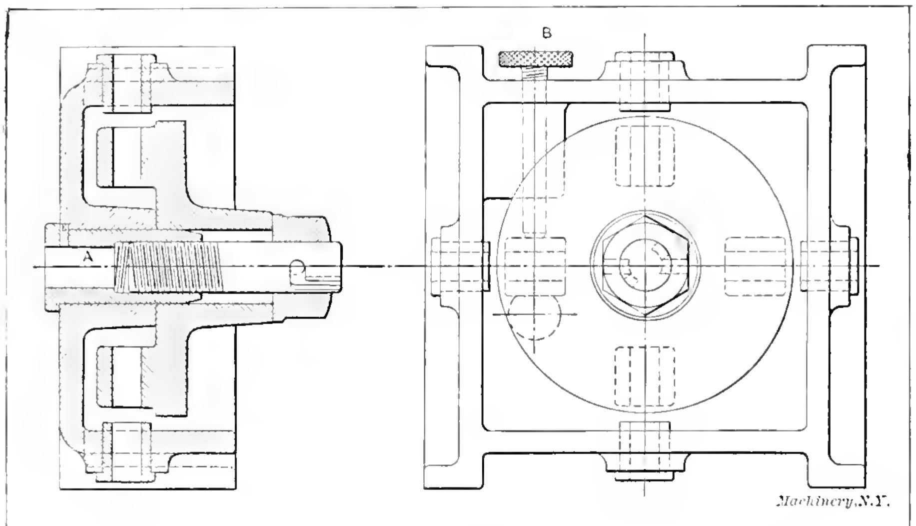
Drill Press Chuck that will hold Round or Square Stock or Flat Plates of Irregular Contour

of cast iron and it is a sliding fit on the shoulder bolts *C*. Bolted across the ends of these bolts is a machine steel piece *D*, 5/8 inch by 2¼ inches, having a 1-inch drilled and tapped hole to receive the clamping screw *E*. This screw, which is 1 inch in diameter, has its outer end squared to receive a wrench. The inner end, which is reduced to 5/8 inch, passes through a hole in plate *F* to which it is loosely riveted. Plate *F* is secured to the jaw with 7/16-inch countersunk screws. This chuck will also serve the same purpose as a vise.

MACHINIST.

QUICK-RELEASING NUT FOR JIG WORK

The application of an efficient type of quick-releasing nut to a box drill jig is shown in the engraving. By referring to the sectional view, it will be noticed that the work is centered by the nut *A* and located also by a knurled screw *B*. As there was a fairly large quantity of these pieces to drill, it was necessary to save time in every possible way. Previously a hexagon-head screw was used for clamping, but insertion and removal of the work took much longer than it should have done. The idea then occurred to me of using a bayonet lock-nut the same as is employed for cutters on facing bars. The sketch shows a hexagon nut with two pins driven in diametrically opposite to each other. These pins fit into corresponding slots in the stud, and all that needs to be done to remove the work is to turn the nut half way around, when it can then be removed from the stud. This method of clamping thus saves the time which would be required for screwing a clamping screw in and out.



Jig equipped with Quick-releasing Nut that facilitates Insertion and Removal of Work

LORIENS.

DESIGN OF TOOL CHESTS AND CASES

As one looks over the mechanical papers of to-day he cannot help but notice the neat and compact design of tool chests that are being advertised and placed upon the market by enterprising firms. No doubt this design is the outgrowth of the call from young men who travel from one end of the country to the other partly from curiosity to see this great republic and partly from a desire to gain wide experience, but who feel that the expressage on a chest the size of a small trunk is too large a drain on the pocketbook for the extra returns in wages received. When one starts to pack one of these modern tool chests, he cannot fail to be impressed with the fact that the tool manufacturing concerns are far behind the times in the designs of tool cases for such tools as micrometers, bevel protractors, height gages, and plain squares. In many instances the cases that come with such tools occupy the lion's share of the tool chest and are many times left behind on this account. The writer would suggest that the makers of such tools place upon the market cases of a flexible type made of leather or other material that would answer this purpose and advertise the same in their catalogues or mechanical papers, and he feels sure there would be a ready demand for them.

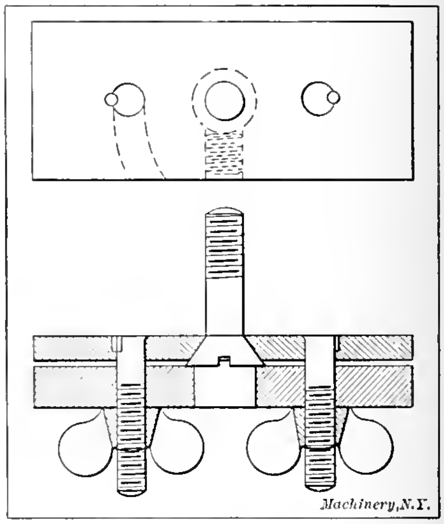
JOHN F. WINCHESTER.

Salem, Mass.

FIXTURE FOR HOLDING COUNTERSUNK SCREWS

As a number of 5/16-inch countersunk screws had to be threaded right up to the head for a certain job, and as those in stock were only threaded about two-thirds their length, I made a fixture as shown in the illustration for holding them while the die was used to cut the extra thread. As will be understood by referring to the plan view, the work was inserted or removed from the fixture by swinging the top plate to one side. To prevent the screw from turning, a plug with a tongue fitting the slot in the screw head was inserted in the hole in the bottom plate. This plug, which is held by a set-screw, was made removable so that it could be replaced in case the tongue should twist off.

ORIGINAL.



Fixture for Holding Countersunk Screws while Extra Thread is being cut

SHEAVES FOR MANILA ROPE

Very little is being written on rope driving in technical papers, although this subject should be of almost universal interest to shop owners, etc., as the transmission of power by means of ropes has become an established fact.

In a general inspection of catalogues of manufacturers of power transmission material, it would appear that very little attention is given to the details of sheave construction; however, next to the ropes, the most important detail is the construction of the sheave, as the best of ropes will be quickly put out of commission if the sheaves are not perfectly smooth as to grooves, well designed, etc.

There seem to be three different angles used for grooves, 45, 50 and 60 degrees, but the 45-degree angle appears to be the most generally adopted, and it will be found that this angle will give the best results for both the English and the American systems of rope driving. It is contended by some that 45 degrees for the English and 60 degrees for the American system is the most correct, but no sound argument has yet been made why the American groove should not be the same as the English system, or 45 degrees.

The word "split," where it is used in reference to sheaves, appears in many catalogues. A split wheel, as it is generally understood, is cast whole with cored slits; wedges are then driven in the cored slits to split the wheel, and this gives fractured joints. This method is used for belt pulleys, but should not be used on sheaves. Sheaves, if not made solid, should always be cast in two pieces, the joints planed, the bolt holes drilled, reamed and fitted with finished bolts. Fig. 1 shows a sectional view of grooves as generally found in catalogues, for the English or multiple system. As generally shown, dimension *t* remains the same, whether the sheave is for one or more ropes. Section *t* is made stronger than section *f* to avoid breaking in handling; but, for instance, take a sheave that is made for ten 2-inch ropes: Section *t* will appear to be nicely proportioned, but for a sheave with two 2-inch ropes, this section will be all out of proportion with section *f* (see Fig. 2). Of course, section *t* cannot fall below a certain

thickness, but there is also no reason for making it the same for any number of ropes.

In laying out the grooves, we will find that for sheaves having six or more ropes, a certain standard for section t will be all right, but for sheaves having less than six ropes, the dimensions given in the accompanying table will be more in accord with section f for sheaves up to 60-inch pitch diameter. Sheaves larger than 60-inch pitch diameter may have

TABLE GIVING THICKNESS FOR SECTIONS t AND f FOR SHEAVES UP TO 60-INCH PITCH DIAMETER AND FIVE ROPES OR LESS

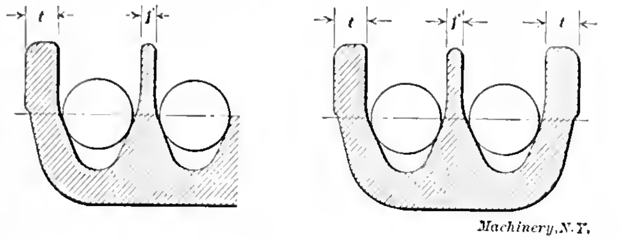


Fig. 1. Fig. 2.

Size of Rope in inches	t	f	Size of Rope in inches	t	f
1 1/8	3/8	5/16	1 1/2	9/16	3/8
1 1/4	7/16	3/8	1 3/4	5/8	3/8
1 3/8	1/2	3/8	2	11/16	3/8

the regular thickness for section t, as shown in Fig. 1, as they become too heavy if the dimensions given in the table are used.

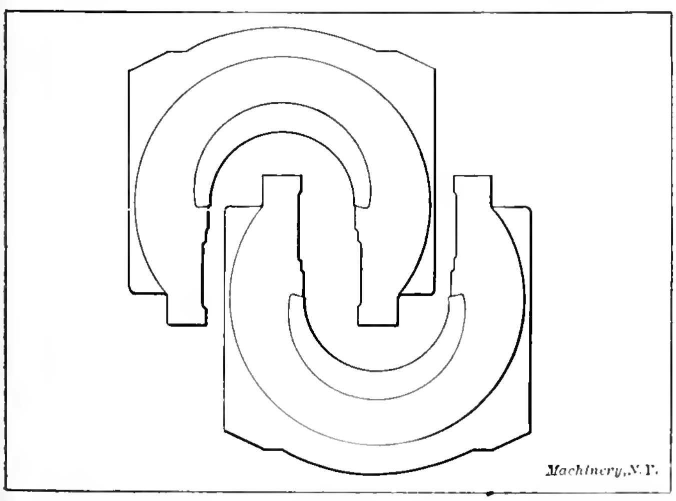
Arguments, etc., as to the advantages of rope driving, may be had from any manufacturer of Manila ropes. There is no doubt that for main drives, ropes have proved superior to belts, but for counter and machine driving, belts are still generally used.

AUGUST WACKERMANN.

Pittsburg, Pa.

CENTER REST FOR DRIVING BOXES

A machinist brought a pretty good shop kink to my notice the other day for laying out a set of driving boxes—one that saves a lot of time and trouble. In most shops when laying out a driving box the machinist fits a piece of wood in it to hold the center for his dividers. Instead of so doing, if the machinist will just slide the other box leg in between the



Simple Way of obtaining a Center Rest when Laying Out Driving Boxes

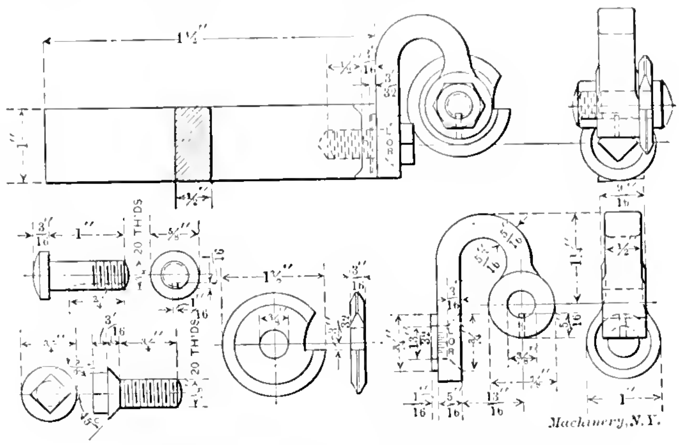
sides of the box being laid out, as shown in the illustration, he will have a good solid piece of iron, which is the same height as the box, on which to lay off the center. As the boxes are heavy, they stay in place and the two can be laid out at the same setting, using one to hold the center for the other.

A. G. JOHNSON.

Two Harbors, Minn.

A SPRING THREADING TOOL

A tool designed for use in cutting master taps, screw gages, and other parts where accuracy is desired, is shown in the engraving. It has all the advantages of a spring tool and is equipped with a removable cutter which can be sharpened and replaced without resetting. The principal advantage lies in the fact that the shape of the cutter may be ground to any desired degree of accuracy and no dependence need be placed on thread tools or gages bought in the market. The cutters are first rough turned, hardened, the hole lapped, and the faces ground parallel. They are then placed singly on a mandrel, and ground to the proper included angle and to a perfectly sharp edge. It will be noticed that the cutting edge



Circular Threading Tool with Spring Holder which may be adjusted for Right- or Left-hand Threads

is not radial, but to give clearance, is ground on a line 3/32 inch below, and parallel to the horizontal diameter. To secure the proper angle at this point, the center of the grinding spindle should be dropped 3/32 inch lower than the center of the cutter arbor, when grinding. If the cutter is to be made for U. S. S. or Acme threads, after grinding to a sharp edge, it is carefully measured on this diameter, the amount of flat calculated and subtracted therefrom, and the sharp edge reduced to this dimension. The engraving plainly shows the construction of the holder, by means of which the cutter can be tilted for right or left-hand threads. The lip of the cutter should be horizontal and the height of the lathe centers.

T. CAIN.

HEAVIER TOOL-POSTS FOR SHAPERS

Some of the so-called high-duty shapers are equipped with rather insignificant looking tool-posts, as shown in Fig. 1, having screws entirely too small for holding the tool. The tool-post screw for 18-inch shapers and over, where a single

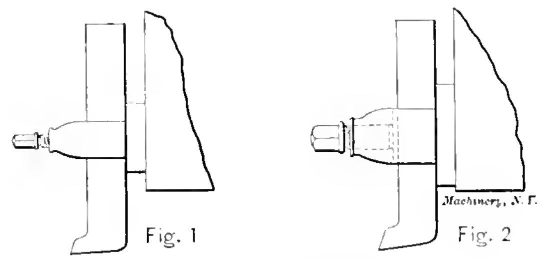


Fig. 1 Fig. 2

Figs. 1 and 2. Light Form of Tool-post found on some Shapers, and Suggested Change

screw is used, should be at least 1 inch in diameter (instead of 5/8 inch) as shown in Fig. 2. The tool-post can then be depended upon to hold the tool right where it is wanted.

Brighton, Mass. F. RATTEK.

* * *

PROTECTING POLISHED STEEL WORK FROM RUST

Polished steel work may easily be protected from rust by the application of the following compound:

Lard	6 parts
Rosin	1 part

The two ingredients are melted together and stirred until cold. The rosin prevents the mass from becoming rancid and also acts as an air-tight film. If rubbed upon a polished steel surface, even very thinly, it effectually preserves and protects the polish. It is easily removed by gasoline or kerosene.—*Brass World.*

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

DEEP HOLE CALIPERS

J. W. M.—I have to determine the size of a hole at the bottom of a 4-inch bore about 12 feet long. What is the best means of accurately calipering under such conditions, using either a standard measuring device or home-made contrivances?

A.—The best means depends on the character of the work, and the degree of accuracy required. The question is referred to our readers for suggestions. Descriptions of deep-hole calipering devices will be acceptable.

OILING MACHINE PARTS WHEN ASSEMBLING

G. B. D.—Should a taper pin be oiled before driving it home?

A.—A taper pin should be oiled before driving home, and in fact almost all ordinary machine parts should be lubricated before assembling whether they are pins, bolts, screws or other members. If a taper pin is oiled before being driven into place, it can be put into place with lighter blows, and will be less likely to work loose than if put in dry.

SETTING A THREAD TOOL FOR THREADING TAPER TAPS

A. B. C.—Should a thread tool be set square with the tailstock spindle or square with the surface of the taper when cutting the thread of a taper tap, assuming the work is done in a lathe provided with a taper turning attachment?

A.—The tool should be set square with the tailstock when threading a taper tap in a lathe provided with a taper attachment. The rule is to set the tool square with the center line of the tap. If the threading is done with the tailstock set over, the tool may be set square with the surface of a straight arbor of the same length of the tap, held between the centers.

TO CALCULATE THE WEIGHT OF HEXAGON BAR STOCK

G. V.—Please give a rule for calculating the weight of hexagon bar stock.

A.—Square the thickness of the stock across the flats and multiply by 0.866, and the area thus obtained by the length, to obtain the volume. The volume, in cubic inches, multiplied by the weight of a cubic inch of the material is the weight. Example: Suppose that the weight of a steel hexagon bar 2 inches across flats and 12 inches long is required; $0.866 \times 2^2 \times 12 = 41.568$, which multiplied by 0.283 pound, the weight of one cubic inch of steel equals 11.76, the weight of the bar, in pounds.

WARPING OF PUNCHED COLD-ROLLED PLATE

F. G. S.—We make a number of 1/16 inch thick cold-rolled 10- by 14-inch sheet steel plates with about sixty 1-inch holes, punched or drilled. We have tried both drilling and punching but the plates have sprung and buckled to such an extent as to make their use impossible. We have tried rolling, peening, heating and laying between heavy cold plates, but all to no avail. Can you suggest a remedy for our trouble?

A.—The difficulty is one that you probably cannot overcome with the material used unless it is annealed before drilling or punching. Cold-rolled stock is in a state of stress due to the cold finishing process. The surface is in a state of compression and the interior in a state of tension. A cold-rolled bar or plate remains straight so long as the interior and exterior forces are balanced as they were when leaving the rolls, but if metal is removed from the surface a change of shape immediately results. This will be observed in turning cold-rolled shafting or cutting long keyways in same. When you punch or drill holes in the plate, the interior and exterior stresses readjust themselves with the resulting change in shape noted. You must carefully anneal the plate before punching or drilling, or use some other material.

PROBLEM IN METAL SPINNING

R. L. C.—I have to do the job of metal spinning, shown in Fig. 1, and am doubtful as to the best method to follow in spinning this shape. The shell is to be 20 inches diameter, 6 inches deep, and 0.060 inch thick. The metal to be used is zinc.

A.—This is an interesting metal spinning job, and not a particularly difficult one. The shell can be best spun with the aid of two spinning forms, such as are illustrated in Figs. 2 and 3. These forms should be made of kiln-dried maple if there are comparatively few shells to be spun. If there are many, the form should be made of cast iron. Fig. 2 shows the first form to be used, which conforms to the outside of the shell as far as the centers of the spherical ring. Beyond these points, the form is straight. The blank to be spun is placed as indicated by the dotted lines, and follower No. 1 is used to hold the work against the form. The chief trouble

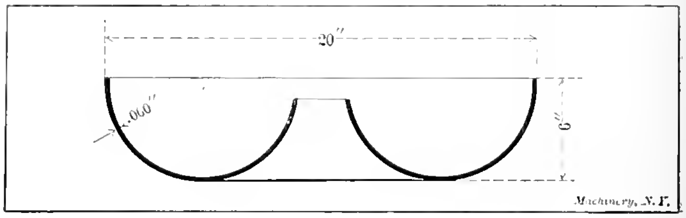


Fig. 1.

will be met in properly starting the shell, because of the small follower that must be employed. However, follower No. 2 may be substituted after working the metal back against the form a few inches, and as this gives a better grip on the shell, there will be no further danger of slipping. After spinning the zinc shell to the shape of the first form (Fig. 2) it will probably have to be annealed, but this can only be determined by trial. In annealing zinc, the flame should not be allowed to touch the metal. The half completed shell is then put on form No. 2 shown in Fig. 3. It is an easy matter to spin the metal around to complete the arc. The dotted line shows the position of the shell before starting the last part of the spinning. Of course, it will be understood that the shell must be trimmed several times during the spinning, and if the trimming is frequently done, a well-shaped shell should

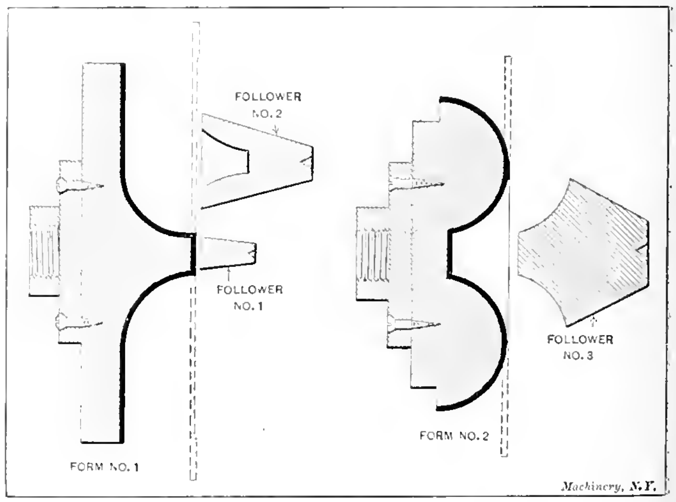


Fig. 2 Fig. 3

result. For spinning on form No. 2, follower No. 3 must be used. Either beeswax or soap should be frequently rubbed over the work while spinning. If it is necessary to cut out the center, it can be done before removing the shell from the last form by simply removing the follower and using a diamond point tool, or in large product work the swivel cutter will work well. The shell will cling to the form without the follower. The spinning speed should be from 800 to 1,000 R. P. M.

* * *

Considerable attention is given by the German technical institutions to the science of aeronautics. A bill has been introduced in the Diet of Würtemburg, asking for $2,250 yearly for a chair in aeronautics at the Stuttgart Technical University. The government also announced that a sum of $12,000 has been offered privately for the purpose of establishing a laboratory for aeronautics in connection with this chair.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BECKER FRICTION FEED VERTICAL MILLING MACHINE

An interesting type of vertical milling machine, embodying some radically new features, has recently been brought out by the Becker Milling Machine Co., Hyde Park, Boston, Mass. This machine will be built in four sizes, known as Models

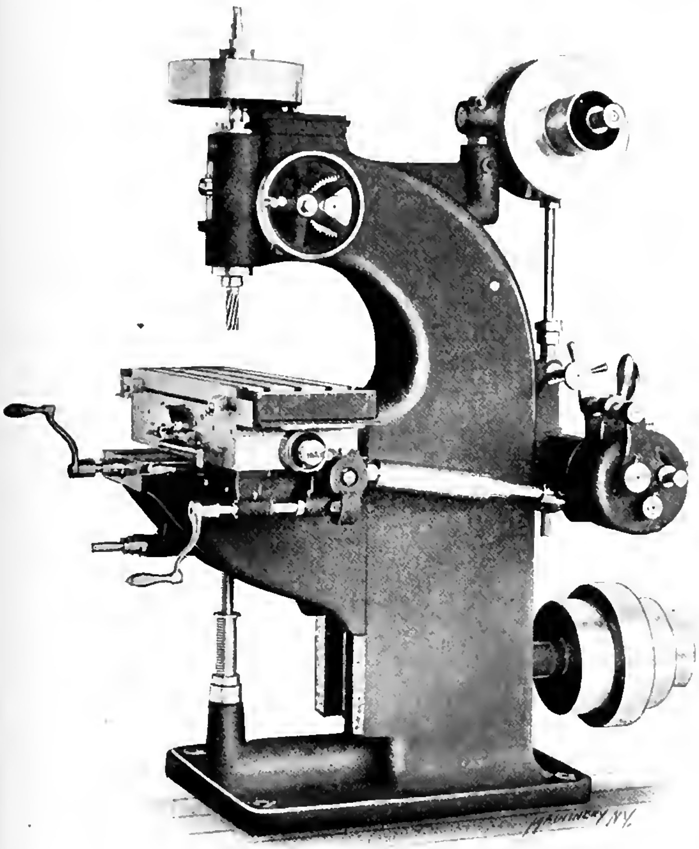


Fig. 1. Side View of Friction Feed Vertical Milling Machine, built by Becker Milling Machine Co., Hyde Park, Mass.

A, B, C and D, respectively. The accompanying half-tone illustrations show the model A machine, and the description applies in particular to this size; but all the sizes to be built embody the same features, with slight modifications in such mechanisms as the back-gearing, gear boxes, etc., which, of course, on the different sizes are made to suit the requirements for, and capacity of, each machine. Fig. 1 shows a side view of the machine and Fig. 2 a rear view, exhibiting some of the important features of the feed mechanism.

Main Spindle Drive

The main drive of the machine may be either by means of a three-step cone pulley as shown in Fig. 1, or by a constant speed single pulley drive, the power being obtained directly from an electric motor or from a pulley on the line shaft. When the single pulley drive is employed, a gear box of simple design and similar in principle to the feed gear box, which will be described later, is made use of in order to obtain the required speed variations on the driving pulley of the machine, which is belted directly to the pulley on the vertical spindle. This gear box provides for five speed changes. The machine shown is not provided with back-gearing, but if required, back-gearing arranged practically on the same principle as that of a lathe, and enclosed in a very compact gear box placed immediately beneath the pulley on the vertical spindle, is provided. The back-gearing for the model A machine is of the regular type, and for the larger sizes, of the double type, so that by means of the back-gearing and a gear box on the main driving shaft, 10 speeds on the model A machine and 15 speeds on the larger sizes may be obtained. Five of these speeds are obtained without the back-gearing, using open belt drive.

As is clear from the illustrations, Figs. 1 and 2, the 3-inch belt from the driving pulley at the bottom of the column passes over two idler pulleys. These pulleys, as is seen in Figs. 2 and 3, are mounted on the hubs of large friction disks that operate the feed mechanism which will be described later. The spindle speeds obtainable by the gear box when the constant speed pulleys run at 405 revolutions per minute—the speed recommended by the makers—are 80, 120, 180, 270 and 405 revolutions per minute. If it be desired to obtain higher speeds than these, a two-step cone pulley may be provided on the machine, and two pulleys of the required size placed on the line shafting. By this simple means another five speeds may be obtained of 150, 225, 335, 505 and 760 revolutions per minute, without resorting to back-gearing.

The column is cast in one piece, so as to insure rigidity. The vertical movement of the spindle head is obtained by means of a hand-wheel on the side of the machine, as shown. The spindle is hardened at the main bearing, and finished by grinding. The bearing boxes are made of bronze, and provided with simple means of adjustment. The head is cylindrical, which insures perfect alignment, and is provided with a micrometer stop gage, placed, as indicated in Fig. 5, in the slot at the front of the column of the machine. The graduated collar of this stop gage is of large diameter, so that each gradua-

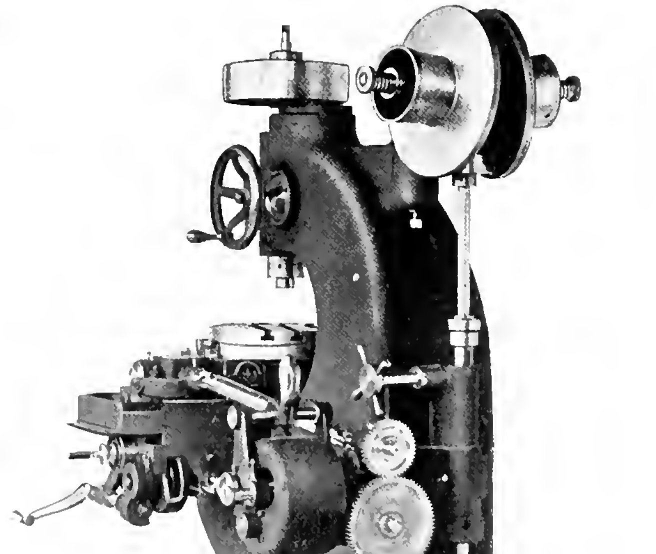


Fig. 2. Rear View of Becker Milling Machine, showing Friction Feed

tion corresponding to 0.001 inch is nearly 1/16 inch wide. This makes it possible to obtain very accurate adjustments without difficulty. At the lower end of the slot in the column a small projection or shelf is provided, on which can be placed circular gage blocks about 1½ inch in diameter, carefully made to standard thickness. By means of these gage blocks it is possible to bring the head down any definite amount; for instance, if it be required to bring the head down exactly three-quarters of an inch after one cut has been made

over the work in the machine, the micrometer stop is first brought against a $\frac{3}{4}$-inch gage block placed on the shelf or on the top of other gage blocks, and when the first milling cut has been completed on one lever, the $\frac{3}{4}$-inch gage block is removed and the head brought down until the stop rests against either the shelf or the remaining gage blocks, and the work is completed. By different combinations of gage blocks it is possible to obtain close measurements for all movements of the head. If it is required to move the head

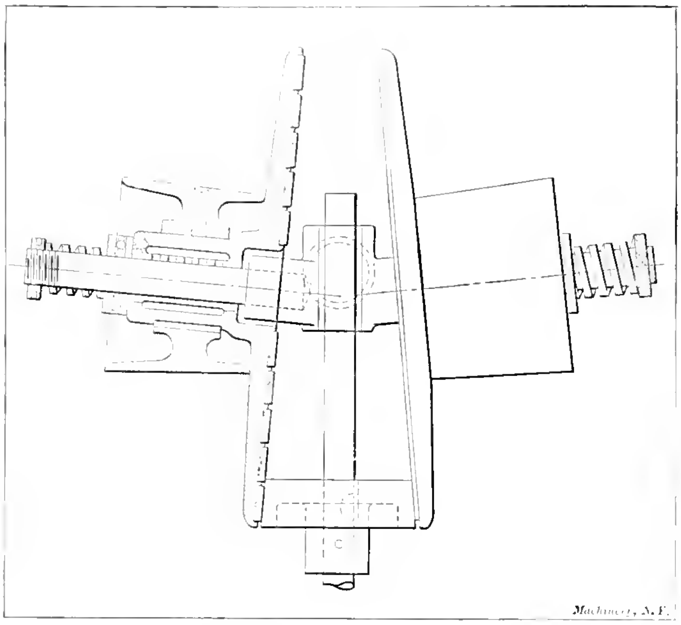


Fig. 3. Friction Feed Disks and Mounting of Idler Pulleys

only a few thousandths of an inch, the stop, of course, is brought against the gage blocks and then the graduated collar is turned the amount required, to raise or lower the head.

Friction Feed of the Machine

The distinctly novel and, without doubt, the most interesting feature of the machine is the friction feed drive. This drive may be defined as being a positive friction feed, inasmuch as the belts on the driving pulleys of the machine will slip or be thrown off their pulleys before the friction feed will cease to operate even on the heaviest cuts. This is due to the ingenious arrangement of the friction disks and the manner in which the pressure is applied to them. It will be noticed in Figs. 2 and 3 that springs are provided on the ends of the studs on which the friction disks are mounted, these springs tending to add to the pressure on the friction roller, but it has been found that by the arrangement employed these springs are unnecessary and can be removed. The pressure is furnished entirely by the driving belt passing over the idler pulleys, which are mounted on shafts placed at an angle upward and backward with the horizontal, as indicated by the position of the friction disks at the ends of the pulleys in Fig. 2. This angular arrangement produces an inward pressure of the belt on the idler pulley, which, in turn, is transmitted to the friction disks and used for obtaining the required pressure on the friction roller.

As there are two idler pulleys both placed at corresponding angles and the belt passes over both with practically the same tension, the drive is balanced, and the difficulty with friction drives usually encountered—that of providing adequate thrust bearings—is eliminated. The angle of the friction roller is 10 degrees on each side, it having been found that with the arrangement used this angle will produce the greatest pressure and the most efficient transmission of power to the feed mechanism. The idler pulleys are conical, being about one-half inch larger in diameter at the outside end than at the end abutting against the friction disks. This feature throws the belt further out on the idler pulley when running at high speed, due to the centrifugal force, and this in turn tightens the belt and increases the belt tension, at the same time increasing the pressure on the friction disks and roller. Thus, the higher the speed or the heavier the cut, the greater the belt tension, and the more powerful the friction drive mechanism.

A line drawing, illustrating in a general way the arrangement of the idler pulleys and friction disks, is shown in Fig. 3. The idler pulleys, as shown by the sectional view, are not cast in one piece with the friction disks, but are fastened to the disks by keys and set-screws, the friction disk being provided with a long hub for this purpose; the hub is provided with ample means for lubrication.

An interesting feature, and one of extreme importance in a friction drive, is the method used for fastening the leather to the cast iron friction disks; one of the chief difficulties of friction drives in the past has been the trouble met with in the loosening of the leather from the disks. A common method employed has been to first attach one disk of leather to the cast iron disk by means of small pins or rivets, turning off the rivet heads level with the surface of the leather, and then attach another thickness of leather, by means of leather cement, to the one fastened to the cast iron disk. This means of fastening gave no trouble as long as the leather was kept free from oil, but as the leather in any friction drive, in order to transmit power efficiently, must be kept soft and pliable, and, therefore, must be oiled occasionally, the oil would dissolve the cement, and the leather disk would become loose.

In the construction used in the friction feed disks on the Becker milling machine, no cement is used between the leather and the disk, and therefore the required amount of lubrication can be supplied to the leather without any danger of interfering with the durability of the drive. The cast iron disk is provided with a number of concentric grooves of a dove-tail shape, as shown in section in Fig. 3. The leather, cut into segments, is pressed into these grooves, where it is held very firmly on account of the shape of the groove. When

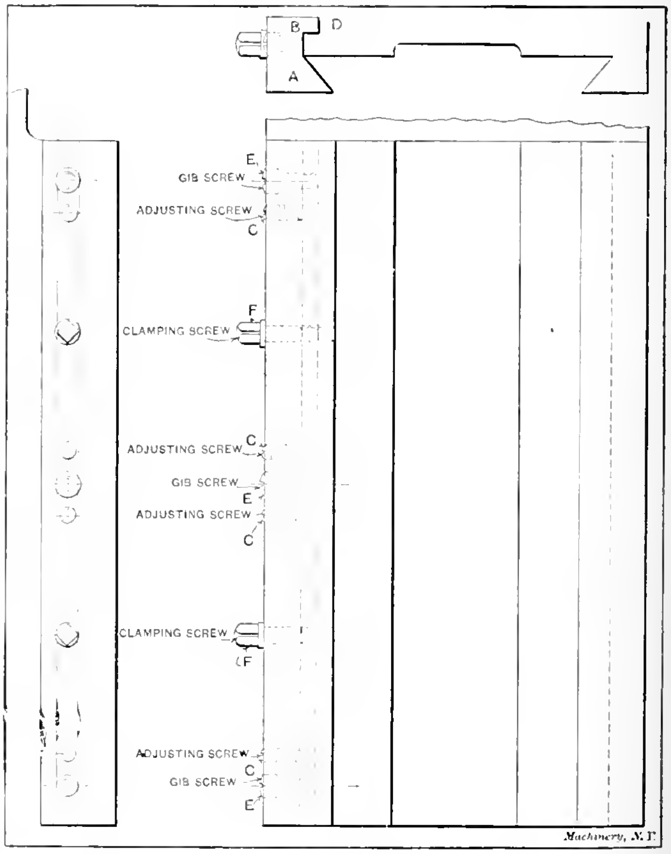


Fig. 4. Construction of Gib for Milling Machine Knee Slide

the pressure is applied to the disks against the friction roller, it is evident that the leather is still more firmly pressed into the dove-tail, so that the heavier the feed is, the firmer is the grip between the leather and the cast iron disks. The friction roller is adjusted up or down as required for different feeds by means of the small hand-wheel or spider shown in Fig. 2 at the back of the column. On the end of the shaft of this spider is a small pinion engaging with rack teeth on the sleeve of the vertical feed shaft. The power from

the vertical feed shaft is transmitted to the feed gear box shown in Figs. 1 and 2 by means of worm and worm-gear. The feed gear box is of a very simple construction. It is operated by means of the handle on the top, and by the push pin on the side of the gear box shown projecting outside of its bearing. By means of this gear box five variations in feed can be obtained without varying or changing the location of the friction roller. One of these feeds is obtained without any of the gears in the gear box proper running, but

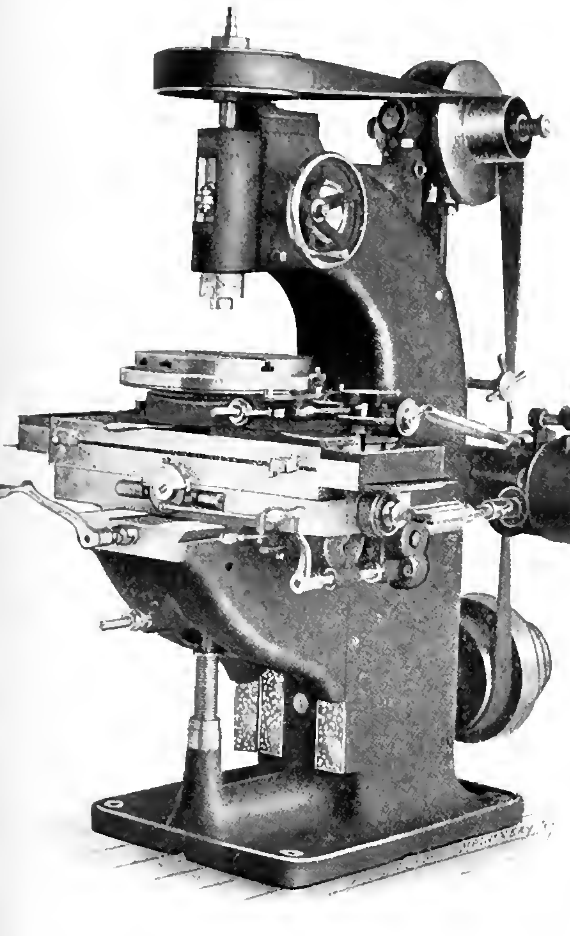


Fig. 5. Becker Milling Machine with Improved Rotary Milling Attachment

by connecting the horizontal feed shaft directly with the telescoping shaft leading to the table. In this way the loss of power incident to transmitting the motion through a great many gears is avoided, and the feed is brought to the table in as direct a manner as possible. By the combination of the friction feed disks and the gear box it is possible to obtain all feeds on the machine between 0.003 inch to 0.067 inch per revolution of the cutter. This refers to the model A machine. On the model B machine feeds can be obtained from the same minimum of 0.003 inch up to $1\frac{1}{4}$ inch per revolution of the cutter.

The design of the gear box is novel, and it differs in construction from the ordinary type in important details. Instead of using a sliding gear or tumbler moving back and forth on the tumbler shaft, the whole tumbler shaft moves by means of the push pin shown It is placed in bearings on the outside of the gear box, thus making lubrication very easy. As there are no interior bearings to oil, there is no need of a complicated lubricating arrangement with oil tubes leading to the various bearings on the inside of the gear box.

The power of the friction drive is well exhibited by the fact that the machine will take a cut in cast iron 1/16 inch deep with a feed of 1/16 inch per revolution of the spindle, with a six-inch cutter. The larger sizes, of course, will permit of proportionally heavier cuts.

Another new feature of the machine is the arrangement of the knee slide. Instead of having a knee provided with a dove-tail slide, and the dove-tail on the column of the machine, the order has been reversed, and the column of the machine is provided with a dove-tail slide, the dove-tail being on the knee. This in combination with the arrangement shown in Fig. 4 for adjusting the dove-tail slide and binding the knee when required, makes it possible to obtain a construction without any loose gibs. The piece *A*, Fig. 4, is made a very close fit in the groove in the column at *B*. In order to adjust the slide properly for the dove-tail on the knee, the adjusting screws *C* are used, which bear against the face *D* of the column, as shown. When the proper adjustment has been obtained it is permanently retained by tightening the gib screws or binding screws *E*. When it is desired to lock the knee to the column of the machine, the clamping screws *F* are tightened, which then spring the gib between the adjusting screws *C* a very small amount, enough to hold the knee rigidly in position. This method of binding insures perfect freedom from change in alignment, and is considered by the builders as a very important improvement in milling machine design. The knee is made with a double wall box construction and is thus unusually heavy and rigid.

Mechanism for Stopping and Reversing the Table

In the front of the machine in Figs. 1 and 5 is shown a new and interesting mechanism for stopping and reversing the table at the end of its travel. Stop dogs are provided as usual, operating a mechanism shown in the center of the saddle. By manipulating the two plungers on each side of the central reversing disk, it is possible to either have the machine move constantly back and forth automatically, or to have it stop at the end of its travel to the right or at the end of its travel to the left. The manipulation of the plungers can be made during any part of either the forward or the backward stroke; the machine will stop first when it comes to the end of its stroke at either the right or left, according to which one of the plungers is manipulated. The central reversing disk is provided with a spring arrangement which throws it over rapidly to either side as soon as the stop dogs have moved it over a certain amount; a pitman connects the disk with a handle which operates the clutch between the two bevel gears used for reversing the table. This makes a very simple arrangement which is exceedingly handy and useful.

The table of the machine is provided with a cover which protects the top of the saddle from chips and dirt whenever the table is moved to extreme positions either to the right or left. This cover does not telescope, but consists of a leather shield with a sheet iron hook at its end, which holds it to the end of the saddle when the end of the table passes by this point. The other end of the leather cover is rolled up in

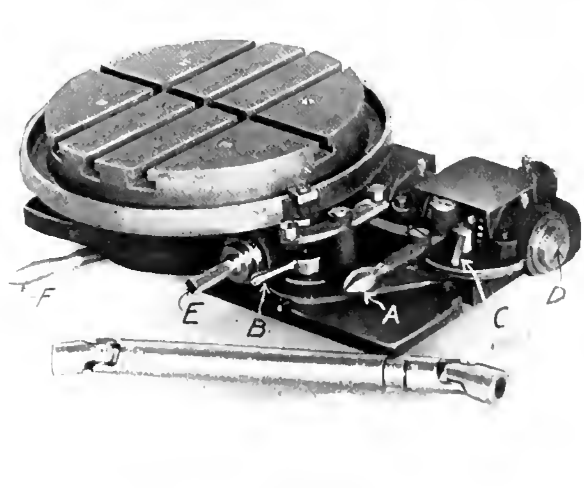


Fig. 6. Rotary Milling Attachment Removed from Table, in order to show Details

a manner similar to that of an ordinary shade. The same arrangement is used back of the table between it and the column, in order to protect the knee and the working parts contained in it from the chips when the table is moved outward.

Drive for the Rotary Milling Attachment

Another improvement which has been introduced on this milling machine relates to the drive for the rotary milling attachment shown in place on the machine in Fig. 5, and in detail in Fig. 6. In the previous types of the Becker milling machine, the rotary attachment was driven through a gear

box placed on the right-hand end of the milling machine saddle, the power being obtained through the regular telescoping shaft. In this machine, as shown very clearly in Fig. 5, the power for the rotary attachment is obtained through an independent telescoping shaft connected directly with the regular feed gear box. In Fig. 6 the attachment is shown by itself, removed from the machine; *A* is the handle which operates the clutch between the two bevel gears, by means of which the motion of the rotating table is reversed. The shaft *D* on which these two bevel gears are mounted is connected by bevel gearing with the worm-gear shaft *E*, from which the power is transmitted to the rotating table through worm and worm-gear. The motion is automatically thrown out by means of the dog shown on the rim of the rotating table, which operates the lever mechanism indicated and returns the handle *A* to a central position. The worm can be thrown out of engagement with the worm-gear by operating handle *B*, and when either thrown in or out of engagement the attachment is locked in position by the binder *C*. This arrangement has the advantage of being easily removed from the table of the machine, it being necessary only to loosen two bolts and slide it off. When required, the rotating table can be locked in position by handle *F*, and regular straight milling can be performed without removing the attachment.

General Remarks

In general, throughout the design of this machine, gears have been eliminated wherever possible. Mr. Becker, who is responsible for the design, considers that entirely too much power is lost by driving through the usual type of gear boxes, and also in obtaining feed changes through gear boxes. For this reason the drive of this machine is so arranged that even when a gear box is introduced, one set of speeds can be obtained without using the gears in the gear box; and by means of the friction feed, a wide range of feeds can also be obtained directly, without introducing the gears in the feed box. Even when the gears in the feed box are running, a maximum of two sets of gears are in engagement at a time, so that the losses due to the gearing are a minimum. The direct friction feed, when arranged as in these machines, is more positive even than a gear feed, because there is no back lash or unsteady, intermittent motion, as is likely to be the case when the gears get badly worn. As the idea of geared driving heads and speed of gear boxes has been carried rather to its extreme in some recent designs, it is all the more interesting to note the efficiency which can be obtained by returning to the older idea of using belt drives in as large a measure as possible. By means of a wide driving belt, large pulleys and high belt velocity, all the power of the regular gear-driven machine can be obtained in an open belt drive, and the present machine will do milling jobs for which the back-gears would ordinarily be used, without throwing in the back-gearing. This machine, therefore, is an interesting development in machine tool design, and will undoubtedly be received with considerable interest by the mechanical trade.

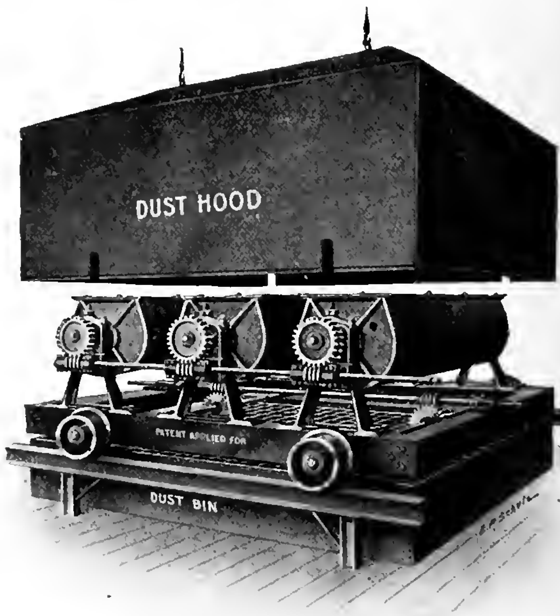
MACHINE FOR SHERARDIZING OR DRY GALVANIZING

The process of galvanizing metal products by the dry or sherardizing method has been previously described in MACHINERY (see article on the subject in the August, 1908, number). It consists, in brief, in packing the articles of iron or steel to be galvanized in air-tight drums with the impalpable powder swept from the flues of zinc smelters. This powder (known to commerce as zinc dust) consists of particles of metallic zinc, about 0.00002 inch in diameter, coated with a layer of zinc oxide. When the work thus packed is heated for the proper length of time to a temperature of 800 or 900 degrees, it is given a lustrous gray coating of zinc. Apparently the zinc dust remains as it was before, the action being somewhat of a mystery. In reality, however, the dust has parted with metallic zinc and it gradually deteriorates, though it may be used over and over again for months.

The apparatus for sherardizing shown herewith is the invention of Albert F. Schroeder, and is built by the Globe Machine & Stamping Co., of Cleveland, O. This firm established the first commercial sherardizing plant in the country, designing practically all its equipment for the purpose. Its experience in this work has been applied to the machine here shown, with the result of great improvement in efficiency and economy over the methods originally followed.

The most important improvement is in the provision made for rotating the drums in which the work is subject to action of the dust. Three of these drums, as shown, are mounted on a car, which can be pushed bodily into the heater. The constant agitation of the work and the dust together brings them into contact at every point of their surfaces, packing the zinc down into the interstices of chains or into the finest threads of bolts and screws. Where this rotating or tumbling is not resorted to, there are parts of the work which are liable to escape galvanizing on account of being in contact with each other, to the exclusion of the zinc.

The rotating of the drums also expedites the process by bringing new dust into contact with the work. It also assists in bringing the interior up to the same degree of heat as the



Schroeder Machine for Dry Galvanizing

oven, by continually bringing new hot dust from the walls to the cooler interior. This shortens the time required, as zinc dust is naturally a poor conductor of heat. For the same reason, the interior temperature tends to keep the same throughout the whole area, enabling the operator to control the process better than under the old conditions.

As may be seen the drums are rotated by worm gearing. The contents are shoveled into them through the opening made by removing a flat plate on top. To empty the drums, they are revolved half way round. The emptying takes place over a bin provided with a screen top, which allows the dust to fall through, leaving the work clear on top. The dust-hood shown is dropped over the machine during this emptying process, preventing its escape into the room. The dust-hood and bin are, of course, located outside the oven, from which the car is removed previous to tumbling.

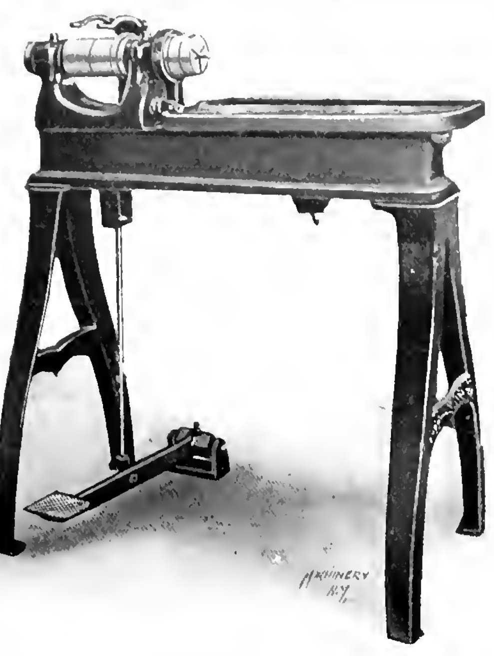
The sherardizing process has been adopted by some of the largest electrical and other concerns of the country, and has been in successful use for several years in foreign countries.

WELLS POLISHING AND FINISHING LATHE

The polishing and finishing lathe shown in the accompanying half-tone illustration is built by the F. E. Wells & Son Co., Greenfield, Mass., and is designed for all kinds of light work, such as polishing, burring, etc., on pieces which can be held in a spring or collet chuck. As indicated in the illustration, the chuck is opened by a foot lever, which at the same time shifts the belt to the loose pulley and applies a friction brake for stopping the machine immediately. When the pressure on the foot lever is released, a spring shifts the

belt back again to its driving position on the tight pulley, and the chuck, at the same time, is closed. This arrangement makes it possible for the operator to have both hands free for handling the work.

The general dimensions of this machine are as follows: The length of the bed is 42 inches; the swing over the bed,



Polishing and Finishing Lathe, built by the F. E. Wells & Son Co., Greenfield, Mass

11 inches; and the capacity of the chuck from ⅛ to 2 inches. The width of the driving belt is 2 inches, and the weight of the machine complete is 325 pounds.

NO. 1 TILTED TURRET SCREW MACHINE

In the department of New Machinery and Tools in the July, 1909, number of MACHINERY, we described in some detail the design and construction of the "tilted turret" screw machine made by the Wood Turret Machine Co., of Brazil, Ind. The

Fig. 1. No. 1 Size Tilted Turret Screw Machine

turret slide of the machine then illustrated was operated by a pilot-wheel. The accompanying illustrations show a smaller size of this machine of the same general design, but provided with a lever feed.

Fig. 2 shows this lever feed to best advantage, and illustrates as well the novel points of its construction. A rack and sector movement is used. The lever and sector form one piece, and the latter meshes with a rack secured to the turret-slide. With the usual construction on small size screw machines, the lever is pivoted to the slide, and is connected to the slide bed by a link or swiveling post. Under these conditions a changing leverage results, which requires the operator to exert more power at the start and finish of the stroke than in the middle. The arrangement shown in Fig. 2, however, permits the operator to exert the same pressure against the work at all parts of the stroke, allowing a much greater effective length of motion, so that longer cuts can be taken than on other machines of the same capacity.

The general construction of this machine is the same as with the designs previously illustrated. The tilting turret, from which the machine takes its name, will be readily recognized. It allows the stock to pass into or directly through the turret head, the center bolt being bored to permit this. When projecting through, the stock passes out through one of the auxiliary holes in the lower half of the turret in the rear, without interfering with tools clamped in the rear position. The construction has other incidental advantages as well. The strain on the center bolt is minimized, since the angular setting of the turret applies a part of the thrust directly onto the slide, doing away with the tipping occurring with the old style high turret. Furthermore, the construction permits the use of die heads or box tools of larger diameter than on other machines of the same capacity and the same swing.

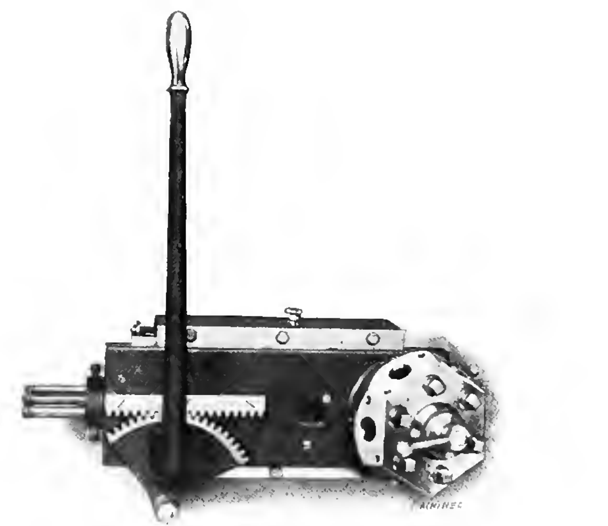


Fig. 2. Lever Feed of No. 1 Tilted Turret Screw Machine

Other features of this design that should be noted are the provision for lining the turret holes horizontally and vertically with the spindle, the provision of independent stops for each hole in the turret, and the arrangement for throwing out the indexing mechanism when only one hole in the turret is to be used. The lock pin holes are bushed so that any wear that may occur can be taken care of by rebushing the holes.

The machine here shown is the No. 1 size, having an automatic bar chuck capacity of ¾ inch. It is provided with an automatic stop feed. This tool may be seen in operation at the demonstration shops of Hill, Clarke & Co., in Boston or Chicago, or at their branch offices in New York, Philadelphia and Cleveland.

BAKER BROS. NO. 0 CYLINDER BORING MACHINE

The illustrations herewith presented show the well-known drilling machine made by Baker Bros., of Toledo, O., in a design especially adapted to automobile cylinder boring. This machine is the smallest member of a line which includes five sizes and types of single, double and four-spindle machines. This particular one is designed for boring small cylinders, being rated for diameters up to 3¾ inch and depths up to 8 inches. This is its range with maximum production, but it will easily bore much larger diameters, as it is provided with an unusually powerful spindle driving mechanism.

A distinctive feature of the machine is the provision made for employing boring bars of nearly the full diameter of the cylinder being bored. It is this feature which accounts for

the large output of which the machine is capable. The bar is driven from the spindle by a tongue and groove joint as shown. It has a bearing in a housing bracket, which is secured to the front of the machine, and carries a bronze bushing fitted to a taper seat. This provides adjustment for the bearing of the hardened boring bar, which is thus held so closely that there is no danger of its following the cored hole.

It is customary to set these machines up in gangs of three or four units. Where the cylinders are reamed, they are roughed under the first spindle, straightened under the second and reamed under the third. When two cuts only are taken before grinding, the cylinders are roughed in the first and third spindles and straightened in the second and fourth. The method of handling the work is such that the cylinders may progress from one spindle to the next without interruption for rough boring, straightened boring and reaming. The design is such as to adapt the machine to the boring of single cylinders, twin cylinders, or four cylinders "cast in block." The engravings show the machine with a fixture for holding an unusual type of open end cylinder.

In regard to the general design of the machine, it may be said that it is adapted to high speeds and feeds. All shafts are ground, and all bearings are bronze bushed. Most of the gears are of steel, hardened where necessary, and run in a bath of oil. The machine swings 12 inches from the center of the spindle to the frame. It has 8 quick change geared spindle speeds, and 12 changes of geared feeds. A single belt-drive is provided, the design of the machine being such that it may be belted directly to the line-shaft, allowing a number of them to be placed side by side to form gangs of any required number of units. The weight of the machine is 3,500 pounds and the floor space occupied is 3 feet, 6 inches square.

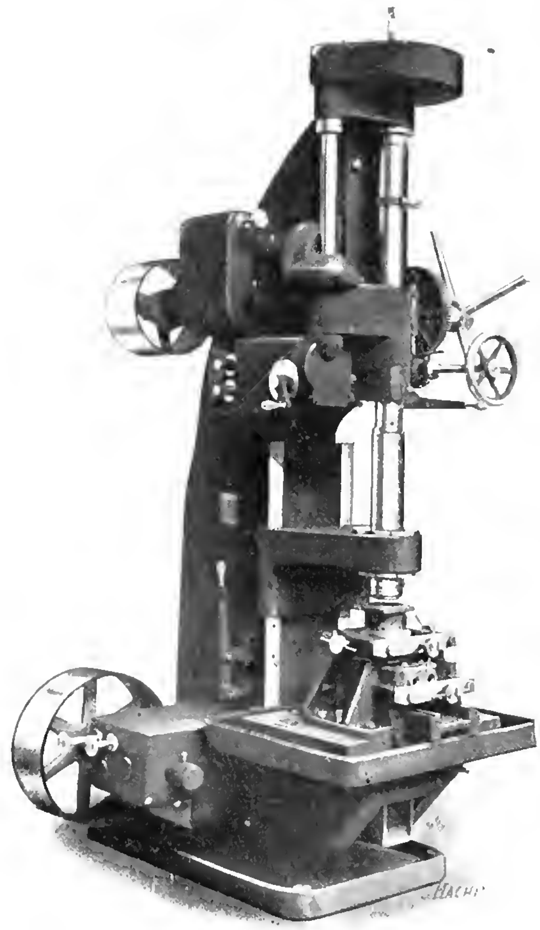


Fig. 1 Baker Automobile Cylinder Boring Machine

The makers of this tool have kept in close touch with automobile work from the beginning, and are prepared both to design and build tools and fixtures for use in machines of this type, or, if preferred, they will give their customers the benefit of their experience in this line in the way of suggestions. When required, special attachments for boring, facing and tapping the seats of automobile cylinders will be furnished. With these attachments, either two or four tools can

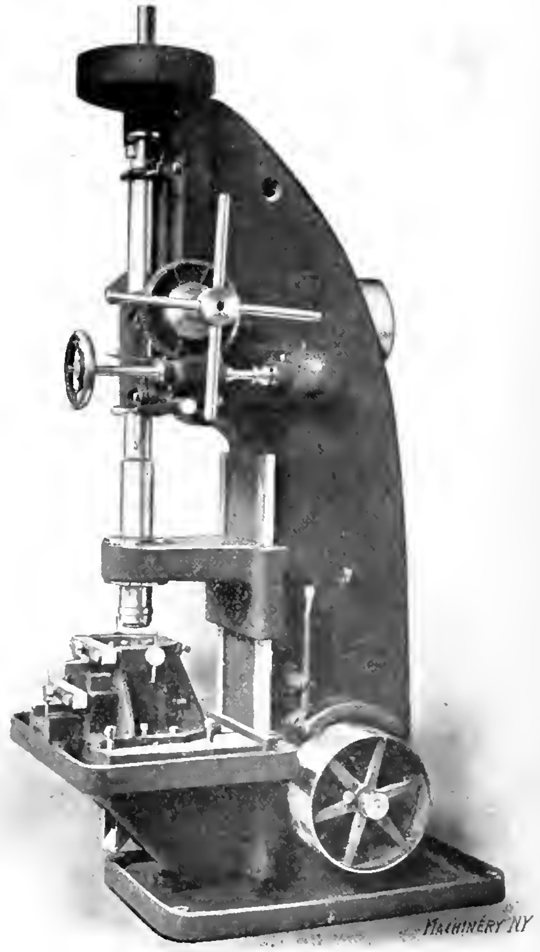


Fig. 2. Side View, showing Single Pulley Drive, Boring Bar Support, etc.

be carried by each spindle, thus materially increasing the capacity of the machine.

P. S. ANROS CO.'S BEAM COMPASS

Every draftsman has experienced the need of a light, convenient beam compass that can be quickly and accurately adjusted and still be rigid enough to insure good work. The P. S. Anros Co. of North Tonawanda, N. Y., have met this demand by putting on the market a very neat and convenient instrument of this kind. It is the acme of simplicity, inex-

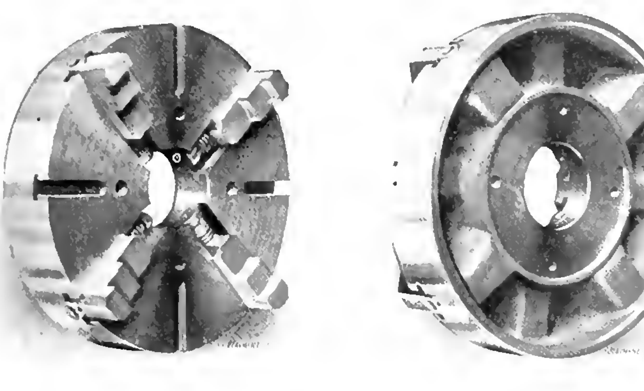
An Inexpensive but Practical Beam Compass

pensive, and at the same time a tool that is thoroughly practical. The construction is such that use is made of the opposite ends of the pen and pencil for the needle points, so that either pen or pencil is instantly available by turning the instrument over. The adjustment of the sliders, which carry the pen and pencil along the beam, is particularly smooth, making it possible to set the compass as accurately as with some of the more expensive instruments. These sliders are simply spring steel bands that fit the wooden beam closely and retain their position by friction. Both pen and pencil are easily adjusted vertically, and they, like the sliders, are held in place by friction. Undoubtedly, draftsmen in need of a beam compass will find this a very handy addition to their set of instruments. The price of the tool is one dollar.

S. E. HORTON FOUR-JAW INDEPENDENT CHUCKS

The S. E. Horton Machine Co., of Windsor Locks, Conn., has entered the chuck field with the line of four-jaw independent chucks herewith illustrated and described. This type of chuck possesses certain advantages for general work. The jaws are reversible by simply running them out and turning them end for end; the independent control of the jaws makes it possible to handle a large variety of rough forgings, castings and pieces of irregular outline; and it permits as well, the truing up of finished work to run with any desired degree of accuracy.

In addition to these general qualifications, this design has special advantages of its own, which fit it to meet the three prime requirements of a good independent chuck—namely, the requirements of strength and gripping power, durability, and workmanship. These advantages are derived largely from the improved proportions given the jaws and screws, as shown in detail in Figs. 5 and 6.



Figs. 1 and 2. Front and Rear Views of the S. E. Horton Four-Jaw Independent Chuck, 18-inch size

The strength and stiffness of the mounting provided for the jaw are shown clearly at the right of Fig. 6. A plain T-slot is cut in the face of the chuck in place of the usual tongued groove construction shown at the left of the engraving. A glance will explain the advantage of this arrangement in the matter of the resistance of the jaw to the lateral thrust (shown by the arrow) imposed on it by the driving of the work. The broad base and liberal bearing surface give, also, unusual strength and long life to the jaws and slides.

A further advantage of this form of jaw is that it permits the use of a screw of unusually large diameter (1¼ inch for the 10-inch chuck and 1½ inch for the 15-inch size). This screw, as shown, has a complete half bearing in the jaw, bringing the tightening strain more nearly in line with the work than the usual construction allows. There is thus less tendency for the jaws to spring away from the work. In addition it should be noted that three bearings are provided for the screw, all of them on turned diameters, no reliance being placed on the threaded surface as a journal. This greatly increases the durability at a point where durability is very necessary. The thrust is so taken up on these bearings as to distribute the strain properly through the chuck body. The shell cannot break out at the end of the screw.

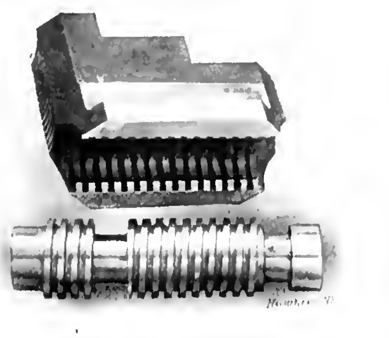


Fig. 5. The Broad Based Jaw and Large Screw

It will be seen that the socket for the wrench is formed in stock of the full root diameter of the thread, thus giving the maximum size and strength at this important point.

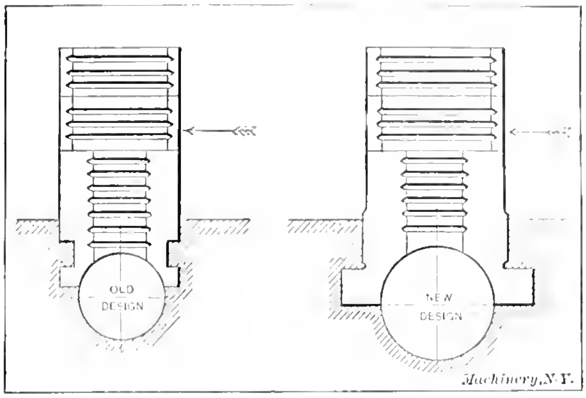
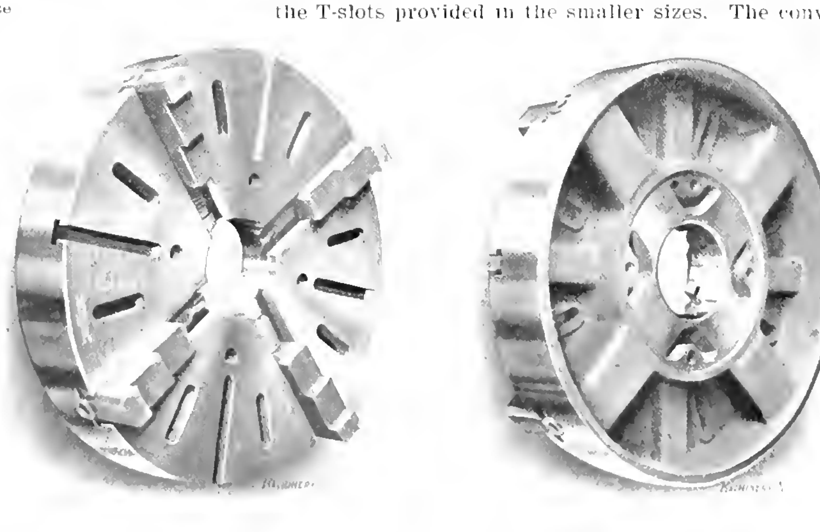


Fig. 6. Comparison of Jaws and Screws in Old and New Designs

As a result of this increase in the stiffness and durability of the jaw and screw, a much heavier clamping strain can be exerted without danger of breakage or excessive wear. For this reason, wrenches of much greater leverage than usual can be, and are, provided. The construction also permits the extension of the jaws for one-third of their length outside of the body, giving an increased capacity. This extended diameter is 11 inches for the 10-inch size, and 16½ inches for the 15-inch.

Figs. 1 and 2 illustrate front and rear views, respectively, of the 18-inch chuck. The body, it will be seen, is of standard design, but of very heavy and rigid proportions. Chucks from 20 inches up are made in the styles shown in Figs. 3 and 4, being provided with through slots for face-plate clamping, in addition to the T-slots provided in the smaller sizes. The convenience of this on large chucks is well recognized by mechanics. The hole through the body is unusually large. This feature, which is permitted by the improved design, is an advantage in holding work having a large hub; or it may be utilized, if desired, in fastening on the spindle face-plate with the hub projecting inward instead of outward as usual. This method of mounting greatly reduces the over-hang, and gives a corresponding advantage in the matter of stiffness, but the central hole of the chuck is not usually large enough to permit it. The hole through the body of the 10-inch chuck is 2¾ inches in diameter; on the 15-inch size, the diameter of the hole is 4 inches.



Figs. 3 and 4 A Larger Size of the Horton Chuck, with Provision for Using Clamp Bolts

In relation to the matter of workmanship, a study of the illustrations will show that the construction is such that accuracy is easily secured. This line also has the advantage of being designed and made by men who have been in the business for many years, and have become specialists in this work. The regular list covers sizes from 8 to 26 inches inclusive.

HAMMOND WIRE BELT LACING TOOL

A tool of simple construction for making wire hinged joints for leather belts, is shown herewith. It is intended to take the place of the more costly machine for this work. Besides having the advantage of cheapness, it has that of portability. These tools may be kept in the various tool-rooms of an establishment and checked out for bench work the same as drills, clamps, etc., it being convenient to hold them in an ordinary vise as shown in Fig. 1.

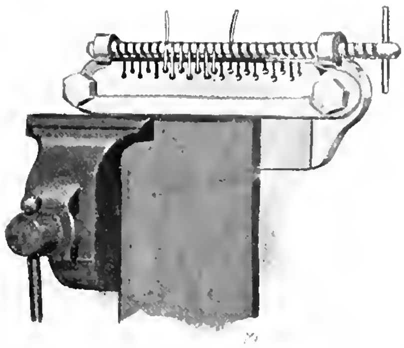


Fig. 1 An Inexpensive and Efficient Wire Belt Lacing Tool

The process of lacing the belt should be obvious from an inspection of the engravings. The threaded guide-rod is inserted in place and the belt (whose end has been squared) is pushed into place between the clamps, being fastened there with its edge resting against the guide-screw. Holes are then punched through the belt with an ordinary awl, the slots cut in the clamping bar serving as a guide. Wires are then threaded through these holes and around the guide-screw, using ordinary pliers for the operation. When the belt has thus been laced, the guide-screw is threaded out of the lacing. After the other end of the belt has been treated in the same manner, the lacings for the two ends are pressed flat in the vise, and then interlocked with each other. A rawhide pivot pressed in between the two, forms the hinge and completes the joint.

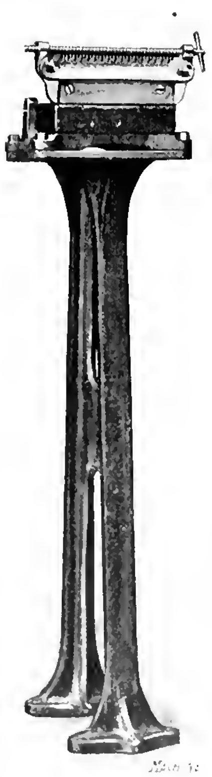


Fig. 2. Tool Mounted on Stand

A belt thus laced is provided with a joint which has a maximum of strength, and a thickness no greater than that of the belt. At the same time, it is flexible enough to run over a very small pulley at high speed. The staggering of the holes greatly increases the efficiency of the joint. There is oftentimes great advantage in lacing a belt away from the machine, in places where such an operation in place would be dangerous or even impossible. A simple insertion of the rawhide pin completes the joint, when the belt is again put in motion.

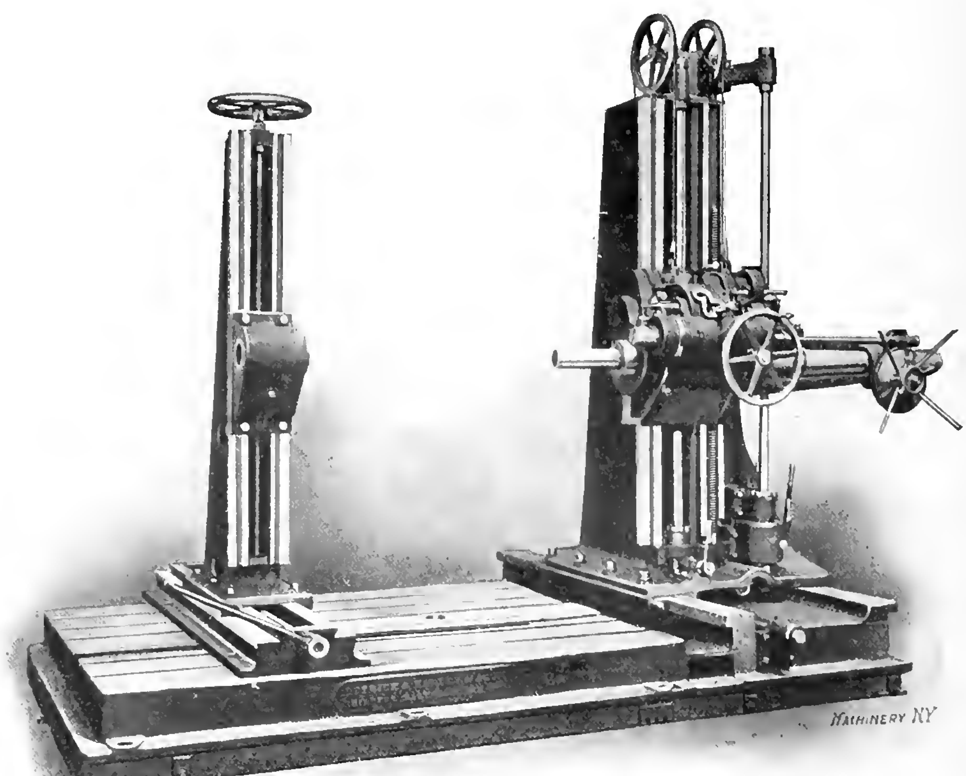
This tool is made by Geo. W. Southwick Co., 35 Warren St., New York. It weighs only three pounds and is sold at a very low price. This tool may be used in a vise, as shown in Fig. 1, or it will be furnished with a stand, as shown in Fig. 2, for use in shops where vises are not employed.

DETRICK & HARVEY NO. 1 HORIZONTAL DRILLING, BORING AND MILLING MACHINE

The accompanying illustration shows a recent design of the horizontal drilling, boring and milling machine made by the Detrick & Harvey Machine Co., of Baltimore, Md. The machine shown is the No. 1 or 50-inch size, so proportioned as to drill and bore anywhere on a surface 50 inches square.

The column is a box section tapered to a broad base, which is gibbed with a sliding fit to the bearing on the runway. This bearing is carefully scraped and guides the column between long narrow surfaces which preserve the alignment with great accuracy. The saddle or head has a vertical movement on the column by hand or by power; the same is true of the column in its movement on the runway. Six changes of power feed are provided in both these movements, of suitable range for milling operations. The bed-plate and length of runway are made in sizes to suit the requirements of the purchaser. Suitable T-slots for clamping the work-table and the outboard boring bar support, are provided.

The steel spindle carried by the saddle is back-geared at the front end, giving a direct drive for heavy face milling operations; the end of the spindle will be threaded if required, for carrying these heavy cutters. A No. 6 Morse taper hole is provided for driving end mills, drills and boring bars. The twelve rates of spindle speed range from 5½ to 125 revolutions per minute. These are controlled by levers on the saddle within convenient reach of the operator. The spindle reverse for tapping is governed by a lever at the bottom of the driving shaft on the column.



New Design of the Detrick & Harvey Horizontal Boring, Drilling and Milling Machine

The following dimensions will give an idea of the capacity of the machine. The spindle has a maximum vertical adjustment on the column of 50 inches, and a standard traverse of the column on the runway of the same amount. The spindle is 4 inches in diameter with a feed of 30 inches. The standard work bed has 50 by 84 inches of surface. With this size

of work bed, the maximum distance from the end of the spindle to the outer support is 61 inches, and the floor space occupied is 12 by 17 feet.

This machine will be furnished if desired with a universal tilting and rotating table by means of which the operator can drill and bore at any angle anywhere on five sides of a cube. This table can be firmly clamped in any position and moved in a direction parallel with the spindle, toward and away from the column. It is provided with T-slots and a central hole. A rotating table without the tilting feature can be furnished when desired.

Other extras which the manufacturers are prepared to furnish are graduated scales for the various adjustments, rotary pump for providing lubricant when drilling on steel, motor drives, etc. The machine will also be furnished without the bed-plate if desired, or for use as a portable machine. It is made in four other sizes to cover the range from 40 to 96 inches maximum capacity of vertical and horizontal movements.

STROMBERG ELECTRIC CHRONOGRAPH

An electric chronograph or time recorder for registering the exact time of the entrance or departure of employes from manufacturing or mercantile establishments, is shown in the illustrations presented herewith. Another model of the chronograph, intended for general office purposes, was illustrated and described in the New Machinery and Tools department of the February, 1909, number. Those who read that description will probably recall that this instrument is a radical departure from the usual time-recording device in that it, together with any number of instruments both for general office and in-and-out recording, can be connected in the same circuit and operated by one master clock, thereby insuring absolute uniformity and agreement. It will thus be seen that all of the clock mechanism is removed from the recorder itself, so that the jar when registering does not in any way affect the delicate mechanism of the controlling timepiece.

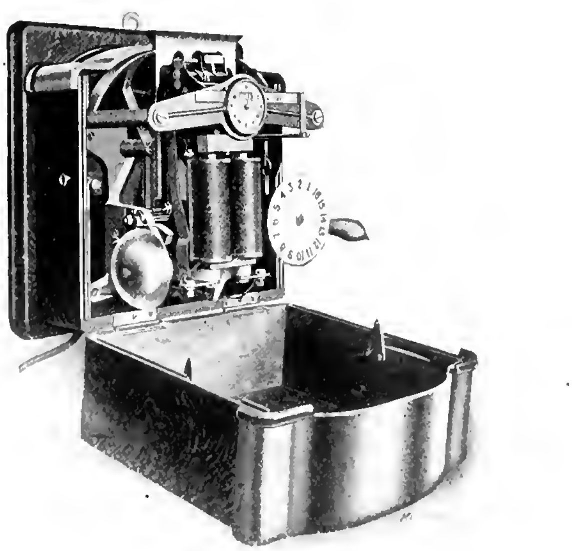


Fig. 1. Stromberg Electric In-and-out Time Recorder Opened to expose Mechanism

Another salient feature of the chronograph is that it prints on the front of the card instead of on the reverse side, as is the case with other makes of in-and-out recorders. It is not necessary to provide a special master clock, as any factory clock equipped with a second hand can be used. The illustration, Fig. 1, shows the interior mechanism of the instrument. The printing wheels and the hand of the dial on the side of the chronograph are moved by a simple magnetic action controlled by a make-and-break device attached to the master clock. Either direct or alternating 110-volt current storage battery or primary batteries may be used to operate the instruments. For alternating current, however, a rectifier, which will be furnished by the company, is necessary to convert the alternating to direct current. The illustration, Fig. 2, shows the chronograph with the time-card cases on either side. The instrument is so made that there are no bolts, screws or other parts exposed, which can be tampered with by a malicious employe. The model for in-and-out recording is fitted with an adjustable gage which insures the recording of time in the proper place on the card, without any manipulation on the part of the operator beyond inserting the card into the chute and depressing the printing arm in the usual manner. When this is done, an exact and indelible record of the time of arrival or departure is accurately recorded. The chronograph is manufactured by the Stromberg Electric Mfg. Co., 108-128 North Jefferson St., Chicago, Ill.

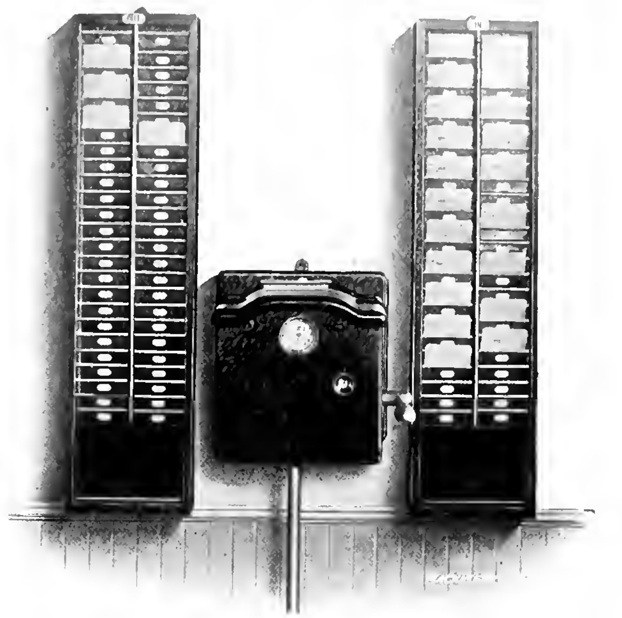
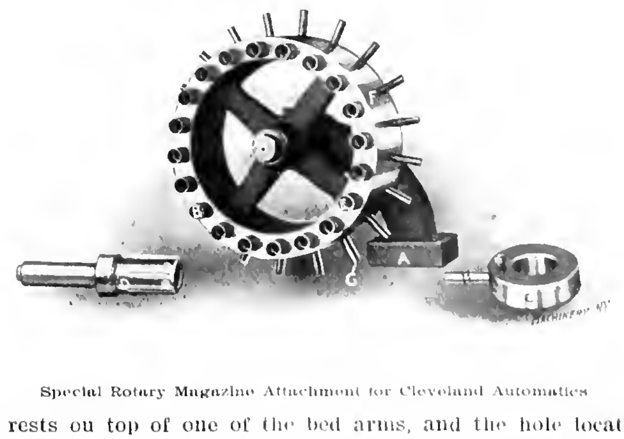


Fig. 2. The Chronograph and the Time-card Filing Cases

CLEVELAND ROTARY MAGAZINE ATTACHMENT

A special rotary magazine attachment has just been brought out by the Cleveland Automatic Machine Co., Cleveland, Ohio, that is exceedingly simple in its construction and yet, undoubtedly, a most effective piece of mechanism. This is not a regular attachment, but simply a new fixture which has been devised to handle some of the second-operation work which, because of peculiar snapes, cannot be easily handled in a standard tilting magazine. This new drum magazine can be applied to any "Cleveland" automatic, and it is recommended by the company to those having thousands of one-piece to make which are exceptionally large at one end, small in diameter, but long and light.

A view of this magazine is shown in the accompanying illustration. When it is attached to the machine, the bracket *A* rests on top of one of the bed arms, and the hole located in position *B*, is in line with one of the turret holes. The collar *C* fits on the cam-shaft, and a conveyor *D* is held in the turret of the machine. Directly back of the hole in position *E*, there is a spring plunger which enters the rear of the hole at this point and serves to hold the drum rigidly with



Special Rotary Magazine Attachment for Cleveland Automatics

the supporting bracket *A*. This plunger, however, allows drum *F* to be indexed to the next hole when pressure is applied to one of the pins projecting from the periphery of the drum.

In operation, the pieces of work are placed in the bushings which are inserted in the face of the drum *F*. When the conveyor is carried forward by the turret, it removes the piece from bushing *B*, and when the turret recedes, the pin *H* in the collar *C* engages pin *G*, thus indexing the drum to the next position. When this magazine is attached to an automatic it is simply necessary to keep it filled with work, and one man or boy can easily attend to six machines. As is evident, the mechanism is exceedingly simple, and this is always a reliable guarantee against trouble of any kind.

PRYIBIL SELF-BALANCING ELLIPTICAL CHUCK

The elliptical chuck is an old piece of apparatus, made in a number of different designs by different manufacturers. It finds a limited application in machine work, and a more extensive one in wood-working and metal spinning. In woodworking it is used for such operations as the turning of oval picture and mirror frames, ornamentations, etc.; the large variety of elliptical and oval shapes in sheet metal requires its use for metal spinning. These more common uses of the device require high speeds. In this respect the elliptical chuck has hitherto been defective, owing to the fact that the

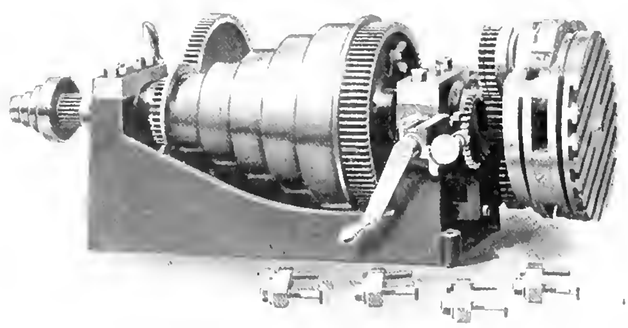


Fig. 1. Pryibil Self-balancing Chuck, adapted to Heavy Work

reciprocating parts are unbalanced, causing excessive and dangerous vibration if it were attempted to run at a rate of speed such as would be used for circular work of a corresponding character. In the chuck herewith illustrated and described, made by P. Pryibil, 512-524 West 41st St., New York City, the reciprocating parts have been balanced so that the

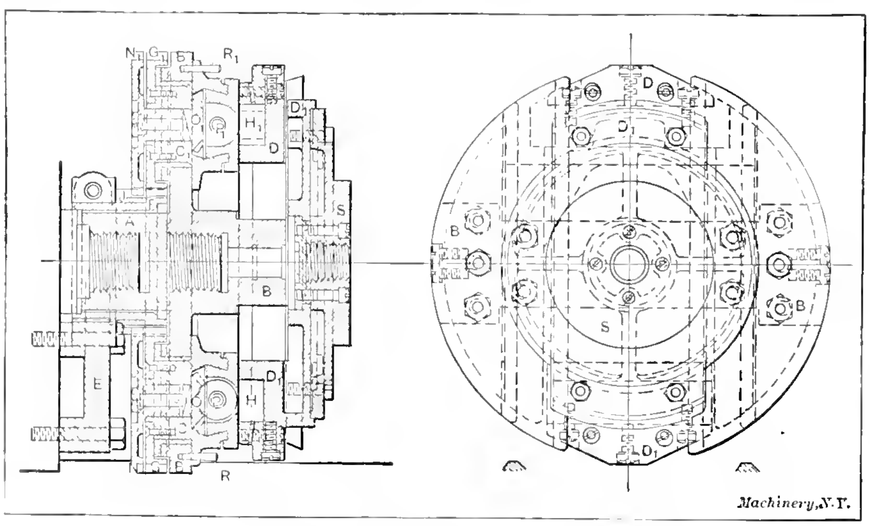


Fig. 2. Section and Face View of Chuck, showing Construction

chuck can run smoothly at high speeds. This greatly increases its capacity, giving a large return in product per hour of work, for the extra mechanism employed.

Fig. 1 shows the heavier form of chuck used for metal turning, attached to an engine lathe head-stock; Figs. 2 and 3 show details of the construction. A false nose *A* is screwed onto the lathe spindle to extend the latter sufficiently to bring the chuck clear of the head-stock. Screwed onto this false nose, and therefore revolving with the spindle, is the main frame *B* of the chuck. This main frame is in the form of a cross

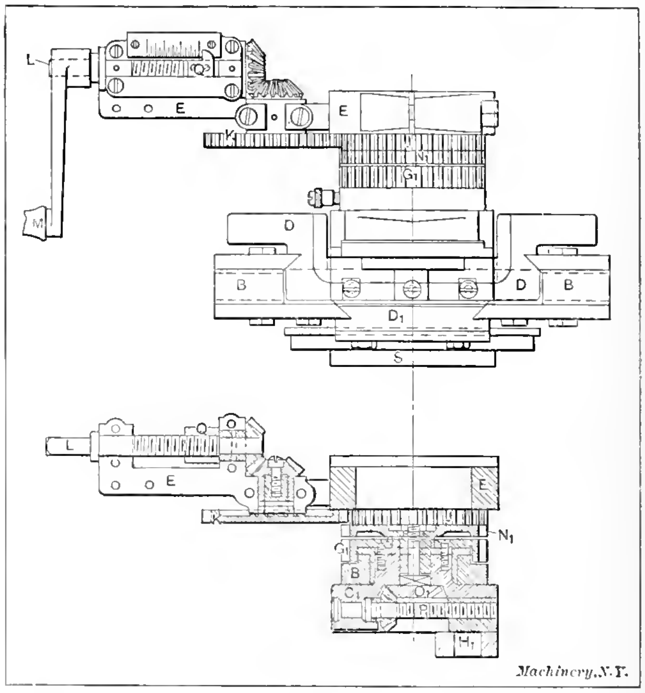


Fig. 3. Top View and Section through Adjusting Mechanism

arm (this construction is not very clearly shown in the engravings) whose vertical arms carry bearings for revolving cranks at *C* and C_1, while the horizontal arms, seen in Fig. 3, are provided with gibs for the two reciprocating slides, one in back at *D* and the other in front at D_1.

The bracket *E*, bolted to the face of the head-stock, has keyed to it a spur gear *F*, concentric with the spindle. Cranks *C* and C_1 have screwed and doweled to them gears *G* and G_1, meshing with this gear *F*. Crank pins at *H* and H_1 (so mounted in cranks *C* and C_1 as to give an adjustable stroke as will be described) are pivoted in square blocks fitted to slots in slides *D* and D_1. It will thus be seen that, as the spindle of the lathe, false nose *A*, and body *B* revolve together, gears *G* and G_1 will roll around on stationary gear *F*, revolving cranks *C* and C_1, and thus causing, through crank pins *H* and H_1, the reciprocating of slides *D* and D_1. Slide D_1 travels back and forth across the face of the chuck, carrying the work, which thus receives a proper movement for elliptical turning. Slide *D*, on the other hand, on the backside of the chuck, moves always in opposite directions to slide D_1. Owing to the fact that these two slides are practically equal in weight, they balance each other in their movement, and permit the rotating of the chuck at a high rate of speed. This is the important innovation in the design.

Adjustments are provided for all the important sliding bearings, such as those for slides *D* and D_1 in body *B*, and for the squared blocks *H* and H_1 in slide *C*. The face-plate *S*, which is mounted on slide D_1 can be rotated and clamped in any position to bring the major axis of the ellipse in any required relation with the work being operated on.

There is another feature which adds greatly to the usefulness of this tool—the provision made for adjusting the eccentricity of the movement while the chuck is revolving. By this means, the difference between the major and minor axes of the ellipse being turned, can be adjusted as required, without stopping the work and without measurement. On the hub of stationary gear *F* is mounted a gear *J* (see Fig. 3), mesh-

ing with a gear K, having a bearing in bracket E. Bevel gears connect this with a shaft and crank L and M, by means of which gear J may be revolved. Gears N and N_1, which also mesh with J, are keyed to bevel gears O and O_1, which in turn operate adjusting screws P and P_1, which are threaded into the adjustable crank pins H and H_1.

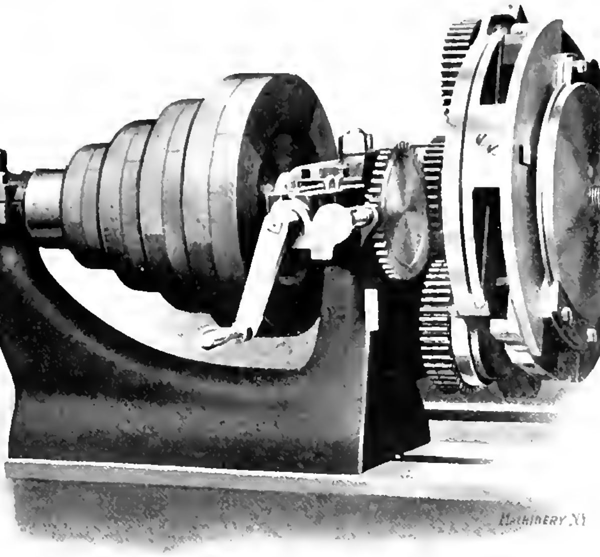


Fig. 4. Lighter Design of Chuck, used for Wood Working and Metal Spinning

It will be seen that with J and F both fixed in position, gears N and G, and N_1 and G_1, will rotate together without any movement relative to each other, so that the adjusting screws P and P_1 will be stationary and the adjustment of crank pins H and H_1 will remain unchanged. When, however, gear J is revolved by crank M, N is moved with reference to G, and N_1 with reference to G_1, so that adjusting screws P and P_1 are rotated and the throw of crank pins H and H_1 is increased or diminished. By this means the difference between the major and minor axes of the ellipse being turned is increased or diminished at will. As may be plainly seen, it makes no difference whether or not the machine is running, for while gears N and G are running around gears J and F, the adjustment can be made either way.

Adjusting shaft L is threaded and is provided with a nut Q, having an index finger reading the amount of eccentricity on a fixed scale. This is a great convenience in setting up the

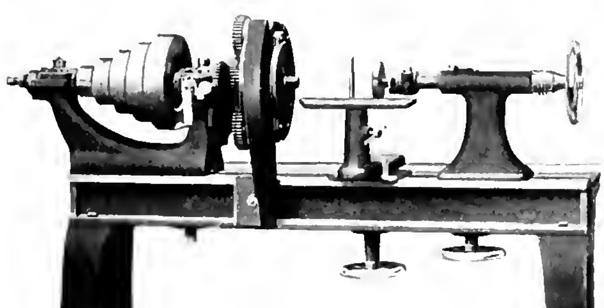


Fig. 5. Elliptical Chuck mounted on Spinning Lathe

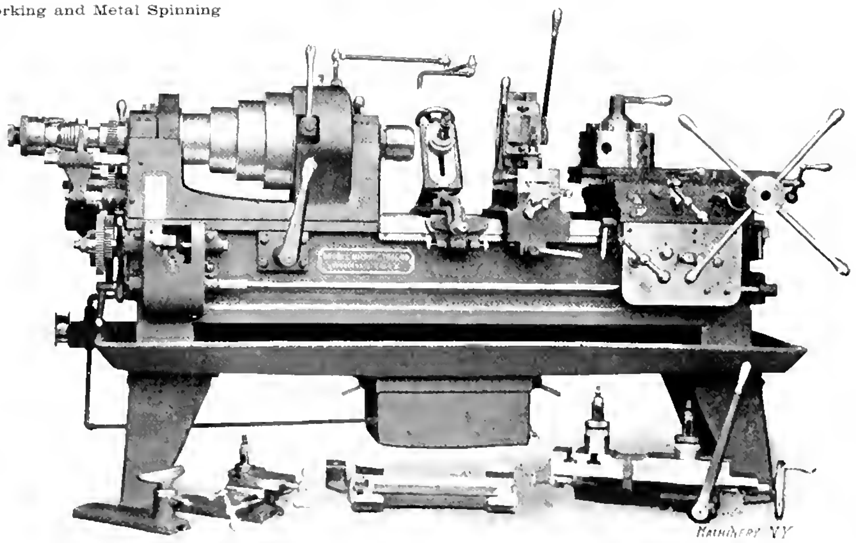
device. To insure the proper relation of all the parts when the chuck is removed from the work, taper pins R and R_1 (see Fig. 2) are inserted to lock the cranks in position. This insures the proper action of the chuck when it is again mounted in place on the machine.

Fig. 4 shows a larger and lighter form of this fixture, operating on the same principle used for wood work and metal spinning. It will be noticed in both Figs. 1 and 4 that a positive means of locking is provided, by a bolt entering the spaces between the teeth of gear K, so that no accidental change of adjustment is possible. In Fig. 5, this interesting device is shown attached to a metal spinning lathe, provided with a proper guard for protecting the workman from the mechanism.

DRESES 20-INCH FULL UNIVERSAL "MONITOR" LATHE

The "Monitor" lathe herewith illustrated and described is built by the Dreses Machine Tool Co., Cincinnati, O. It is designed for general brass and similar work of a heavy character, made from castings, forgings and stock. It is provided with such adjustments as make it possible to manufacture, without special tools, many pieces for which it would not pay to equip the ordinary machine of this type.

The turret carriage feed mechanism is similar in design to that of the standard engine lathe. A positive geared feed is provided, with a quick gear change box, giving eight variations.



A Monitor Lathe with Universal Adjustments for a Wide Range of Work

These changes cover the ordinary standard pipe threads, as well as giving suitable turning and boring feeds. Provision is made for obtaining other feeds and pitches by the use of change gears.

The turret slide is in two parts, with a taper dove-tail plate interposed, on the lower side of which is carried a shoe swivel sliding on the bar of the taper attachment. The latter is shown dismounted from the machine, lying on the floor under the center of the bed. This, when in use, slides on the inside of the bed and is held in place by a suitable clamping bolt. It can be readily removed and no special provisions are necessary in the design of the bed for holding it. By its use, inside or outside, taper or straight threads, can be chased by a tool in the turret without the use of a tap or die.

The upper section of the intermediate dove-tail plate has a screw with a ball crank for cross feeding by hand. Positive stops are provided for setting the turret holes in alignment with the spindle. The turret slide is provided with a pilot wheel for rapid movement, and with a screw for finer adjustments. The pilot wheel may be removed from its stem so as to be out of the way when the screw feed is in constant use. The turret is adjustable for wear on its seat. The locking bolt withdraws at the return movement of the top slide, making the rotation of the turret semi-automatic.

The head-stock is provided with carefully enclosed friction

back gears, with clutches of the toggle joint type, so designed that the whole operating mechanism can be put in place or removed without taking out the spindle. The automatic chuck is operated with the handle shown below the cone pulley.

Various forms of cross-slides, rests, etc., are provided, as shown in the illustration, fitting the machine for a wide range of work. The chasing bar has a yielding follower holder, which maintains contact with the leader when chasing taper work. The taper attachment for the chasing bar is provided with knurled screws for minute adjustment. A vertical forming rest is also shown in place on the bed. The cutting-off rest is shown on the floor at the right, and hand and slide rests at the left. The taper attachment has already been mentioned.

This lathe is furnished with a pan, oil reservoir, pump and piping, adapting it for iron and steel as well as brass. It swings $20\frac{1}{2}$ inches over the V's, has a bed 6 feet 6 inches long, and weighs about 3,600 pounds.

CUTTER GRINDING HEAD FOR B. & S. UNIVERSAL GRINDING MACHINES

The cutter holding head and its attachments, shown herewith, is made by the Brown & Sharpe Mfg. Co., of Providence, R. I. It is similar in design to the corresponding parts pro-

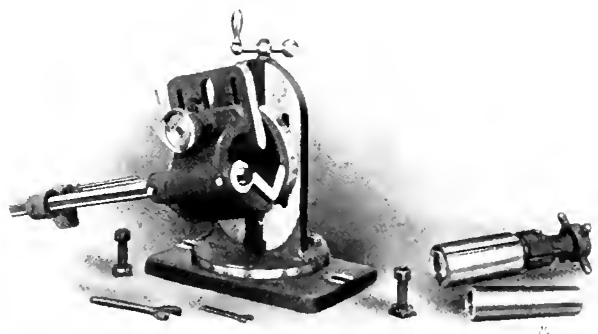


Fig. 1. Universal Cutter Sharpening Head and Equipment

vided for their No. 13 universal and tool grinding machine, but is arranged to be used on any of the universal grinding machines made by the builders. The device should, therefore, prove a great convenience in shops whose requirements are so small as to make the purchase of a special cutter and reamer grinding machine inadvisable, but whose management still desires to obtain the benefit of the economical production only possible with milling cutters kept in proper cutting condition.

The attachment consists principally of a swivel vertical column, upon the slide of which a swivel head for supporting

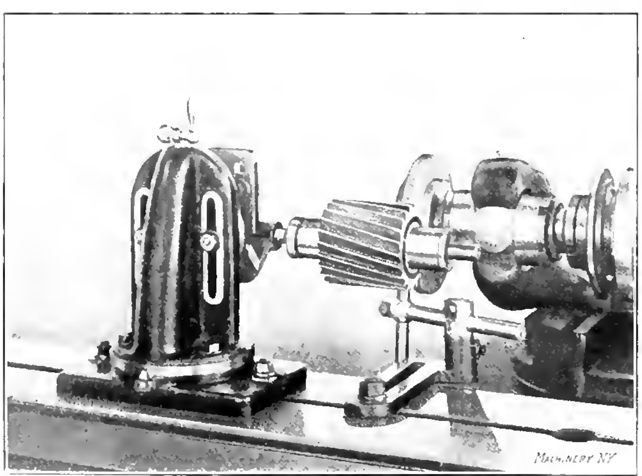


Fig. 2. Spiral Milling Cutter being sharpened on Cutter Bar

the work is fastened. The vertical column is mounted on the base-plate which, in turn, is securely fastened to the table by means of a clamping bolt at each end, passing through slots in the base casting.

The base plate is of solid construction and has a large bearing surface upon the table, thus insuring a rigid support for the vertical column. It is made in two styles, one of which has a tongue on the under side to fit the T-slot in the table of universal machines; the other has a longitudinal V-way that fits over a way of like design on the table of the No. 13

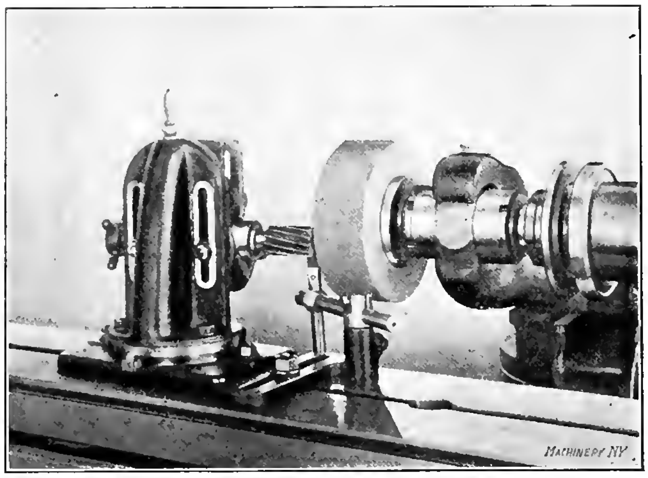


Fig. 3. The Taper Shank Mill Sleeve in Use

universal and tool grinding machine. In either case the alignment of the head, with relation to that of the table, is correctly and simply maintained. The column swivels in a horizontal plane and may be set at any angle with the table. A dial graduated to degrees, encircling the entire circumference of the base, facilitates quick adjustment to any desired angle. Two bolts, which pass through the base and slide in circular slots in the base plate, serve to securely clamp the column.

In the convenience and adaptability of the work head are found the features of the attachment. It is simply and compactly constructed and has a large bearing surface on the vertical column, thus making it fully capable of resisting vibrations due to the action of the wheel on any work within

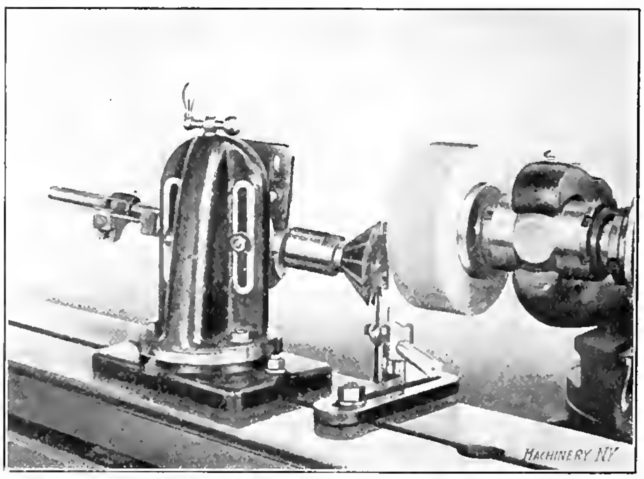


Fig. 4 Grinding the End Teeth of an Angular Cutter, supported in the Vise

the range of the attachment. The head swivels in a vertical plane and may be clamped at any angle up to 90 degrees either side of zero, its position being indicated by a dial graduated to degrees on the circumference of the base. The clamping bolts pass through circular slots in the head casting and vertical slots in that of the column. Provision is made for a vertical adjustment of 4 inches, by means of a ball crank at the top of the elevating screw. With the head at its extreme height, work up to 16 inches in diameter will swing over the table; by turning the head at right angles, light work up to 24 inches in diameter can be accommodated.

Two methods of holding work are provided; milling cutters being clamped directly by their shanks or arbors in a V-shaped vise, while work requiring sliding shells is supported on a rod known as the cutter bar. The vise is rigid and readily adaptable to many varieties of work. The lower jaw consists of a heavy V-shaped trough in which the shank or arbor of the work is placed. The upper jaw pivots, and is adjusted by

means of a hand clamp screw. A long drop-back rest is carried by the upper jaw. To fasten work, this rest is lowered until it touches the piece and is clamped in this position. Then, by simply adjusting the hand clamp wheel the drop back rest is securely fastened upon the piece. An adjustable center rod is provided for supporting and taking the end thrust of work having a tapered shank; it may also be used for taking the end thrust of centered pieces that are not clamped solidly in the vise while grinding.

The cutter bar is made of steel, ¾ inch in diameter, and has a flat side for clamping screws to seat upon without injuring the working surface. It is supported in bearings in the work head casting and, in addition to holding work to be ground, serves as an arbor for the upper portion of the vise to pivot upon. It can be adjusted to any length and clamped by means of set screws. An additional cutter bar ⅝ inch in diameter can be furnished when so desired.

A device known as a taper shank mill sleeve is furnished with the universal head and is particularly useful in grinding work having taper shanks, such as end mills, etc. It consists of an outer sleeve that can be rigidly clamped in the vise, and a taper bushing in which the work is held. The bushing is free to turn in the sleeve, but is held positively against the end of the sleeve by a spring. A handle fastened to the outer end of the bushing serves to hold the work against the tooth rest as well as for indexing. Two taper bushings are furnished with the attachment; one No. 7 and the other No. 9.

By the employment of this device, it will be seen, reamers, milling cutters, counterbores, countersinks and a large variety of other cutting tools can be quickly and accurately sharpened. The attachment is simple in design, convenient in operation, and is easily removed and placed in position.

COLBURN FLOATING REAMER HOLDER

The tool herewith illustrated and described is intended for holding reamers in turret machines, particularly vertical boring and turning machines with turret heads, when it is necessary to so support the reamer that it will find its own center in the work. In other words, the tool is a floating holder. It is impossible to depend on having the turret near enough in line or the reamer straight enough to permit holding it rigidly for a power operation. Floating reamer holders

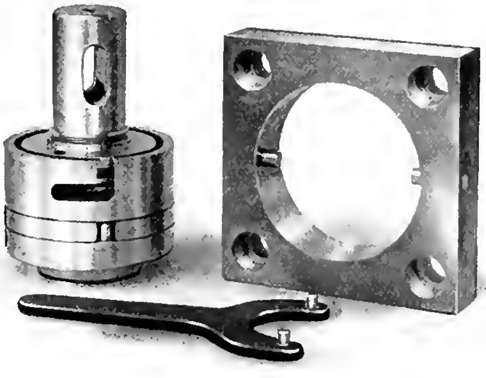


Fig. 1. Colburn Floating Reamer Holder

have been made for many years in individual shops for home use. The design here described is intended to make a commercial product of the device, the object being to provide a construction which would be thoroughly practical and satisfactory in every particular, and which could at the same time be readily adapted to machines of any make.

In Fig. 1 the tool is shown assembled; Fig. 2 shows it separated into its component parts; Fig. 3 shows it in use in the machine, and Fig. 4 is a detailed drawing. The construction of the tool will perhaps be best understood by referring to Figs. 2 and 4.

The reamer, which may be of the solid or shell, adjustable or non-adjustable styles, is mounted by its taper shank in socket E. The latter is driven from sleeve C by a universal coupling arrangement. This consists of a collar F, interposed between C and E, and provided with slots closely engaging pins G which are fast in E, and pins G_1 which are fast in C. E and the reamer which it contains are thus allowed to find their own centers with relation to the work, there being no cylindrical fit between socket E and sleeve C. At the same time a strong and direct drive is provided. This coupling will be seen to be an interesting use of a well-known mechanical principle. To keep the faces of C, F and E tightly pressed

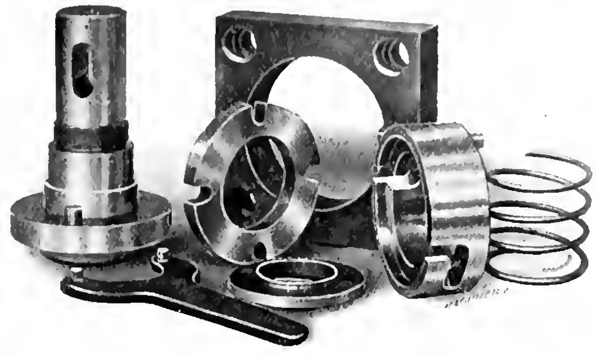


Fig. 2. Reamer Holder separated into its Component Parts

together, nut I is threaded onto the socket, compressing spring H against its seat in C. The spring may be adjusted to be strong enough to overcome the weight of the reamer and its shank, and to keep the parts of the holder tightly pressed together.

The socket and sleeve are held in a base A by a bayonet lock arrangement, which permits their instantaneous insertion or removal, as may be required. The bayonet grooves

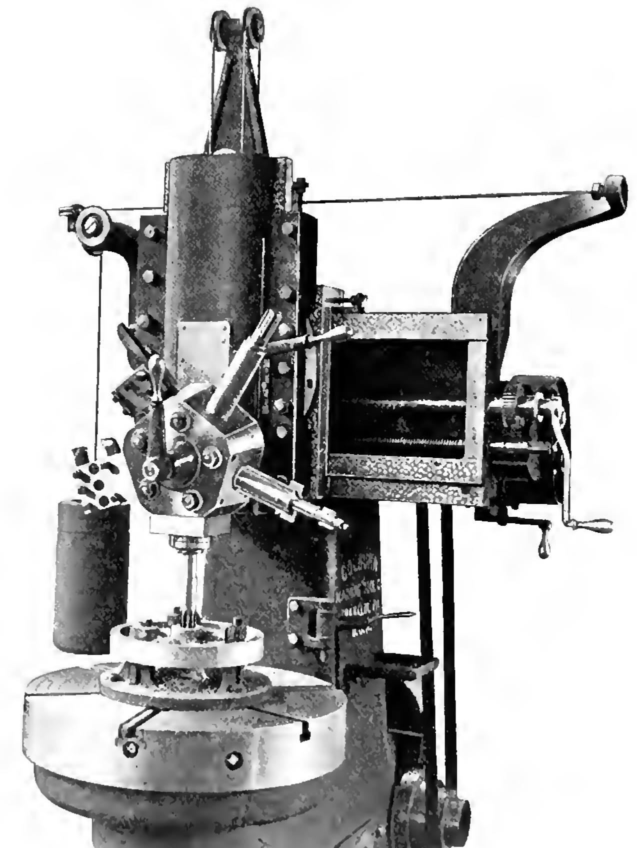


Fig. 3. Reamer Holder in Use in Vertical Boring Mill

are formed in sleeve C, and they are engaged by pins B driven into A as clearly shown in the engraving. Base A is the only member which has to be fitted to the turret; this will be provided by the makers, the Colburn Machine Tool Co., Franklin, Pa., for any dimensions to agree with the machine on which it is to be used.

The advantage of this device may be summed up as follows. It is a commercial product made on a manufacturing basis after a carefully thought out design, instead of being a home-

made and make-shift contrivance. It will fit any make or style of reamer, it only being necessary to provide a shank having the usual Morse taper. It can be used on any make or style of boring mill having a turret with flat sides. It will hold the reamer parallel with the axis of rotation at the same time that it permits it to center itself.

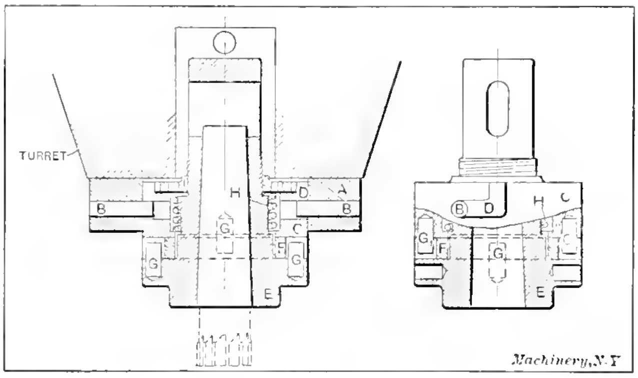


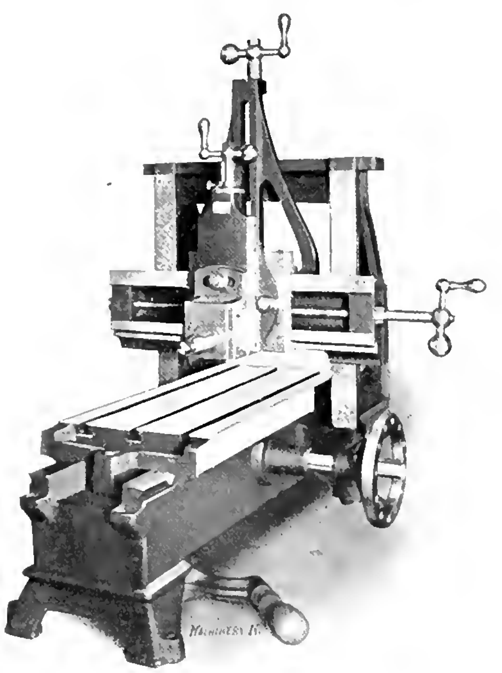
Fig. 4. Details of the Construction

These holders are made in two sizes. The No. 1 has a No. 4 Morse taper socket capable of holding reamers up to 3 inches in diameter; the No. 2 size has a No. 5 Morse taper socket, and will carry reamers up to 4 inches in diameter.

SCHNEIDER HAND-OPERATED METAL PLANER

The illustration shows a metal planer of small size, built by the Schneider Machine Tool Co., 20 East 9th St., Cincinnati, O. This planer is built for hand-operation only, so is especially fitted for model, experimental and tool work.

The illustration shows that the machine is built on the general lines of the heavier power-driven planers. It is provided with a modification of the cross-rail elevating mechanism, however, which is more appropriate to a machine of this size. A slide or frame attached to the back side of the cross-rail extends upward above the top of the housings, where it forms a bearing for a single elevating screw. A slot cut in this frame is guided by a bearing block attached to the housing tie-piece. By this means the rail is kept accurately in alignment with the surface of the table even though but one screw is used instead of two as usual.

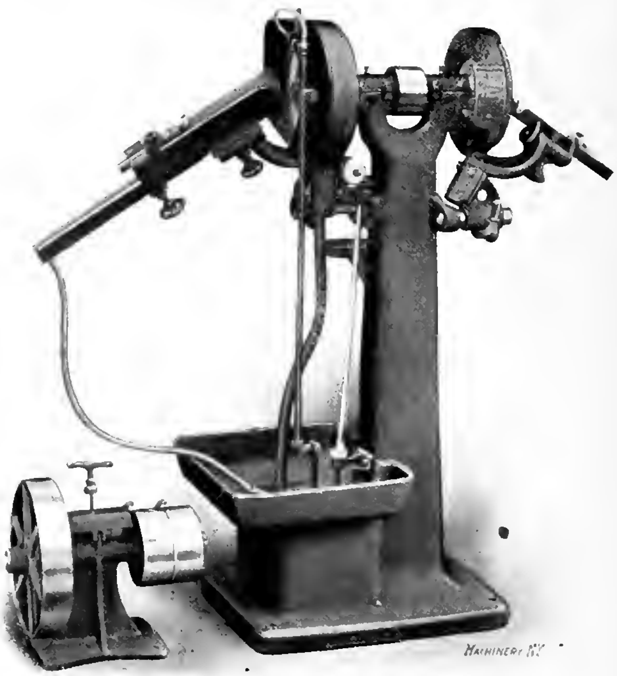

Hand-operated Planer for Tool, Model and Experimental Work

A rack and gear are used as in larger planers for reciprocating the table; the gear is mounted directly on the shaft to which the hand-crank is attached. The hand-wheel on this shaft, as shown, is provided with a series of holes into any one of which a locating pin on the crank may be inserted, thus permitting the latter to be set in any position that is convenient for the cut on the table. It also permits rapid change in position whenever required by the work.

The machine is substantially built to secure the stiffness required for accurate work. The bed has flat ways and is provided with oil channels and pockets to prevent the lubricant from running down outside or inside of the bed. The table takes in 10 inches between the housings, and 8½ inches under the cross-rail. The rack is 24 inches long. An automatic cross-feed will be furnished if desired.

IMPROVEMENTS IN THE "YANKEE" DRILL GRINDER

An improved "Yankee" drill grinder has lately been placed on the market by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich. Some difficulty has been experienced in previous constructions in regard to the handling of small drills in a holder of sufficient capacity to take care of the large sizes of drills which are in more common use. In the machine now placed on the market this difficulty has been eliminated, and the machine combines a capacity for handling

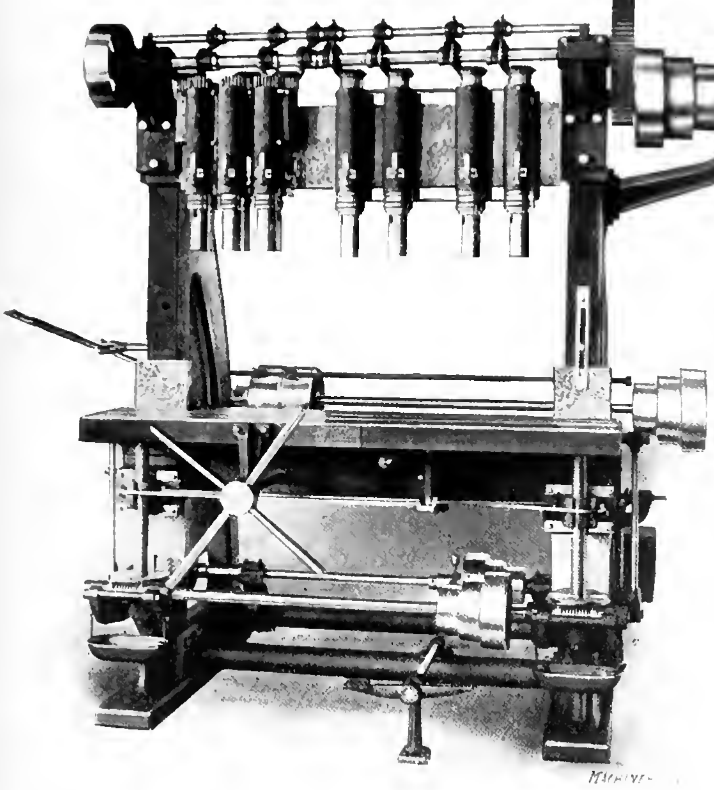

"New Yankee" Drill Grinder with Improved Drill Holder for Smaller Sizes; built by the Wilmarth & Morman Co., Grand Rapids, Mich.

large sized drills with the greatest convenience in grinding small drills. A large holder is furnished for wet grinding of large drills, having a maximum normal capacity for 2¼-inch diameter drills with a minimum capacity for ⅛-inch drills. A smaller holder, however, is also provided in which, with greatly increased convenience, drills from a maximum of ⅝-inch diameter down to a minimum of No. 60 drill gage size can be ground. A finer grade of emery wheel is provided for the smaller drills, and, as seen in the accompanying illustration, two operators can be working, one on each of the two holders, without interfering with each other. Both holders embody the regular "New Yankee" construction, by which the time-consuming preliminary adjustments are avoided by means of the angle of the V-shaped groove or trough which automatically locates each different size of drill in the right position for grinding.

The clearance can be adjusted when required, so as to provide for either the small amount of clearance desirable for working in hard steel, or the much greater clearance necessary for drilling softer metals. The normal clearance, however, is maintained for drills of different sizes for ordinary service, without any adjustment being required on the part of the operator. The machine shown in the accompanying engraving is designated by the makers as the style "WPL." Its general design, outside of the features referred to, is entirely along the same lines as that of the well-known regular type of the "New Yankee" drill grinders.

ANDREW AUTOMATIC CYLINDER BORING MACHINE

M. L. Andrew & Co., of Cincinnati, O., make a multiple drill of the double housing and cross-rail type, which we have before illustrated in a variety of designs for a variety of applications. (See, for instance, the department of New Machinery



Andrew Multiple Spindle Drill Modified for Cylinder Boring

and Tools in the November, 1907, and the April and November, 1908, numbers of MACHINERY.) Still another modification of this machine is herewith illustrated.

This particular design is intended for the boring operations on automobile cylinders. The multiple spindles are divided into two groups. The three shown at the left are permanently gibbed and bolted to the cross-rail, in such a position that they can bore the four valve seat chambers and the two spark plug holes, in the time required to finish one hole on the single-spindle machine. The four spindles at the right of the cross-rail are gibbed to the rail, but are adjustable on their mounting. In the arrangement shown, they are tied together by gages at the top and bottom to preserve definite center distance. These may be used for boring the cylinders themselves, or for boring angle holes for cylinder plugs.

The general design of the machine is the same as those we have previously illustrated. The spindles are of high carbon steel, running in phosphor-bronze bearings with ball thrust collars. They will be provided with either No. 4 or No. 5 Morse taper sockets as desired. The table is fed upward with steel feed-screws, operated by carefully-made worm-gearing. The feed-screw nuts are of phosphor-bronze, opened and closed by a hand-lever on the front of the table; the feed throw-out is automatic. The pilot-wheel controls the rapid movement or adjustment of the feed. The table itself is made extra heavy, is provided with T-slots, and is counterbalanced. The three spindle speeds are designed to be suited to the different diameters of holes in the work in automobile cylinder operations.

GANG RADIAL DRILLING MACHINE

The radial drill made by the Wm. E. Gang Co., Cincinnati, O., has been redesigned, as shown in the engraving.

The general design of this radial drill is well known. The spindle is driven from a horizontal shaft which passes through the swinging column, where it is connected by gearing with the vertical drive-shaft. This construction gives much more direct drive than usual. Another distinctive feature of the machine is the placing of the power-elevating mechanism on the arm instead of at the top of the column. The screw is thus a stationary one acted on by a revolving nut.

In the new design, the particular point of interest is a new spindle drive mechanism. *A*, in Fig. 2, is the horizontal driving shaft, passing through the column as described. This shaft has keyed to it a pinion *B*, driving bevel gears *C* and *D* in opposite directions. These latter revolve loosely on the shaft, and are provided with internal seats against which friction rings may be expanded, so that either of them can be connected with shaft *F*. This double friction clutch is operated by lever *N* through collar *E*. By this means the spindle is quickly reversed in either direction. Spur gear *G* is solid with shaft *F*, and spur gear *I* is keyed to it. These mesh with gears *H* and *J* respectively, which run loose on sleeve *L*. Sliding jaw clutch *K*, controlled by lever *O*, may be operated to engage either one of these with the shaft. This corresponds to the usual back gear provision, giving eight changes of speed with the cone pulley drive, or twelve with the speed box.

An important point in the drive thus described is the fact that the friction clutches for reversing operate between the high-speed shafts *A* and *F*—that is to say, the back gears are placed between the

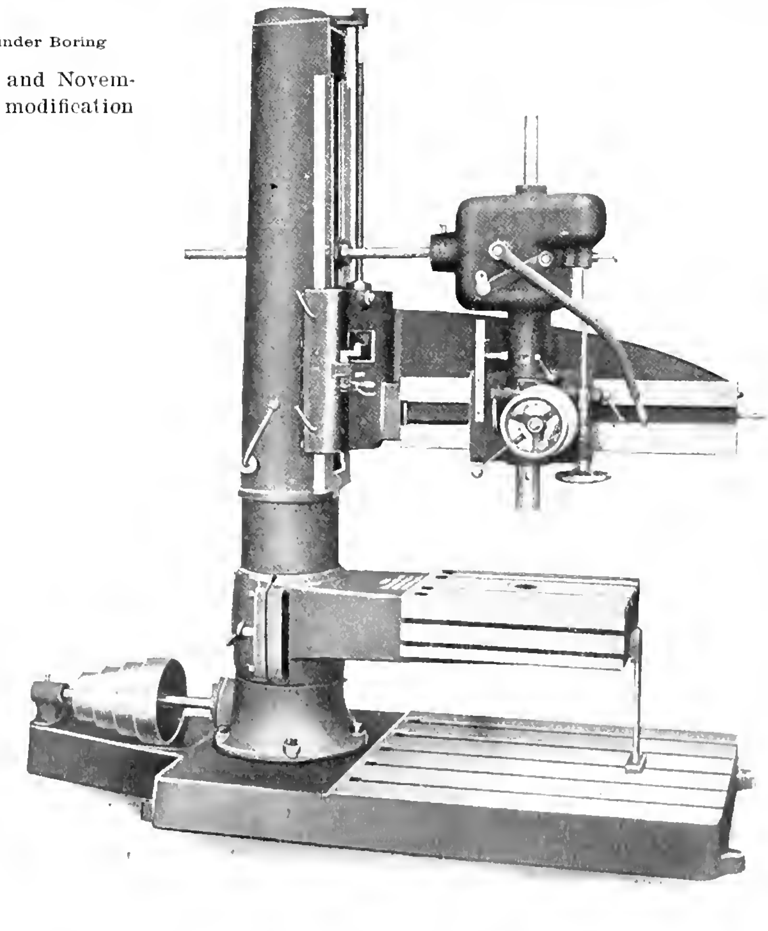


Fig. 1. Gang Radial Drilling and Tapping Machine

clutches and the spindle. By this means they are relieved of the excessive strain that would be thrown on them in such work as heavy tapping which requires the reversal of the

spindle while the tap is lodged in the work. The friction clutch operates without shock or jar.

Another important improvement is the depth gage and automatic stop. The gage is shown at *R*, and the adjustable tripping dog and pointer at *S*. The point of novelty lies in the fact that the graduated scale, instead of being on the spindle and moving with it, is attached in a stationary position on the head. The adjustable dog and pointer is clamped

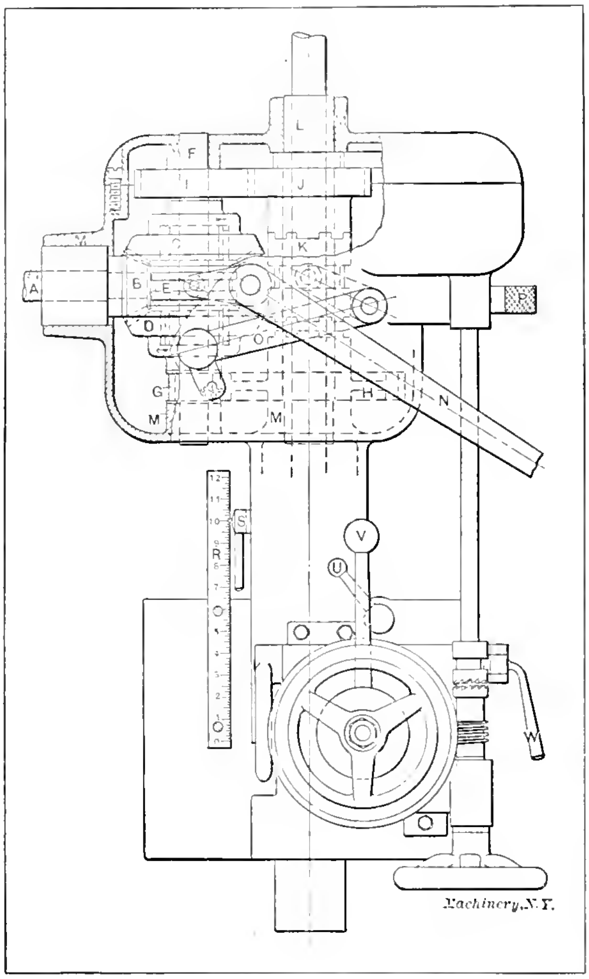


Fig. 2. The Improved Spindle Drive of the Gang Drill

in any required position by a bolt seated in a T-slot in the spindle sleeve. Thus arranged, with the zero point at the lower end of the graduated scale and in a fixed position, all the operator has to do in preparing to drill or counterbore a hole to a given depth is to bring the tool down onto the surface of the work, set the pointer on dog *S* opposite the graduations on the scale corresponding to the required depth, tighten the pointer and start the feed. When the pointer gets to zero, the feed will be knocked out automatically, and the spindle can travel no further. All depths are read from zero.

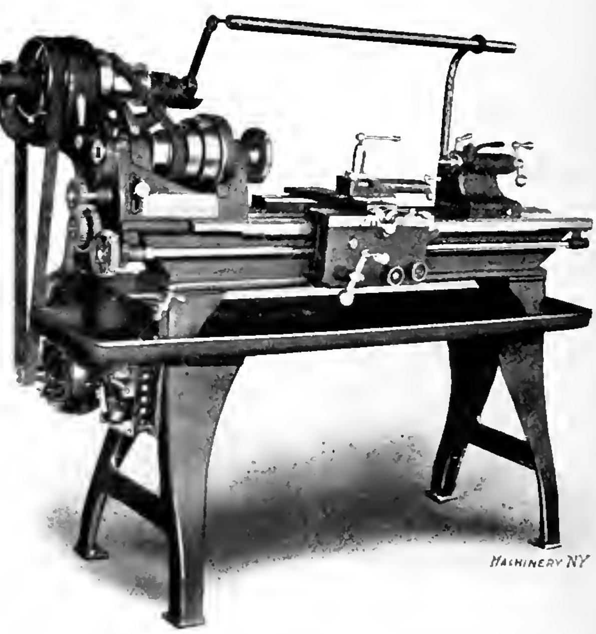
Four rates of feed are provided on this machine—0.008, 0.011, 0.014 and 0.017 inch per revolution of the spindle. The changes are made by turning knurled knob *P*. The feed is taken from a positive connection with gear *J*, through the change mechanism and a worm and worm-gear connection for the rack-pinion. The worm-gear drives the rack-pinion through a friction clutch, operated by quick return lever *V*. Lever *W* operates the positive clutch shown, which can be disengaged when it is desired to use a hand worm feed.

The head is firmly gibbed on the radial arm, and may be adjusted in and out by rack and pinion actuated by a handwheel. It is locked in position by clamp screw and lever *U*. It will be noted that, in accordance with their usual practice, the builders have enclosed all the gearing, thereby protecting both the operator and the mechanism from injury. This construction also minimizes the number of bolted-on bearings, and gives a pleasing appearance of neatness and simplicity to the design.

This machine will be furnished with a square, round, plain swiveling, worm swiveling, round tilting, square box or square tilting table. The square box form of table is shown in the illustration.

SENECA FALLS MOTOR DRIVE FOR "STAR" LATHES

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has recently brought out a new type of motor drive for its 9- and 11-inch "Star" lathes. This new arrangement is shown in the accompanying illustration. The advantage of this type of motor drive over other methods employed is in its adaptability to the varying conditions imposed by the users of small engine lathes, as they ask for motors for all kinds of electric current. For this reason the drive has been designed so as to use any kind of constant or variable speed motor. Preferably, it should be non-reversible, and with a speed of 1,000 to 2,000 revolutions per minute. This drive may be easily attached to a lathe. A pulley on the motor of the proper size transmits the power by belt to a countershaft pulley that runs constantly in one direction. A belt is also used to transmit motion from the countershaft to the lathe spindle. Means are provided for quickly tightening these belts so that they can be kept at the proper tension until worn out, without shortening them. Experience has proved that this method of driving small lathes has advantages over rigid gearing and chain belt drives, as the use of belts will often prevent damage to both motor and lathe. Starting, stopping, and reversing the rotation of the lathe spindle is controlled by a shifting bar placed horizontally above the lathe within easy reach of the operator. When this bar is in the central postion, the lathe is stationary. By shifting it to the left, a forward motion is imparted to the lathe spindle, while shifting it to the right gives a reverse movement.



Small Lathe equipped with the New Seneca Falls Motor Drive

The driving mechanism consists of friction clutches and gears for reversing the motion, which are encased and run in a bath of oil. This mechanism is simple in its construction and it is not liable to damage or disarrangement. The bearings are thoroughly lubricated by oil rings.

LELAND SENSITIVE MULTI-SPINDLE DRILL

The accompanying half-tone illustrations show a front and rear view of a four-spindle sensitive drill press built by W. H. Leland & Co., Worcester, Mass. This machine is known as the Leland "sensible" sensitive drill press, and in its design several new and interesting features have been introduced. Chief among these features are the arrangement for obtaining proper belt tension, the variable lever ratchet feed for the spindle, the arrangement of positive spindle stops, and the general design of the frame and the table, which makes it possible to obtain the maximum of strength without giving the machine a clumsy or unattractive appearance. The ma-

chine, however, is very heavy in comparison with the general type of these machines, it being about 250 pounds heavier than some other machines of its class. This additional metal has been distributed with care, so as to put it in such places where it will render the machine more efficient.

As will be seen in Fig. 2, the machine is provided with loose and fast pulley drive for the main driving shaft in the rear. The loose pulley is made smaller than the tight, to relieve the tension on the belt when the machine is not running. On the main driving shaft are placed the four-step cone pulleys from which the power is transmitted to the upper horizontal driving shafts and from there in the usual manner to the vertical spindles. The arrangement for obtaining the proper belt tension on the vertical belts between the cone pulleys as well as on the horizontal belts from the pulleys which drive the vertical spindles, is of especial interest. As shown in Fig. 2 the frame, or, as it has been commonly called, the "goose-neck," of the individual drills, is of a triangular construction, that is, it is provided with two braces in the back so placed that the belt tension from the two belts will largely strain these braces as compression members, thus insuring the maximum strength.

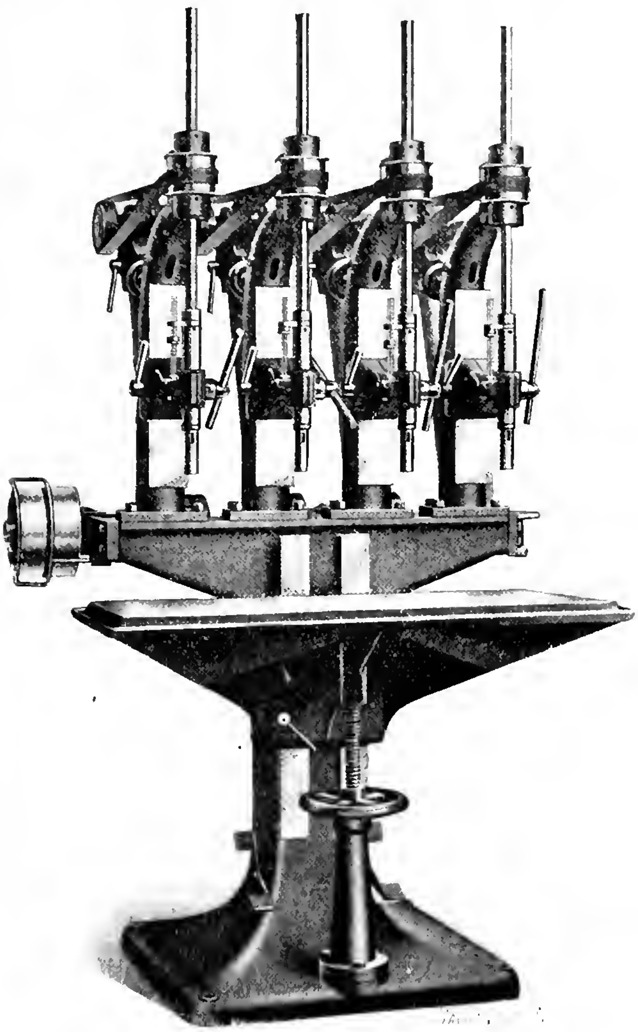


Fig. 1. Sensitive Four-spindle Drill, built by W. H. Leland & Co., Worcester, Mass.

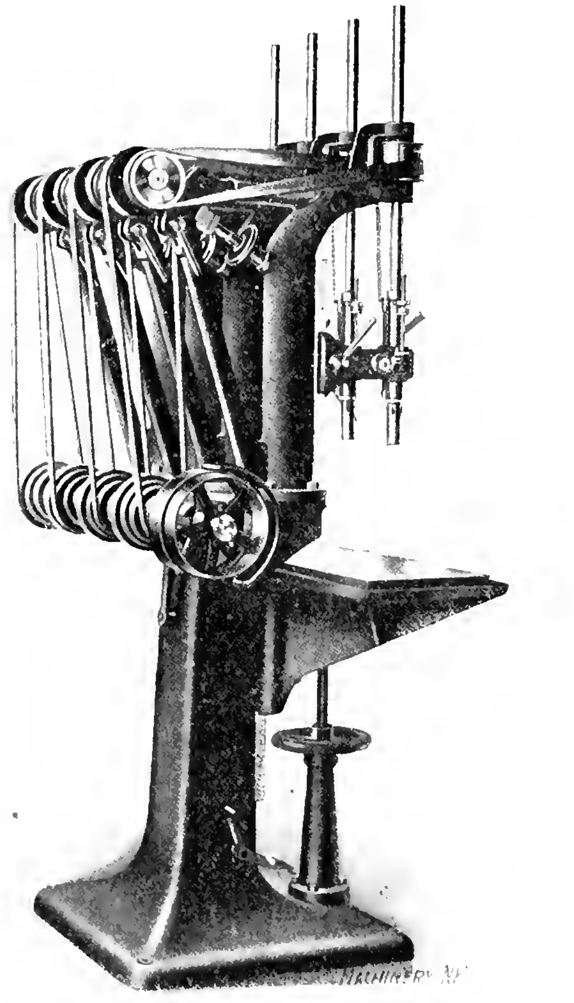


Fig. 2. Rear View of Leland Sensitive Drill, showing Driving Arrangement

At the back where these two braces join, the frame is provided with a slot, the sides of which may be brought together or tightened by means of the handle shown in Fig. 2, immediately below the pulley transmitting power to the vertical spindle. The bearings for the upper cone pulleys and the pulley driving the spindle are held in this slot, and are supported by a screw which enters into an elongated nut provided with a hand-wheel, as shown, between the two braces. The end of the elongated nut rests in a socket in the back of the main column of the frame or goose-neck. When the binding handle mentioned is loosened and the hand-wheel operated, the screw is moved either out or in, according to the direction of rotation of the wheel, and as the bearings for the cone and driving pulleys are directly connected with the screw, they will consequently move outward or inward, as the case may be. Owing to the fact that the thrust on the screw is taken in a direction such that the axis of the screw bisects the angle between the vertical and horizontal belt pulls, the tension on both of the belts will adjust itself automatically so that it will be of the same amount in each, this being possible on account of the socket joint in the main column which takes the thrust. When the bearings have taken their proper location, the bracket carrying them is clamped in position in the slot in the back of the frame, by means of the handle already referred to. This means for tightening the belts is both convenient and efficient. It is quickly operated and it equalizes the tension on both belts automatically. When small holes are drilled and less belt tension is required, the belts may be slackened. When heavier drilling is to be done, it is but a moment's work to again get heavier tension on the belts.

The main driving shaft is provided with a bearing in the center, as well as at each end, in order to maintain perfect alignment; and at the top of the spindle, a bearing is provided at each end of the spindle pulley. It will be seen in Fig. 1 that apparently the pulley on the vertical spindle is wider than necessary. As a matter of fact, this pulley is actually a drum, and the extra width is required on account of the swinging action of the driving pulley when adjusted for belt tension. The width of the belts used is $1\frac{1}{4}$ inch, but the spindle pulley is more than twice the width of the belt. This permits the belt to assume a normal position on the pulley when the shaft in the back is moved either up or down, as required.

The machine is built in two styles, one having all ball-bearings, while the other is provided with bearings with inserted bushings, these latter being made of Parsons white brass. All the bearings on the machine when provided with inserted

bushings are ring-oiled with the exception of the vertical bearings, which are equipped with felt storage for the oil. The bushing bearings are superior in many respects to the usual plain babbitted bearings. When ball-bearings are used, the belts; of course, run in oil and the bearings are dust-proof.

The base of the machine is of a box-shaped section and the top of the base onto which the individual drill frames are bolted is also made of a box section, which maintains the truth of the surface onto which the frames are bolted, a feature which is highly important if accuracy is expected. The table of the machine is heavily ribbed on the under side in a manner very similar to that of a surface plate; this is indicated both in Figs. 1 and 2. This method of ribbing is very necessary on a machine of this type, where accurate work is to be performed. Often the tables of sensitive drill presses are not strong enough to carry the heavy weight of the work with its drill jig, when placed on one corner of the table, without springing to some extent, and in such cases it is, of course, impossible to drill a hole that is at right angles to the base surface of the work. The table is raised and lowered by an elevating screw which is stationary and engages with a revolving nut hand-wheel, the thrust being taken by a ball-bearing. It is not necessary to cut a hole in the floor in order to get the extreme range of the vertical movement of the table. A groove is provided around the edge of the table for oil or other drilling compound.

It will be seen in Fig. 1 that a foot-treadle is provided on both sides of the machine, so that the shipper may be operated by the foot from either side, according to the position of the operator. A locking arrangement consisting of a latch which holds the shipper positively in position when once operated, is provided. This locking arrangement, however, does not prevent the shipper from returning to its original position when the foot-treadle is again pressed, but it locks it in the position to which it has been brought by the last operation of the shipper treadle.

The sliding head is held at any desired position on the face of the column by a binder on the side of the head. An interesting feature in the design of the head is the ratchet feed employed. The feed is by a lever, as usual, which is of sufficient diameter and length to allow of heavy feeds for large drills. By means of a slight twist of the handle, the ratchet pawl is brought out of engagement with any one groove in the ratchet collar, and brought into engagement with the next groove, the engagement being positive as long as there is no twisting action on the handle. This design is very simple, but handy and efficient. The lever can be moved quickly from a short to a long leverage, and can be locked, if required, in any position, but the tension on the spring employed in the ratchet feed device provides enough pressure to ordinarily hold it in any position. The lever is knurled on the end sufficiently to get a good grip.

On the side of the spindle a positive stop arrangement is provided. This device is made in two styles. The regular style consists of a screw provided with two nuts, one of which acts as a check nut binding the other on the screw on which they are both mounted. The nuts abut against a projection of the head when the spindle is brought down. This stop is positive and can be adjusted for very fine differences in measurements when required. It is set, of course, by means of a scale or standard measuring blocks. The special type of stop consists of a micrometer stop arrangement which makes it possible to take actual measurements directly, without the use of a scale. The screw on which the stop nuts are mounted has, in this case, been milled away nearly to its center, and on the flat surface thus provided a scale is graduated, on one side of the center line in tenths, and on the other side in fourths, of an inch. A graduated micrometer collar is then provided on the screw, by means of which it is possible to take any measurements varying by thousandths of an inch. The micrometer screw is adjustable in its end bearings, so that it can be brought up or down as required, in order that readings for different depths of drilled holes may be made to start at zero. The thread of the micrometer screw is a ratchet thread being made like a square thread on one side, and with an angle on the other. As the square side of the thread takes the thrust, this makes a very strong, positive and durable stop.

The machine is furnished with from one to four spindles, as required, and it will drive to their full capacity, high-speed drills up to 29/32 inch in diameter, these drill sizes regularly having a No. 2 Morse taper shank, the spindle being provided with a No. 2 Morse taper socket.

The general dimensions of the machine are as follows: The distance from the face of the column to the center of the spindles is 7 inches and the distance between the spindles 9 inches. The maximum distance from the lower spindle end to the table is 24 inches, and it is possible to bring the spindle clear down to the table. The vertical adjustment of the spindle head is 11 inches, and that of the table 12 inches; the vertical feed of the spindle is 5 inches. The diameter of the spindle pulley is 4 inches. The working surface of the table for the 4-spindle machine is 11 x 41 inches, the outside of the table being 14 x 44 inches. The tables of the one-, two- and three-spindle machines are, of course, proportionally smaller. The diameter of the main driving pulley is 8 inches and its face 2½ inches for the four-spindle machine. The floor space required for the same machine is 33 x 48 inches and the weight is 1,230 pounds.

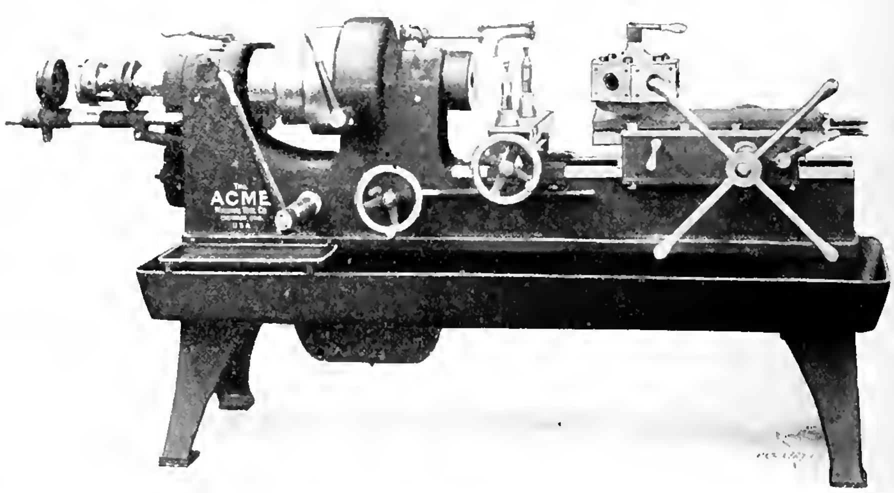


Fig. 1. The Acme Turret Lathe

THE ACME TURRET LATHE

The turret lathe or screw machine herewith illustrated and described is the product of a new firm, the Acme Machine Tool Co., of Cincinnati, O. The machine gives evidence on the first inspection of having been designed to meet the demand for a high grade, powerful tool, for use with high-speed steel. This is evidenced, for instance, by the fact that the head-stock is cast solid with the bed, and by the provision of a wide-faced, three-step cone with a friction clutch back-gear drive. The clutches are so arranged that the spindle can be stopped by throwing the operating lever to the middle position. The deep chip pan should also be noted. This will hold a liberal quantity of chips and oil, making it unnecessary to be constantly cleaning it out when taking rapid reduction cuts on steel.

The spindle runs in ring oiling babbitted bearings of ample size. The end thrust is taken at the front bearing, thus avoiding danger of binding or loosening from the unequal expansion of the steel spindle and the cast iron bed. The automatic chuck is forged solid on the end of the spindle, reducing the overhang, and supporting the collet firmly at its extreme outer end. A master collet is furnished with each machine, together with one set of bushings for stock of the largest capacity of the spindle. The chuck and stock-

feeding lever is placed within easy reach of the operator. Special attention has, in fact, been given to the location of all the hand wheels, levers, etc., to permit easy manipulation without requiring the operator to shift his position.

Interesting details of the turret slide mechanism are shown in Figs. 3 and 4. The turret *A* is hexagonal in form and is provided with tapped holes for attaching tools to the face, in addition to the regular holes with the binder bushings. A hole of the same diameter as those in the turret is bored through the turret stem *B*, thus allowing long work to be turned with short stiff tools. The tool clearance over the top of the slide is made extra large to permit the use of large dies and turret tools, while the slide itself is made wide to give rigidity to the turret and tools. This will be seen in Fig. 4.

Taper gibs *C* and *C*, also shown in Fig. 4, adjust the slide horizontally, while the slide bed has interposed between it and the top of the bed, the taper shim *D*, which by means of screws *E*, *E*, can be adjusted forward or back so as to raise or lower the turret. These two adjustments, working in combination, serve to preserve the alignment of the turret holes with the spindle. An interesting point in the construction of the taper shim *D* will be noticed in Fig. 3. The points of screws *E* bear on inclined surfaces, so that when the turret slide bed is raised from the bed of the machine, shim *D* goes with it, being held without danger of dropping loose.

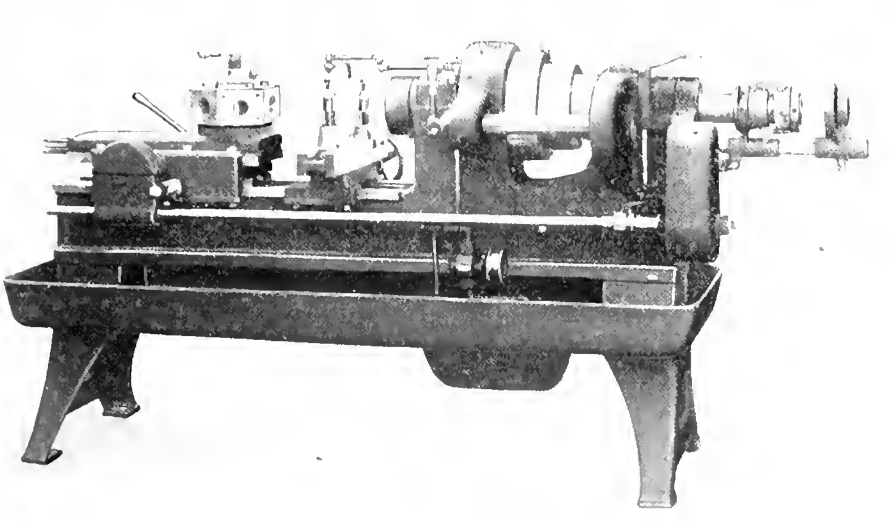


Fig. 2. Rear View of Machine, showing Feed Mechanism

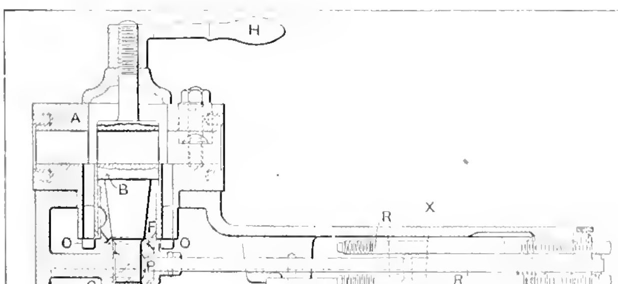


Fig. 3. Longitudinal Sections, showing Turret Indexing and Feed Mechanisms

The neck of the turret contains a bronze sleeve *F*, which is keyed to it, and thus revolves with it. This is bored taper to form a seat for the binding bolt *B*. By adjusting nut *G*, the turret may be held to its seat with any desired degree of freedom, irrespective of the action of the regular clamp handle.

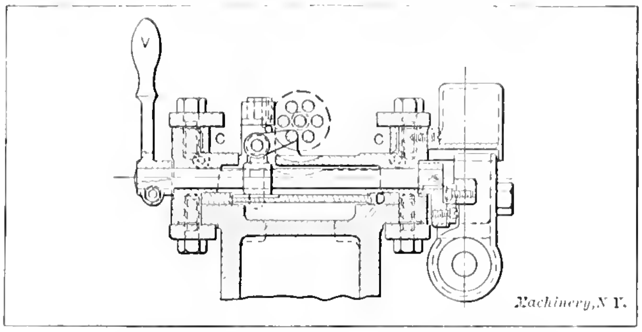


Fig. 4. The Feed and Automatic Stop Motions

The turret revolving mechanism is shown most plainly in the lower view of Fig. 3. As the turret slide nears the limit of its backward movement, the roll on the end of lock bolt lever *J* runs up the incline of tumbler *K*, thus withdrawing the turret lock bolt *L* against the pressure of spring *M*. When *L* has been withdrawn, pawl *N* engages one of six hardened pins *O* driven into the neck of the turret (see upper view) and thus revolves the latter. At the conclusion of the indexing at the extreme end of the stroke, the roller at the end of *J* runs off the back side of tumbler *K*, locking the turret in position again. As the slide comes forward for its next cut, the tumbler *K* tips down out of the way of *J*, and pawl *N* snaps in back of the next pin *O*, both being thus in position to index again on the next return movement.

Details of the turret feed mechanism are shown in both Figs. 3 and 4. An independent stop is provided for each face of the turret. Bushing *F*, already mentioned, has bevel gear teeth cut on it meshing with a corresponding bevel gear *P*, which, by means of the shaft to which it is pinned, revolves the stop cylinder *Q*. This latter carries a series of six stop screws *R*, which are thus brought successively into position in line with the stop screw abutment *S*. The striking of the stop screw against this abutment first throws out the automatic feed (if it is engaged), and then brings up against a positive stop immediately afterwards. This permits using the automatic feed in turning up to a shoulder, which may then be finished by hand, allowing the cut to run out until the face has been smoothed up. The abutment *S* is pinned to a rod *T*, carrying a collar engaging the trip *U*, by means of which the power feed is thrown out. Lever *V* is used for throwing the feed out or in by hand. Also pinned to *T* is the handle *W*, which permits abutment *S* to be swung around out of the way of the stop screws, so as to feed beyond the positive stop, should occasion so require.

The power feed is driven positively from the spindle by gearing enclosed in the case shown at the right of Fig. 2. This gearing provides four changes of feed, controlled by a handle extending over the rear head-stock bearing. This power feed may be attached to the machine after it is purchased, if desired by the user, without additional machining.

The cross-slide is provided with a large graduated dial and positive stops. It has a hand longitudinal adjustment by means of the hand-wheel, bevel gears and screw shown on the front of the bed. This screw runs in a bronze nut screwed to the flat gib of the cross-slide, and is protected from chips and dirt by means of steel tubing. Power feed will be supplied for this cut-off if desired.

A double taper friction countershaft of improved design is

supplied. The construction of the clutch is shown in Fig. 5. The shaft A_1 has keyed to it the driving sleeve B_1. Interlocking with projections on this sleeve, but free to slide on the shaft, is a friction clutch C_1. Bearing sleeve D_1 is a sliding fit in the hub of pulley E_1 and revolves on driving sleeve B_1. It is provided with a large oil chamber holding enough lubricant to run a month or more without refilling. When thimble J_1 is pressed toward the left, levers K_1, of which one only is shown, operate to engage the friction surfaces of E_1 and C_1 in a perfectly obvious manner. Ample adjustment for wear is provided by loosening screw H_1 and turning nut F_1 to bring

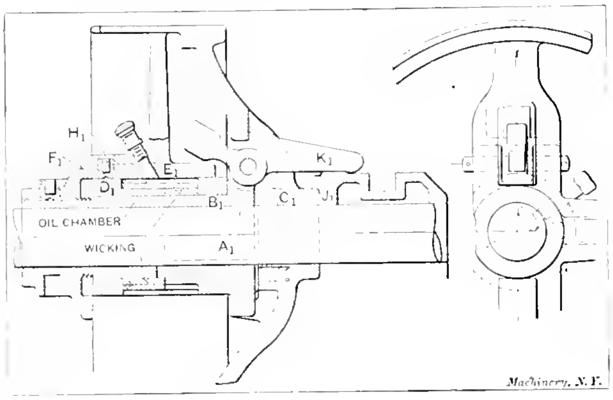


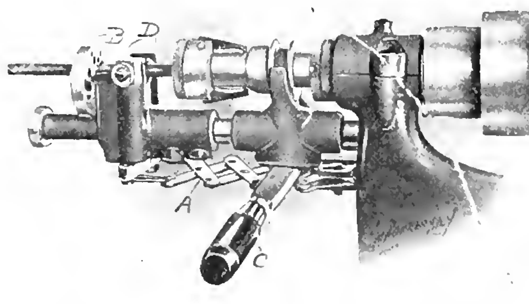
Fig. 5. Detail of Countershaft Clutch Construction

the pulley into closer engagement with the cone surface of C_1. This construction will be appreciated by mechanics who have had to dismantle the counter-shaft and face of the hub of the pulley, in order to get more adjustment.

The machine illustrated is provided with chuck and stock feed, and power feed for the turret slide. It may be purchased without these attachments, however, either of which may be added at a later time without requiring any further machine work on the lathe. The same is true of a power feed to the cut-off slide, which will also be provided for work which requires it.

WELLS IMPROVED WIRE FEED

The accompanying illustration shows an improvement which has been introduced on the hand screw machine made by the F. E. Wells & Son Co., Greenfield, Mass. The advantage of this wire feed is that a single lever movement takes care of all operations and movements of the various parts necessary, including the opening of the chuck, the feeding of the stock forward, and the closing of the chuck. It is not necessary

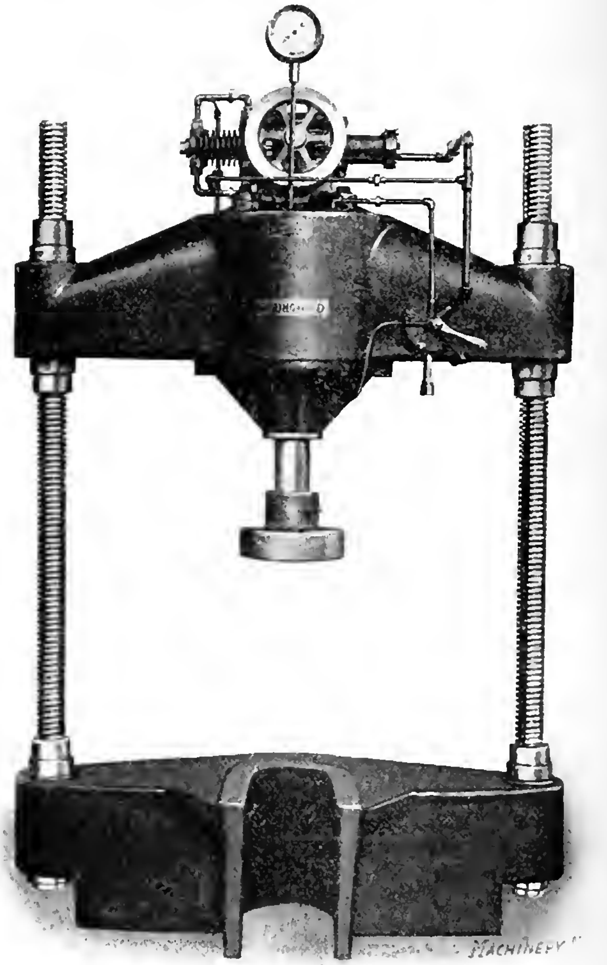


Improved Wire Feed Mechanism, made by the F. E. Wells & Son Co., Greenfield, Mass.

to fasten a dog, collar, or other device to the stock, as is the case with the ordinary type of wire feed. The operation of the device is briefly as follows: When the lever C is pulled forward, the two fingers D, which are provided with cam surfaces on their inner faces, are given a slight turn so that they grip the stock between them. By means of the pantograph, or "Jacob's ladder" arrangement shown at A, the bracket holding the fingers D is made to move through a distance very much greater than that of the movement of the lever C, so that a considerable length of stock may be fed in by a comparatively short movement of the feed lever. When the lever C is moved back after the stock has been pulled forward, the fingers are again opened and are ready to take a new hold on the stock as soon as the handle C is again operated forward. At the same time that the fingers are released and moved back, the bracket immediately above the handle C, which is provided with a yoke engaging with the chuck closing collar, is moved backward, and the chuck is closed, so that thus all the operations of feeding the stock forward and the opening and closing of the chuck are accomplished by a slight movement of a single lever, without any additional manipulation. The disk shown at B is a guide for the stock and can be adjusted for different diameters.

SPRINGFIELD PNEUMATIC PRESS

The illustration shows an ingenious press for shop use made by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. It is intended for general shop use in the insertion and removal of heavy arbors, and in making the press fits met



Pnaumatic Press with Automatic Intensifier

with in machine building. It is an improved design of the machine shown in the department of New Machinery and Tools of the August, 1908, number of MACHINERY.

This machine operates by air pressure, either direct or intensified, as will be described. It consists primarily of two heavy frame castings, upper and lower, held together by the strong screws shown on each side. The construction of the lower base permits a large wheel up to 38½ inches in diameter to be placed between the screws. The opening permits the work to be pushed into place instead of being lifted off as would often be necessary if a circular opening only were provided. The two upright screws support the upper frame on the nuts shown. These are adjustable so that the upper frame can be lowered or raised to agree with the height of work being operated upon.

As stated, the press is operated pneumatically. The piston is 15 inches in diameter with a stroke of 8 inches. With an initial pressure of 80 pounds this gives a pressure on the work of 7 tons when direct air pressure is being used. For work

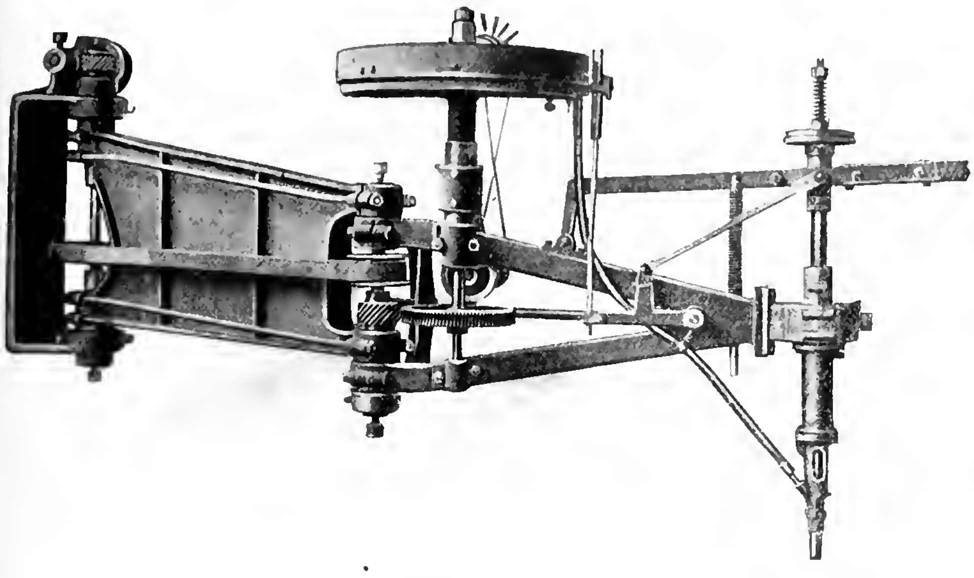
requiring a greater effort, the automatic pump mechanism, shown mounted on the top of the upper frame, is used. This is, in effect, a compressed air engine driving an air compressor capable of giving a maximum pressure of 225 pounds against the 15-inch piston, giving a pressure on the work of about 20 tons.

All the movements of the press are controlled by the valve shown at the right-hand side of the upper frame. In one position of this handle, the piston is raised, and in the next position the initial air pressure is admitted above the cylinder. Should this not be sufficient to drive the work together, the handle is moved to the third position, which automatically starts the pump, gradually increasing the pressure to the desired point. A gage is furnished so that the operator may know at all times what pressure is being applied to the work.

The distance between the upright screws is 38½ inches. The maximum distance of the plunger at its topmost position to the bottom of the base is 42 inches. The machine requires a floor space of 24 by 48 inches.

REYNOLDS RADIAL SCREW DRIVING MACHINE

In the January, 1909, issue of MACHINERY an automatic screw driving machine built by the Reynolds Machinery Co., Moline, Ill., was illustrated and described. The accompanying illustration shows another machine built by this company, which is the latest addition to the line of screw driving machines manufactured by the firm. This machine covers a range of work for which the regular stationary type shown with the previous description is not available, and bears the same relation to the regular or upright type as a radial drilling machine does to an upright drill press. The illustration shows the machine, which consists merely of an arm which can be mounted in any convenient manner, for example, on a post or on the wall of the building in which the machine is used. The working parts of the machine are mounted on the arm which is provided with a joint at about one-half of the distance of the spindle from the wall. The arm is of such proportions that the screw-driving spindle can be brought to a maximum distance of 7 feet from the post, and owing to the jointed construction, the arm may be swung around so that the spindle can be placed in any position within the circumference of a 14-foot diameter circle, except for a small area close to the post.



Radial Automatic Screw Driving Machine, built by Reynolds Machinery Co., Moline, Ill.

The spindle of the machine is spring counterbalanced so that it is automatically raised as soon as the operating lever is released. In operation, the screws are simply thrown into the pan or hopper shown at the top in the illustration. The work is then placed in such a position that the spindle end can reach the place where it is desired to drive the screw. The operator holds the feed lever in in one hand and places the other on the head of the machine so as to be able to swing it quickly into the desired position. He then depresses the lever as soon as the spindle comes in the desired position, thereby starting the screw. The spindle runs at about 800 revolutions per minute, so that the screws are driven in place practically instantly. The size of the machine shown in the half-tone is capable of driving screws up to No. 20, 4 inches long. The magazine, the friction-driven spindle, chuck, hopper, etc., are of the same design as that successfully used in the stationary type of machine previously described.

The machine is built to deliver, if necessary, 3 horse-power to the spindle, thus providing ample power for the largest screw within its capacity. It may be driven either from the line-shaft, counter-shaft, or by individual motor.

NEWTON CYLINDER BORING MACHINE

A new design of cylinder boring machine, which has been adopted as a standard by its builder, the Newton Machine Tool Works, Inc., Philadelphia, Pa., is shown in the accompanying engravings. This machine, as is evident after an examination of the illustrations, is exceptionally massive. The spindle is 8 inches in diameter and its bearings, both in the driving head and outer support, are amply large to insure rigidity and a minimum of wear. The particular machine

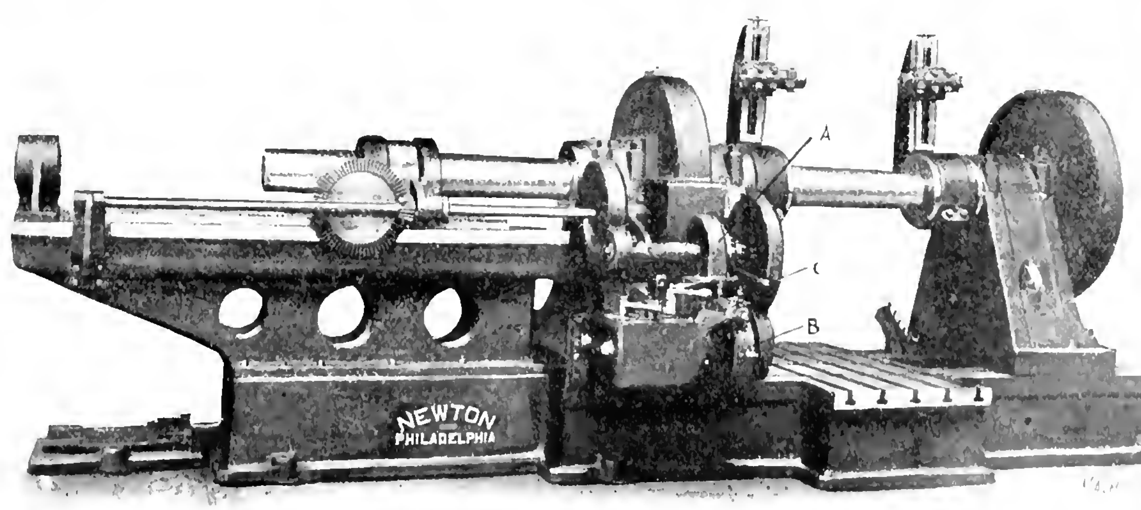


Fig. 1. Front View of the Latest Design of Newton Cylinder Boring Machine

illustrated is intended to be driven by a variable speed motor which will be belted to the single driving pulley shown at the rear of the machine in Fig. 2. From the shaft on which this pulley is mounted, the motion is transmitted by spur gears to a driving worm meshing with a large worm-wheel which is mounted on a sleeve that revolves in bearings at each end of the head. This sleeve, which is 33 inches in length, transmits the motion to the boring-bar. The driving worm is of hardened steel, while the worm-wheel is of cast iron with an outer ring of bronze. The worm is provided with roll thrust bearings, and it has a triple thread of 6-inch lead. The bearing sleeve in the outboard head for supporting the end of the bar, is of large diameter and has a length of about 20 inches. The feed motion for the bar is transmitted from the end of the driving shaft to the worm-wheel B, which is mounted on the feed box shaft. From this shaft, through the different combinations of gears, nine changes of feed are obtained. A feed yoke which may be gripped to the bar at any point, and which is driven by pinions on either side of it meshing with racks mounted upon a supporting bed, serves to transmit the motion to the bar. This bed, as will be seen, is unusually rigid. For the fast traverse of the bar the worm shaft is connected with an idler male friction gear at A. The hand-lever C operates a friction clutch, controlling the fast traverse of the spindle and also the tooth clutch that engages the feed. With this design of drive and feed it is possible to obtain great variations in the spindle speed, although the present machine is arranged for from 3 to 9 revolutions per minute of the spindle, and for feeds ranging from 0.062 inch to 0.647 inch per revolution of the spindle. The length of the feed is 72 inches, and the distance from the center of the spindle to the top of the work table is 37½ inches. The facing arms are mounted on extensions of the spindle sleeves, permitting adjustments of the spindle without interfering with the arms. If desired, these arms can remain stationary while the spindle rotates. They are furnished with swiveling tool-holders which are mounted on a slide having a reversing power feed. This machine is furnished, when desired, with a counterbalance, as shown, to equalize the weight of the facing arms and to insure a steady even motion of the spindle when boring and facing at the same time. The machine has a capacity for boring cylinders up to 40 inches in diameter, and it will bore and face cylinders up to 50 inches in length. When motor-driven, the machine requires a 15-horse-power motor which should have, preferably, a 3 to 1 speed variation.

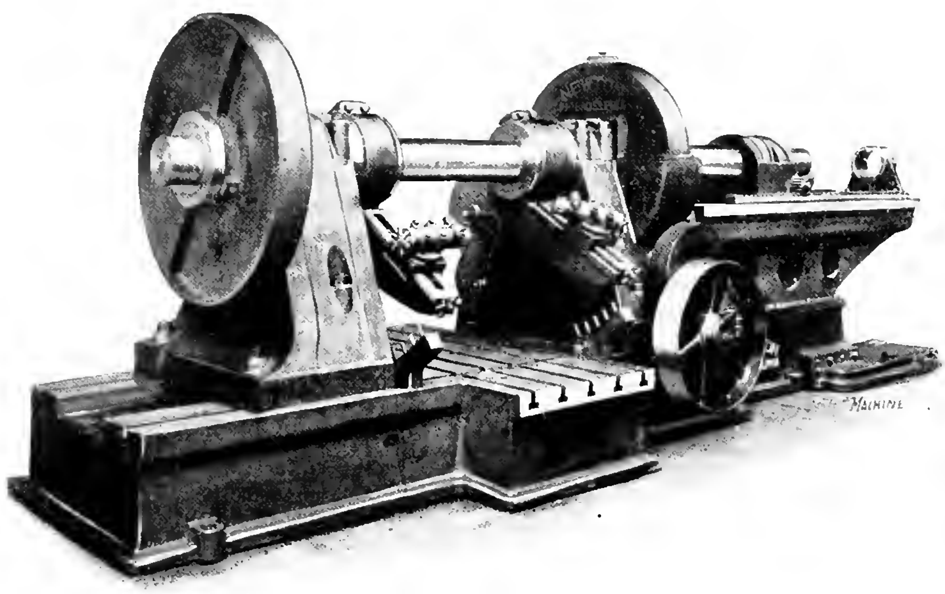
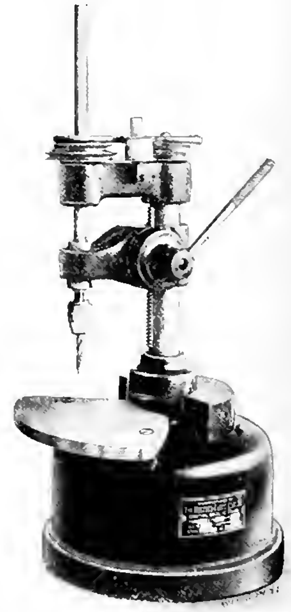


Fig. 2. Rear View of the Newton Cylinder Boring Machine

HOLTZER-CABOT UNIVERSAL DRILL

The accompanying illustration shows a small drill made by the Holtzer-Cabot Electric Co., 621 Albany St., Boston, Mass. This machine is intended for use in garages, machine and repair shops, and in manufacturing plants where light metal work is handled, as well as in all other places where there is a considerable amount of light drill press work. The arrangement of the drill is rather ingenious and novel. As shown in the illustration, the drill is mounted directly on the motor casing, the main driving shaft passing up through the inside of the column, and transmitting the power by means of a round belt on a three-step grooved pulley, a small idler being provided to furnish the required contact of the belt with the pulley, this being necessary on account of the short center distance between the two grooved pulleys. The chuck will take drills up to 13/64 inch diameter. The tool is equipped with a ¼ horse-power motor and is arranged to drill at speeds varying from 800 to 2,700 revolutions per minute. Motors are supplied for any class of electric current supply.



A Small Drill Press of Novel Design

* * *

NEW MACHINERY AND TOOLS NOTES

Combined Punch and Shear: Covington Machine Co., Covington, Va. This is a punch and shear of the type in which the two machines are set back to back, with a common driving mechanism. The novelty of the design lies in the provision of sliding gears for giving a choice of either of two different speeds, depending on the service demanded.

Handy Die Stock: Handy Mfg. Co., Bridgeport, Conn. This die-stock is intended to cut a wide range of sizes with one set of dies, and without requiring the use of special tools for adjustment. It is at the present made in four sizes—the smaller size with single and the larger with double end chasers, to give different pitches for different diameters of pipe.

Speed Indicator with Timing Attachment: Karl Weiss, 30 Woodlawn Terrace, Waterbury, Conn. This is a combination of watch movement and speed indicator, which automatically throws the worm gear out of mesh with the worm at the expiration of any desired time, up to three minutes. Its use makes the watch unnecessary when timing shafts and other rotating parts.

Hand Press: Standard Machinery Co., Providence, R. I. This machine is of the vertical slide type, with a cast iron frame mounted on a table with legs. The slide is cast in one piece and has attached to it a machine steel rack, operated by a pinion mounted on the lever shaft. It is adapted to fine work requiring more sensitive action than is obtainable with a hand-wheel or foot-treadle.

Centrifugal Hot Air Polishing and Drying Machine: Tolhurst Machine Works, Troy, N. Y. This machine is intended for cleaning small metal articles after electro-plating. It has been fonnd that when such work is rotated at high speed in a centrifugal drier and subjected to a blast of hot air for 10 minutes or so, a high polish results. While the action is somewhat obscure, it is said to give unusually good results.

Draftsmen's Square and Protractor: D. J. Kelsey, New Haven, Conn. This protractor is similar in design to the maker's celluloid protractor, but is made of sheet steel. The edges of the tool are turned down to secure stiffness and to

prevent the contact of broad bearing surfaces of metal with the paper, and the consequent rubbing of dirt into the drawing. The swinging arm is graduated in 32nds of an inch. A vernier reading to 10 minutes is provided.

Double Spindle Polishing and Buffing Lathe: Osborn Mfg. Co., Cleveland, O. This tool comprises two separate buffing and polishing spindles, mounted in a single frame, of light but very rigid construction. The shape of the front legs is such as to permit two men to work easily on the same machine without interfering with each other. The spindle drives are separate, so that the stopping of one spindle does not interfere with the other, while the advantages of the double machine in the matter of space economy are retained.

Adjustable Drill Jig: G. R. Carlson, 367 Ellicott St., Buffalo, N. Y. This tool has a work-table 5 inches square, mounted on slides having screw adjustments in both horizontal directions, read by micrometer dials graduated to thousandths of an inch. A drill bushing is supported by a vertically-adjustable overhanging arm. The work-table is provided with slots for holding parallels or stops for locating the work. The device weighs about 15 pounds, and should be useful in work made in too small quantities to make a special jig profitable.

Twenty-inch Drill: Aurora Tool Works, Aurora, Ind. This machine is an improvement over previous designs, the principal improvement consisting in increasing the strength and weight of the machine. It is built either plain or with back gears. The maximum distance between the spindle and the table at the base is 31 inches, and between the spindle and the regular drill table, 20 inches. The table has a traverse of 20 inches and the spindle a traverse of 7 inches. The machine requires one horse-power for its drive. The floor space occupied is 36 by 18 inches.

Calibrating Apparatus for High Pressure Gages: Watson-Stillman Co., 192 Fulton St., New York City. This apparatus is designed for calibrating master gages or for comparing other gages with a master gage. In the first case the pressure is applied directly by weights acting on a piston in a carefully designed and fitted cylinder. Provision is made for eliminating friction effects and for controlling the pressure within fine limits, permitting accurate work in testing. In the second case the two gages are connected with a cylinder in which the pressure is produced by a hand-operated screw action.

Turbine Dynamometer: Herschell-Spillman Co., N. Tonawanda, N. Y. This is an absorption dynamometer in which the resistance is furnished by a turbine pump construction, discharging in a closed circuit through a by-pass. The by-pass may be throttled more or less to change the load imposed by the action of the blades on the water. The introduction of a small supply of fresh water serves to regulate the temperature and keep it below the boiling point. It is particularly adapted to automobile engine testing and will be furnished with a frame to fit the same testing stand in which the engines are mounted.

Adjustable Bolt and Clamping Device: Red Wing Adjustable Bolt Co., Red Wing, Minn. This adjustable bolt is intended for various temporary uses, but particularly for securing work to the tables of machine tools. It can be quickly shifted to vary the length, and is therefore of advantage in cases where it would otherwise be necessary to have a large assortment of different lengths of bolts for clamping. The bolts are provided with ratchet-shaped stops, on any one of which a clamp may be secured. Two bolts comprise a set, and by means of these and a U-clamp, work of a great variety may be clamped down.

Bi-centric Master-keyed Padlock: Yale & Towne Mfg. Co., 9 Murray St., New York City. This is a new design of padlock of the highest quality, embodying the makers "Bi-centric" system of master-keying. Separate plugs are provided for the master key and the operating key. When thus made, the locks may be arranged in any number of sets, each set controlled by a master key and all controlled by a grand master key. No two padlocks have keys alike, and the original simplicity and security of the pin-tumbler mechanism is not impaired. The locks can also be arranged as for safe deposit system, so that the use of two keys is required to operate the lock.

Ronson Universal Wrench: Cryder & Co., Park Ave. and 63rd St., New York City. This wrench, when closed is only 6 inches in length and weighs but 8 ounces, though it provides 9 wrenches in one, ranging in size from 3/16 to 13/16 inch. It consists in general of a set of four wrenches, held together by a screw and wing nut in the center. The wrenches are slotted so that any one of the four wrenches may be projected outside of the others, when it is to be used. When one of the wrenches is pulled out for use, the others form a handle, giving considerable leverage. The screw passing through the slot in the wrenches has a square body, making it impossible for the members to turn.

Stop Mechanism for Lathe Cross-slide and Carriage Movements: Lodge & Shipley Machine Tool Co., Cincinnati, O. In the July and August, 1909, numbers of Machinery, department of New Machinery and Tools, we described two special forms of Lodge & Shipley lathes, in which an improved stop mechanism was incorporated as one of the principal features. The builders are now prepared to furnish their regular patent head lathes in the smaller sizes with this stop mechanism, giving such lathes many of the advantages of the turret machine in the matter of the duplication of diameters and shoulder lengths. With the use of these stops, a single tool may be used for turning or boring duplicate work of considerable complication.

Automatic Tapping Chuck: Pawtucket Tool Co., Inc., Pawtucket, R. I. Two styles of automatic tapping chucks, known as styles A and B Thompson chucks, have been brought out by this company. The style A chuck is intended for use in radial drills and the style B more especially for upright drills; the latter style contains its own reversing mechanism, while the other is employed on machines on which such mechanism is already incorporated. There are no projecting parts on these chucks. The advantages claimed for them are that they are simple in construction and require no tightening and loosening. Holes can be tapped clear to the bottom, and the breakage of taps is practically eliminated. The chuck stops automatically and instantaneously at the bottom of the hole.

Riveting Machine: Charles Greiner Co., New Haven, Conn. The principal feature of this machine is its high speed; the machine will strike from 1,000 to 6,000 blows per minute when the treadle is depressed. The principal working element of the machine is a spring cushion hammer which works in a gun metal cylinder and which is actuated by the engagement of a roll at its upper end, with cam-like projections on the end of a flange which revolves on a horizontal plane and is driven by a friction clutch. In combination with the great number of blows per minute the hammer spins at a high rate of speed and causes the head of the rivet to be evenly spread. The elastic blow prevents injury to fine work and allows working of rivets at different heights without altering the adjustment.

Horizontal Boring, Drilling and Milling Machine: Fosdick Machine Tool Co., Cincinnati, O. This machine, known as the style A, is a new design capable of performing all the operations of drilling, milling, tapping, boring, facing, etc., on light and heavy work, within the dimensional limits of the machine. It is of the type in which the spindle is mounted on a head, vertically adjustable on the face of a column, which is itself horizontally adjustable on the base of the machine. A particular feature of the design is the rugged construction of the slide mechanism for operating the boring bar feed. Special attention has also been given to placing the spindle-driving gears close to the work, so as to reduce to a minimum the torsional stress in the spindle. Power feed and quick-return movements are applied to the movement of the column on the base, and to the movement of the head on the column. Eight changes of positive feed are provided for these movements, as well as for the end motion of the spindle. There are sixteen spindle speeds, ranging from 4 to 216 revolutions per minute. The machine is built in two sizes. The No. 1 machine has a table 42 by 72 inches area, and the No. 2, 42 by 120 inches. An outboard support for the boring bar is provided, adjustable horizontally and vertically. The machine will also be furnished, if desired, with a constant or variable speed motor drive. All the gears are of steel and the bearings are all bronze bushed. Careful attention has been given to workmanship and design in all details throughout the machine.

* * *

VANADIUM FORGING DIES

The severity of the service imposed on riveters and forging dies, boiler punches and other tools in similar uses often makes the upkeep abnormally expensive even when the best carbon steel is used. It is in such trying situations that certain alloy steels have shown marked superiority—a superiority so great in fact as to be in some instances very noteworthy. For example, in a ship-building yard on certain severe work, pneumatic hammer riveting dies made of the best carbon steel obtainable and treated in approved manner lasted only about ten hours each. The vibrations crystallized the shanks of the dies, the result being breakage at the juncture of the shank and the die proper. When these carbon steel riveter dies were replaced by vanadium steel dies, their life was greatly extended, fourteen months' service being reported by one concern using this alloy for its pneumatic riveter dies. An article on the characteristics of vanadium steel referring to its marked superiority for severe service was published in the engineering edition of Machinery, October, 1907.

The accompanying illustration shows a pair of forging dies made of mild type H vanadium steel supplied by the American Vanadium Co., Frick Building, Pittsburg, Pa., which are worthy of attention in this connection. In this case the bes-

carbon steel dies lasted only about two days when worked to the limit of capacity. The vanadium steel dies substituted have been in service for four months, and are still in good shape. The ratio of gain in endurance is already 60 to 1, and the prospect is that it will be much greater. Type H vanadium steel analyzes: carbon, 0.75; chromium, 0.90; vanadium (contained), 0.25; sulphur and phosphorus, very low. The amount of vanadium contained is small, being only about 1/400 of the total. It is evident, as has been before remarked, that vanadium has a very subtle and marked physic effect to make so great a change in characteristics of steel when administered in such small quantities. It seems to make a great improvement by its presence alone aside from its chemical combina-

Vanadium Forging Dies

tion. Vanadium acts as a deoxidizer, and counteracts the effect of fatigue and induced crystallization, the prime cause of failure of riveter dies, forging dies, and other dies and punches subjected to severe and often repeated shocks.

It is interesting to note that recent practice in making vanadium alloys tends toward the use of even smaller quantities of vanadium, particularly in iron castings. Where the practice several years ago ran about 0.25 per cent it is now found advisable to reduce the vanadium content to 0.12 or 0.10 per cent. Sometimes even smaller percentages are used with marked increase of tensile strength and elasticity.

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In the account of MACHINERY'S seventh annual outing in the November number it was stated that the Sandy Hook R. R. is the only railroad owned by the United States Government. This statement is an error. The Panama R. R. is also owned by the government; it was purchased with the Panama Canal.

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PERSONALS

R. H. Victory, formerly of the Lowell Machine Shops, Lowell, Mass., is now assistant superintendent with the Eastern Bolt & Nut Co., Providence, R. I.

David Millington is now traveling in Europe introducing a new line of full and one-half automatic screw machines lately brought out by Ludwig Loewe & Co., Berlin, Germany.

Charles Flannigan has been made superintendent of the Fox Machine Co., Grand Rapids, Mich., succeeding Matthew Lund, who has been placed on the road as salesman for the company.

John W. Doyle, for fifty-two years an employe of the George W. Prentiss Wire Co., Holyoke, Mass., and for many years foreman of the fine wire department, has resigned on account of ill health.

Guy H. Gibbs, who has been with the Westinghouse Electric & Mfg. Co. for the past eight years, four of which have been with that company's Cincinnati office, is now with the Western Electric Co. at Cincinnati.

T. Commerford Martin, for many years editor of the *Electrical World*, has retired to become permanent secretary of the National Electric Light Association. Mr. Martin is writing the biography of Thomas A. Edison.

C. A. Koehler, for the past three years foreman of the wood pattern department of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned to become foreman of the wood pattern work of the Stevens-Duryea Co., Chicopee Falls, Mass.

Henry L. Barton, for several years works manager of the Westinghouse Machine Co., East Pittsburg, Pa., has left that company, and with others has formed a new company known as the Metal Products Co. which will manufacture automobile parts in Detroit, Mich.

Charles E. Meech, secretary of Wilmarth & Morman Co., Grand Rapids, Mich., who has been in charge of the company's Alaska-Yukon-Pacific exposition in Seattle, Wash., is now making an extended business trip in the interests of the company along the Pacific coast.

Holden I. Crane, for the past six years connected with the operating department of the Cincinnati Milling Machine Co., Cincinnati, Ohio, and Percy S. Crane, a well-known Cincinnati business man, have formed the Crane Machine Tool Co., and have taken over the sensitive drill business of the Knecht Bros. Co.

Francis Walker has been employed sixty-four years without a break in the Fairbanks Co.'s scale factory, St. Johnsbury, Vt., and for forty-nine years has been at the head of its foundry department. Col. Walker, as he is known in his home town, was eighty-four years old October 27, and, despite his age, he is at his post every day directing the work of 160 men.

A. P. Warner, vice-president of the Warner Instrument Co., Beloit, Wis., whose purchase of a Herring-Curtiss aeroplane was mentioned in the August number, has made a few successful trials on the Morgan farm near Beloit. The first flight was made November 2, when a height of about fifty feet was attained. Mr. Warner has an improved form of aeroplane in mind, and if his plans are successful it is possible that he will manufacture aeroplanes for sale.

* * *

OBITUARIES

Frank J. Ludington, an inventor of cigarette-making machinery, died at Waterbury October 2, aged sixty-three years.

Richard Watson Gilder, editor of the *Century* and a well-known author and poet, died suddenly of heart disease in New York, November 18, aged sixty-five.

George W. Hoffman, manufacturer of the U. S. metal polish, and other specialties, died at his home in Indianapolis, Ind., October 22, after a short illness. The business will be continued by his widow.

Joseph B. Bancroft, president of the Draper Co., Oakdale, Mass., manufacturers of cotton mill machinery, died at his home in Oakdale, October 25, aged eighty-eight. He succeeded Gen. William F. Draper as head of the Draper Co., two years ago.

Tatem Parsons, the first engineer of the locomotive *John Bull*, died at Camden, N. J., November 5, aged ninety years. He was the first engineer to handle the throttle. The famous locomotive is now in the National Museum at Washington, D. C.

Lemuel Coburn, president of the Coburn Trolley Track Co., Holyoke, Mass., died at his home in Holyoke, October 26, aged seventy-nine years. Mr. Coburn was the inventor of the Coburn trolley apparatus and of many other devices, among which was a successful rag cutter for paper mills. This rag-cutting machine first brought Mr. Coburn prominently before the mechanical world.

John Moffitt, inventor of the threshing machine, died recently in Denver, aged eighty-four years. Moffitt constructed his first threshing machine on his father's farm near Canton, Ohio, in 1851, to do away with the old flail method of threshing grain. It proved to be so great an advance that it brought him international fame. The new machine was exhibited at the world's fair in London in 1851 where it attracted the attention of royalty itself. Mr. Moffitt built and sold his thresher for several years and later became interested in the rubber business in Boston. Still later he went to California and engaged in mining, and developed a cheap and expeditious method of smelting; also improved mining machinery.

Edward D. Entwhistle, who in his youth was a fireman and engineer of George Stephenson's locomotive *Rocket*, died at his home in Des Moines, Iowa, November 1, in his ninety-fifth year. He was only sixteen when employed by Stephenson as fireman of the *Rocket* on its epoch-making trial trip from Manchester to Liverpool in 1831. After a few trips Stephenson turned the care of the locomotive over to Entwhistle, who made two trips daily over the first railroad for nearly three years. Mr. Entwhistle came to the United States, and in 1856 settled in Des Moines. He was first employed in the United States as engineer on the steamer *Troy* running on the Hudson River, and later was engineer of one of the lake steamers for several years. In Des Moines he was in charge of the engines of various large mills. He had a clear memory of his trial trip with Stephenson, and the enthusiasm of the crowds who witnessed it. He lived in Des Moines for fifty-three years.

Robert M. Van Arsdale, publisher of the *American Engineer and Railroad Journal*, died suddenly of apoplexy at his home in New York, November 23, aged sixty-one years. Mr. Van Arsdale was connected with trade journalism from his twenty-fifth year when he became associated with a high tariff paper in Chicago. In 1875 he joined the staff of the *Railroad Gazette* as advertising solicitor, and remained with that journal until he purchased the *National Car Builder* and began its publication in 1880, with James Gillet editor. In 1896 Mr. Van Arsdale purchased the *American Engineer and Railroad Journal* from M. N. Forney, who remained its editor for one year, when the two papers were combined under the name of *American Engineer, Car Builder and Railroad Journal.* Two

years later the name was changed to the present title, *American Engineer and Railroad Journal*, G. M. Basford then being the editor, who was succeeded by R. V. Wright, the present editor, in 1905. Mr. Van Arsdale had a wide acquaintance among railway mechanical officials and manufacturers of railway supplies, and was a man highly esteemed by his friends and acquaintances. He is survived by his widow. The burial was in Chicago.

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COMING EVENTS

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 20 West 44th St., New York.

December 6.—New York meeting of the American Society of Refrigerating Engineers. Secretary W. H. Ross, 154 Nassau St., N. Y.

December 7-10.—Thirtieth annual meeting of the American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th St., New York. The professional papers assigned to the meeting are as follows: Tests on a Venturi Meter for Boiler Feed, Charles M. Allen; The Pitot Tube as a Steam Meter, George F. Gebhardt; Efficiency Tests of Steam Nozzles, F. H. Sibley and T. S. Kemble; An Electric Gas Meter, C. C. Thomas; Tan Bark as a Boiler Fuel, David M. Myers; Cooling Towers for Steam and Gas Power Plants, J. R. Bibbins; Some Studies in Rolling Mill Engines, W. P. Caine; An Experience with Leaky Vertical Fire Tube Boilers and the Best Form of Longitudinal Joint for Boilers, F. W. Dean; Testing Suction Gas Producers with a Koerting Ejector, C. M. Garland and A. P. Kratz; Bituminous Gas Producer, J. R. Bibbins; The Bucyrus Locomotive Pile Driver, Walter Ferris; Line Shaft Efficiency, Mechanical and Economic, Henry Hess; Pump Valves and Valve Areas and a Report on Cast Iron Test Bars, A. F. Nagle. The social entertainment will be in charge of the members residing in and around New York, under the direction of a local committee, of which Mr. William D. Hoxie is chairman. A number of excursions are planned to points of interest, and a lecture for members and guests on agricultural machinery will be given in the evening of one of the meeting days.

December 8-10.—Annual meeting of the American Society of Chemical Engineers, Philadelphia, Pa. J. C. Olsen, secretary, Polytechnic Institute, Brooklyn, N. Y.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

SOCIETIES AND COLLEGES

Teachers' College, Columbia University, New York, has planned a series of night courses by which young men who have first-rate technical ability in the wood-working and machinist's trades can prepare themselves for the profession of teaching in industrial schools. This course is being offered at night in the school in industrial arts, and covers mathematics, drafting, design, wood-working, machine shop work, industrial history and methods of teaching industrial arts. A three years' course of night work will enable an expert mechanic, otherwise qualified, to gain a diploma as teacher of industrial arts.

Technical Publicity Association, New York, held its second fall meeting Thursday evening, November 11, at the National Arts Club, 14 Gramercy Park. The subject of the evening's discussion was the merits of special issues of technical and trade papers. The argument for the affirmative was opened by James H. McGraw, president of the McGraw Publishing Co. The question was debated pro and con with enthusiasm. The vote on the question was in the negative, it being the opinion of the majority that there is no valid reason for the publication of special numbers to celebrate birthday anniversaries, etc.

Technical Publicity Association, of New York, held its first monthly meeting for 1909-10 Thursday evening, October 14, at its headquarters, 14 Gramercy Park. Mr. Charles S. Redfield, advertising manager of the Yale & Towne Mfg. Co., was toastmaster. George H. French, head of the advertising and sales department, delivered an address on the principles of advertising, of much general interest to advertisers and publicity managers. Howard M. Post, advertising manager of the Western Electric Co., told of plans for a systematic study of the direct results of trade paper advertising. The burden of Mr. French's talk was the psychology and psychological aspect of advertising copy.

British Association of Engineers, 17 Victoria St., Westminster, S.W., has instituted an employment register for the use of engineers seeking employment, the principal features of which are: No fee of any kind will be charged, the cost of the management being defrayed by the association with a view to the ultimate benefit of the profession; qualified engineers of all grades may have their names recorded, though in making the selection, preference, naturally, will be given to members of the society; only a few names of probable suitable candidates will be submitted for each vacancy, so as to facilitate the employer's choice; and effort will be made to get personal knowledge of the candidates with full details of their qualifications, etc. A. S. C. Ackerman is the secretary.

NEW BOOKS AND PAMPHLETS

Fuel Tests with Illinois Coal. By L. P. Breckenridge and Paul Diserens. 55 pages, 6 x 9 inches. Published by the Illinois Engineering Experiment Station, Urbana, Ill.

Utilization of Fuel in Locomotive Practice. Bulletin No. 402. By W. F. M. Goss. 28 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Incidental Problems in Gas Producer Tests. Bulletin No. 393. By R. H. Fernald, C. D. Smith, J. K. Clement and H. A. Grine. 29 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Commercial Deductions from Comparison of Gasoline and Alcohol Tests on Internal Combustion Engines.—Bulletin No. 392. By Robert M. Strong. 38 pages, 6 x 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Bulletins of Revenues and Expenses of Steam Roads in the United States for April, May and June, 1909. Published by the Interstate Commerce Commission, Washington, D. C.

These bulletins give the mileage of various railway systems and tables of revenues and expenses of railroad systems operating more than 500 miles of lines.

The Slide Rule. By J. J. Clark. 62 pages, 4¾ x 6¾ inches. Published by the Technical Supply Co., Scranton, Pa. Price 60 cents.

This book on the Mannheim slide rule is a plain, simple, practical description of the instrument and its use. The principles of logarithms are explained and the methods of use of the rule in combined multiplication and division, locating the decimal point, principles of reciprocals, square and square roots, cubes and cube roots, and trigonometrical functions. The treatment of the slide rule is one that will be appreciated by many who have never been able to use it with facility or satisfaction. The description is prepared in the plain, understandable style characteristic of the work of Mr. Clark, who is manager of the textbook department of the International Text Book Co., and dean of the faculty of the International Correspondence Schools. The book is highly recommended to all in need of a practical treatise on the subject.

Handy Man's Workshop and Laboratory. By A. Russell Bond. 467 pages, 5½ x 8 inches, 370 illustrations. Published by Munn & Co., Inc., New York. Price, $2.

This book was compiled largely from contributions published in the *Scientific American*, and valuable suggestions received in response to the opening of the department devoted to the interests of the "handy man." It treats of fitting up a work shop, shop kinks, the soldering of metals, and the preparation of solders and soldering agents, the handy man in the factory, and the handy man's experimental laboratory, and the handy man's electrical laboratory, the handy man about the house, and model flying machines. It will be found of considerable interest and probable value by amateurs and other tinkers who have a penchant for making models, model apparatus and repairing machinery. The book is an appropriate present for boys of mechanical tendencies and inventive ability.

Cyrus Hall McCormick—His Life and Work. By Herbert N. Casson. 264 pages, 5¼ x 8 inches. Published by A. C. McClurg & Co., Chicago, Ill.

In this book Mr. Casson has given an account of the life and activities of McCormick, the inventor of the reaper, in the same interesting style characterizing his books, "The Romance of the Steel" and "The Romance of the Reaper." The effect of the invention of harvesting machinery on the world's industrial activity is tremendous and can scarcely be over-estimated. The reaper made the work of one man as effective in harvesting grain as that of ten laborers before its advent. The harvesting machine has greatly increased the available food supply and is one of the great contributing causes of the advancement made in civilization and material comforts during the past sixty years. The book will be read with profit by all interested in the characteristics of a man who had the genius of the inventor combined with the capability of a remarkable business man.

Mechanical World Electrical Pocket Book for 1910. 271 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6 d. net.

This electric pocket book is a companion publication to the well-known Mechanical World Pocket Diary and Year Book. The Electrical Pocket Book is confined to data on electrical matters comprising electrical units, resistance, specific resistance, mechanical and electrical unit equivalents, magnetos, electric bells and bell currents, electric transmission of power, dynamos and motors, methods of distinguishing electrical energy, alternating current systems, alternating current generators, polyphase motors, machine driving by electric motors, horse-power required to drive machinery, starting switches, motor generators, rotary converters, transformers, care and management of dynamos and motors, balancers, boosters, accumulators, conductors, cables, house wiring, circuit breakers, testing circuits, electric measuring instruments, lamps and lighting, electric welding, etc.

Prevention of Industrial Accidents. By Frank E. Law and William Newell. 194 pages, 5¼ x 7¾ inches. Published by the Fidelity and Casualty Co., New York. Price, 25 cents.

The appalling frequency of industrial accidents has aroused general interest in ways and means of accident prevention. Aside from the humanitarian aspect of the matter, the financial loss alone is so great as to demand the attention of manufacturers, business men and all concerned in the prevention of accidents from a purely selfish motive. In 1908 $22,392,072 was paid in premiums for liability insurance, which is an indication of the responsibility carried by the manufacturers and the burden imposed on industry as a whole by industrial accidents. The pamphlet discusses care on the part of employers and employees; safety devices; steam boilers; electrical apparatus; elevators; the factory; wood-working machinery, etc. It is thoroughly practical and will be found of general value by manufacturers and by employees in charge of apparatus likely to cause injury or death by accident.

The Steam Engine. By Charles H. Benjamin. 316 pages, 6 x 9 inches, 198 illustrations and diagrams. Published by the Technical Press, Brattleboro, Vt. Price, $3.

This treatise was prepared with the intention of covering practically the whole list of subjects relating to the steam engine, and is designed primarily for a text-book rather than a work of reference for engineers, although it will serve admirably for the latter purpose. The author explains the elementary principles of engines so that they may be readily understood by students. It pays much attention to practical problems, and questions in economy in operation are referred to the results of recent experiments made under working conditions. The contents of the work by chapters are as follows: Definition of terms, elementary principles, the simple steam engine, thermodynamics of air, thermodynamics of steam, valve and link motion, indicators and indicator diagrams, compound engines, conveyors, fly-wheels, steam in the cylinder, condensers, and heaters, piping and flow of steam, steam engine performance, steam engine design, specifications and costs. It closes with standard tables of weights of water, ammonia table and hyperbolic logarithms. The typographical excellence of the book is notable, the text, illustrations and press work being unexcelled.

Industrial Training; Twenty-Sixth Annual Report of the Bureau of Labor Statistics. 394 pages, 5½ x 8¾ inches. Published by the State Department of Labor, Albany, N. Y.

The report reviews the general conditions as to advancement in the manufacturing industries of New York State; the supply of skilled workers; the training of workers in industrial establishments; apprenticeship systems; attitude of employers and organized labor toward general industrial or preparatory schools; and attitude of organized labor toward trade schools. The summary of investigations is that the need of skilled male labor in the industries of the state is most severe in the manufacture of blown glass, many of the machinery and metal trades, manufacture of boots and shoes, and in certain of the building trades. It was found that the apprenticeship system in such industries as machine and building trades can be made more effective by introducing definite provision for systematic instruction. The need and value of general industrial and preparatory trade schools for boys and girls between fourteen and sixteen years is strongly testified by the report-

Providence, R. I., U. S. A.

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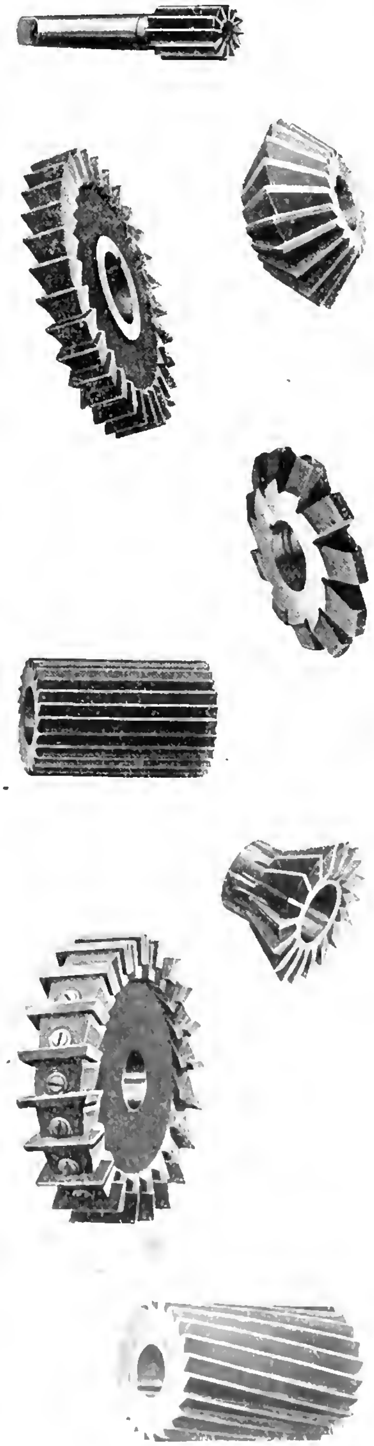

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of employers in all industries and is agreed to by the labor unions. Practical trade schools seem to be most in need in the machine and buildings trades. An extension of evening schools giving both practical and technical instruction in the trades is demanded by employers in a large proportion of the industries.

HAND BOOK FOR MECHANICS. By Franklin E. Smith. 328 pages, 5 x 7½ inches. Published by D. Van Nostrand Co., New York. Price $1.50 net.

This book is intended for the general instruction of mechanics, particularly those who are weak in arithmetic. It treats of notation, addition, subtraction, multiplication, division, weights and measures, reduction of fractions, addition of fractions, arithmetical signs, subtraction of fractions, multiplication of fractions, division of fractions, decimal fractions, reduction of decimal fractions, addition of decimals, subtraction of decimals, multiplication of decimals, division of decimals, proportion, compound proportion, interest, involution and evolution, cube root. Part II treats of arithmetical signs and characters, and explains the solving of formulas. Part III is on mensuration and gives rules for finding the circumference, diameter and area of circles, area of ellipses, triangles, rhomboids, trapeziums, volume of solids including the sphere, cylinder, pyramid, cone and frustum. Part IV treats of weights, specific gravity, dimensions, measurements and weights of vessels, calculation of contents of tanks, cisterns, etc. Parts V and VI treat of the elements of simple machines, including the lever, pulley, wheel and axle, inclined plane, wedge and screw, and strength of materials. The work is one that can be recommended for the instruction of apprentices, mechanics and others who have not had the advantages of a good common school education, and it will also be found useful by those who desire to renew their knowledge of the things learned in youth and partly forgotten through disuse.

MECHANICAL DRAWING FOR TRADE SCHOOLS. By Charles C. Leeds. 122 pages, 8 x 11 inches. Published by D. Van Nostrand Co., New York. Price, $2 net.

The author, who is assistant to the head of the school for apprentices and journeymen Carnegie Technical Schools, has presented a work on mechanical drawing that is a refreshing contrast to many of the books on the subject that have been published. It has been prepared with the idea of making students in mechanical drawing think and work without merely copying models. It is the outgrowth of his work in the Carnegie Technical Schools where the importance of developing the faculty of imagination and mental picturing an object was forcibly impressed on him. It is a faculty that many students lack, and the need for developing it became very apparent. The book in the beginning treats of the tools and elementary processes used in drawing, comprising pencils, pencil points, drawing board, T-square, triangles, drawing lines, laying off dimensions, use of compass and dividers, drawing circles and arcs tangent to lines, lettering, sketching, inking, etc. The plan of the work is that of displaying the drawing to be made on the right-hand page, giving the instructions for making the drawing on the left-hand page. A large number of practical examples are given, comprising the following: Flanged pin, machine bolt, clamp, sleeve, problems in projection, flanged pulley, 8-inch hand-wheel, lathe face-plate, positive clutch coupling, compression shaft coupling, safety flange coupling, geometrical problems, ellipses, spur gear, conic sections, intersections and developments, bevel gear, 12-inch speed lathe details, comprising the legs, bed, tool-rest, tail-stock and head-stock, examples of tabular data, bench grinding details comprising the frame, commutator bar, commutator ring, armature spider, generator frame, worm gearing, plate cam, periphery cam, conventional signs used in structural work, standard framing, beam connection, etc. The book is one that we can recommend to those who would learn mechanical drawing at home, and to the instructors in trade schools and other institutions requiring a good practical work on the subject.

ELEMENTS OF MACHINE DESIGN—PART I. By W. Cawthorne Unwin. 531 pages, 5½ by 8½ inches. 387 illustrations and diagrams. Published by Longmans, Green & Co., London and New York. Price $2.50.

This well-known textbook on machine design was first published in 1877, and it since has been revised three times. In the revision of 1890 the chapters relating to steam engine details were published separately as Part II. Part I deals with general principles, strength of materials, rivets, bolts and other fastenings; journals and shafting; couplings; pedestals; transmission of power by gearing, belting, ropes and chains. In the present revision the work has been almost entirely rewritten, and the page size has been changed from 4½ by 6¾ to 5½ by 8½ inches. In the foreword the author writes of the great task of originally writing the book, and of the still greater task of keeping it abreast of the times, as follows: "If originally the author had fully realized the multiplicity and complexity of the problems which arise in designing machinery, the present treatise would probably not have been written. If he had now for the first time the task of writing it, he would no doubt take the view that for an adequate scientific treatment of the subject a much larger treatise would be necessary. . . . 'There are now so many aids to the study of the application of scientific principles to all branches of engineering practice and so much of engineering experience has been made accessible, that the difficulty of dealing with the subject at the time this book was written will hardly be recognized now. . . . This treatise was intended to occupy a distinct field between works on applied science and empirical books of rules and collections of examples of machine details." The practical nature of Unwin's work has been generally recognized, and the machine designer using it will find that the present edition upholds the plan of the former editions and extends and improves it. One new chapter on keys and cotters has been added besides the general additions and changes in all other chapters. The index his been somewhat extended, but much room is yet left for improvement.

CATALOGUES AND CIRCULARS

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating and listing standard boring and facing tools for Gisholt lathes.

WASHBURN & GRANGER, 120 Liberty St., New York. Catalogue B of Dean dumping, shaking, and stationary boiler grates.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Copy of revised navy specifications covering electric motors and controlling devices.

HYDRO MFG. CO., Pittsburg, Pa. Circular of "Hydro" recording and velocity gage for measuring the rate of flow of gases in pipe lines or ducts.

SCHUTTE & KOERTING CO., Philadelphia, Pa. Circulars of Koerting deep-well water jet pump and water jet eductors for mines, tunnels, etc.

E. C. ATKINS & CO., INC., Indianapolis, Ind. Circular illustrating and describing Atkins AAA car mover, being an improved form of pinch-bar.

COLLINS WIRELESS TELEPHONE CO., 54-56 Clinton St., Newark, N. J. Catalogue of wireless telephone sets for experimental, lecture, office and field purposes.

PEERLESS ELECTRIC CO., Warren, O. Booklet illustrating the use of Peerless motors on paper box machinery, blowers, pumps, envelope mailing machines, etc.

FOSDICK MACHINE TOOL CO., Cincinnati, Ohio. Circulars of Nos. 1 and 2 Fosdick horizontal boring, drilling and milling machines of the elevating head type.

WALTON CO., Hartford, Conn. Circular of Walton extractor of broken taps. This extractor is made in 16 sizes, suitable for taps ¼ to 1¼-inch diameter.

PIKE MFG. CO., Pike, N. H. Mailing card advertising Pike's "Little Four" sharpening set, reversible oil stone, "Koenig" razor hone and "Pykarvo" knife sharpeners.

EMERSON ELECTRIC & MFG. CO., St. Louis, Mo. Bulletin No. 3309 replacing bulletin No. 3307 of electric forge blowers, direct connected for direct and alternating currents.

CRESCENT LAMP CO., 516-518 West Monroe St., Chicago, Ill. Circular of incandescent lamp guards, including the "Loxon," which is a guard that prevents theft as well as breakage.

NORTH BROS. MFG. CO., American St. and Lehigh Ave., Philadelphia, Pa. Circular illustrating and describing the "Yankee" breast drill with right- and left-hand ratchet movement.

AMERICAN BLOWER CO., Detroit, Mich. Sectional catalogue No. 250 of A B C blowers for cupolas, forges, melting and heating furnaces, forced draft, pneumatic tube systems, etc.

S. E. HORTON MACHINE CO., Windsor Locks, Conn. Price list of four-jaw independent reversible jaw chucks, made in seven sizes, covering the usual ratings of 8-inch to 26-inch sizes inclusive.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Treatise on Cochrane feed water heaters and the profitable utilization of exhaust steam in condensing and non-condensing steam power plants.

F. W. DEVOE & C. T. RAYNOLDS CO., New York and Chicago. Catalogue of artists' and drawing materials, comprising colors, India inks, pencils, rubbers, pantographs, drawing instruments, T-squares, protractors, etc.

CELFOR TOOL CO., Buchanan, Mich. and 207 Railway Exchange, Chicago, Ill. Catalogue No. 10 of Celfor tools, reamers and three-lip drills, Rich flat drills, Celfor-Rich and quick-change chucks, reamer sockets, and grinding machinery.

SCHUMACHER & BOYE, Cincinnati, Ohio. Mailing folder illustrating S. & B. instantaneous change gear engine lathes, built in 18-inch, 20-inch, 24-inch, 26-inch, 30-inch, 36-inch, and 48-inch sizes. Details of construction, including double-plate apron and head-stock, are also shown.

CAMERON ENGINEERING CO., 154-156 Berriman St., Brooklyn, N. Y. Circular on overhead tramways, trolleys, switches, cranes, and scales for overhead handling and weighing; a pulley block crane mounted on four truck wheels, made in five sizes, and having a capacity from ½ to 3 tons.

STROMBERG ELECTRIC MFG. CO., 108-128 North Jefferson St., Chicago, Ill. Descriptive circular of new wall type electric chronograph for registering the time of entrance and exit of employees, the time of starting and completion of jobs and other purposes where a time registering device is essential.

UNION STEAM PUMP CO., Battle Creek, Mich. Catalogue B of Union air compressors, comprising a complete line of various types and sizes in ordinary use for operating pneumatic tools, coal cutters, pumps, sand blast work, and for other purposes, in foundries, machine shops and manufacturing plants.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Pamphlet describing Cochrane steam stacks and cut-out valve heater and receiver, and its application in connection with commercial systems of exhaust steam heating. The diagrams illustrating the installations of service are printed in colors.

CARBORUNDUM CO., Niagara Falls, N. Y. Vol. VII of the "Revised American Statesman Series" on Benjamin Franklin, by F. W. Haskell, president of the Carborundum Co. The biography treats of the activities of B. Franklin in a brief but startling way, and we have no doubt that all readers of MACHINERY fortunate enough to receive one of these unique booklets will be much edified by the story.

GEORGE WESTINGHOUSE, Pittsburg, Pa. Pamphlet describing the Melville-Macalpine speed reducing gear for marine turbines; the 6,000 horse-power hydraulic absorption dynamometer used for testing the reducing gear at the works of the Westinghouse Machine Co., East Pittsburg, Pa., and report of tests of the reducing gear; also report of efficiency of high-speed steam turbines.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, O. Catalogue and stock list No. 3 of machines and small tools for the fabrication of iron and steel, comprising standard punches, coupling nuts, button-head rivet snaps (chrome-nickel alloy steel), twist drills, chisels, backing out punches, shear blades, punching machines, shears, I-beam punch, angle shears, bending rolls, rotary planers, wall radial drills, etc.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1181 of portable direct current ammeters and voltmeters. The characteristics of these instruments are accuracy and durability, though they are neither bulky nor heavy. They are operated on the D'Arsonval principle with a permanent magnet and moving coil. The magnetic structure is so arranged that the moving element can easily be taken out for repairs.

MAX VIEWEGER, 50 Church St., New York. Prospectus of the American Exposition to be held in Berlin, June, July and August, 1910, with diagram of floor space in exposition buildings Nos. 1 and 2. The prospectus gives the name of the American and German committees, which include such distinguished citizens as J. Pierpont Morgan, David R. Francis, John Wanamaker, Dr. George F. Kunz, Emil L. Boas, Dr. Nicholas Murray Butler, William G. McAdoo, C. A. Moore, etc.

NATIONAL-ACME MFG. CO., Cleveland, O. Circular illustrating the Acme automatic screw machine and samples of its work, also some interesting statistics. The company has a product department wherein 10,000,000 pounds of iron, steel and brass stock are annually cut into 100,000,000 parts. 3,000,000 screws and parts are carried in the New York store, 77 White St., 3,000,000 parts in the Chicago store, 56 West Washington St., and 15,000,000 in the Cleveland factory.

ARMSTRONG BROS. TOOL CO., 113 North Francisco Ave., Chicago, Ill. Catalogue and price list of Armstrong tool-holders, for turning, reaming, boring, slotting, drilling, cutting-off metals; and other machine shop specialties comprising lathe tool sets and cabinets, grinding holders, Armstrong cutting-off and grinding machines, drill and reamer holders, lathe tool-post, lathe dog, bolt driver, quick-action drill vise, planer jack, universal ratchet drill, automatic drill drift, C-clamps, etc.

NATIONAL TUBE CO., Frick Building, Pittsburg, Pa. Catalogue H-1909 of material manufactured by the Kewanee Works of the company, embracing wrought pipe for steam, gas, water and air, cast and malleable iron and brass fittings, brass and iron body valves and cocks, drive well points and well supplies. The catalogue is attractively arranged and well printed; some of the illustrations are partly in color to distinguish brass from iron. It should be in the files of all concerns using pipes, valves, cocks, flanges, and other supplies mentioned.

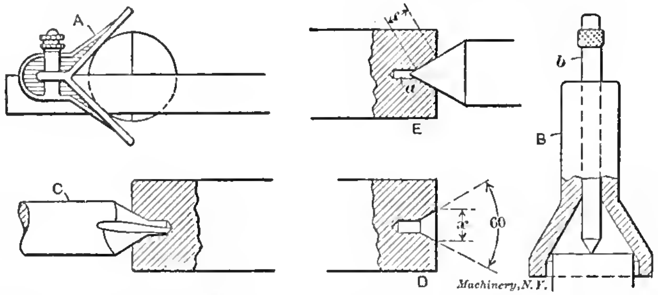
BUCKEYE ENGINE CO., Salem, Ohio. Catalogue of Buckeye electric blue-printing machines with testimonials of many users. The catalogue is unique in that the upper and lower edges of each page imitate the characteristics of blue-prints, being in blue with white lines. The Buckeye Engine Co. was one of the first American concerns to use blue-prints and it has consistently promoted their use for many years.

Supplement to MACHINERY, January, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Centering"

SHOP OPERATION SHEET NO. 121

Franklin D. Jones — MACHINERY, January, 1910



Making a Lathe Arbor—Centering

1. Select a piece of tool steel of a good grade, and cut off, in a hack-saw, a length suitable for the arbor to be made. This length will depend upon the diameter of the arbor, and it is equal to 9 times the diameter for sizes from ½ inch to 1 inch; 8 times, for sizes from 1 inch to 1½ inch, and 7 times for diameters between 1½ and 2 inches.

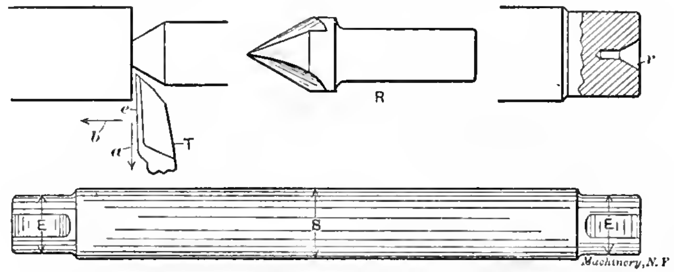
2. With a center square *A* draw two lines at right angles to each other across each end of the stock as shown, and at the intersection of these lines make a center-punch mark. If a cup or bell center-punch *B* is available, the center may be located without first drawing the lines by placing the conical part over the end of the work as shown and striking the end of punch *b*. If accurate results are expected, this punch should only be used on work which is round and square on the end. Furthermore, it should always be held in alignment with the piece being centered.

3. A combination center drill and reamer *C* is next caught in a drill chuck inserted in the spindle, or in a regular chuck of small size, and set perfectly true. A center is then drilled and reamed into one end of the work, while the other is supported by the dead center, which should be inserted in the previously made punch mark and be set in the position for straight turning. The piece may be kept from revolving while it is being reamed by attaching a dog to it close to the tail-stock end, and then adjusting the cross-slide until the dog is in contact with it. A little lard oil or other lubricant should be used when reaming. The included angle of the taper of the center, is 60 degrees (as at *D*) this being the angle to which lathe centers are ground. The size of the largest part *x* of the center, should be made equal to one-half the diameter of the arbor for sizes up to 1 inch. For larger sizes up to 5 inches in diameter dimension *x* should be made equal to (diameter — 1) ÷ 8 + 0.5. A section through a correctly formed center as it appears when in contact with a lathe center, is shown at *E*. The small hole *a*, besides being a reservoir for lubricant, provides clearance for the point of the lathe center, which should not come in contact with the mandrel, so that the latter may have a good bearing throughout the conical part *c*.

NOTE.—When a regular centering machine is available, it is not necessary to locate a center in the end of the work, as the latter is properly located with reference to the drill by the universal chuck with which the centering machine is provided.

SHOP OPERATION SHEET NO. 122

Franklin D. Jones — MACHINERY, January, 1910



Making a Lathe Arbor—Turning

1. After the stock has been accurately centered, it should be carefully placed between the lathe centers. At times work is spoiled because the driving dog bears on the bottom of the driving slot in the face-plate with the result that the live center is in contact with only one side of the center in the work. Then again, chips or dirt in the centers, or the lack of oil, often results in inaccuracies which well-fitting lathe and work centers were intended to overcome.

2. The first operation performed on a cylindrical part which is being turned between the centers, is to square the ends; that is, face them so that they are flat and at right angles to the work. This is done with what is known as a right-side tool, the cutting end of which is shown at *T*. The stock should have been cut off to nearly the correct length, so that it will not be necessary to remove much metal from the ends. Usually the tool is not set so that the straight cutting edge *e* is at right angles with the axis of the work, but at a slight angle as shown. The point is then brought into contact with the work close to the center, after which the tool is fed out in the direction of the arrow *a* by the cross slide. A smooth finishing cut may be obtained by slightly rounding the tool point.

NOTE.—If the end of the work does not need to be exactly flat, the tool may be set approximately at right angles with the work axis, and then be fed in the direction of the arrow *b*, thus removing a chip equal to the width of one side. Obviously, this method is confined to comparatively small diameters.

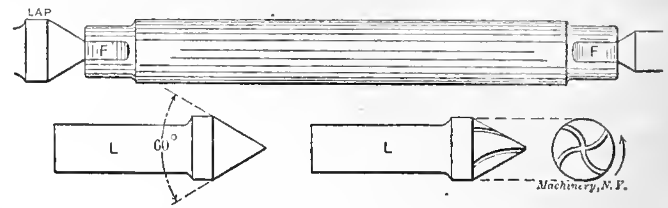
3. The arbor is first rough turned, after which it should be annealed to relieve it of any internal strains which may have been set up. The ends *E* are then finished and polished, and the body *B* is turned to size with a suitable allowance for grinding. This allowance will depend on the size and style of arbor, some being distorted in hardening more than others. An allowance of from 0.012 to 0.015 inch should be sufficient.

4. The centers are next rounded at *r* by holding one end of the arbor in a true-running chuck, while the other is supported by a steady-rest, and using a hand graver. If the corner *r* is left sharp it is easily bruised.

5. Grip a 60-degree center reamer *R* in the chuck and set it perfectly true. Then, with the spindle locked and the arbor mounted between the reamer and dead center, ream each center by hand, turning the work slowly.

SHOP OPERATION SHEET NO. 123

Franklin D. Jones — MACHINERY, January, 1910



Making a Lathe Arbor—Finishing

1. The flats *F* on the ends, against which the set-screw of the driving dog is to bear, are next milled. The arbor is then ready to be hardened. This is done so that the accuracy of the centers is not easily impaired, and to give a hard surface to the arbor and make it more rigid.

2. When a piece of steel is hardened, it is usually distorted or sprung out of shape more or less; for this reason the centers in each end of the hardened arbor should be lapped true so that their axes exactly coincide. A lap *L* made of brass or copper will give excellent results. The conical ends should be finished to the same taper as the lathe center, or to an included angle of 60 degrees. All scale and dirt should be removed from the centers before lapping is begun.

3. Grip the lap in the chuck of a speed lathe (preferably) and set it perfectly true. If the tail spindle is not provided with a lever feed, remove the spindle cap so that the spindle may be easily moved back and forth. Place a little medium grade emery and oil in one center hole and with the other resting against the tail-center push the work gently against the lap which should be revolving at a high speed. Almost as soon as the lap and work are in contact, they should be separated, the work turned part way around, and again moved against the lap. After this operation is repeated a number of times, the work should be turned end for end. In this way the two centers are finally ground true and in alignment with each other. A new and perfectly true lap should be used for finishing the centers and a fine grade of emery used. As the abrasive toward the mouth of the center moves more rapidly than that farther in, and as centrifugal force tends to move it to the largest part of the hole, the lap will cut faster at this point. Because of this tendency, centers which are to be hardened and lapped are sometimes reamed to an angle (say 59 or 59½ degrees) of somewhat less than 60 degrees. Spiral grooves are sometimes cut into conical laps, which serve to carry the abrasive and oil back toward the point. In order that these grooves may be effective, they should curve toward the direction of rotation, as shown in the end view.

4. The arbor is next ground to the required size. A description of this operation will be found on sheet No. 96. After rough grinding, it is good practice to allow the work to "season" before taking the final cut.

NOTE.—The steel used for making arbors should not have too high a carbon content, as such steel is more liable to crack or spring out of shape when it is being hardened. A steel for arbors of medium size, having one per cent of carbon, will give good results.

I—AREAS OF SMALL RECTANGLES

	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4
1/32	0.000977							
1/16	.001953	0.003906						
3/32	.002930	.005859	0.008789					
1/8	.003906	.007812	.011719	0.015625				
5/32	.004883	.009766	.014648	.019531	0.024414			
3/16	.005859	.011719	.017578	.023437	.029297	0.035156		
7/32	.006836	.013672	.020508	.027344	.034180	.041016	0.047852	
1/4	.007812	.015625	.023437	.03125	.039062	.046875	.054687	0.0625
9/32	.008789	.017578	.026367	.035156	.043945	.052734	.061523	.070312
5/16	.009766	.019531	.029297	.039062	.048828	.058594	.068359	.078125
11/32	.010742	.021484	.032227	.042969	.053711	.064453	.075195	.085937
3/8	.011719	.023437	.035156	.046875	.058594	.070312	.082031	.09375
13/32	.012695	.025391	.038086	.050781	.063477	.076172	.088867	.101562
7/16	.013672	.027344	.041016	.054687	.068359	.082031	.095703	.109375
15/32	.014648	.029297	.043945	.058594	.073242	.087891	.102539	.117187
1/2	.015625	.03125	.046875	.0625	.078125	.09375	.109375	.125
17/32	.016602	.033203	.049805	.066406	.083008	.099609	.116211	.132812
9/16	.017578	.035156	.052734	.070312	.087891	.105469	.123047	.140625
19/32	.018555	.037109	.055664	.074219	.092773	.111328	.129883	.148437
5/8	.019531	.039062	.058594	.078125	.097656	.117187	.136719	.15625
21/32	.020508	.041016	.061523	.082031	.102539	.123047	.143555	.164062
11/16	.021484	.042969	.064453	.085937	.107422	.128906	.150390	.171875
23/32	.022461	.044922	.067383	.089844	.112305	.134766	.157227	.179687
3/4	.023437	.046875	.070312	.09375	.117187	.140625	.164062	.1875
25/32	.024414	.048828	.073242	.097656	.122070	.146484	.170898	.195312
13/16	.025391	.050781	.076172	.101562	.126953	.152344	.177734	.203125
27/32	.026367	.052734	.079102	.105469	.131836	.158203	.184570	.210937
7/8	.027344	.054687	.082031	.109375	.136719	.164062	.191406	.21875
29/32	.028320	.056641	.084961	.113281	.141602	.169922	.198242	.226562
15/16	.029297	.058594	.087891	.117187	.146484	.175781	.205078	.234375
31/32	.030273	.060547	.090820	.121094	.151367	.181641	.211914	.242187
1"	.03125	.0625	.09375	.125	.15625	.1875	.21875	.25

The fraction giving the altitude of the rectangle is found at top of the columns, the base in the left-hand column, and the area in the body of the table.

The areas of intermediate rectangles varying by $\frac{1}{64}$ can be found by interpolation as the following examples show:

One side given in 64 ths.
$$\frac{3}{32}\times\frac{5}{64} = (\text{next smaller area} + \text{next larger area}) \div 2$$
$$\text{next smaller area} = \frac{3}{32}\times\frac{1}{16} = 0.005859$$
$$+\ \text{next larger area} = \frac{3}{32}\times\frac{3}{32} = \underline{0.008789}$$
$$\frac{\underline{0.014648}}{2} = \underline{0.007324}$$

(Continued on Sheet No. 2.)

Contributed by M. Joachimson

II—AREAS OF SMALL RECTANGLES

	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2
9/32	0.079102							
5/16	.087891	0.097656						
11/32	.096680	.107422	0.118164					
3/8	.105469	.117187	.128906	0.140625				
13/32	.114258	.126953	.139648	.152344	0.165039			
7/16	.123047	.136719	.150391	.164062	.177734	0.191406		
15/32	.131836	.146484	.161133	.175781	.190430	.205078	0.219727	
1/2	.140625	.15625	.171875	.1875	.203125	.21875	.234375	0.25
17/32	.149414	.166016	.182617	.199219	.215820	.232422	.249023	.265625
9/16	.158203	.175781	.193359	.210937	.228516	.246094	.263672	.28125
19/32	.166992	.185547	.204102	.222656	.241211	.259766	.278320	.296875
5/8	.175781	.195312	.214844	.234375	.253906	.273437	.292969	.3125
21/32	.184570	.205078	.225586	.246094	.266602	.287109	.307617	.328125
11/16	.193359	.214844	.236328	.257812	.279297	.300781	.322266	.34375
23/32	.202148	.224609	.247070	.269531	.291992	.314453	.336914	.359375
3/4	.210937	.234375	.257812	.28125	.304687	.328125	.351562	.375
25/32	.219727	.244141	.268555	.292969	.317383	.341797	.366211	.390625
13/16	.228516	.253906	.279297	.304687	.330078	.355469	.380859	.40625
27/32	.237305	.263672	.290039	.316406	.342773	.369141	.395508	.421875
7/8	.246094	.273437	.300781	.328125	.355469	.382812	.410156	.4375
29/32	.254883	.283203	.311523	.339844	.368164	.396484	.424805	.453125
15/16	.263672	.292969	.322266	.351562	.380859	.410156	.439453	.46875
31/32	.272461	.302734	.333008	.363281	.393555	.423828	.454102	.484375
1"	.28125	.3125	.34375	.375	.40625	.4375	.46875	.5

Interpolation (Continued)

Example: $\frac{3}{64}\times\frac{7}{64} = \frac{\text{next smaller area} + \text{next larger area}}{2} - \left(\frac{1}{64}\right)^2$

Both sides given in 64 ths.
$$\text{next smaller area} = \frac{1}{32}\times\frac{3}{32} = 0.002930$$
$$\text{next larger area} = \frac{1}{16}\times\frac{1}{8} = \underline{0.007812}$$
$$\frac{\underline{0.010742}}{2} = 0.005371$$
$$\text{deduct } \left(\frac{1}{64}\right)^2 = \underline{0.000244}$$
$$\underline{0.005127}$$

Contributed by M. Joachimson

IV—CHIMNEY DIMENSIONS FOR CORNISH, LANCASHIRE AND TUBULAR BOILERS

Type of Boilers		Cornish					Lancashire							Tubular Boilers										
Diameter of Boiler		46"	50"	56"	60"	66"	60"	66"	70"	76"	80"	86"	90"	50"	56"	60"	66"	70"	76"	80"	86"	90"	96"	10"
Grate Area Per Boiler, Square Feet		10	14	15	16	21	22	26	30	36	39	44	47	10	14	16.5	21	30	34	38	39	43	46	49
Chimney		Number of Boilers to One Chimney																						
Height, Feet	Diam.: Feet Inches																							
40	2' 0"	1	1	1										1	1	1								
45	2' 3"	2												2										
50	2' 6"		2		1		1								2		1							
55	2' 9"	3		2				1						3		2								
60	3' 0"	5	3			1			1	1				5	3			1	1					
65	3' 3"			3	2		2				1	1				3	2			1	1	1		
70	3' 6"		4					2					1		4								1	
75	3' 9"			4												4								1
80	4' 0"		5		3	2	3		2						5		3	2						
85	4' 3"			5				3		2						5			2					
90	4' 6"				4	3	4		3		2					6	4	3		2	2			
95	4' 9"				5		5	4				2					5					2	2	
100	5' 0"					4	6		4	3	3		2				6	4	3	3	3			2
105	5' 3"						7	5									7							
110	5' 6"					5	8	6	5	4		3					8	5	4			3		
115	5' 9"						9	7			4		3							4	4		3	
120	6' 0"						10	8	6	5		4						6	5			4		3
125	6' 3"							9	7		5		4					7		5	5		4	
130	6' 6"							10	8	6		5						8	6			5		4
135	6' 9"								9	7	6		5						7	6	6		5	
140	7' 0"								10		7	6							8	7	7	6		5
145	7' 3"									8			6										6	
150	7' 6"								12	9	8	7								8	8	7		6
155	7' 9"									10	9	8	7							9	9	8	7	
160	8' 0"										10		8							10	10	9	8	7
165	8' 3"									12		9												8
170	8' 6"										12	10	9									10	9	
175	8' 9"												10										10	9
180	9' 0"											12												10
185	9' 3"										15		12											
190	9' 6"											14												
195	9' 9"											15												
200	10' 0"												15											

Contributed by A. Wind

III—AREAS OF SMALL RECTANGLES

	17/32	9/16	19/32	5/8	21/32	11/16	23/32	3/4
17/32	0.282227							
9/16	.298828	0.316406						
19/32	.315430	.333984	0.352539					
5/8	.332031	.351562	.371094	0.390625				
21/32	.348633	.369141	.389648	.410156	0.430664			
11/16	.365234	.386719	.408203	.429687	.451172	0.472656		
23/32	.381836	.404297	.426758	.449219	.471680	.494141	0.516601	
3/4	.398437	.421875	.445312	.46875	.492187	.515625	.539062	0.5625
25/32	.415039	.439453	.463867	.488281	.512695	.537110	.561523	.585937
13/16	.431641	.457031	.482422	.507812	.533203	.558594	.583984	.609375
27/32	.448242	.474609	.500976	.527344	.553711	.580078	.606445	.632812
7/8	.464844	.492187	.519531	.546875	.574219	.601562	.628906	.65625
29/32	.481445	.509766	.538086	.566406	.594727	.623047	.651367	.679687
15/16	.498047	.527344	.556641	.585937	.615234	.644531	.673828	.703125
31/32	.514648	.544922	.575195	.605469	.635742	.666016	.696289	.726562
1	.53125	.5625	.59375	.625	.65625	.6875	.71875	.75
	25/32	13/16	27/32	7/8	29/32	15/16	31/32	1
25/32	0.610352							
13/16	.634766	0.660156						
27/32	.659180	.685547	0.711914					
7/8	.683594	.710937	.738281	0.765625				
29/32	.708008	.736328	.764648	.792969	0.821289			
15/16	.732422	.761719	.791016	.820312	.849609	0.878906		
31/32	.756836	.787109	.817383	.847656	.877930	.908203	0.938477	
1	.78125	.8125	.84375	.875	.90625	.9375	.96875	1.00000

Areas of rectangles larger than given in table:

Example: $\overset{a}{1}\overset{b}{\tfrac{11}{16}} \times \overset{c}{2}\overset{d}{\tfrac{3}{32}} = a\times c + b\times c + a\times d + b\times d$

$$\begin{aligned} a\times c &= 1 \times 2 = 2.000000 \\ b\times c &= \tfrac{11}{16} \times 2 = 1.375000 \\ a\times d &= 1 \times \tfrac{3}{32} = 0.093750 \\ b\times d &= \tfrac{11}{16} \times \tfrac{3}{32} = \underline{0.064453} \\ & \qquad\qquad \underline{3.533203} \end{aligned}$$

Contributed by M. Joachimson

MACHINERY

January, 1910

THE DESIGN OF AUTOMOBILE SPRINGS*

EGBERT R. MORRISON†

Egbert R. Morrison‡

It is doubtful if scientific calculations ever entered into the design of the original forms of such springs as are used under ordinary road carriages. Satisfactory as they are, they are not engineering results, but accepted standards born long ago of the cut-and-try methods of the blacksmith shop. Their manufacture belongs to such arts as are taught by father to son, or acquired through years of experience, during which have been gathered the "tricks of the trade." The manufacturer of this class of springs does not attempt to arrive at results by mathematics. He has learned as a part of his trade that certain styles of carriages should have certain springs.

Sufficient time did not exist during the development of railroad cars for a gradual development of definite types of springs for various types of cars. It devolved, therefore, upon the engineer to design these springs; but as soon as the spring maker found that the 70,000, 80,000, and 100,000-pound capacity car each had its own peculiar set of springs, and that any car could be fitted with springs according to its capacity, he adopted the engineer's designs as another class of standards. Railroad cars, while resting on springs whose dimensions were originally scientifically estimated, are now, therefore, suspended largely upon springs belonging to a few fixed classes.

With the advent of the automobile, came a carriage traveling fast over uneven country roads, meeting severe usage in inexperienced hands, and demanding the extreme of comfort and safety. The question of springs and spring suspension thus becomes of primary importance, so that in these carriages each particular design requires a specially designed suspension. Automobile springs are fundamentally cantilevers, the same as all leaf springs. This class of springs more readily lends itself to an easy vibration, as well as to a better general design of the machine. It is possible to carry a load on a narrow-leafed elliptic leaf spring where there would not be room for a helical spring. Also, the addition of a leaf to an elliptic leaf spring adds to its capacity without changing its deflection, while the addition of a coil to a helical spring does not change its capacity but adds to its deflection.

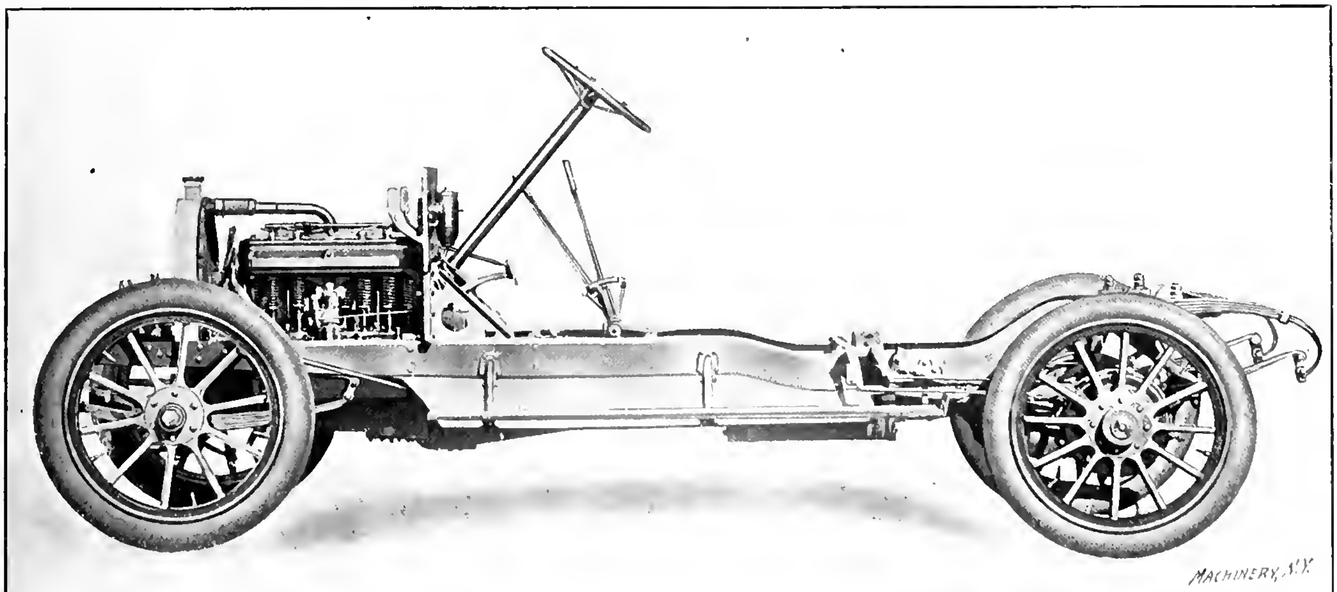


Fig. 1. Chassis of an F. B. Stearns Motor Car, showing Three-quarter Elliptic Spring Suspension in Rear and Semi-elliptic Springs in Front

Any leaf spring, tightly banded around the middle, should be considered as composed of two cantilevers of length l, where l is one-half the distance from center to center of the end bearings less one-half the width of the band. The length of each cantilever is then expressed (see Fig. 2):

$$l = \frac{c - w}{2}$$

To consider a spring a simple beam of length c, is to overlook the effect of the band. It is easily demonstrated that variations in the width of the band cause corresponding variations in the strength and deflection of the spring. The elliptic spring, graduated throughout, with but *one* leaf in each section extending from end bearing to end bearing, is fundamentally a cantilever of *uniform strength;* and the formulas applicable are based on the fundamental formulas of that type of cantilever. An elliptic spring with *all* leaves in each section extending from end bearing to end bearing is, on the other hand, a cantilever *of uniform section*, and the formulas for this type of cantilever are then applicable.

* The following information relating to various classes of springs and kindred subjects has previously been published in MACHINERY: What a Machine Designer should Know about Springs, May, 1898, July, 1898, August, 1898; Rig for Winding Springs, January, 1901; A Device for Winding Springs, May, 1902; A Device for Winding Small Springs, July, 1902; Hardening Coil Springs, July, 1902; Winding Small Springs, October, 1902; Experience in Making Small Coil Springs, June, 1904; To Increase the Working Length of Coil Springs, August, 1906, November, 1906; Securing Uniformity in Phosphor-Bronze Springs, September, 1907, engineering edition; Tools for Winding Springs in an Engine Lathe, December, 1907; The Design of Springs for Gas Engine Valves, May, 1908, engineering edition; Helical Springs, January, 1909, engineering edition; Winding Springs with Initial Tension, February, 1909; Winding Springs, April, 1909. See also MACHINERY'S Data Sheets No. 3, March, 1899, Formulas for Strength and Deflection of Common Springs; No. 22, July, 1903, Formulas for Coil Springs; No. 42, March, 1905, Lathe Gearing to Wind Coil Springs; No. 107, January, 1909, Allowable Pressure and Corresponding Compression of Helical Springs of Round Steel.

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The springs used in automobile practice are frequently combinations of these two forms, inasmuch as a considerable portion of the leaves extend the full length from bearing to bearing. It follows that neither of the above formulas will apply, but that the applicable formulas may be derived by combining the fundamental formulas for the two types of cantilevers. The load capacity of a cantilever is not affected by its form, for in either case:

$$P = \frac{S\,b\,h^2}{6\,l}$$

in which P = load,
S = allowable stress,
b = width of beam,
h = thickness of beam,
l = length of cantilever.

In other words, the load capacity is equal for like conditions, such as stress, size of beam, and length of span.

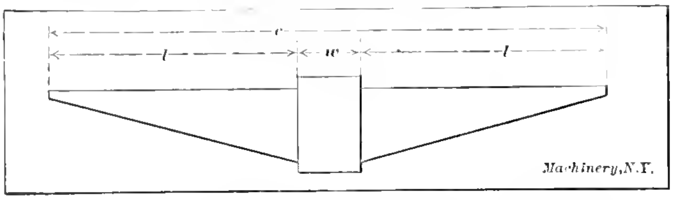


Fig. 2. Diagrammatical Sketch of Graduated Spring, giving Length Notation used in Formulas

A great difference exists, however, in the deflections under the same load, one being fifty per cent more than the other:

$$f = \frac{4\,P\,l^3}{E\,b\,h^3},\ \text{for uniform section cantilevers,}$$

$$f = \frac{6\,P\,l^3}{E\,b\,h^3},\ \text{for uniform strength cantilevers,*}$$

in which f = deflection, and E = modulus of elasticity.

When such a difference as this exists, it is rather remarkable that many engineers calculate the properties of an elliptic spring no matter what the cantilever conditions, as though all elliptic springs were subject to the same rules and formulas; but, as a matter of fact, the proportion of back leaves, or the leaves on the longer side of the spring which commonly extends the full length, ranges from 5 to 50 per cent of the total number of leaves. It is not unusual to see attempts made through actual tests of the springs themselves to find the proper constant with which to modify the uniform strength equations so as to render them applicable to springs composed of uniform section cantilevers in combination with uniform strength cantilevers. The desired modifier, however, is a variable quantity, depending upon the relative size of the fundamental spring elements.

Lack of due consideration of this combination of different cantilevers accounts also for the different and conflicting formulas which various authorities advance. Thus Goodman, in "Mechanics Applied to Engineering"; Reuleaux, in his "Constructeur"; and "Des Ingenieurs Taschenbuch" (Hütte), give formulas all of which reduce to uniform strength cantilevers. Molesworth and the Automotor Pocket Book base their formulas on uniform section cantilevers. Henderson, who assumed all semi-elliptic springs to contain one-fourth full length leaves, and made an approximation of the result, was the first to recognize the influence of the combination of cantilevers.

Deduction of General Formulas

For further consideration we will adopt the following notation, discussing only the semi-elliptic spring:

P = total load on spring,
P_1 = portion of load on one end of spring,
P' = portion of load on one end of full-length leaves, or on uniform section cantilever,
P'' = portion of load on one end of graduated leaves, or on uniform strength cantilever,
n = total number of leaves,
n' = number of full-length leaves,
n'' = number of graduated leaves,
$r = \frac{n'}{n}$,
S = maximum fiber stress in spring,
S' = maximum fiber stress in full-length leaves,
S'' = maximum fiber stress in graduated leaves,
f = total deflection of banded leaves,
f' = total deflection of full-length leaves if unbanded,
f'' = total deflection of graduated leaves if unbanded,
b = width of leaves,
h = thickness of leaves,
l = length of cantilever,
L = net length of spring, i. e., actual distance between end bearings, less width of band,
x = proper initial space between fundamental cantilevers before banding.

It is but reasonable to assume that the maximum fiber strain should be the same in both fundamental parts, or

$$S' = S''.$$

But

$$S' = \frac{6\,P'\,l}{n'\,b\,h^2},$$

$$S'' = \frac{6\,P''\,l}{n''\,b\,h^2}.$$

Hence

$$\frac{P'}{P''} = \frac{n'}{n''}.$$

In a well-designed spring there should be, at full load, a division of the work proportional to the respective number of leaves in the two fundamental parts. The fundamental formulas of the two cantilevers have shown, however, that such proportional loads would produce different deflections in their respective carriers. This difference in deflection would cause a separation of the two portions of the spring were they initially together and unbanded. Were they initially together and banded the result would be internal stress under load which would mean that a division of the load proportional to the respective number of leaves in the two fundamental parts could not exist.

It is evident that by placing a space between the two fundamental parts when unloaded and unbanded, equal to the difference between the two deflections, there will result no space between the two fundamental parts at full load; and hence if banded in this position there will be no internal stress, so that the load on each part will be proportional to the number of leaves in that part. If then the load be removed, it follows that the band alone holds the two portions together and that there must exist a resulting stress upon the band and leaves.

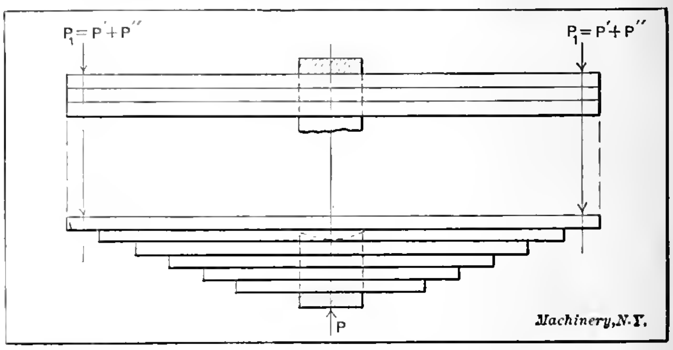


Fig. 3. Showing Division of Spring into Cantilevers of Uniform Section (Upper Portion) and Cantilevers of Uniform Strength (Lower Portion). One of the Full Length Leaves should always be considered as a Part of the Graduated Leaves

Now

$$f' = \frac{4\,P'\,l^3}{E\,n'\,b\,h^3} \tag{1}$$

and

$$f'' = \frac{6\,P''\,l^3}{E\,n''\,b\,h^3} \tag{2}$$

But, as shown,

$$\frac{P'}{P''} = \frac{n'}{n''},$$

* The formula given is that for a cantilever of uniform strength where the height h is uniform, but the width of the section of the cantilever decreases towards the outer end; b is the width at the support.—Editor.

or

$$P' = \frac{n' P''}{n''}.$$

Hence $f' = \dfrac{4 P'' l^3}{E n'' b h^3}$, as derived by substituting in (1).

Hence,

$$f'' - f' = \frac{2 P'' l^3}{E n'' b h^3}.$$

Also, since

$$\frac{P'}{n'} = \frac{P''}{n''} = \frac{P_1}{n} = \frac{P}{2n},$$

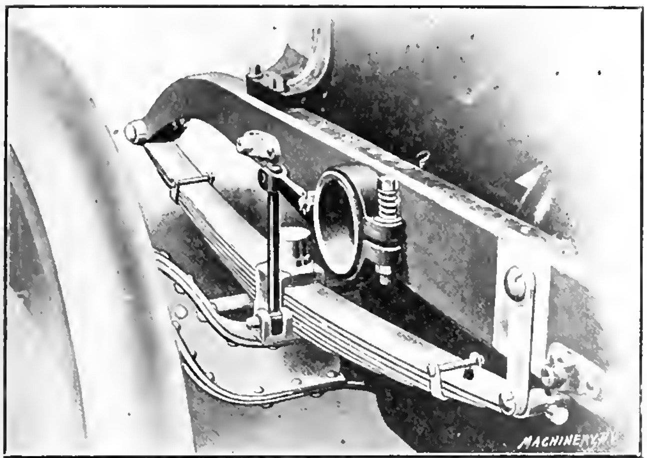


Fig. 4. Front Spring Arrangement of the 1910 Model Winton Six-cylinder Car

we have

$$f'' - f' = \frac{P l^3}{E n b h^3}.$$

Also since

$$l = \frac{L}{2},$$

$$f'' - f' = \frac{P L^3}{8 E n b h^3},$$

or

$$x = \frac{P L^3}{8 E n b h^3}.$$

This last expression is then a general expression of the proper initial distance between the two fundamental portions

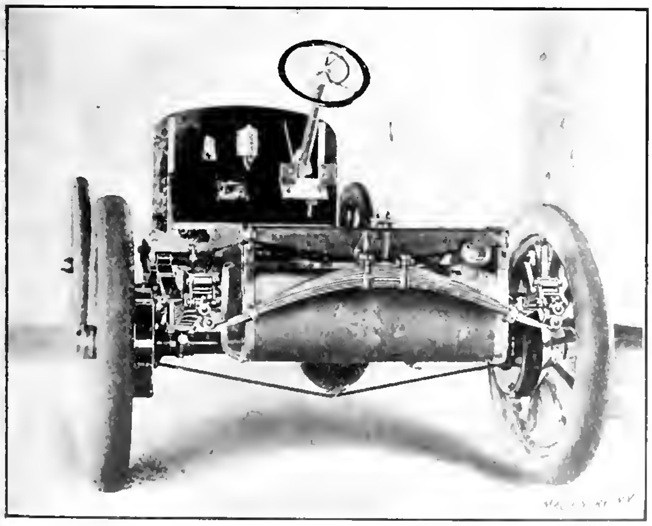


Fig. 5. Spring Support of the Lozier Motor Co.'s "Light Six" Car

before banding, expressed in terms of total load on spring, total number of leaves in spring, and net span of spring. To find the actual working deflection of the entire spring it is only necessary now to ascertain how much either portion is deflected by the process of banding. For this purpose let us adopt the following notation:

P_x = force exerted by band,

f_x' = deflection of full-length leaves caused by band,

f_x'' = deflection of graduated leaves caused by band.

Then,

$$f_x' = \frac{2 P_x l^3}{E n' b h^3} \text{ and } f_x'' = \frac{3 P_x l^3}{E n'' b h^3}.$$

Hence

$$\frac{P_x l_3}{E b h^3} = \frac{f_x' n'}{2} = \frac{f_x'' n''}{3}$$

or

$$f_x' = \frac{2}{3}\left[\frac{(1 - r)}{r}\right] f_x''$$

But

$$f_x' + f_x'' = \frac{P l^3}{E n b h^3}$$

Hence

$$f_x'' + \frac{2}{3}\left[\frac{1 - r}{r}\right] f_x'' = \frac{P l^3}{E n b h^3}.$$

$$f_x'' = \left[\frac{3r}{2 + r}\right] \frac{P l^3}{E n b h^3}$$

But

$$f_x'' = \frac{3 P_x l^3}{E n'' b h^3}$$

Hence

$$\frac{3 P_x l^3}{E n'' b h^3} = \left[\frac{3 r}{2 + r}\right] \frac{P l^3}{E n b h^3}$$

or

$$\frac{3 P_x l^3}{E (1 - r) n b h^3} = \left[\frac{3 r}{2 + r}\right] \frac{P l^3}{E n b h^3}$$

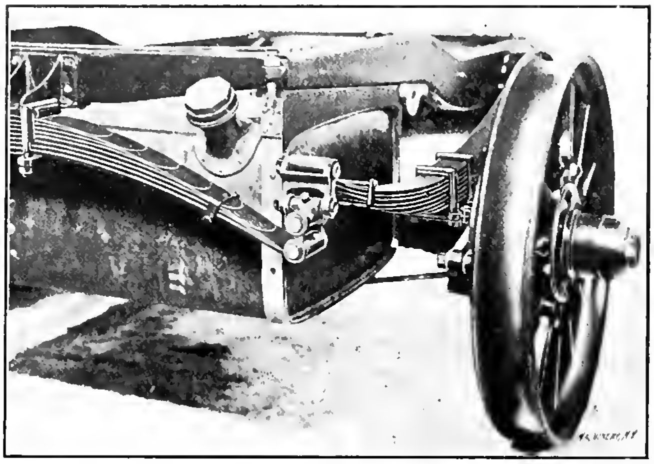


Fig. 6. Arrangement of Semi-elliptic Springs on the Lozier Motor Co.'s Four-cylinder Model

or

$$P_x = \left[\frac{r (1 - r)}{2 + r}\right] P$$

The expression inside the bracket in the above equation becomes zero for either extreme value of r, as would be expected, the extreme values of r being unity and zero. The formula gives the force exerted by the band, *i. e.*, the load upon the band.

The total deflection of the graduated leaves, as already developed, is,

$$f'' = \frac{3 P l^3}{E n b h^3}.$$

The deflection of the graduated leaves, caused by the band, is

$$f_x'' = \left[\frac{3 r}{2 + r}\right] \frac{P l^3}{E n b h^3}$$

The difference is, therefore, the deflection left to the graduated leaves after banding, or the general formula sought for the deflection of such a spring:

$$f'' - f_x'' = \left\{3 - \left[\frac{3 r}{2 + r}\right]\right\} \frac{P l^3}{E n b h^3}$$

or,

$$f = \left[\frac{6}{2 + r}\right] \frac{P l^3}{E n b h^3}$$

or, since $l = \dfrac{L}{2}$

and

$$P = 2\,P_1 = 2\left[\frac{S\,n\,b\,h^2}{6\,l}\right]$$

$$f = \left[\frac{6}{2+r}\right]\left[\frac{2\,S\,n\,b\,h^2}{3\,L}\right]\frac{L^3}{8\,E\,n\,b\,h^3}$$

Hence

$$f = \frac{1}{2\,(2+r)} \times \frac{S\,L^2}{E\,h}.$$

This last expression is then a general formula for the deflection of all semi-elliptic springs. If all the leaves are graduated, $r = 0$, and

$$f = 1/4 \cdot \frac{S\,L^2}{E\,h}.$$

If all the leaves are full length, $r = 1$, and

$$f = 1/6 \times \frac{S\,L^2}{E\,h}.$$

As was to be expected, the spring composed of all graduated leaves has a deflection, according to the above general formula, 50 per cent above that of a spring composed of all full-length leaves. For values of r above zero, the deflection will be found to decrease until r equals unity.

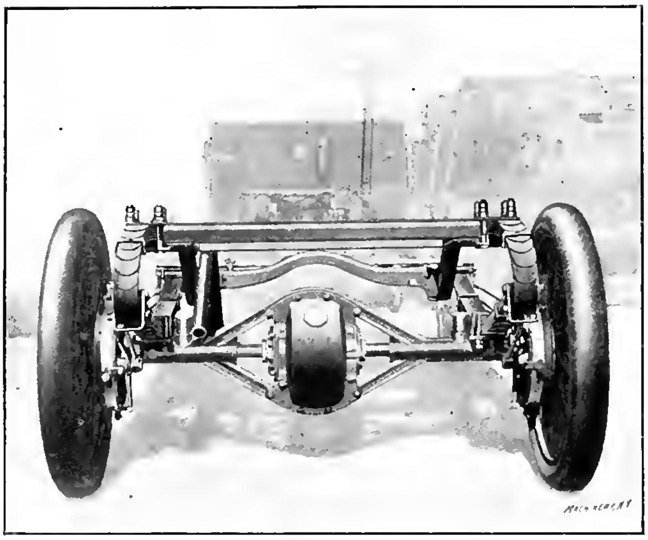


Fig. 7. Three-quarter Elliptic Spring Suspension on the F. B. Stearns Co.'s 15-30 H. P. Car

General Remarks

The general formulas given above were first deduced by the writer in the early part of 1905, at which time they were placed before Prof. C. H. Benjamin, then of the Case School of Applied Science, with a view of making extended experiments for the preparation of a thesis. It was the intention to have springs built with initial space as deduced, and compare the actual deflections of such springs with the estimated deflections. Although these experiments were not carried out, they are mentioned because it is believed that when such experiments are made, they will prove valuable. The deduction of the formulas is here published for the first time. This deduction was made in connection with certain springs which were giving very poor service, although designed by the same formulas as other elliptic springs. It was the writer's conclusion that had the springs been built with the proper initial space between the fundamental parts, these springs would not have broken, and that the omission of this space caused an over-stress in the full-length leaves, and an under-stress in the graduated leaves, which caused the over-strained leaves to break, throwing an overload upon the previously under-stressed leaves which also broke when the stress was excessive. This conclusion seems to explain why springs of this type are frequently found with only the long leaves broken; the remaining leaves, all being of one type, divide the resultant overload evenly so that the over-stress is not so excessive. Perhaps the strongest indication of the correctness of the deduction lies in the well-known fact that the percentage of breakage is always much greater with semi-elliptic springs (of the combination type, usually) than with full elliptic springs. Also, it is generally found upon unbanding these springs that no initial space exists.

Comparison of deflections estimated from the above formulas, with actual deflections has in some cases been quite satisfactory, while in other cases the actual deflections have appeared closer to those estimated by uniform strength formulas. In such cases where the writer has been able to make comparisons, however, the springs had been *made to specified deflections which evidently were estimated by the uniform strength formulas.* Experienced spring makers know that it is quite possible by putting a "pull" in the springs to vary the deflection and load. This trade term, "pull," is itself nothing more nor less than the introduction of an initial space between the leaves before banding.

Suspension of Automobiles

In road carriages, except in the heavier wagons, it is usual to find but two springs, one over each axle placed across the width of the carriage. In automobiles, one finds almost invariably at least the rear suspended upon two springs running lengthwise of the car, while, as is shown in the accompanying illustrations, it is the tendency to use the same suspension in the front. Such an arrangement takes up the forward and side lunges in a manner impossible with simple transverse springs. The further use of links and shackles, and of scroll ends, adds to the comfort, allowing the car to swing upon the springs rather than to be thrown upon them. In quite a few models, the two rear springs are attached in front to the frame and in the rear to a platform spring, which is itself attached to the center of the rear cross member of the frame. The three-quarter elliptic spring lends itself to both comfort and convenience of arrangement, and is rapidly coming into general use in this country, our manufacturers having apparently adopted it from foreign cars.

Steel Used in Automobile Springs

Automobile springs call for a high grade of steel, the ordinary spring steel lacking in strength and elasticity. Various grades of high carbon, silicon, manganese, nickel, chromium, and vanadium steels are used. Often such alloys are used as silico-manganese, chrome-nickel, and chrome-vanadium, the stiffening elements seeming to rank in the order given. Data as to the physical properties of such steels cannot well be given, as such properties must depend upon the proportions in the particular alloy used. Certain alloys of the vanadium group having an elastic limit of from 180,000 to 225,000 pounds per square inch, and tensile strength from 190,000 to 250,000 pounds, appear to be the most ideal steels yet produced.

Calculations of Springs

The calculation of spring properties by formulas is long and tedious. The writer appends, therefore, a table based on a modulus of elasticity of 25,400,000 and a fiber stress under maximum safe load of 80,000 pounds per square inch. Calculations of springs made of materials having other physical properties are made by simple proportion. This table is to be used only when all leaves are fully graduated.

SEMI-ELLIPTIC SPRING TABLE

Giving safe load and deflection for 1 inch wide leaves, 1 inch net length. Used only when all leaves are fully graduated

Thickness of Leaf	P_u	f_u	Steel	P_u	f_u
$\frac{1}{32}$	52.08	0.02519	$\frac{9}{32}$	4218.75	0.00280
$\frac{1}{16}$	208.33	0.01260	$\frac{5}{16}$	5208.33	0.00252
$\frac{3}{32}$	468.75	0.00840	$\frac{11}{32}$	6302.08	0.00229
$\frac{1}{8}$	833.33	0.00630	$\frac{3}{8}$	7500.00	0.00210
$\frac{5}{32}$	1302.08	0.00504	$\frac{13}{32}$	8802.08	0.00194
$\frac{3}{16}$	1875.00	0.00420	$\frac{7}{16}$	10208.33	0.00180
$\frac{7}{32}$	2552.08	0.00360	$\frac{15}{32}$	11718.75	0.00168
$\frac{1}{4}$	3333.33	0.00315	$\frac{1}{2}$	13333.33	0.00157

The safe load on one leaf one inch wide is found by dividing the constant given under P_u by the net length. The corresponding deflection is found by multiplying the constant given under f_u by the square of the net length.

Example: What is the safe load on a semi-elliptic full graduated spring of five leaves if of one-quarter by two inch steel; length between end bearings, thirty-six inches; band or seat, three inches?

Net length $= 36 - 3 = 33$ inches.

Load on one leaf one inch wide $= \dfrac{3333.33}{33} = 101.01$ pounds.

Load on one leaf two inches wide $= 2 \times 101.01 = 202.02$ pounds.

Load on five two-inch leaves $= 5 \times 202.02 = 1010.10$ pounds.

Corresponding deflection is:

$$0.00315 \times (33)^2 = 3.43 \text{ inches.}$$

Formulas can easily be deduced making it possible to use the accompanying table for other classes of elliptic springs than those of the semi-elliptic type with all leaves fully graduated.

The formulas for the semi-elliptic spring with all leaves graduated are:

$$P = \frac{2\,S\,n\,b\,h^2}{3\,L} \text{ and } f = \frac{S\,L^2}{4\,E\,h}.$$

To find the values of P_u given in the table, insert $S = 80,000$, $n = 1$, $b = 1$, $h =$ the value given in the first column in the table, and $L = 1$. To find the values of f_u, insert in the second formula $S = 80,000$, $L = 1$, $E = 25,400,000$, and $h =$ the value given in the first column in the table.

Now if the values in the table are to be used for other springs, constants can be deduced by which the table values may be multiplied.

For a semi-elliptic spring with a portion of the leaves graduated the load P remains the same as for a spring with all leaves graduated. The formula for the deflection, however, is:

$$f = \frac{1}{2\,(2 + r)} \times \frac{S\,L^2}{E\,h}.$$

The values in the table, therefore, must be multiplied by $\dfrac{2}{(2 + r)} \times L^2$ to find the deflection for any given combination full leaf and graduated spring of effective length L.

For a full elliptic spring with all leaves graduated, P still remains the same as for a semi-elliptic spring, but f doubles its value, or:

$$f = \frac{S\,L^2}{2\,E\,h}.$$

The values in the table, therefore, in this case must be multiplied by $2\,L^2$.

For the full elliptic spring with part of the leaves only graduated, the load P remains the same as before, but the deflection is twice that of a semi-elliptic spring:

$$f = \frac{1}{2\,(2 + r)} \times \frac{2\,S\,L^2}{E\,h} = \frac{S\,L^2}{(2 + r)\,E\,h}.$$

In this case, then, the values for the deflection in the table are to be multiplied by $\dfrac{4}{2 + r} \times L^2$.

The flexibility of a spring is the amount of deflection as compared to the load. This may be expressed as so many inches deflection per hundred pounds, or y.

Example:—Assume a full-elliptic, fully graduated spring, where

$S = 80,000$,
$E = 25,400,000$,
$b = 1\frac{3}{4}$ inch,
$n = 4$,
$h = \frac{1}{4}$ inch,
$L = 30$ inches.

Then the safe load equals:

$$P = 4 \times 1\tfrac{3}{4} \times \frac{3333.33}{30} = 778 \text{ pounds.}$$

And the deflection equals:

$$f = 30^2 \times 2 \times 0.00315 = 5.67 \text{ inches.}$$

Then,

$$y = \frac{5.67}{778} \times 100 = 0.73 \text{ inch.}$$

On the other hand, assume that the thickness and number of leaves is unknown. Then we have:

$P = 778$ pounds,
$S = 80,000$,
$E = 25,400,000$,
$b = 1\frac{3}{4}$ inch,
$L = 30$ inches,
$y = 0.73$ inch.

Then

$$f = \frac{778}{100} \times 0.73 = 5.67 \text{ inches.}$$

But $f = 2\,f_u L^2$, where f_u is the constant for deflection in the accompanying table:

Hence,

$$f_u = \frac{f}{2\,L^2} = \frac{5.67}{1,800} = 0.00315.$$

The thickness of steel in the table which corresponds to this value of f_u is one-fourth inch.

The number of leaves is found by using P_u, thus.

Load on one leaf, one inch wide is:

$$\frac{3333.333}{30} = 111.11 \text{ pounds.}$$

Load on one leaf one and three-quarter wide is:

$$111.11 \times 1\tfrac{3}{4} = 194.25.$$

Number of leaves is then,

$$\frac{778}{194.25} = 4.$$

The present calculation makes no allowance for the leaves of a spring varying in thickness. Where such springs are used, the deflection of the different leaves will not be uniform. Hence, in such springs also a suitable initial "pull" should exist, and such springs should be estimated by a general formula based upon a combination of different cantilevers, thus making allowance for different depths of cantilevers. It is much better to use springs composed of but one thickness of leaves, as the combination of different thicknesses adds a complexity scarcely necessary.

Results obtained from fully graduated full elliptic springs would seem to show that the action of the friction between the leaves is not great enough to seriously affect the bending action, in that the formulas give results agreeing very closely with actual conditions.

* * *

ELECTRIC VS. STEAM LOCOMOTIVES

Almost at the same time as the experiments carried on for several years past on the Swedish state railways have led the railway administration in that country to install electric traction on one of the state railways for both passenger and freight traffic, it is decided by the Swiss railway administration to return to the use of steam locomotives on one railway line after two years trial with electric locomotives. The main reason for this appears to be that electric operation proved more costly than expected, the excess of cost of electric operation over that of steam operation being about $1,000 a year per mile of road electrically operated. The results obtained by the Swiss railway administration are significant, inasmuch as Switzerland is especially adapted for electric operation of the country's railways. The abundant water power available makes it possible to generate electric current as cheaply as conceivable. Coal, on the other hand, is costly in Switzerland, due to the fact that all coal must be imported. The results of the experimental operation in Switzerland indicate that electric traction will be profitable only on the lines having very heavy grades or dense traffic. If this is the case in a country where water power can be obtained in abundance and where coal is costly, it indicates that the existence of the steam locomotive is placed on a very firm foundation in countries where water power is comparatively scarce and coal abundant, as, for instance, in the United States.

* * *

A chair in aerial navigation has been established at the East London College of the London University. Prof. A. P. Thurston will have charge of this department and lecture on aerial navigation and subjects connected with this science

CUTTING SQUARE HOLES ON A KEYSEATING MACHINE

ETHAN VIALL*

The making of square holes of any considerable length in tough metal is always something of a problem, especially if the holes are to be of uniform size within very narrow limits. As a general rule, such holes would be made by running a number of broaches through a drilled hole, but a method is in use at the shop of Blood Brothers Machine Co., Kalamazoo, Mich., where holes 1¼ inch square and 4 inches long are made in a very tough grade of steel by first drilling a hole the same diameter as the side of the square wanted, cutting out the corners on a Mitts & Merrill keyseater and then finishing the hole by forcing a short sizing-broach down through it.

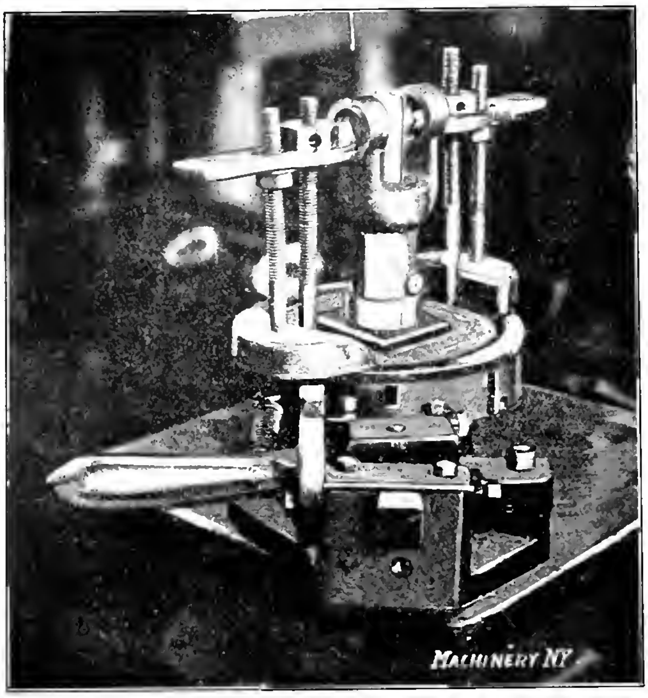


Fig. 1. Indexing Fixture used on Keyseating Machine while Squaring Holes

The part in which this square hole is made is the hub of a fork for a universal joint, manufactured by the firm mentioned. After the fork is drilled it is placed on a keyseater fitted with the indexing fixture shown in Fig. 1, and one corner of the hole cut out. The fixture is then indexed a quarter turn, the next corner cut, and so on until the hole is squared within a few thousandths of the size wanted. The work is then placed in a small hydraulic press and a sizing broach run through as mentioned before.

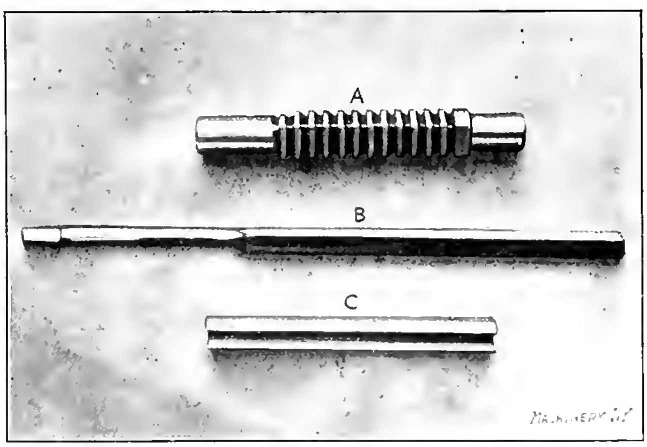


Fig. 2. Broach, Cutter and Cutter Guide used in making Square Holes

The cutter used to cut out the corners is shown at *B*, Fig. 2, the cutter guide at *C* and the broach at *A*. In Fig. 3 are shown samples of the work, after it has been drilled as at *A*, cut out as at *B*, and broached as at *C*.

In cutting out the hole, enough of the round is left to act as a guide for the pilot on the broach. Those who have ever used a broach of this type know of its tendency to crowd over to one side when it is not started perfectly straight. By having a pilot-guide, this tendency is largely overcome and the hole is started and kept straight with little difficulty.

Some will no doubt think that the keyseater method of rough squaring the holes is slower than draw-broaching, but all things being considered, the use of a keyseater is, in a case like this, probably cheaper owing to the amount and toughness of the metal to be removed. At least two and perhaps three draw-broaches would have to be used, and the actual time would be about the same, while the cost of the broaches would be very largely in excess of cutters. By the method just described, from twelve to fifteen holes are finished per hour, a liberal supply of soapwater being used while cutting.

The push-broaches used for this job are about fourteen inches in length with a 2½- or 3-inch pilot and a 2-inch shank. Beginning with the first tooth, the size increases 0.001 inch for each one up to the last or sizing tooth. This is left twice as wide across the top as the others as shown at *A*, Fig. 2. The other teeth are ¼ inch wide with a ¼-inch flute, and the face or outside is ground perfectly straight and parallel with the center line of the tool, giving absolutely no clearance. The cutting edge, however, is hooked under just enough to cause it to cut a nice curling chip, all sharpening, of course, being done on the cutting edge and not on the outside, as that would change the size. By giving the teeth no outside clearance, the tendency to "creep" in case the metal were a little softer on one side, is minimized, and with the aid of the pilot a perfectly straight hole is made.

Beside cheapness, another advantage claimed for this method, is that there is no tearing of the metal, perfectly smooth holes being obtained. Of course, full-sized square holes could be made without the use of a broach, but more time would undoubtedly be taken in getting as accurate results.

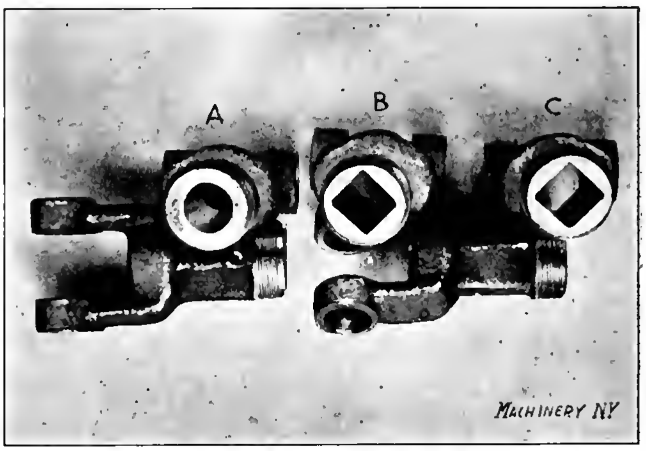


Fig. 3. Universal Joint Forks, showing Drilled, Machined, and Broached Holes

The keyseater may also be used to cut triangular, hexagon, octagon or almost any other shaped holes by simply grinding a cutter to the proper outline, and if any quantity were wanted, an indexing fixture similar to the one shown could be easily made.

* * *

The Norwegian Parliament has just passed a measure of great industrial importance, relating to the future exploitation of the country's water power. This act recognizes distinctly the rights of the whole nation to the country's national resources in the form of available water power. Concessions for use may be given for a term of from 60 to 80 years, but at the end of the concession the water fall, with regulating works connected therewith, and the sites and rights required for the exploitation of the water power and for the power station, become the property of the state with full ownership and without compensation; this latter provision gives to the state a compensation for the privilege conferred upon the private exploiting company during the period of the concession. Water falls of a capacity of less than 1,000 horse-power are excepted from the rulings of this act.

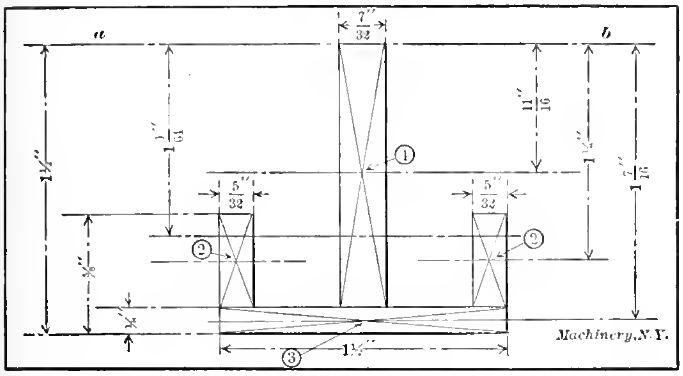
* Associate Editor of MACHINERY.

TO CALCULATE THE DEFLECTION OF A SPECIAL STEEL SECTION*

MARTIN JOACHIMSON†

The problem presented in the following, although taken from actual practice, has been selected as a specimen for calculations relating to special steel sections, because it involves all the calculations which ordinarily occur in such cases. When sections are built up of plates and angles, the areas, center of gravity and moment of inertia of the parts can be found in the hand-books published by the various steel companies; this of course simplifies the calculations.

The problem in the present case is as follows: How much will the proposed section, shown in the accompanying engraving, deflect under a total load of 400 pounds, if this load be



Section of Built-up Beam, used as Example for the Calculation of Moment of Inertia and Deflection

uniformly distributed over the total distance between the supports, which is 6 feet? The formula for the deflection of the beam is:

$$D = \frac{5\,Wl^3}{384\,EI}$$

in which D = deflection in inches,

W = total load = 400 pounds + weight of beam,

l = length between supports in inches = 72 inches,

E = modulus of elasticity for steel = 29,000,000,

I = moment of inertia of section.

This formula was given in MACHINERY's Data Sheet No. 48, September, 1905.

The weight of the beam and the moment of inertia of the section must now be obtained before the deflection can be calculated. The general formula for the moment of inertia with respect to any given axis is:

$$I = \Sigma\,(ad^2 + i)$$

in which a = area of each part making up the complete section,

d = distance from the center of gravity of each part to the axis with respect to which the moment of inertia is required,

i = moment of inertia of each part.

The Greek letter Σ (sigma) indicates that the sum of the moments of inertia of each part with respect to the axis required gives the total moment of inertia.

The position of the neutral axis must be determined before we can determine the moment of inertia with respect to this axis. The neutral axis of the whole section passes through the center of gravity of the section. The location of the center of gravity is determined with respect to the line ab by the formula:

$$\text{distance of center of gravity from line } ab = \frac{\Sigma\,(ad)}{A}$$

in which a = area of each part making up the complete section,

d = distance from the center of gravity of each part to line ab,

A = total area of section.

indicates in this case, as above, that the sum of the areas of the various parts multiplied by the distance of the center of gravity of each part to the line ab, is required. The use of this formula will be understood from the following simple calculation:

First find the total area of the section. The different rectangles in the section of the sample beam are called (1), (2), (3) and (4), respectively.. The areas of the sections are then as follows:

$$\text{Area (1)} = \frac{7}{32} \times 1\tfrac{3}{8} = 0.300781$$

$$\text{Area (2)} = \frac{5}{32} \times \tfrac{1}{2} = 0.078125$$

$$\text{Area (2)} = \frac{5}{32} \times \tfrac{1}{2} = 0.078125$$

$$\text{Area (3)} = \frac{1}{8} \times 1\tfrac{1}{2} = 0.1875$$

The areas are found from the tables in the accompanying Data Sheet Supplement; in the case where 7/32 is to be multiplied by 1⅜, of course, 7/32 is multiplied by 1, and then by ⅜, and these two products are added. Now to find the weight of the section per foot, multiply the sum of the areas obtained by the factor 3.4 for steel, as a steel bar weighs 3.4 pounds per foot when the section is one inch square. Then the weight per foot equals:

$$0.64453 \times 3.4 = 2.19 \text{ pounds,}$$

and the weight of the whole beam 6 feet long equals:

$$2.19 \times 6 = 13.14 \text{ pounds.}$$

Now to find the distance of the center of gravity of the section from the line ab, multiply the area of each section by the distance of its center of gravity from the line ab, thus:

area	× distance	= moment
0.30078	× 11/16	= 0.20678
0.07812	× 1⅛	= 0.08788
0.07812	× 1⅛	= 0.08788
0.1875	× 1 7/16	= 0.26952
0.64452		0.65206

Now adding the four moments obtained gives us 0.65206 as shown, which equals the quantity $\Sigma\,(ad)$. Dividing this sum by the total area, which equals 0.64452 gives us the distance of the center of gravity of the whole section from the line ab:

$$\frac{0.65206}{0.64452} = \frac{65}{64} = 1\ 1/64 \text{ inch, very nearly.}$$

We are now ready to find the moment of inertia of the section. The moment of inertia of a rectangular section is found by the formula:

$$I = \frac{bh^3}{12}$$

in which h equals the height of the rectangle and b the width or breadth, the height meaning the dimension which is at right angles to the neutral axis. This formula is found in any engineering hand-book. The individual moments of inertia of each rectangular section are now found with respect to their own neutral axis, as below:

$$\frac{\frac{7}{32} \times (1\tfrac{3}{8})^3}{12} = 0.04739$$

$$2 \times \frac{\frac{5}{32} \times (\tfrac{1}{2})^3}{12} = 0.00325$$

$$\frac{1\tfrac{1}{2} \times (\tfrac{1}{8})^3}{12} = 0.00024$$

Having now found the moment of inertia of each section we find the quantity $ad^2 + i$ for each of the sections with relation to the neutral axis of the section. The sum of these various quantities gives us the total moment of inertia, I.

a	d	d^2	i	$ad^2 + i$
0.30078	21/64	0.1077	0.04739	0.07976
0.15625	7/64	0.01196	0.00325	0.00512

* With Data Sheet Supplement.

† Address: 518 West 156th St., New York City.

a	d	d^2	i	$ad^2 + i$
0.1875	$\frac{27}{64}$	0.1780	0.00024	0.03361
				$I = 0.11849$

We can now find the deflection by inserting our values in the original formula for the deflection, W being 413.14 pounds and $I = 0.1185$.

$$D = \frac{5 \times 413.14 \times 72^3}{384 \times 29{,}000{,}000 \times 0.1185} = 0.5847 \text{ inch.}$$

This deflection, of course, would be too much for practical purposes.

* * *

BOILERS AND CHIMNEYS*†

A. WIND‡

The writer read with great interest the article entitled "Simple Method of Stack Design," published in the August, 1909, issue of MACHINERY. The expression "horse-power" of a boiler, used in this article, is an expression that is not customary in England. The term horse-power for a boiler seems to me very vague, because the boiler when used for two different types of engines would give a very great difference in the amount of power that may be obtained from it. A boiler, for instance, may be able to evaporate say 6,000 pounds of water per hour at 120 pounds working pressure. Assuming twenty pounds of steam for every horse-power, this boiler would be a 300 horse-power boiler; but if the boiler were supplying steam to an engine exhausting into the air and working under unfavorable conditions, 35 pounds of steam per horse-power might be required. In this case the boiler would be of only 170 horse-power. Again, a boiler may not be used for raising steam for engine driving, but it may be used for boiling purposes, as in paper mills, creosoting plants or celluloid works; then the term horse-power would convey an altogether wrong idea.

I find, therefore, that it is better to follow the custom used in England and on the Continent, of speaking of boilers as being built to evaporate so many pounds of water per hour under ordinary circumstances. At the works where the writer is employed this method of designating boilers applies as well to water tube, Lancashire, Cornish and multi-tubular boilers. Of course, it must be understood that a boiler being built to evaporate 6,000 pounds of water per hour when fired with good coal by hand, would be able to evaporate 8,000 pounds of water per hour, or thereabouts, when fired with a mechanical stoker and fed with pre-heated feed water.

[Our correspondent apparently has an erroneous idea as regards the meaning of a boiler horse-power, as this expression is used in the United States. The Centennial standard boiler horse-power adopted by the American Society of Mechanical Engineers in 1884, is defined as an evaporation of 30 pounds of water into dry steam under a pressure of 70 pounds per square inch above atmosphere from feed water at a temperature of 100 degrees F., or the evaporation of 34½ pounds of water from feed water at a temperature of 212 degrees F. into steam of the same temperature. This standard is equal to 33,305 B. T. U. per hour.—EDITOR.]

As regards the size of chimneys, the writer would say that the draft that is necessary for hand firing will almost without exception be sufficient when firing the boiler with an ordinary mechanical stoker. In the accompanying Data Sheet Supplement heights and diameters of chimneys for different kinds of boilers are given. This table is based upon the grate area of the boiler, assuming the burning of from 20 to 25 pounds of coal per square foot of grate per hour. The size of the grate in many instances will vary very little with the length of the boiler. In the works where the writer is employed the same grate is put into a Lancashire boiler 25 feet long as in one 30 feet long. This applies also to Cornish and multi-tubular boilers. When two or more boilers are worked together it is not necessary to calculate the size of the chimney for the total combined grate area of all the boilers, as it is very seldom that all the boilers are fired in all furnaces at exactly the same time. Therefore, a greater number of boilers permits of a comparatively smaller size of chimney. The table in the accompanying Data Sheet Supplement gives the diameters of boilers, grate areas and the diameters and heights of chimneys for any number of boilers from one to five, in the case of the Cornish type, one to fifteen in the case of the Lancashire type, and one to ten in the case of the multi-tubular boilers. In each case the height of the chimney is taken to be 20 times its diameter.

Where forced draft or induced draft plants are installed, the size of chimneys can, of course, be considerably reduced. Each given size of chimney would prove sufficient for 33 per cent greater capacity than shown in the table, when such draft is employed. To determine the size of the chimney for six boilers with induced draft, for example, select the chimney given in the table corresponding to four boilers.

The sizes of chimneys given in this table correspond to the ordinary practice in England and on the European continent. It may, of course, differ slightly from that customary in the United States, but the writer thinks that, nevertheless, this table may be of interest to steam engineers in America.

* See MACHINERY, August, 1909, engineering edition: Simple Method of Stack Design.
† With Data Sheet Supplement.
‡ Address: Woodfield Ave., Penn, Wolverhampton, England.

* * *

RECIPROCITY

W. L. CHENEY*

"I will put in one of your machines if you will put in one of mine"; how often we hear this expression!

It is all rot, and time it was so understood. The only legitimate reason for buying a machine is that the buyer will be better off for having bought it. The interest of the buyer of a machine is in what the machine will earn for him; therefore he should buy the one which is best for his purpose, and it follows that a man who buys a machine which is *not* best for his purpose, simply because the other fellow will buy one of *his* machines, is worse than silly, because his profit is soon eaten up by the increased cost of what the inferior machine produces, and after that it is all loss. This is so simple a proposition that it is axiomatic, and there is, therefore, no use arguing with a man who cannot see it at first glance when it is brought to his attention.

The same principle applies to different *grades* of machines of approximately similar design. Either one machine *is* better designed and made, will do more and better work, and is in the repair shop less than another, or it is *not;* if it *is*, why buy the other because of a few dollars saving in first cost, and go on losing profits ever after?

The mistake is often made of assuming that the interest of the seller of a machine is only in the profit which the sale brings; but the seller has a further interest and *this is identical with the interest of the buyer*, because the profit on the sale of a machine ends with the sale, and no concern can live on the profit from *one* sale. The man who habitually sells machines which are not best for the user's purposes has a hard row to hoe. Nothing helps sales like the "good word" from the satisfied user. So, what can be said that is strong enough against the folly of two men who make "exchanges" and "trade deals" for no other reason than their blind worship of the fetish of "reciprocity?"

* * *

Attention is called in the *Electrotechnische Zeitschrift* to the fact that the static charge of the cover-glass of electrical instruments is the source of many errors in electrical observations. The longer the pointer, the nearer it is to the glass, the feebler the directive force of the instrument, and the drier the atmosphere, the greater will be the error in the reading. In a dry warm room instruments have been known to indicate wrong as much as twenty per cent when touched with the dry hand. By drawing a piece of soft leather across the glass of a galvanometer, deflections up to five per cent may be produced. The deflections are not lasting, of course, but it may be as much as an hour before the pointer will again indicate correctly. Errors are produced, for instance, when cleaning the glass by wiping off the dust. As a preventative for the difficulty, it is stated that breathing upon the glass will eliminate the static charge.

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MACHINING CYLINDERS AND PISTONS FOR AUTOMOBILE ENGINES*

HAROLD WHITING SLAUSON†

Less than ten years ago, an automobile race held in France was won by a certain car propelled by a two-cylinder gasoline motor developing four horse-power. Today, duplicates of this motor, so far as number of cylinders, bore and stroke are concerned, are made by the thousand in one of the large French factories; but these motors now develop *twelve* horse-power—an increase of 200 per cent! This is indeed a striking illustration of the improvements in design and the rapid strides in shop and manufacturing methods made in the automobile industry during the past decade and it serves to show why the modern motor car renders such vastly better service than did its ancestor of ten or twelve years ago.

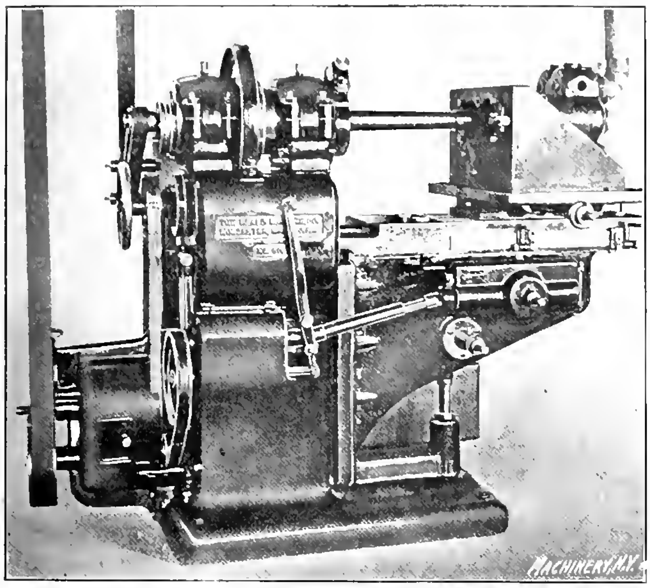

Fig. 1. Heald Grinder used in Premier Factory, showing Exhaust Attachment for Drawing off the Iron and Emery Dust

Much of this increased efficiency has doubtless been due to improved shop methods and tools whereby a far better fit of pistons and rings in the cylinder has been made possible. Good compression and the ability of the piston rings to prevent the escape of gas during the comparatively short time that the so-called explosion lasts is of such vital importance to the internal combustion motor that it is doubtful if the square pistons of the time of Watt would have served the purpose for any prime mover in which the source of energy is located in the cylinder itself. Owing to the higher temperature and pressure generally found in the internal combustion motor cylinder, the rings must be tighter and the piston looser than is the case with the steam engine, while the higher speed of the former power plant necessitates the minutest attention to details of workmanship and material to prevent undue wear of the moving parts. This higher speed also requires a more perfect balance of piston, connecting-rod and crank-shaft, and it is the practice in one of the leading American automobile factories to allow a margin of but ¼ ounce between the weight of any two pistons in any of the motors turned out.

There may be said to be almost as great a variety of methods in use for the preparation of the cylinder and piston of a modern automobile engine as there are makes of cars on the market. There are a number of different ways for performing the operations of boring, grinding and reaming cylinders and for grinding, "lapping" and "running in" pistons and rings, and nearly every possible combination of the processes for treating these two principal parts of a motor will be found in the numerous automobile factories of this country. One factory may bore the cylinders and grind both cylinders and pistons; another may treat the former in the same manner, but prefer to "lap in" the pistons; a third may ream the cylinders and both grind and "run in" the pistons; while still another may perform all four operations. When to these are added the drilling and tapping of holes in the casting, the facing off of the base, valve seats and the like, and the reaming of the pockets, it is small wonder that every cylinder on one of the well-known makes of cars has received nine different operations at the hands of as many different artisans before it is ready for its installation as a part of the completed motor.

In many of the shops special machine tools have been designed for the purpose of performing but a single operation on a number of cylinders at once. On the other hand, however, excellent work is performed in those factories in which attachments have been improvised for use on regular tools and machines such as will be found in any well-equipped machine shop, and the quality of the output will compare favorably with that of the concerns employing the most modern special equipment. Horizontal boring mills in a variety of forms are used in the majority of factories for giving the rough and finishing cuts to the cylinder castings. In some of the factories which make engines having the cylinders cast in pairs, a double mill is used having two bars which bore both cylinders at once. Several of these are in use in the Peerless factory at Cleveland, and each is equipped with a turret on which the casting is held while the cylinders are being bored. Another pair may be set in place while the operation of boring is in progress on the first set, and when these are completed, the turret is turned and the new casting is in position to be worked.

The rough and finishing cuts in the boring mill were formerly the only machine operations that the interior of the cylinder received, and even today some of the manufacturers do not consider it necessary to grind the walls. When the cylinders are not ground after being bored, it is necessary that the motor shall be run under belt power for a considerable time before the walls are worn sufficiently smooth to permit the engine to operate efficiently under its own power. In lieu of grinding, graphite has been found to produce good results when worked into the cylinder walls by the piston. The small particles of this substance fill every minute pore and hole left in the cylinder walls by the boring tool, and produce an almost perfectly smooth surface. As graphite is unaffected by heat, the high temperatures of the combustion chamber do not injure or alter it and it remains in its place in the cylinder walls for a practically indefinite period.

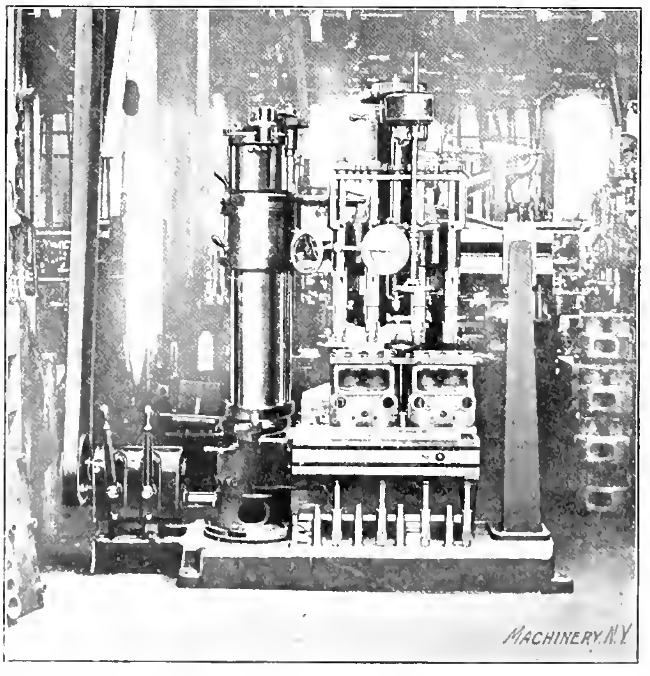

Fig. 2 "American" Radial Drill in Winton Factory, with Four-spindle Attachment for Reaming Automobile Cylinders

All of the motors for the Gaeth automobile, made in Cleveland, are bored on a lathe, and the results speak highly for the methods of treating cylinders employed in this shop. The cylinders are cast in pairs, and when bored, each pair

* For articles previously published on this and kindred subjects, see "The Design and Manufacture of a High Grade Motor Car," "Manufacturing Methods in the Stevens-Duryea Automobile Works," "Automobile Factory Practice," Efficient System for the Rapid Assembly of Motor Cars," "Treatment of Gears for Automobile Motors and Transmissions," October, 1909, and articles there referred to.

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is held in place on a fixture which is attached to the faceplate of the lathe. This fixture is so arranged that either cylinder may be turned into the proper position for boring without the necessity of removal from the faceplate. When one of the pair is finished, the other cylinder may be swung into position with only a few seconds' delay, and as no readjustment is necessary, it is certain that the two borings in the casting will be absolutely uniform. After the finishing cut of the boring tool has brought the cylinders to within about 0.010 inch of their proper diameter, the same lathe is converted into a grinding machine by the addition of a small electric motor and emery wheel, and the cylinders are then ground to exact size.

The emery wheel is attached to the end of a long spindle, which is in reality an extension of the armature of the motor, and the whole apparatus is clamped rigidly to the tool carriage of the lathe. The motor is run at high speed, while the back gear of the lathe is used to turn the cylinder casting slowly in the opposite direction. The length of the spindle on the motor allows the emery wheel to travel the entire distance of the cylinder walls to be ground, without danger of interference between casting and tool or carriage. Although this method of converting a lathe into a grinder is by no means new to machine shops, it is not common in automobile factory practice.

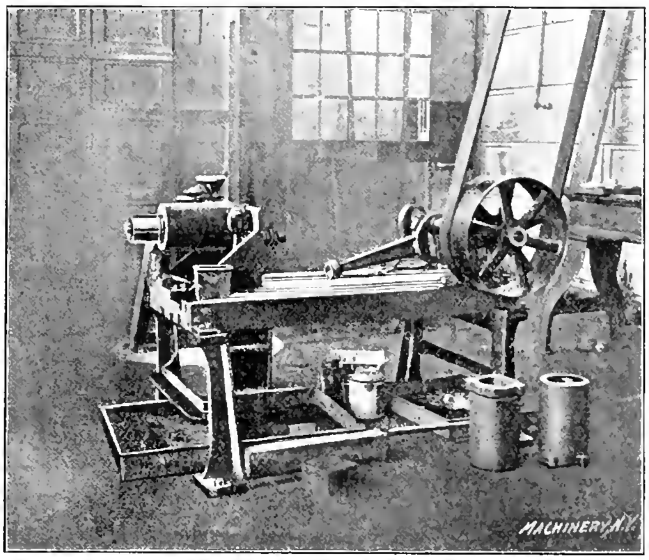


Fig. 3. Piston Lapping Machine in Marmon Factory, showing Connecting-rod Disconnected at Ball-and-socket Joint*

The cylinder of a modern automobile must of necessity be designed with such a small factor of safety in order to bring the whole machine down to the required lightness, that the utmost care must be taken in boring and grinding to prevent any weakening of the walls which might produce disastrous results if the pressure in the combustion chamber should become too great. Although these cylinder castings are constructed of the finest quality of gray iron, too deep a cut or too rapid speed in the boring mill may produce sufficient heat to strain the material unduly, and although all the factories exercise the greatest care in this respect, the methods employed in two of the shops to prevent such an occurrence are worthy of note.

In the factory in which the Marmon car is made, in Indianapolis, the cylinder casting is placed on the boring mill in a special fixture. This fixture contains intake and outlet water pipes with terminals which are attached to the respective plugs of the cooling system of the cylinder. When the boring mill starts its cut on the cylinder wall, water is run through the fixture and the jacket of the casting, thus keeping the material at an even temperature throughout the operation. It has been found that, with this method, the boring mill can be run at a higher speed and take a deeper cut with no attendant danger of inducing strains in the cylinder walls.

An entirely different practice is employed at the Premier factory, also located at Indianapolis. This method is a *cure*, whereas that described above is a *prevention*. After the first rough cut has been taken on the boring mill, the cylinder is removed and taken to the heat treating room where it is thoroughly annealed. This process is repeated after the final or finishing cut, and while it is not probable that the metal has received any strains due to the excessive generation of heat in the boring mill, any internal strains that may have been set up will surely be removed by these heat treatments.

After these operations, the cylinder is placed in the fixture on the Heald grinding machine and, as shown in one of the accompanying illustrations, Fig. 1, is connected at its valve openings to an air suction pipe which serves to remove all emery and iron dust formed in the casting. This type of grinder is in use in many of the leading automobile factories. The emery wheel is mounted on the end of a spindle which revolves at high speed on its axis. The bearing of this spindle is set in an adjustable eccentric which serves to give a circular sweep to the emery wheel in the opposite direction to that of its rotation. In other words, the eccentricity of the bearing of the spindle causes the outer point of the periphery of the emery wheel to describe a circle of the same diameter as that to which it is desired to grind the cylinder. An idler pulley, actuated by a cam, moves with the eccentric and serves to keep at the proper tension the belt which drives the spindle. [See MACHINERY, April, 1908.]

Many of the factories making motors having cylinders of small diameter and stroke accomplish the results attained by the finish-boring cut and grinding by means of the single operation of reaming. For this purpose, a large drill press, a lathe or a vertical boring mill with revolving table is used. (See Fig. 2.) It is a simpler operation than any of those already described, requires the use of fewer tools and machines and, in cylinders of small size, produces very satisfactory results.

Opinions seem to differ among many of the automobile manufacturers in regard to the necessity of grinding pistons. To say that, in all the leading factories, all the pistons are ground, would be unfair, for many a car, whose proved reliability and efficiency place it among the leading makes, has been designed and built in a shop in which the piston has gone directly from the lathe to the cylinder. Some makers claim that, inasmuch as the contact of the piston itself with the cylinder walls is not an essential in preventing leakage, it is useless to bestow the extra time and labor of grinding upon it—especially if the emery wheel has left the wall of the cylinder with a hard, glazed surface which would wear the rings to a perfect fit after a few hours' run of the motor under belt power. Others claim that too much attention cannot be bestowed upon these important moving parts of an internal combustion engine, and hence grind both the piston and the rings before installation in the motor.

The piston casting, of course, is turned, bored and the ring grooves cut to size in a lathe. The process following this operation in use in the Gaeth factory is interesting and unique in the extreme and, so far as the writer has been able to ascertain, is employed in this establishment exclusively. After the piston has left the lathe and the rings have been fitted to their grooves by the usual method, a special cement is applied to the rings, which holds them firmly in place. After this cement has hardened, the piston is taken to the lathe, the emery wheel attached and the surface ground down to exact size. The rings have been cemented in place so that their notched ends are closed around the pins in the grooves and, in consequence, they are ground down flush with the surface of the piston at all points on their outer circumference.

When this grinding is completed, only the closest scrutiny will reveal several very fine lines which indicate the sides of the rings. These lines defining the rings cannot be detected by the most sensitive touch, and it is evident that the whole surface is, to all intents and purposes, absolutely smooth. After the rings have been thus fitted, the cement is dissolved, the rings spring out to their normal positions and the piston is ready for installation in its cylinder.

As evidence of the attention given to detail by the leading automobile designers, the dimensions of every piston as it is

* For a more detailed view of the opposite side of this machine and additional information, see the article: Automobile Factory Practice, published elsewhere in this number.

finished in this factory are worthy of note. Instead of being of the same diameter throughout its entire length, the piston is tapered for a distance of one inch down from its upper end. Although this difference in diameter is small, amounting to 0.020 inch for the lower half of this tapered part and an additional 0.007 inch for the upper half, it has been found to be sufficient to allow for the greater expansion which occurs at this end of the piston, caused by its proximity to the combustion chamber and the intense heat generated therein.

A Norton Grinding Co.'s grinding machine is used in the Premier factory for piston grinding, and is typical of the machines used for this purpose in many of the best automobile shops. It is a too familiar sight in most of the best-equipped machine shops to require description.

In the majority of cases, when the piston and rings are not ground, they are "lapped in." This consists in moving the piston and rings up and down in the cylinder, under belt power attached to the flywheel, for several hours, and at the same time introducing an abrasive material between the moving surfaces. At the end of this operation, the rings and all parts of the piston which may have come in contact with the cylinder walls will have been worn smooth and to a practically perfect fit. The motor is then tested on the blocks under its own power with a variable load attached in the form of a dynamometer. When the engine has been thoroughly "tuned up" and all adjustments made, it is ready for installation in the chassis, and finally the completed car, with the exception of the stock body, is taken out for a severe and thorough road test. This road test generally covers a couple of hundred miles at the least, and when this is completed, it is almost certain that the rings will have been worn to as perfect a fit as though they had been ground.

At the Marmon factory, a special machine, Fig. 3, is used for lapping in the piston rings, which, while simple, is very effective. An iron casting is bored and ground to the exact size of the cylinder diameter and is mounted on a fixture at one end of a short bed. Directly opposite the opening in this casting and mounted on a shaft with axis at right angles to the stroke of the cylinder, is an eccentric and connecting-rod. The free end of this connecting-rod terminates in a ball-and-socket joint which can be attached to the connecting-rod of the piston to be lapped. The shaft on which the eccentric is mounted is driven by belt power and a reciprocating motion is thus communicated to the piston in the casting. The ball-and-socket joint allows the piston to be rotated by hand during its travel in the casting, thus bringing all parts of its surface in contact with every point on the cylinder walls. A hole is drilled in the upper side of the cylinder casting and a funnel attached through which may be fed the abrasive mixture—generally composed of finely powdered emery and oil. The fixture in which this casting is mounted will accommodate a pair of the motor cylinders, in which the pistons may be lapped, but it is simpler and more convenient, as a rule, to use this iron block ground exactly to the proper bore.

It is manifestly impossible in an article of this length to describe all of the variations of methods for the treatment of gas engine cylinders and pistons in use in the numerous automobile factories in this country. The practices dealt with in the foregoing paragraphs, however, represent the methods used in many of the leading factories. The impression gained from a recent inspection of the majority of the leading factories brings the writer to the conclusion that shop practices are becoming more uniform and that, as the industry has advanced, the number of different methods for producing the best work with the attendant expenditure of a minimum amount of time and labor has greatly decreased.

* * *

The large stern frame for the new White Star liner *Olympic* was lately transported from Darlington to Belfast. It weighs 70 tons and measures 68 feet by 22 feet. The traffic on the North-Eastern Railway had to be stopped while the frame was transported by the railroad from Darlington to West Hartlepool, owing to the fact that the width of the frame prevented cars from passing on the adjoining tracks.

AUTOMOBILE FACTORY PRACTICE*

NORDYKE & MARMON CO., INDIANAPOLIS, IND.

ETHAN VIALL†

The Nordyke & Marmon Co. has manufactured flour and cereal mill machinery for nearly sixty years, and in this business is well known the world over. In 1905 the company placed an air-cooled motor car on the market and continued this type of car until 1908. A change was then made to the production of water-cooled motor cars and since then rapid strides have been made in the matter of enlarged and improved manufacturing facilities. At present the company is manufacturing one chassis, known as the "Marmon Thirty-two" (now in its second season), and the parts have reached a standardization that is almost perfect.

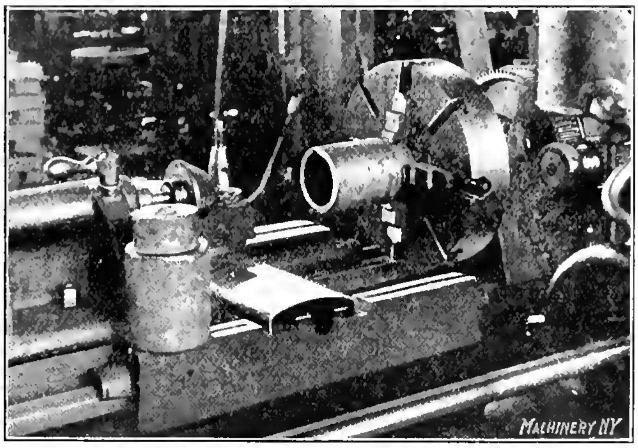


Fig. 1. First Operation on Pistons: Breaking the Inside Edge, Roughing Outside and Cutting Off Chucking Plug

While the shop equipment is not as extensive as in some other automobile factories, it is large and very complete, including modern tools of the best makes. The tool, jig and fixture equipment is unusually good, showing on every hand evidence of considerable skill and ingenuity. Profiting by the mistakes of others, the company has been enabled to cut out a lot of expensive experimenting, so that its car and its shop practice compare very favorably with those of firms who have been building automobiles for a longer period. The general superintendent follows the plan of calling the various

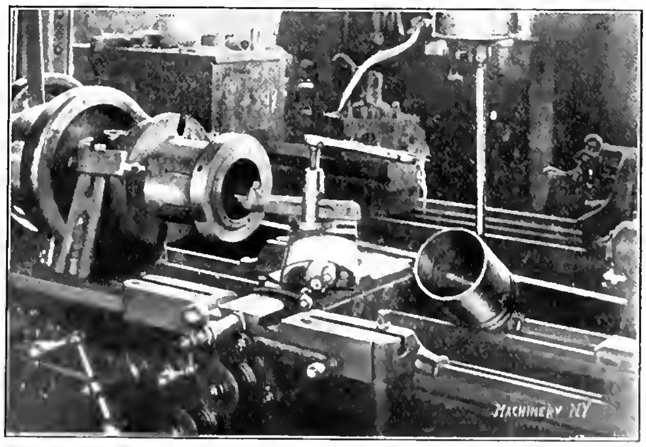


Fig. 2. Second and Third Operations: Boring Inside, Truing Edge, Facing and Centering End

foremen together whenever a new tool or machine is being designed and allowing each one to take a "whack at it," discussing the good or bad points until by the time they are ready to make it, the rough, impractical spots have all been taken off. So as a rule, the tool or machine, when made, works just as desired, without any great change or alteration being necessary, for if there are flaws anywhere, a half dozen or more keen, bright, mechanical foremen are pretty apt to detect them long before they leave the designer's hands for the toolroom. Then, too, the general foreman had been in the automobile business with one of the oldest and largest

* See "Manufacturing Automobile Equalizing Gears" in the December, 1909, issue of MACHINERY, and article there referred to.

† Associate Editor of MACHINERY

concerns in the world from its inception, until he took his present position, and, in consequence, he knows how good tools should be used and how parts should be handled to the best advantage.

A rather unusual, though good plan of the foreman, is to have jigs and fixtures made, when possible, to fit more than one class of machines. For instance, a jig intended for use in a screw machine may also be used in a lathe or a drill-press, or a lathe fixture may be used on a boring mill, or perhaps, in some cases, on a milling machine also. In this way a few machines of one class are not overcrowded while others are idle, because the parts to be machined can easily be placed where most convenient and promptly finished, where otherwise they might be held up for days, as so frequently is the case.

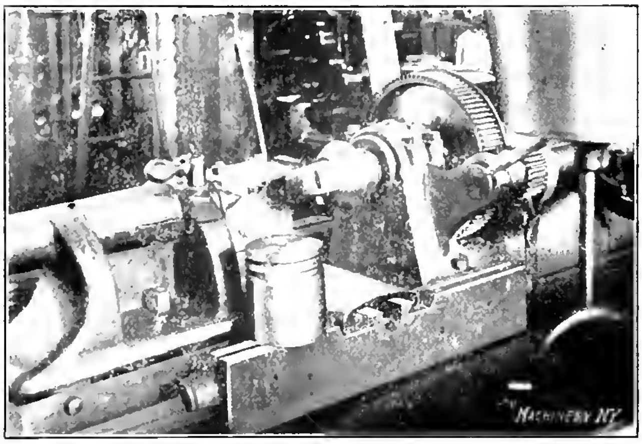


Fig. 3. Fourth Operation: Turning Outside and Cutting Ring Grooves

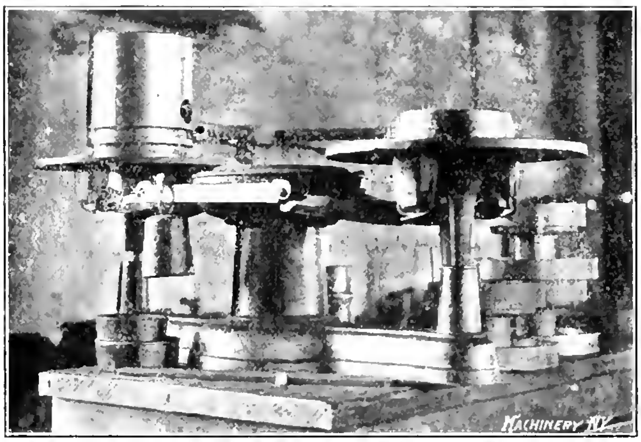


Fig. 4. Scales on which the Pistons are weighed

Everywhere, hand feed is dispensed with if practical, and power feed used. Especially is this noticeable in the drilling operations, and the result is an almost uniform rate of output, which is not true where hand feed is used, as then the rate is highest when the man is fresh and decreases as he tires.

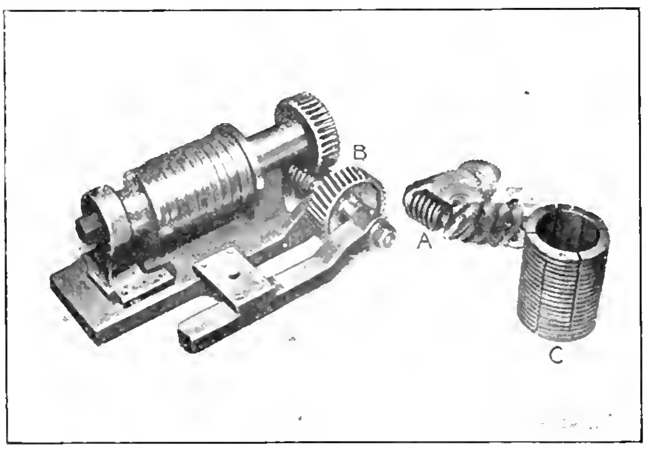


Fig. 5. Milling Fixture and Tools for Cutting off Piston Rings

Piston castings are made with an extension of reduced diameter instead of the usual flange or lugs. They are first placed in a regular lathe chuck as shown in Fig. 1, the inside edge beveled slightly for the large tail center, and the outside rough turned. The casting is then cut off, leaving the extension in the chuck, and placed in the hollow chuck shown in Fig. 2. The inside is then bored out to the wrist-pin bosses; the inside edge trued up; the casting turned end for end; and the closed end surfaced off and centered. The piston is then put into a lathe fitted, as in Fig. 3, with a large center and a floating driver which goes in between the wrist-pin bosses; the grooves are next cut and the outside trued up. From this point on, the piston goes through the processes common to the majority of automobile shops, which have been repeatedly described in these columns. Finally it is brought to a certain weight by testing it on balance scales as in Fig. 4, superfluous metal being removed until it balances.

Piston rings are made by first truing up a cast iron sleeve and then placing this sleeve on an expanding arbor and cutting it into rings with a gang of milling saws. The method is similar to that employed in the Stevens-Duryea shop, as described in the October number, except that here the work is done on a regular instead of a vertical, milling machine, the fixture and parts shown in Fig. 5 being used. In using this fixture, the worm *A* is placed on the arbor with the milling saws and meshes with the gear *B*, causing the expanding arbor to rotate as the cut proceeds. Different expanding sleeves or bushings are provided for the various sizes of piston rings, one of which is shown at *C*. The rings are split straight across by two saws while clamped between the flanges of the fixture shown in Fig. 6. Extra clamping mandrels, like *D*, which fit the table bracket, are used for the various sizes.

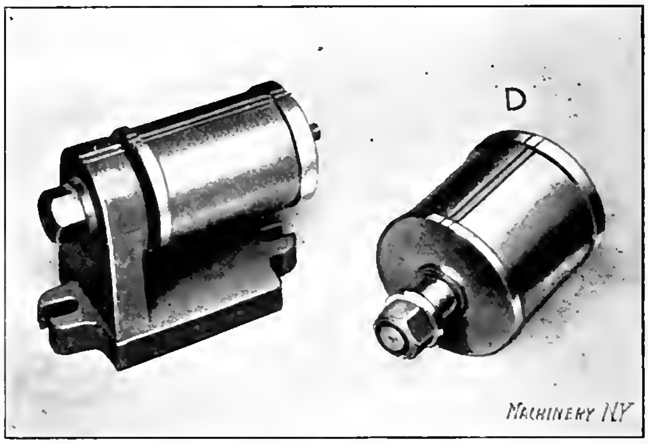


Fig. 6. Milling Fixture for Splitting Piston Rings

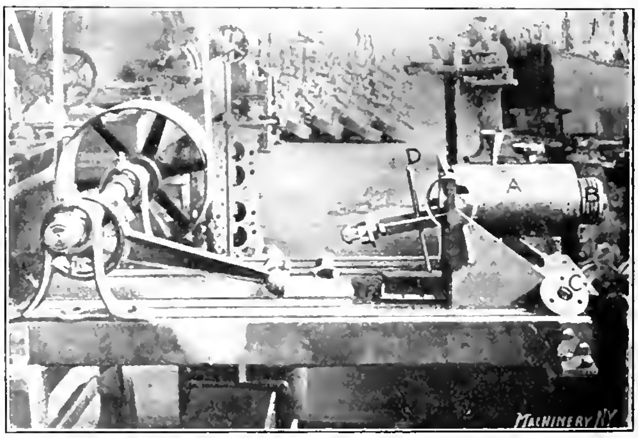


Fig. 7. Piston Ring Lapping Machine

Lapping the Piston Rings

Instead of lapping the piston rings in the engine cylinder in which they are to be used, as is commonly done, the rings are lapped in the machine shown in Fig. 7. The cylinder used is a cast-iron sleeve *A*, which is bored to the exact size of the cylinders, and is easily replaced. The rings are placed on the false piston *B* and held by screwing on the flange *C*, which merely keeps them from coming off the piston and does not clamp them tight enough to prevent their expanding. As the machine moves the piston and its load of rings

back and forth in the cylinder, it is revolved by hand by means of the handle *D*, the connecting-rod joint being made so as to allow the piston to be turned easily. While the operator turns the rings, he feeds emery and oil through the funnels in the top of the cylinder.

Timing the Fly-wheels

Nowhere have I seen a better arrangement for marking the timing points on fly-wheels. Instead of the usual "cut-and-try" method of marking after the fly-wheel is in place, it is here marked before assembling on the shaft. Two of the bolt holes in the center of the fly-wheel are drilled farther apart than the others, in a drill jig, and these serve as guides when placing the wheel on the flange pins of the marking

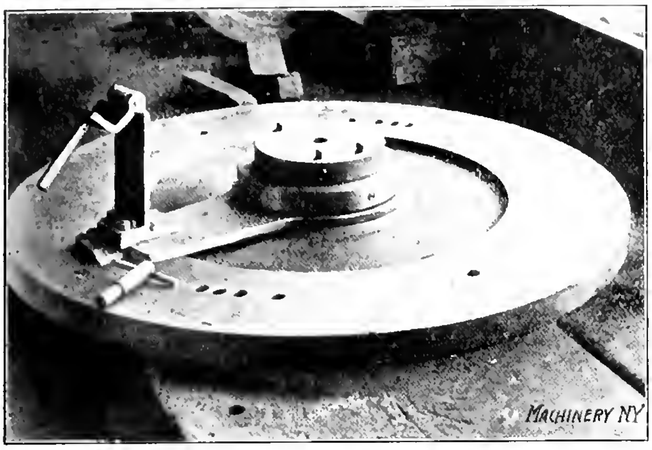


Fig. 8. Fly-wheel Timing Gage

gage shown in Fig. 8, and also make it impossible for the assembler to put it on wrong. The fly-wheel is placed on the gage as shown in Fig. 9 and is, of course, stationary while the arm or marking guide is movable. This arm is set at the various points by a hardened pin passing through its base and fitting into bushed holes in the circular bed of the gage. The respective markings are stamped into the rim of the wheel with steel stamps lettered to indicate: "inlet closed," "exhaust closed," etc.

Balancing Fly-wheels

Fly-wheels are balanced after the fashion of balancing a millstone or a limber cockhead drive by spinning them on the

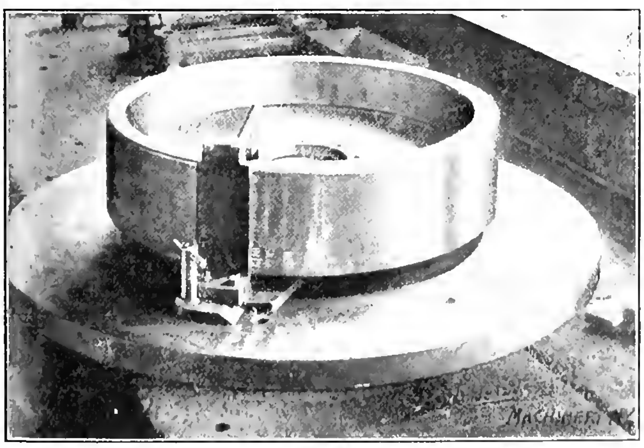


Fig. 9. Timing Gage with Fly-wheel in Position

machine shown in Fig. 10. The rim is marked with chalk and then enough metal drilled out to balance it. An experienced man can tell pretty accurately how much to drill out and where, by the appearance of the marks. Fig. 11 shows how the machine looks with the fly-wheel removed. The flanged center to which the fly-wheel is bolted, is still in place. Fig. 12 shows the machine with this center removed and set up on edge so as to show the bottom of it and the cockeye in the center. The cockhead on which the flanged center rests, and the two drive pins, are also shown. By this arrangement the fly-wheel is given the necessary freedom of movement to enable it to seek its balance while in rapid motion. The wheel is also put in standing balance on the crankshaft.

Rolling Bronze Bushings

The crank ends of connecting-rods are bushed with Parson's white bronze, and the final sizing is done, not by reaming, but by rolling with the tool shown in Fig. 13. The connecting-rod is held in the jig shown, which has a guide bushing

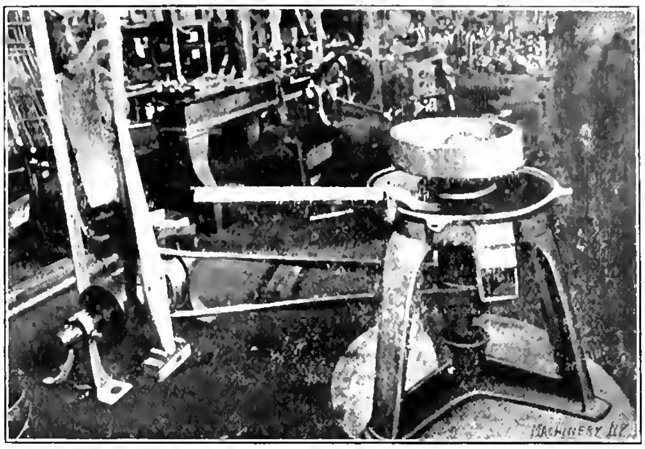


Fig. 10. Fly-wheel Balancing Machine with Wheel in Place

in the bottom for the pilot of the roller tool, at the right. This tool is so made that it may be adjusted for size, to a limited extent. The rollers are highly polished, hardened steel rollers with rounded ends, held in place by a cupped retaining ring at each end and supported by the steel center of the tool body. Not only does this tool give an excellent

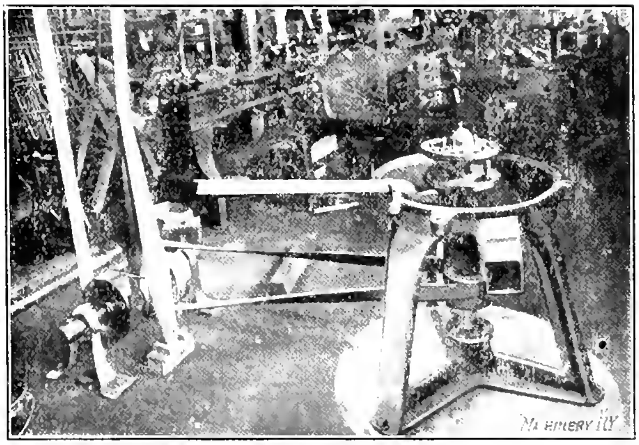


Fig. 11. Balancing Machine with Wheel Removed

finish to the bearing surface, but it also presses the metal firmly into place. Through an oversight, an unbushed connecting-rod was used when photographing, but the connecting-rod shown on the balancing device (Fig. 14), shows the style of bushing used. This device was made for balancing

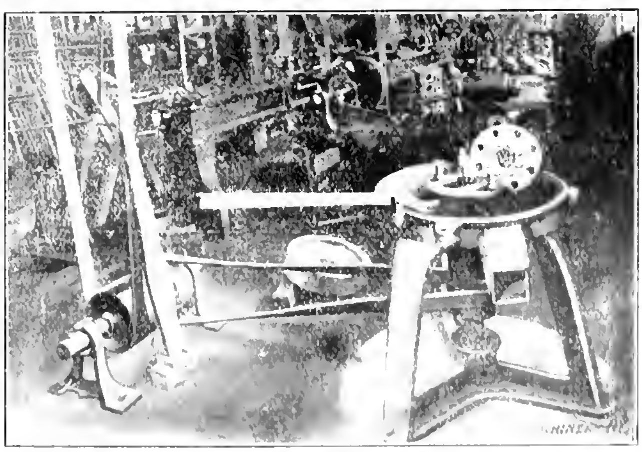


Fig. 12. Balancing Machine with Floating Disk Removed

connecting-rods so that the weight would be properly distributed.

Casting Bronze Ends onto Steel Axles

Phosphor-bronze ends are cast on the pressed steel rear axles, which prior to this operation appear as in Fig. 15. The

casting is done by standing them on end in a mold and pouring molten phosphor-bronze around the ends; they then appear as in Fig. 16, the bronze castings being shown with runners and risers still in place. As a rule, in fusing one metal onto another, considerable extra metal is run through the mold, but in this case it is not necessary, as a perfect union takes place between the tubular steel axle and the

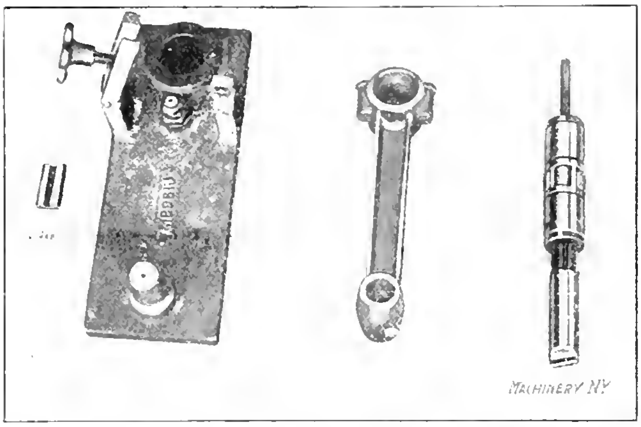


Fig 13 Rolling Tool and Chuck for Sizing Bronze Connecting-rod Bushings

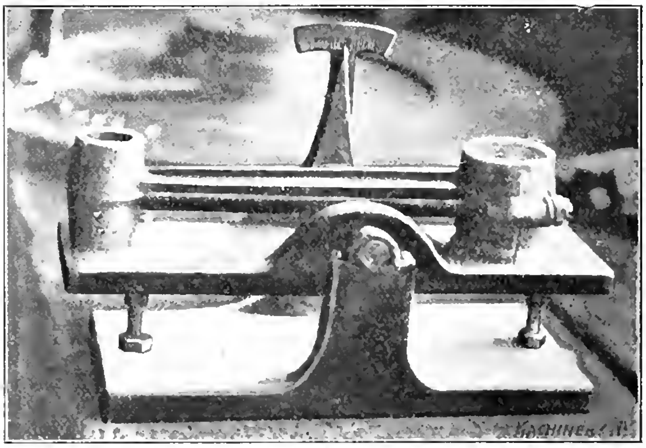


Fig 14 Scale for Balancing Connecting-rods

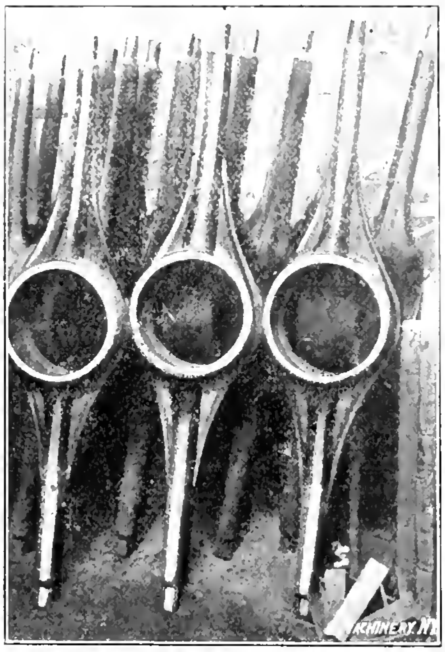


Fig 15 Rear Axles before Phosphor-bronze Ends are cast on

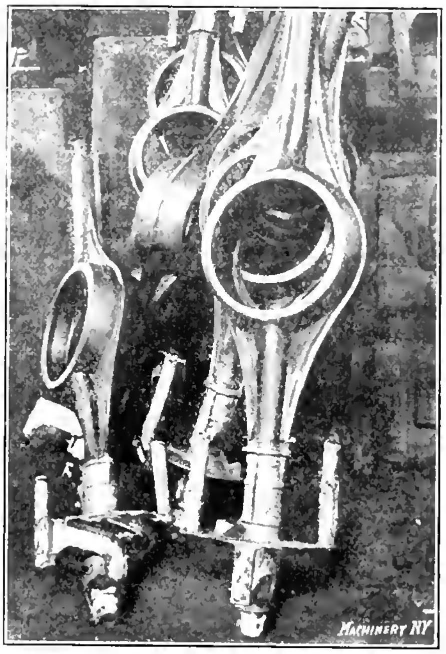


Fig 16. View of Rear Axles after the Bronze Ends are cast

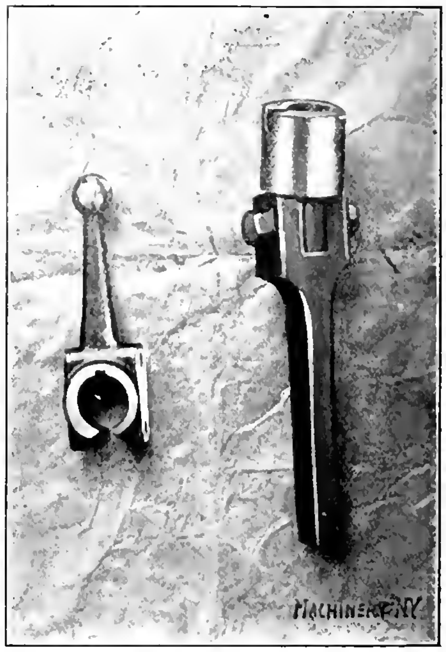


Fig. 17. Ball Turning Tool and Sample of its Work

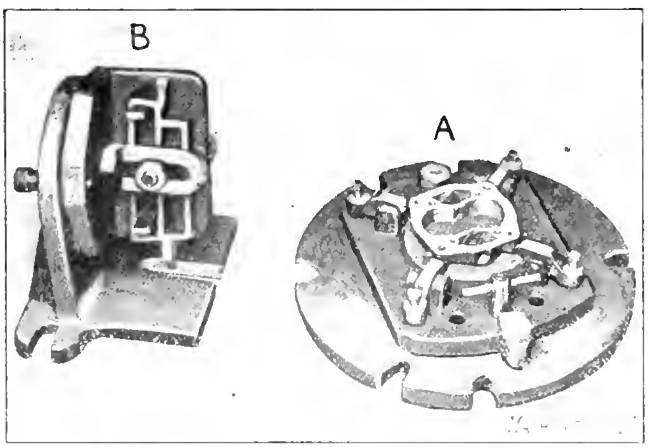


Fig 18 Fixture for Milling Quadrants, and Oil Pump Casing

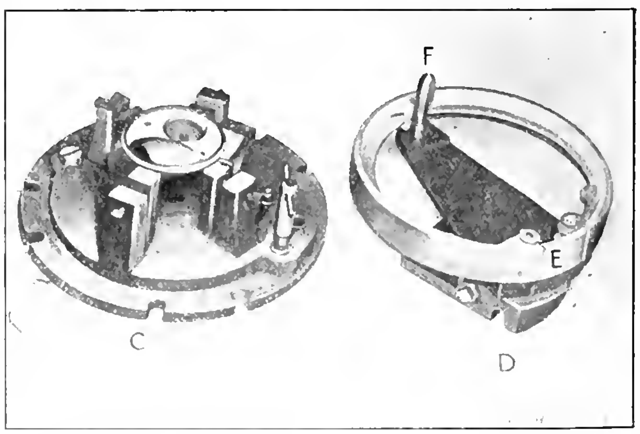


Fig 19 Fixtures used in Surfacing Part of Muffler and Cutting Brake Band

bronze without extra metal other than shown. After one end has been cast on, the axle is reversed and the other end ...ked in a fresh mold and cast as before.

Turning Balls

...e simplest ball turning tool imaginable is shown in Fig. ... It consists simply of a hardened cylindrical piece of steel ... to a shank for the tool-post, as illustrated. The hole ... cutter is just the size of the ball wanted, and it is notched on one side just enough to go over the ball arm nicely. The forging on which the ball is to be finished, is held in a chuck with formed jaws, and the tool is fed straight onto the forged ball, cutting it to size quickly and smoothly and leaving no teat on the end, as so many other tools used for this purpose do. No rake is necessary on this tool, but it should be ground perfectly square on the end, which can easily be done by holding the end against the side of an emery wheel if no other means is at hand. This tool is, of course, only used for finishing or smoothing up balls already formed, such as forged ball-cranks, ball-levers or parts of universal joints, and it is not intended for cutting balls from the solid.

At A, Fig. 18, is shown an indexing jig for holding the body

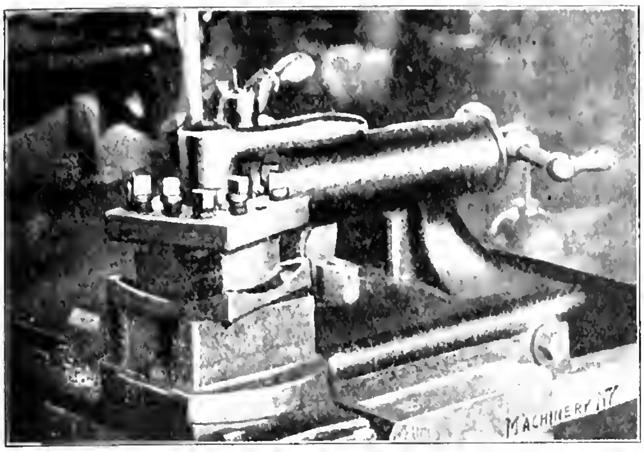


Fig. 20. Lathe Turret Tool-post for Holding Four Tools

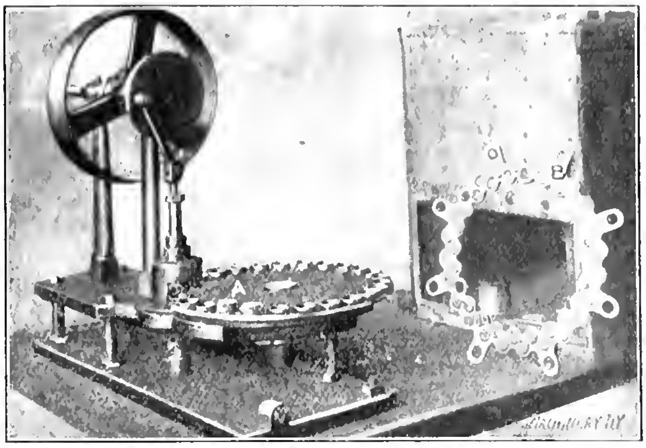


Fig. 21. Friction Disk Cork-inserting Machine

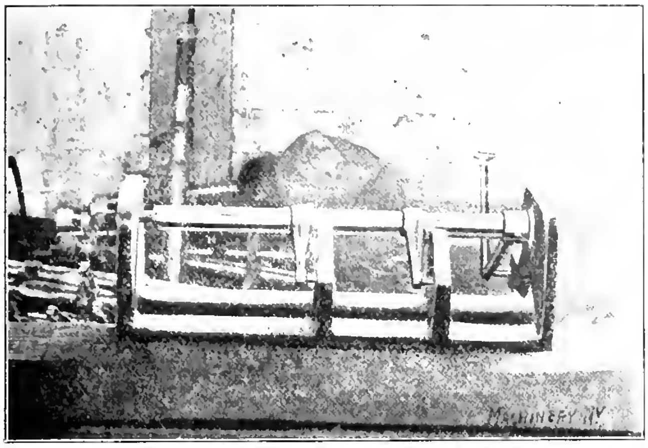


Fig. 22. Jig in which Foot-lever Pin-holes are drilled

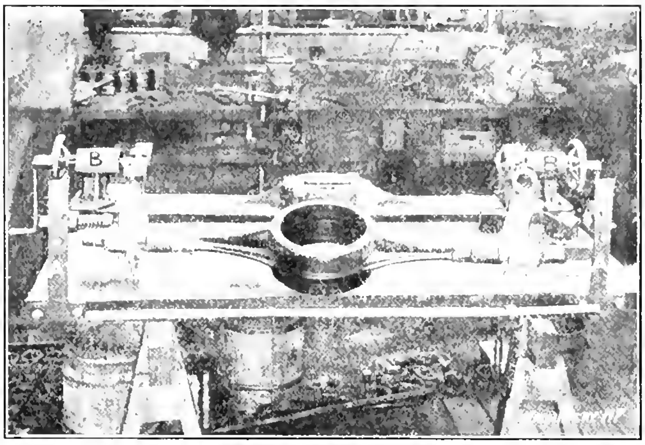


Fig. 23. Centers for Testing and Reaming Rear Axles

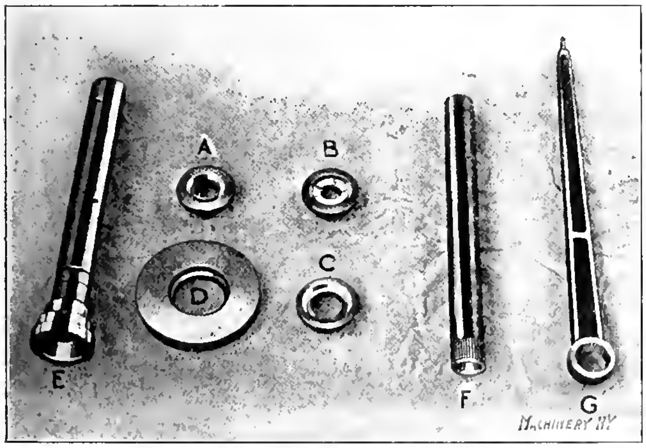


Fig. 24. Tools for Corrugating Ends of Shafts, and Sample of Work

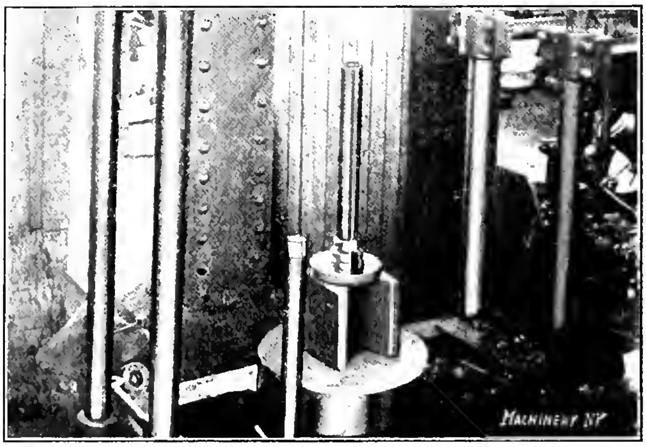


Fig. 25. Hydraulic Press in which Shaft Ends are corrugated

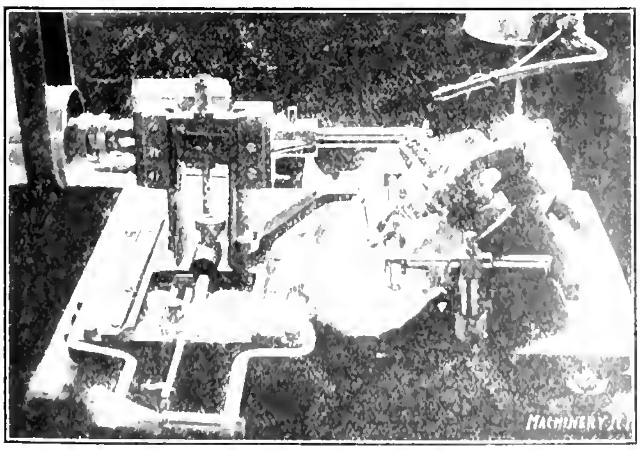


Fig. 26. Change Gear Tooth-chamfering Machine

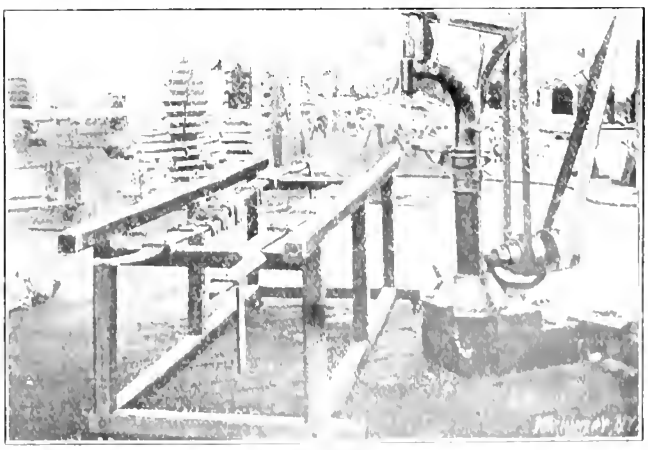


Fig. 27. Frame [illegible] Stand and Jigs

of a small oil gear-pump while facing it off and boring out the recesses for the gears. The indexing of the work from one center to the other is common enough, but the method of clamping the casting in the jig (which is plainly shown) is not so well known, though it is very effective and leaves no parts projecting above the surface of the casting to interfere with the tool. At B is another indexing jig used to hold change gear lever quadrants while milling the ends with an

end mill. In Fig. 19 the jig *C* is another application of the indexing idea for turning two circular parts not concentric. The part shown is the cast-iron end of a muffler drum. Owing to the irregular shape of part of the casting, it is rather a difficult piece to hold, as the only regular part on it is the thin flange, the upper part of which must be turned. The clamping bas been successfully accomplished, however, by using "posts" on the upper, inner edge of which has been turned a shallow L-shaped circular groove, into which the flange of the casting fits. These posts, though of cast iron, will stand a certain amount of springing and are tightened onto the rim of the casting by means of the set-screws in the

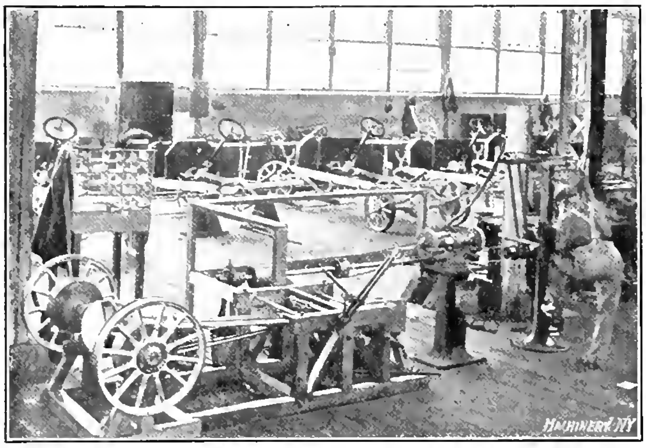


Fig 28. Assembling Stands for Rear Axle Mechanism

heavier posts back of them. The jig *D* is used to hold brake rings while sawing out the part *E*. The cuts are taken as indicated in the engraving. As they are radial, only one milling saw is used. After the first cut is made, the handle *F* is moved over against the other stop for the last cut.

Many of the lathes in the shop have been fitted with the handy four-tool turrets shown in Fig. 20. Rockers are fitted to the bottoms of the holders to center the tools properly. These turrets save tool changing and the consequent annoyance and delay on many lathe jobs.

Formerly the clutches on Marmon cars were made with cork inserts. While this type of friction disk is no longer used here, the machine used to put the corks into the disks will be of interest because of its simplicity and the rapidity with which it did the work. Guide plates like *A* (Fig. 21), with flaring holes in them corresponding to the holes in the

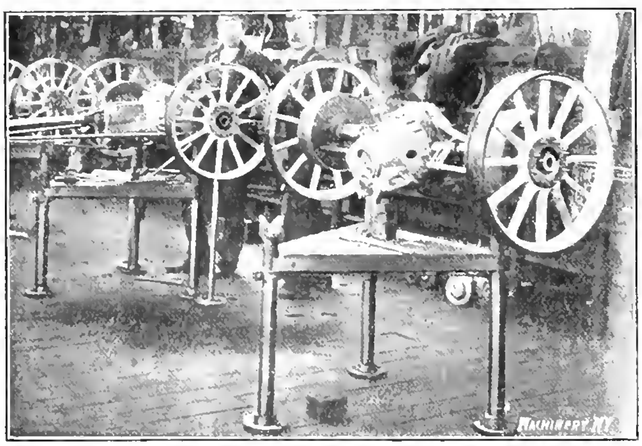


Fig 29. Apparatus for Testing Rear Axle Mechanism

friction plates into which corks were to be inserted, were used, and corks were placed into these holes and automatically fed under the plunger which pushed them down into the disk beneath. A friction plate with a double row of corks, is shown at *B*, but these were put in by using a taper tube and hand punch, none of the style for which the machine was intended being in stock.

Fig. 22 is a jig for holding foot levers in the proper position on the shaft while drilling and pinning, previous to brazing.

Fig. 23 shows a fixture used for testing rear axles and center reaming them. At *A*, *A*, are the centers on which the axle is spun when it comes from the foundry after having the bronze ends cast on, in order to see if it is straight enough for turning. If it isn't, it is sprung or bent into correct alignment before it is strapped into place at *B*, *B* and the ends center reamed, ready for turning in a lathe.

Instead of keying or just pinning levers onto the ends of the rocker-shafts in the usual way, all end levers have the hole corrugated and are pressed onto the corrugated end of the shaft and then pinned. The hole in the lever is corrugated by broaching, and the shaft ends are made to correspond by using dies like *A*, *B* and *C*, Fig. 24. A die of the right size is placed in the collar *D*, and the end of the guide tube *E* is placed on top. The shaft is then forced down the required distance through the die, in a hydraulic press, as shown in Fig. 25. A shaft and lever is shown at *F* and *G*, respectively, in Fig. 24.

Sliding gears have the ends of the teeth chamfered in the semi-automatic machine shown in Fig. 26. In this machine the feeding is done by hand, but the indexing is automatic, the gear being moved one tooth as the feed lever is drawn back.

Frame sides are drilled while clamped to the stands shown in Fig. 27, the drill jigs lying on top of the stand being used.

The stands used while assembling the rear axle mechanism, which in this case includes both the change gears and differential, are shown in Fig. 28, and in Fig. 29, is shown the apparatus used to test out the assembled mechanism. A very thorough try-out is given the various parts before allowing them to be placed in a machine.

* * *

NEED OF A GOOD APPRENTICESHIP SYSTEM

J. F. RICHMAN*

Every day finds us getting farther and farther away from a satisfactory solution of the apprenticeship problem. In this age of high speed and rapid production, the heads of manufacturing companies have neglected this one important stone—the foundation of the future army of mechanics. Only about one man in fifty applying for a position, can truthfully say that he is an all-around machinist. The employers are not entirely to blame; employes are responsible to a greater or less degree (judging by years of experience) as the following illustration will show:

Sam has served his apprenticeship and worked as a journeyman for fifteen or twenty years, and is capable of doing any job in the factory; on account of his skill and industry, he is given a job on the milling machine at a rate of 35 cents per hour. Joe comes in from the farm and is put on a similar machine and rated at 17½ cents per hour. In three or four months Joe goes to his foreman and demands a raise. The foreman remonstrates with him on account of his inexperience. He replies, in a sort of braggadocious style, "Well, I am doing as much as Sam and he is getting 35 cents," and he threatens to leave. The foreman, rather than break in a new man, grants him the raise. In a few months the same process is repeated, until Joe is receiving the same amount as Sam. Then Joe requests a change, but is informed that he has no practical knowledge of other machine tools. Joe is aware, by this time, that he cannot command 35 cents except on a special class of work, and is not willing to work for lower wages; consequently he remains a milling machine hand all his life.

The writer has seen many such cases and has them under his supervision. On the other hand, manufacturers have found that when a man is kept on one job continually, he can accomplish better results than an all-around man working on all types of machine tools, and making no one a specialty. For this reason they desire to make specialists as much as possible.

I would like to ask the mechanical world where we are going to get our foremen, superintendents, and managers in the future? It is true that the technical man is coming to the front; but he, too, must have the practical experience, as well as the support of the well-trained, all-around mechanics.

* Address: Care of Hudson Motor Car Co., Detroit, Mich.

THE UNITED STATES CREAM SEPARATOR

ITS DESIGN AND MANUFACTURE

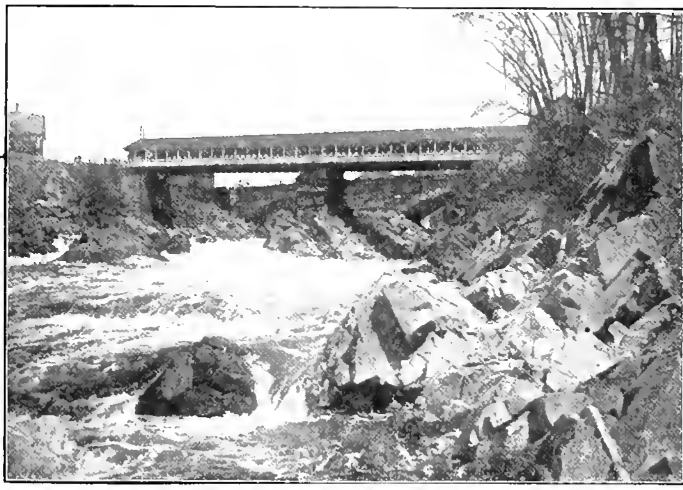
RALPH E. FLANDERS*

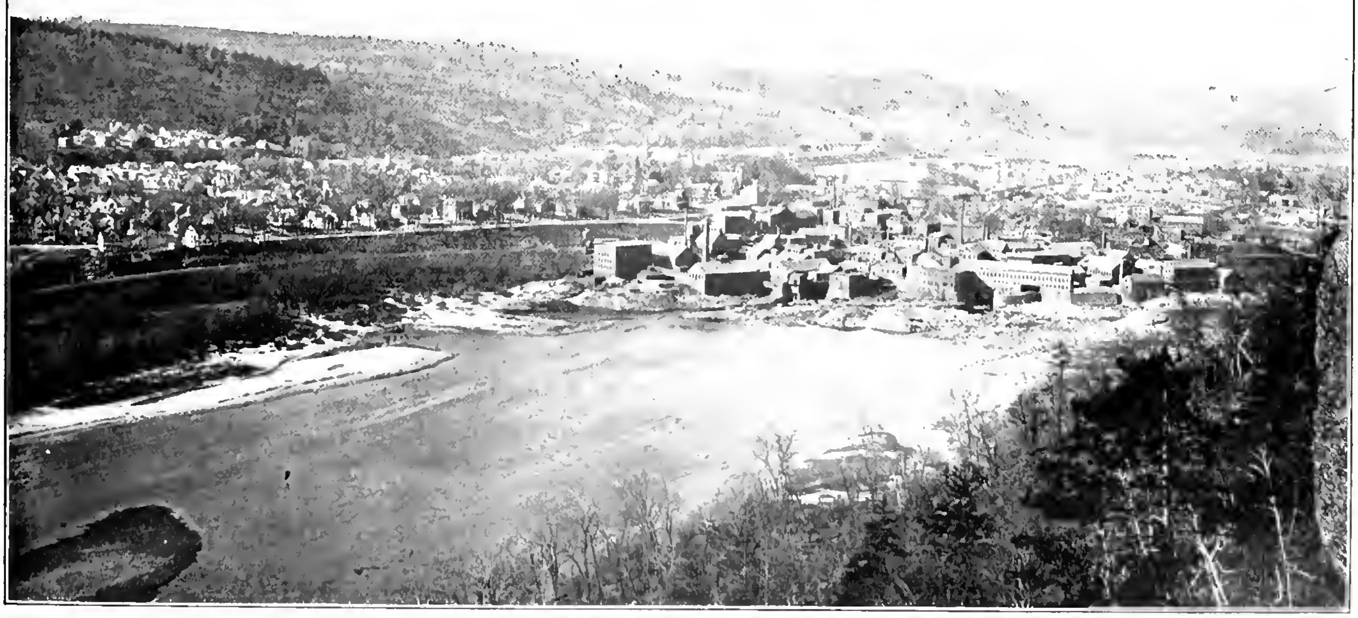
The village of Bellows Falls, Vt., was foreordained by Nature, when she laid out the geography of New England. For the past forty odd miles the Connecticut River has been pursuing a placid and unobstructed course, but here it finds the way barred by an outcropping ledge, set like a dam, between high hills on each side. Over and through this ledge the water has worn a rough, crooked passage. The first pulp mills were built here many years ago, the owners being drawn by the fine water power, and by the vast drives of spruce logs, which each spring are floated from far-away forests on the Canada border, to mills in this and other towns nearer the centers of civilization.

The town is famous for its bridges, as well as for its pulp mills. The latter are located on an island between the main bed of the stream and the power canal, which at ordinary times carries the greater part of the flow. Means of communication have to be provided to reach this island from both sides. Furthermore, the town is an important railroad center. The main Connecticut valley line of the Boston & Maine R.R. crosses the river here, the station being located on the island. An important branch of the Fitchburg division climbs down from the hills on the New Hampshire side, while a main line of the Rutland Railroad climbs up into the still higher hills of the Vermont side. All these lines of transportation, with the local electric car line, require no less than sixteen bridges in the little one-quarter mile square space about the island.

Among these bridges may be found fine examples of almost every one of the important types in use. Spanning the river above the island is shown, in Fig. 1, a famous two-hinged arch which was described in the various civil engineering papers at the time of its erection a few years ago. In Fig. 2 are shown two older examples, the one in the rear being a solid masonry arch, while the one in front is an excellent example of the interesting structures found the whole length of the Connecticut valley, built by local "bridgewrights" as they may be called. This one has a lattice frame and a central pier, and is built of timber. Others of these homemade bridges have Howe truss frames, while still others combine the lattice frame with a wooden arch as a reinforcement.

The writer has seen bridges of this kind in which not an ounce of iron was used. All the joints were mortised and tenoned, and fastened with wooden pins. The floor boards were pegged to the beams. The roof boards were pegged to the rafters, and even the hewn shingles were fastened in the same way. Perhaps the longest of these Connecticut River bridges is the one at Springfield, Mass., which many readers of MACHINERY must have seen. Some one has compared them to huge caterpillars crawling across the stream. Anyone who has seen one of them from the distance, with its long, dark and oftentimes crooked body, its stumpy legs resting in the flowing stream, will appreciate the aptness of the comparison.





Figs. 1 and 2. Bellows Falls, Vt., Famous for its Pulp Mills, Bridges and Cream Separators. Two Examples of Bridge Construction. The Homemade Toll Bridge and the Masonry Railway Bridge

The United States Cream Separator

All this is digression, however. The chief thing of interest to the mechanic in Bellows Falls, is the plant of the Vermont Farm Machine Co., whose best known product is the United States separator, used by farmers throughout the country for separating milk into cream and skimmed milk. Through the kindness of the management the writer was permitted to visit the shop and study the various operations which go

* Associate Editor of MACHINERY.

into the making of their product. The work done here proved to be of such interest as to suggest the writing of this article.

Mechanics in the past hundred years have added tremendously to the productiveness of the individual farmer. The mowing machine, the reaper, the threshing machine, the portable engine and other tools have enabled him to cultivate tens and hundreds of acres with better care than he could formerly give to one. The cream separator is a later addition to this list of farm machinery. It has only come into common use

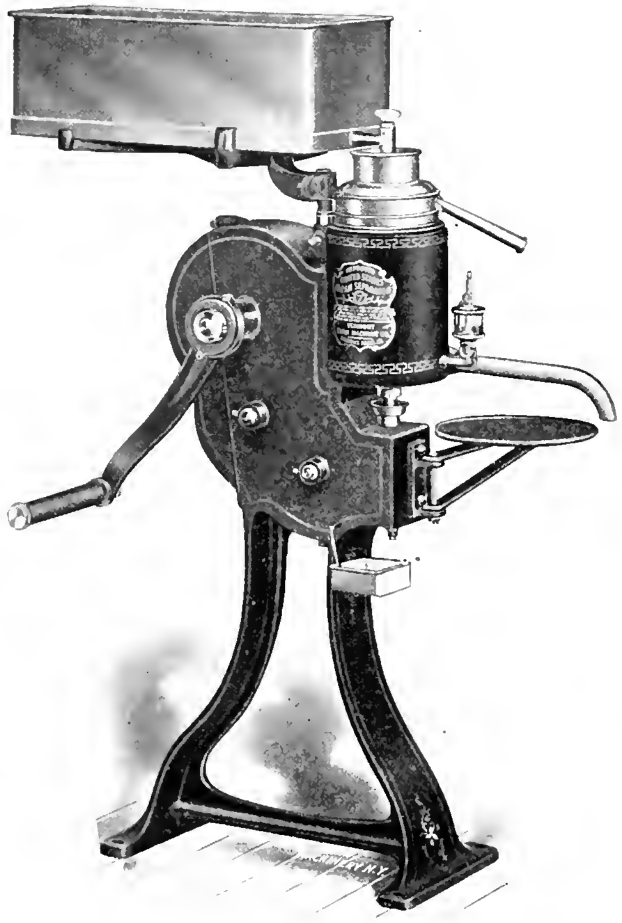


Fig. 3. The United States Cream Separator

in the past twenty years and is still in process of improvement. It enables the farmer to separate the cream immediately after milking, without waiting for the slow and uncertain influence of gravity. The cream is skimmed much cleaner than by the old process, leaving less of it in the milk. The thickness of the cream is under absolute control and is of a better quality, being cleaned from the dirt which is almost sure to find its way into the milk pail. It leaves the skimmed milk fresh and in the best condition to feed to growing cattle.

All these are agricultural features, however. From a mechanical standpoint the separator is interesting because it requires the highest grade of work of any machine used on the farm, being on a par in this particular with the best grade of machine tools. At the same time it has to be so designed and constructed as to be used by people comparatively unskilled, without danger of seriously injuring the mechanism. The important points of durability and easy replacement of parts in case of breakage must also be provided for.

Description of the Separator

The United States separator is shown in elevation and section in Figs. 3 and 4. The milk is emptied into pan *A*, from which it flows through a faucet into the feed cup *B*. A float in this feed cup, entering the faucet, serves to regulate the flow so as to keep an even level in the cup and a consequent even rate of flow through the machine. From *B* the milk passes down into a rapidly revolving bowl *C*, whose construction will be described later. Here the cream is separated from the skimmed milk, the former leaving the machine at *D* and the skimmed milk through spout *E*. The bowl is revolved at some 8,000 or 9,000 revolutions per minute by power, or, as in the case shown, by hand-crank *F*. This drives the train of gearing shown. The last member of this train is the worm-wheel *H*, which, contrary to the usual office of the worm-wheel, drives the steep pitch worm *J*. This worm is cut on the spindle of the bowl which thus receives its rapid motion.

The gears run in a bath of oil which lubricates all the teeth and all the bearings. The easy running of the machine is naturally of extreme importance. The bowl is geared up from the handle in the ratio of about 150 to 1, and with this tremendous increase a slight amount of friction will mean a great difference in the amount of work imposed on the operator. This is one of the points which necessitates very careful work in the construction of the machine. So well are the gearing and journals made and fitted that the weight of the handle will start the bowl in motion.

The bowl and spindle rest on a thrust bearing *K* in the base, formed of a single hardened ball between the hardened stationary and revolving thrust faces. A compressed felt cushion under the lower face supplies elasticity to prevent undue shock. The crank *F* drives shaft *G* by means of a ratchet which permits the bowl to be revolved only in one direction. If it were attempted to drive it in the other direction, there would be a tendency for the bowl to unscrew from the worm and lift out of the frame. The same tendency would be met with if the handle were rigidly fastened to the shaft and it suddenly met with an obstruction, stopping the movement of the train of gears. The ratchet prevents damage

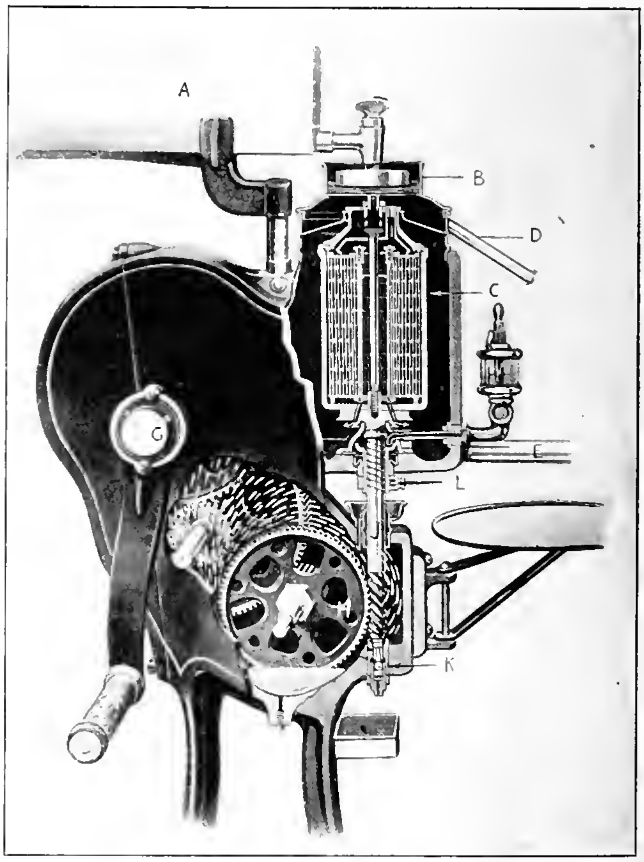


Fig. 4 Mechanism of the United States Separator

from these causes. When the machine is stopped, the bowl and its connected spindle may be easily lifted out for cleaning.

Worm-wheel *H* revolving in the bath of oil, lubricates all the gears and bearings of the train, as well as the worm and step-bearing. The upper neck bearing, *L*, of the spindle, is oiled by a sight-feed lubricator, and is held in a central position by an elastic steel washer, whose compressing effect may be increased or diminished by means of the thumb-screw shown. This adjustment of the spring washer makes provision for steadying the spindle under varying conditions of running balance.

How the Cream is Skimmed from the Milk

In the centrifugal machine the cream is separated from the milk very much faster, but in exactly the same way that it is done in a pan on the "swing-shelf" in the cellar—that is to say, the cream rises to the top because it is lighter, while the milk globules sink to the bottom because they are heavier. The sole function of the separator is to hasten this process by intensifying the force of gravity and by making it a continuous operation, automatically skimming the cream as fast as it rises to the top. The way in which it does this will be understood by reference to Fig. 5, where is shown a section

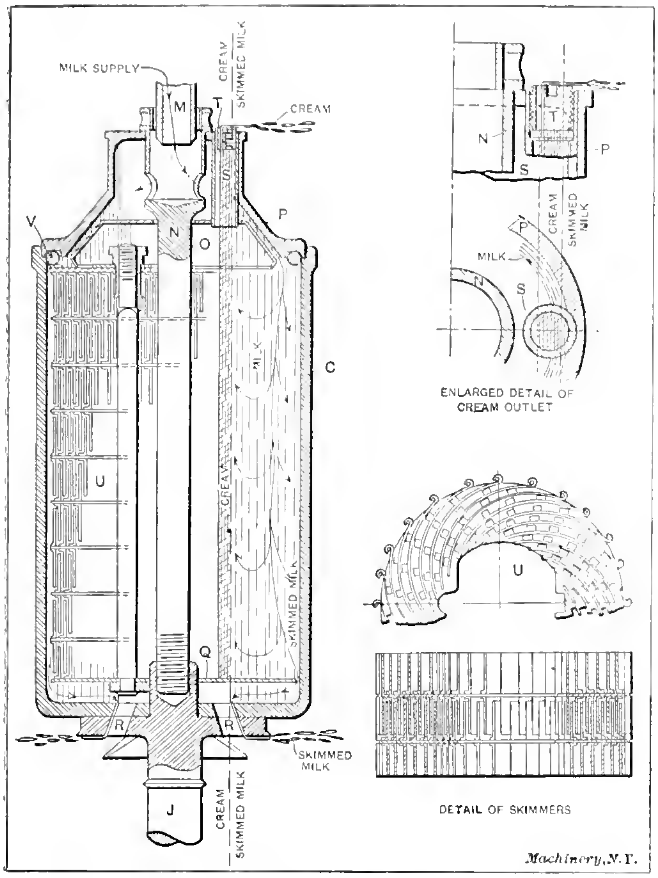


Fig. 5. The Bowl of the Separator, showing the Flow of the Skimmed Milk and Cream

through the bowl. All the parts shown revolve at a high rate of speed with the exception of the stationary nozzle M for the milk.

It was said that the separator is a machine for intensifying gravity, thus hastening the rising of the cream. In the bowl shown, which is 3⅜ inches inside diameter, and revolves normally at 9,000 revolutions per minute, the centrifugal force at the outside edge would be

$$\frac{0.000341 \times 1^{11}/_{16} \times 9{,}000^2}{12} = 3{,}880$$

times the forces of gravity—in other words, an ounce located at this point would weigh 3,880 ounces. This result is obtained from the regular formula for centrifugal force.

Now this centrifugal force acts horizontally, and it so far surpasses the vertical force of gravity that the milk stands in a vertical wall against the side of the bowl, forming a hollow cylinder within it as shown at the right side of the bowl section in Fig. 5. A section at the left of the center line is shown with the skimmers in place. These, as will be explained, intensify the action but do not alter the principle.

In Fig. 5 the milk enters through a nozzle M, into the hollow top of the cover bolt N, and out through the side holes into the cover P. From here it passes through the narrow space between the cream chamber O and the cover into the main body of the milk within the bowl. Here, having attained the speed of the bowl, the centrifugal force begins to separate the cream globules from the milk as has been described, the former moving toward the center, and the latter settling close to the shell of the bowl as shown by the separating arrows. The skimmed milk passes downward through the bowl, and around the outside of diaphragm Q, which evidently prevents the escape of cream, since none of the light fat globules will be found at the outlet passage, so near the periphery. From the space below the diaphragm Q, the skimmed milk finds an outlet through the drain holes R, from which it is thrown outward against the casing in which the bowl revolves, running out through tube E in Fig. 4.

It will readily be seen that the distance of holes R from the center determines the inside diameter of the hollow cylinder of milk and cream. The inside diameter above diaphragm Q is smaller than that below, owing to the fact that there is no cream in the lower space. This layer of cream, prevented from escape at the bottom, spreads over the whole inner wall of the cylinder of milk, reaching up through the cream tube S above cream chamber O. The upper end of this tube is closed by cream screw T, which has drilled through it a small eccentric hole. Through this hole the cream is thrown out against the inner wall of the cream pan and its cover, from which it is drained by the cream spout D in Fig. 4.

The purpose of the eccentric hole in the cream screw T is to control the thickness of the cream. By turning this screw the outlet hole may be brought closer to or further away from the center, draining the cream either at the inner stratum, where it is thickest, or at a larger diameter, where it begins to be more diluted with milk. A very slight change of this screw will make a great difference in the consistency of the cream. It is to be understood, of course, that the machine takes practically all the cream, in any case, but it will take as much milk with it as may be required to give the desired consistency. Too thick cream is difficult to handle and unsatisfactory to use.

This whole process of continuous separation will be understood more clearly, perhaps, if Fig. 5 is turned a quarter way round, so that its right side becomes the bottom of the

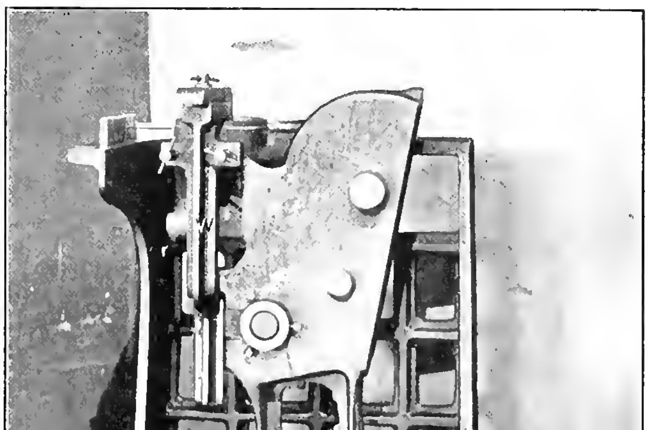


Fig. 6. Lining up the Frame in the Cradle which holds it for the Various Drilling and Finishing Operations

view. If then it be considered that the layers of cream and milk be acted on by gravity, or by a similar force many times as great, it will be seen that the milk flowing in through tube M, through the bowl and under diaphragm Q and out at R, becomes separated from its cream, the latter escaping at tube S.

Details of the Bowl Construction

The machine as just described, works very much as the earliest forms did. It is found by experiment, however, that the capacity and clean skimming qualities of the machine can

be greatly improved by filling the space between diaphragm *Q* and cream chamber *O* with a series of guides or "skimmers," *U*. These skimmers serve three purposes. First, they rapidly bring the cream up to the velocity of the bowl; second, they encourage an even, steady flow of milk through the machine without stagnant areas, guiding the milk outward and toward the bottom and the cream inward and toward the top; and third, they so prolong the passage of the milk that it is thoroughly subjected to the action of this separating centrifugal force, so that the cream is more thoroughly removed.

The form of skimmer used in this machine is shown in place in the bowl at the left of Fig. 5, and in detail at the right of the engraving. The whole space between *O* and *Q* is filled with these skimmers, which interlock with each other, as shown, in such a way as to double the number of milk passages, thus increasing the tortuousness of the flow and making the separating action more efficient.

A point in the construction of this bowl which should be noticed is the method of packing the joint between the cover *P* and the bowl *C*. After the skimmers *U* have been placed in the bowl, rubber ring *V* is loosely laid on the upper one and the cover *P* is placed on top of this, making a metal to metal joint with *C*, and enclosing the ring in the groove shown. Cover bolt *X* is next tightly screwed in place with a spanner wrench, clamping *P* and *C* fast together. This, however, would not make a tight joint against the enormous centrifugal pressure. It remains for the rubber ring *V* to do this, under the influence of the centrifugal force, which, at high speed, causes the ring to hug tightly into the joint, effectively preventing the escape of milk. The higher the speed and the higher the consequent milk pressure, the more effectively will the ring make the joint, thus sealing it against the escape of milk.

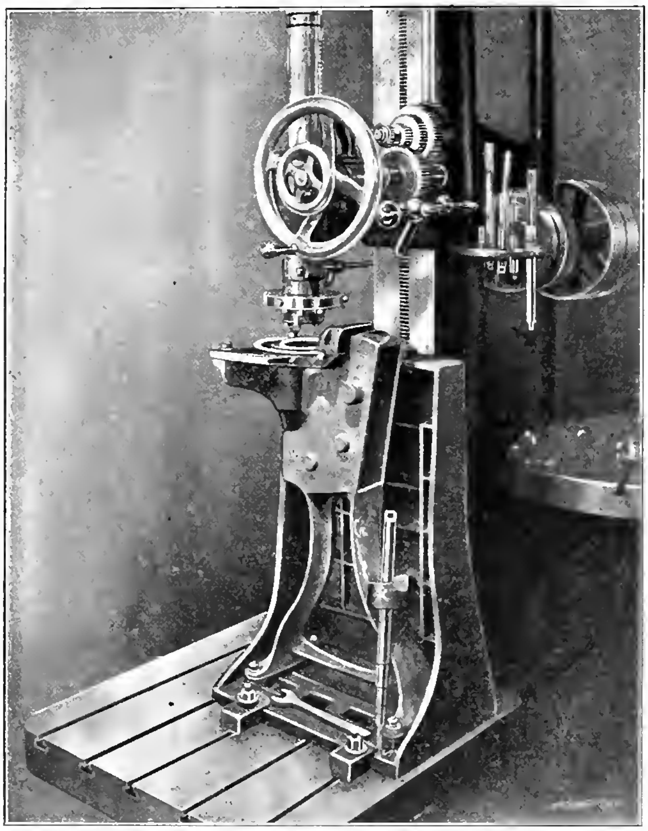


Fig. 7 Machining the Holes and Cylindrical Surfaces about the Axis of the Bowl and Spindle

Machine Work on the Frame

As intimated, a study of the manufacturing methods employed at this plant gives one a very high regard for the quality of workmanship required for making these separators. It is out of the question to describe all the operations involved, so certain of the more interesting ones have been selected as examples of the remainder of the work.

In Fig. 6 is shown a fixture used for lining up the work. Several of these fixtures (or "cradles" as they are locally called) are provided. A man is continuously engaged in setting the work up in these cradles, so that all the holes and surfaces will machine out. For this purpose he uses various height gages, squares, scratch gages, etc., locating from the finished surfaces of the cradle, using as well the special tool *W*, which shows how to get the proper relation between the spindle and the worm-wheel shaft, with the proper amount of finish around the hubs. One man is thus engaged in laying out the work continuously, while other men perform the drilling operations. While this is a practice which has often been mentioned and universally commended, this is the first time that the writer ever remembers having seen it in actual use.

After thus being lined and set up in the cradle, the frame, still mounted therein, is carried through the various drill-press operations required to finish it. The first of these is the machining of the holes on the axis of the bowl and spindle. This is done on a drill press, as shown in Fig. 7, with various special cutter heads, boring bars, etc., carefully supported and strongly driven to secure proper alignment. The head shown in place on the machine is cleaning out the inside diameter of the bowl casing and finishing the edge or rim. Roughing and finishing tools, both mounted in the same head, follow each other in this operation. Boring bar *X* is provided with the necessary cutters for boring the various surfaces of this axis at one cut, thus giving assurance of their true relation to each other.

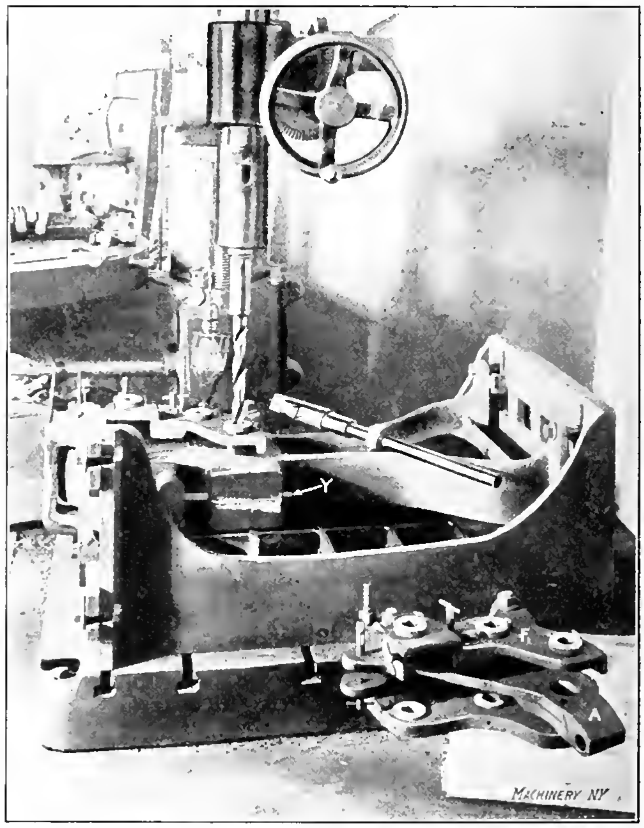


Fig. 8. Drilling, Reaming and Counterboring the Bearings for the Gears

In Fig. 8, the frame, still mounted in its cradle, is shown laid on its side and having the shaft holes for the driving gears drilled, reamed and counter-bored. One of the jigs for doing this is shown dismounted from the work at F_1 in front of the cradle. This jig has a central tongue *A*, entering the opening in the side of the frame, and provided with a hole through which passes the arbor *Y*, shown in the frame being machined. This arbor, fitting in the spindle bearing holes in the frame, locates the jig, and with it all the centers of the gearing train, in proper relation with the spindle. The counter-boring bar *Z*, as shown, is used for facing the hubs for the gear shafts, being fed down on them for cutting on the upper side, and drawn upward with the cutter reversed for finishing on the lower side.

After these operations have been completed, together with one or two more of less importance, the frame is thoroughly inspected. The outfit for doing this is shown in Fig. 9. Mounted on the axis of the spindle bearings is shown a sensi-

tive test indicator B_6 attached to the end of arbor A_6. By revolving this arbor, the test indicator tells whether or not the spindle bearing holes are concentric with the finished surfaces at the upper end of the bowl casing. By the use of a series of multiplying levers on the same arbor, it is also possible to use the same indicator for finding out whether the lower spindle bearing holes are in line with the neck bearing at the lower end of the case.

The center distances for the gearing are also carefully tested by means of gages like that shown at C_6. This consists of a strap with a fixed plug at one end and a movable plug at the other. With the fixed plug in one hole, it should be

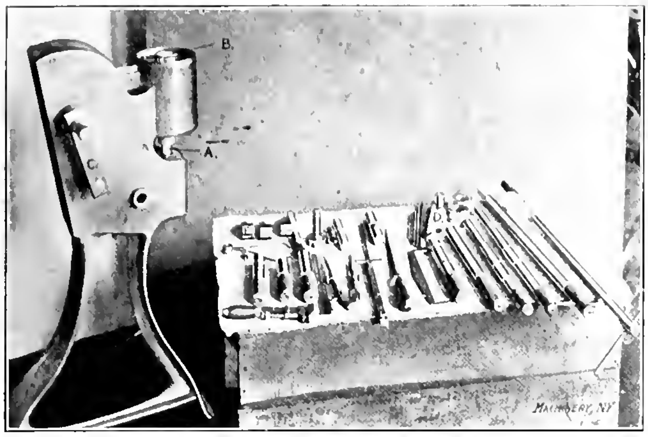


Fig. 9. Tools used by the Inspector in testing the Work done on the Frames

possible to push a standard plug through the other end of the strap into the hole in the casing, if the drilling and reaming has been done properly. This is tested on both sides of the frame, and a similar strap is provided for the second gear reduction, as shown at D_6. Various other plugs, test arbors, etc., are shown. The gage at E_6 is mounted on an arbor passing through the worm-wheel bearings. When swung up and down, it must just barely touch a corresponding arbor placed in the spindle bearings.

Machining the Spindle

The spindles of this machine are made of high carbon steel drop forgings, and are roughed out on the Potter & Johnston automatic chucking machine. It might seem at first as though this would be an impossible job, but the machine has been equipped with special tools which make the operation quite practicable. The spindle (see J, Figs. 4 and 5) is first held

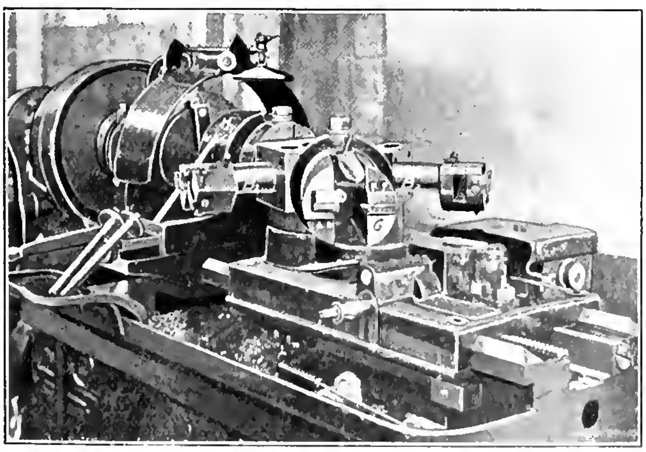


Fig. 10. Rough-turning and Centering the Spindles on the Potter & Johnston Automatic Chucking Machine

in the chuck of the machine by its stem while the flange end is machined. This is a commonplace operation for the automatic. The second operation, shown in Fig. 10, is more unusual. The finished flange of the spindle is held in the chuck with the tail of the work projecting forward. In the turret of the machine are mounted two sets of two tools each, a finished piece of work being delivered at each half revolution of the main cam drum.

The tool at work in the illustration is identical with that shown at G_6, which will perform the same operation on the next piece placed in the chuck. This is a turning tool which commences at the chuck end of the work and feeds outward. The purpose of taking the cut in this way is to permit back resting from the beginning of the cut on the finished diameter left by the first operation, and at the same time to obtain the better results expected in feeding outward on a slender piece, as compared with what would be obtained by feeding against it.

To produce the desired result, the back-rest and cutting tool are mounted on swinging jaws in the heavy holder shown. These jaws are normally held outward by a spring so that they pass over the work freely, when being brought up to the cutting position next to the chuck. When they have arrived at this position, however, both follow rest and blade are closed in onto the work by two special cross-slides (one slide is shown at H_1) which are given the form of one-half bearings, and encircle the finished cylindrical surfaces on the outside of the jaws of the turning tools. The movement of the two cross-slides toward the center, to bring the blade down against the work, is effected by a right- and left-hand cross-slide screw operated by a modification of the regular cross-slide cam mechanism. After the shank of the spindle has thus been rough turned, the second tool, B_6, turns the small diameter at the outer end and centers it.

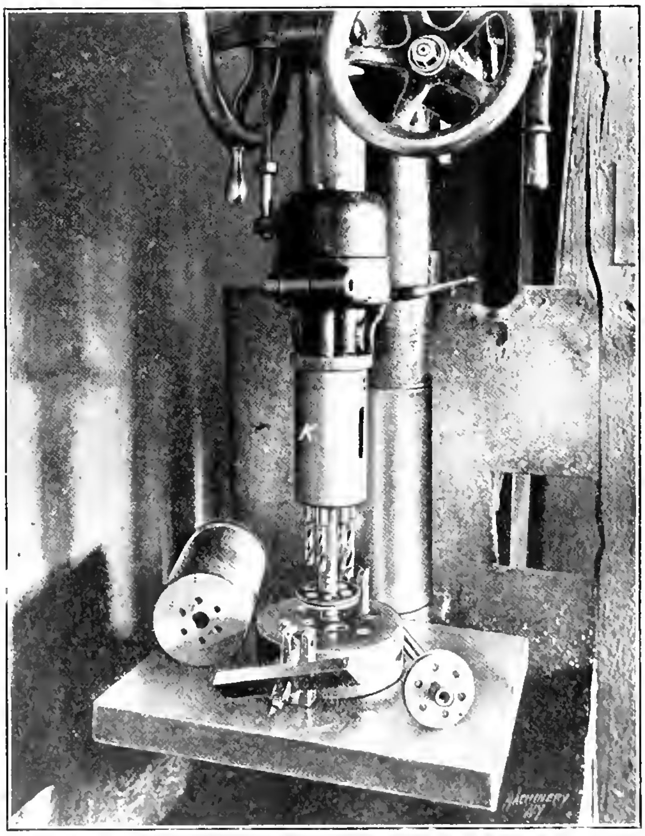


Fig. 11. Multiple Spindle Attachment for Drilling the Rivet Holes in the Spindle Flange and Bowl

The next interesting operation on the spindle is the drilling of the six holes by which it is riveted to the bowl. This is done in a drill press provided with a special multiple spindle attachment, as shown in Fig. 11. The drill spindles are operated by a crank mechanism similar to that used in other devices of this kind, permitting a strong drive at very close center distances. The center of the attachment is hollow, permitting the spindle to pass up through it as shown. The bowls are drilled with the same device, the outside diameter of body K being small enough to enter the bowl. The same attachment is used for countersinking the holes in both pieces.

From this point on, the operations on the spindle become merged with those on the bowl, as will be described.

Machining Operations on the Bowl

Cream separator bowls have to be made of first-class material. A four-inch bowl running at 11,000 revolutions per minute (a peripheral speed of two miles per minute) is subject to a very high strain, and when it is considered that there is always a possibility of some husky dare-devil hired man getting hold of the crank and turning it about twice as

fast as it ought to be turned, it will be seen that provision has to be made for emergencies.

The bowls are therefore made from cold or hot-drawn seamless blanks of high carbon steel, and before sending them out in the machines, they are tested at a speed nearly double that at which they will run normally. This means that the centrifugal strain will be four times as great as the normal, since this increases with the square of the velocity.

The cup blanks of the bowls first have a hole drilled in the center of the bottom by means of a simple jig which centers itself accurately. This hole is the one into which the plug end of the spindle projects, as shown in Fig. 5. It is drilled

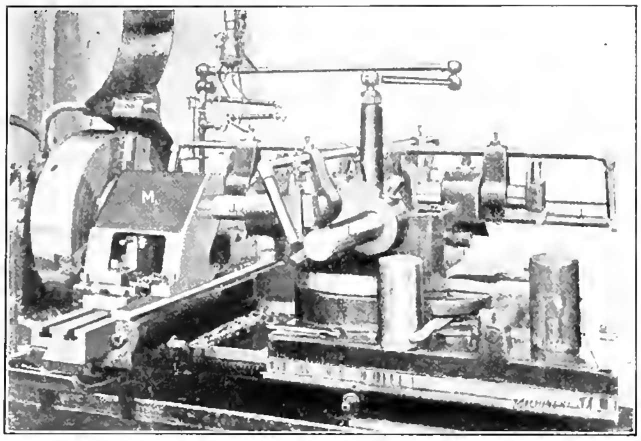


Fig. 12. Turning and Facing the Outside of the Bowl with Supported Tool-holders of Special Construction

first, in order that it may serve to locate and steady the outer end of the blank in the outside rough turning shown in Fig. 12.

This is another Potter & Johnston automatic operation, and is performed with an interesting outfit of tools. The work, of which a rough and a turned sample are shown on the turret slide, is held in a special chuck which grips it ou the inside of the rim, while the outer or closed end is steadied by a projecting plug on the end of a pilot solid with the chuck. This leaves the whole of the exterior surface of the bowl free to be turned, without interference with the chuck jaws or other holding devices.

On this machine, as in Fig. 10, two sets of tools are mounted in the turret, so that the machine completes two pieces of work at each revolution of the cam drum. The first operation is the rough turning and facing of the blank. In the

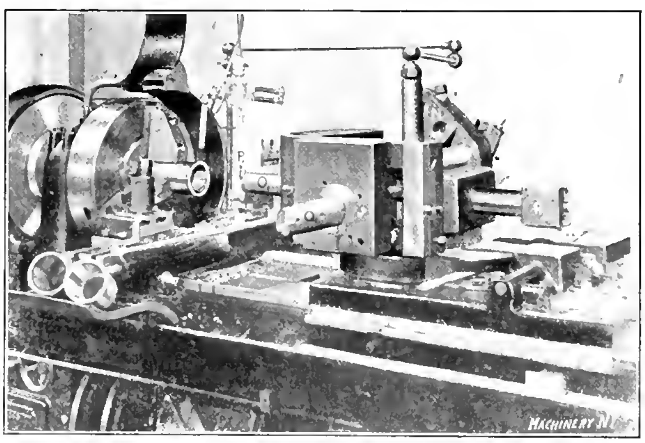


Fig 13. Boring and Facing the Bottom of the Bowl with Turret Tools manipulated by the Cross-slide

second operation the blank is finish turned and the corner is rounded. The unusual feature of the tool equipment is the provision made for steadying the outside turning tools. These are mounted in long overhanging bars J_1 and L_1, as shown. To give the maximum of stiffness with this long overhang, a bearing M_1 for these tool-bars is immovably bolted to the cross-slide bed. This bearing is bored out to form a seat for the bars and in this seat they are supported during the cut, so that the turret is under no strain except that for feeding the tool ahead. There is no deflection in the turret mechanism of a kind that will limit the rate of feed, or impair the accuracy of the cuts. Oiling arrangements are provided, as shown, to bring a stream to the point of each tool when it comes into operation.

The next automatic operation on the bowl, that of finishing the bore, is shown in Fig. 13. Here also a special tool equipment is provided. The bowl is held by its outside diameter in soft jaws, turned in place, so that the first and second operations run true with each other. An oil pipe passes through the hollow spindle and discharges oil through the hole drilled in the bottom of the bowl, so that the flow outward clears away the chips as fast as they are made in the boring operations. A valve at the nozzle of this oil pipe opens automatically when a piece of work is pressed into the chuck, and closes again when it is removed.

The first cut taken in this operation is that of rough boring and rough turning the end, which is performed by the standard combination tool N_1 at the back side of the turret in the engraving. The second operation is that which is shown about to commence, and consists in rough facing the inside of the bottom. The projecting tool-holder O_1 for this operation is mounted in a cross-slide on the face of the turret, and is normally pressed back by a stout coiled spring. The turret is fed up until the blade has reached the proper depth, when the rear cross-slide comes up, carrying a roller abutment P_1 which feeds the turret cross-slide tool forward on its sliding base, facing the bottom of the cut from the center in toward the side.

The third tool Q_1 and its cut are like the second, being first a finish facing operation performed in the same identical

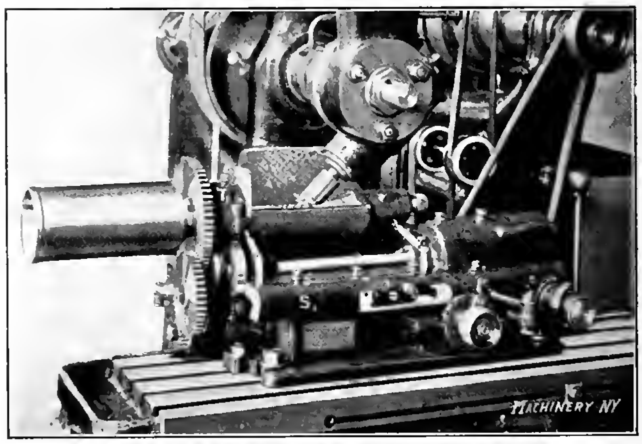


Fig. 14. Milling the Spindle Driving Worm in a Completely Automatic Attachment for the Plain Milling Machine

way. At the end of this operation, however, the cross-slide abutment remains stationary, while the turret is fed backward with the back side of the tool bar held up to its work by the roller on the abutment. By this means the same blade is made to face the bottom of the hole and finish the bore.

The fourth and last cut is taken with the inserted blade reaming or counterboring tool R_1, which finishes the outer edge of the bowl very accurately to size. After this operation the bowl is drilled in the attachment shown in Fig. 11, and the bowl and spindle are riveted together.

Reasons for the Use of Automatic Machines

It struck the writer that the tool equipment illustrated in Figs. 10, 12 and 13, together with others of a similar nature not here described, make up the most ingenious and highly developed equipment he has ever seen used on an automatic turret machine. All of those illustrated, it will be seen, adapt the machine for taking long cuts with rapidity and precision, thus bringing it more closely into competition than usual with the engine lathe and with certain forms of highly specialized hand-operated lathes for the same work. This brings up the question of the field of the automatic machine—a question which is never ending, because of the ever-changing conditions under which it is decided in different shops.

A natural thought in looking at Figs. 10, 12 and 13 is that the tool designer has taken considerable pains to adapt these automatic machines to work for which they are not usually employed. But that this process of adaptation has been well done, there can be little doubt to any one who watches these

machines at work. They require very little attention, and produce work up to the high standard required of them.

Various other advantages are urged for this type. That of low labor cost is taken for granted in successful automatic machinery. Besides this, a less expensive grade of labor may be employed, and men may be more easily changed from one job to another. On hand-operated machines working at a high efficiency, there is a tendency for the workman to specialize, and his production, when he is broken in on a new job, suffers more than does that of the automatic machine and its operator under the same conditions. The use of the automatic thus gives a greater flexibility to the organization.

One experienced man is employed to look after the tooling and setting up of the twenty odd turret machines used here. By giving proper care to the cutting edges, the automatic machines under his control can be depended on to produce work of a high degree of uniformity in dimensions, hour after hour, and day after day. Neither he nor the men under him are rushed in getting out the maximum production of the machines—the duties of the operatives being, ordinarily, simply that of putting in and taking out the work.

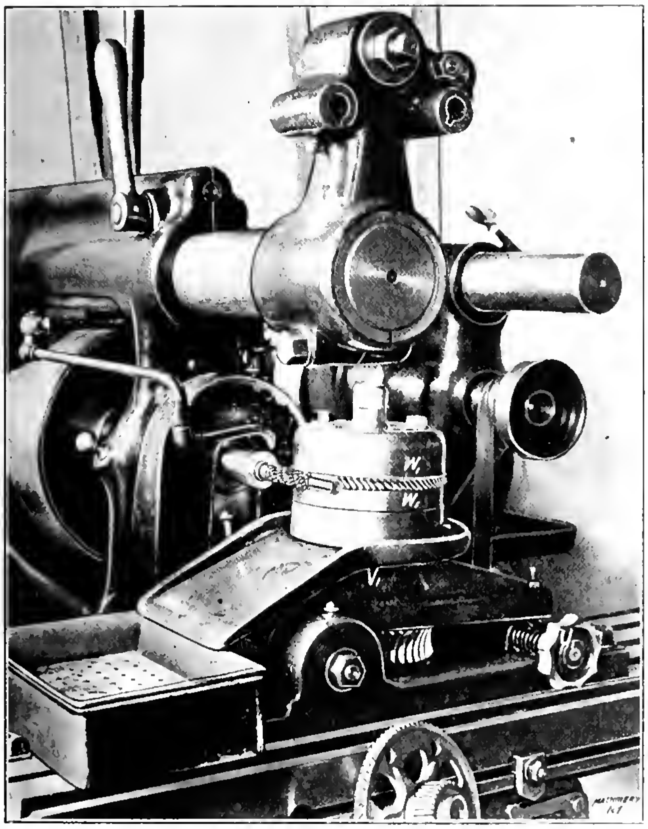


Fig. 15. Hobbing Attachment for Cutting the Teeth in the Driving Worm-wheels; Overhanging Arm turned back to show Hob

Against these advantages must be weighed the advantages of hand machines in other respects, such, for instance, as the lower capital investment, the (sometimes) higher output per machine, the more constant personal supervision, and the less elaboration required in the tool equipment. In striking the balance between these advantages and disadvantages, the management of this shop feels that it has reached the right conclusion for conditions as they occur in the work here.

Finishing Operations on the Bowl and Spindle

After being assembled, the bowl and spindle are finish turned on the outside over the whole length in the engine lathe, the work being held on an internal expanding chuck, which accurately centers and holds the bowl by its interior surface. This gives assurance that the outside of the bowl and the whole length of the spindle will be turned true with the inside of the bowl. The neck bearing, next to the flange of the spindle, is, in this operation, turned and filed to its finished size, which is required to be accurate within 0.0002 inch. Stock is left for grinding at the lower or step bearing end of the spindle. The reason for finishing the neck bearing at this time will be understood in connection with the operation shown later in Fig. 16.

The bowl and spindle being thus finish turned all over, the work is next taken to the milling machine department to have the worm thread cut on the spindle. This is done in the special Brown & Sharpe milling attachment shown in Fig. 14. This attachment is entirely automatic. The main table of the milling machine is locked in position at the proper point to center the cutter with the work and set it to proper depth. The work is mounted on a supplementary slide S_1 in the fixture, whose feed-screw is geared (to give the desired lead of helix) with the quill chuck, which grasps the spindle by the neck bearing.

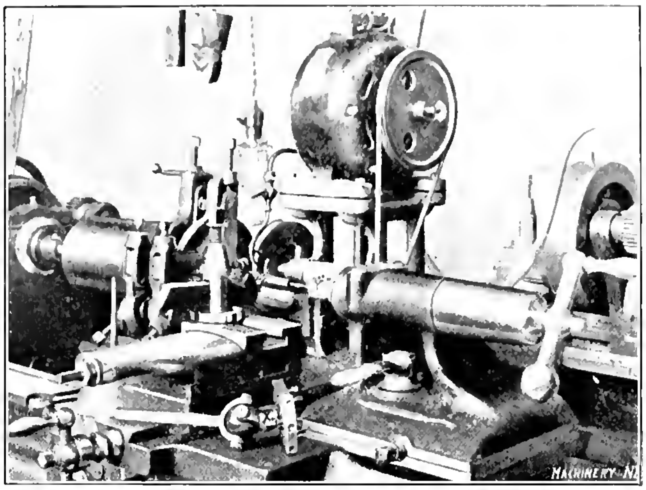


Fig. 16. Finish Turning and Grinding the Bowl Spindles

Properly set up in this way, the mechanism of the device feeds the spindle forward, cutting one thread. When this thread has been cut the proper length, an automatic stop throws in operation mechanism which first rocks the spindle, carrying head T_1 back away from the cutter, returning the slide to its initial position, then indexes the spindle for the cutting of the second thread, and lastly sinks the cutter in to depth again. Besides this, the device is "full automatic" to the extent that its feed movements are arrested when the required number of threads have been cut. The mechanism is connected to the regular telescoping feed shaft of the miller. The cutter is mounted on the regular vertical and angular milling attachment, set to agree with the desired helix angle of the thread.

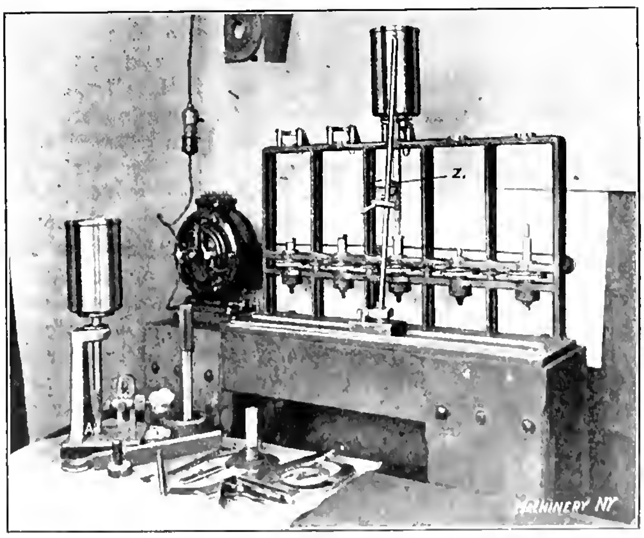


Fig. 17. Testing Outfit for Inspecting the Bowls and Spindles

The corresponding operation for hobbing the worm-wheel may be mentioned here though it is a little out of the strict order of operations we have been following. In this attachment (see Fig. 15) the worm-wheel is mounted on a vertical work-spindle on a special fixture in the milling machine, the table of which has been clamped in the desired position as in the previous case. This work-spindle is driven by worm-gearing and a train of spur-gearing connecting it with the spindle in the proper ratio.

The feeding of the hob in to depth is done by hand through the operation of knob V_1 shown at the base of the machine.

This, through suitable connections, rocks the work-spindle base V_1 about the axis of the work-driving worm, thus moving the work in toward or away from the hob as may be desired. The work is only located by the work-spindle, being held by special face-plate clamps W_1, which clasp the rim firmly, close to the cutting point. This prevents the distortion which would otherwise be inevitable in so small and light a worm-wheel.

In Fig. 16 is shown a lathe rigged up for the finishing operation on the worm-spindle. The work is held in two back-rests, one of which bears on the neck bearing, which was filed to size in the finish turning operation before described; the other back-rest bears on the spindle just above the worm bearing. As these surfaces were finish turned "in the air," while the bowl was held accurately by its interior bore, every assurance is given that the bowl is so held as to run true; and as the spindle was chucked by these same surfaces in the worm cutting operation, it may be assumed also that this will run true. The bowl is driven from the spindle of the lathe by a universal joint driver X_1, which is shown lying on the top of the carriage in Fig. 16. The four pins in its face bear on the bottom of the bowl and take the thrust of the cutting. The copper friction pieces at the sides are expanded by the taper screw shown so as to grip the sides of the bowl and drive it firmly without distorting it.

The lathe is provided with a turning tool for taking finishing cuts over the step-bearing, and with a motor-driven grinding attachment, as shown, for finish grinding the step-bearing. A suitable tail-stock holder is furnished for carrying drills, bits, etc., for finishing the hole in which the hardened step is inserted. This, with various minor operations, completes the work on the bowl and spindle.

Inspecting and Balancing the Bowls

The outfit shown in Fig. 17 is used by the inspector for testing the work on the bowl and spindle. The frame shown at the back contains a series of motor-driven spindles, each provided with a true running socket for receiving various designs of separator spindles and bowls. One of these is shown in place. The dial test indicator Z_1 is mounted on an adjustable swiveling and sliding post, so that the truth of any or all of the revolving surfaces, from one end to the other, may be tested by it.

The fixture shown at A_2 is for testing the truth of the worm cutting. The spindle is inserted in bushings in the fixture, which bear on the journals on which the spindle is to revolve in the completed machine. The dial indicator is mounted on a plunger which may be moved in to a positive stop, and is in turn carried by a standard on the base of this fixture. A forked point is provided for the indicator plunger, which straddles the worm thread and bears on the pitch line. By bringing this plunger over each worm thread in turn, the pitch radius at each thread is indicated; the truth of the tops of the threads is a matter of comparatively little importance; the question is, "Do the acting surfaces of the threads run out?" That question the indicator solves accurately and quickly.

The various other tools shown, consisting of depth gages, internal and external micrometers, snap gages, etc., are used in obvious ways to test the accuracy of the various diameters and lengths of the work. All this accuracy in the bowl and spindle is required to produce the proper balance for quiet running at high speeds. The more accurately the machining operations are performed, the less time will have to be spent on the costly and tedious work of compensating for errors in balance.

The balancing of the bowls is done with all the rotating parts assembled and (in this firm's practice) with the bowl full of liquid. This latter is an important improvement in this operation, as the distribution of weights in the bowl must inevitably be somewhat different when it is full from what it is when empty. It makes the balancing operating more costly but better results are obtained.

This job of balancing separator bowls is a peculiar one, being a trade in itself. So far as we know but one article descriptive of it has ever been written, and that was published in MACHINERY.* It is said that the men have to learn the business for themselves, it being almost impossible to teach it, and that different men work in different ways. Some men cannot learn to do it at all. What is reputed to be a fair statement of the case was made by a German in this shop, who tried for six months to get on to the job and finally failed. "First, I put in some solder on the top and then on the bottom, and then I put in some more, and then I fill her up with solder, and then I take it all out, and she run better than she did before." All of which is rather discouraging for the editor, who likes to set things down definitely in black and white.

This concludes the list of operations selected for this article, to show the character of work required and obtained in the building of cream separators. On hearing the name "Vermont Farm Machine Co.," a vision naturally arises in the mechanic's mind of a blacksmith shop sort of an establishment, where plows, shovels, harrows, cultivators and other tools of that kind are made. It is to be hoped that this article will dispel this illusion, and that the name will henceforth stand in the reader's mind for machine shop work of a very high grade indeed.

* See "Cream Separator Bowl Balancing" in the September, 1907, issue of MACHINERY.

* * *

DON'TS FOR PATTERN-MAKERS

H. E. WOOD*

Don't use watery glue.

Don't glue battens on a pattern.

Don't be afraid to ask for information.

Don't set a plane flat down on your bench.

Don't try to glue up a piece of wet lumber.

Don't forget to put draft on your patterns.

Don't use green or wet lumber; it is no good.

Don't forget to make allowance for your finish.

Don't try to trim work without a very keen-edge tool.

Don't nail a standard pattern unless absolutely unavoidable.

Don't forget to mark your loose pieces with the pattern number.

Don't sandpaper your work until you are all through with trimming.

Don't start to build a pattern before you understand the drawing.

Don't put on more than one coat of shellac without sandpapering it.

Don't forget to study other men's work, and profit by their experience.

Don't be in too much of a rush when you are working on a complicated job.

Don't put any unnecessary work on a pattern that is to be used only once.

Don't waste leather fillets in places where wooden ones can be used just as well.

Don't hold a hand lathe tool at right angles to the center line of a revolving piece.

Don't try to scrape a piece of work in a lathe, but hold the chisel so as to cut it.

Don't try to drive a nail through a piece of hardwood without first boring a pilot hole.

Don't make a pattern to suit your own liking, but remember that it goes to the foundry.

Don't make a coreprint so that it is impossible for the molder to get it out of the sand.

Don't put a leather fillet around a small curve without wetting it in luke-warm water.

* * *

An iron and steel scrap heap of enormous dimensions was shown in an illustration in a recent issue of the *Iron Trade Review*. The scrap heap is one of the relics of the great conflagration in San Francisco in April, 1906, the principal accumulations being those in the yards of the Great Western Iron and Steel Co., where four scrap heaps 100 feet square and 40 feet high were recently stored. All the scrap was cut in equal lengths of 18 inches and piled in one solid mass, with the sides practically as smooth and solid as a brick wall. Only one scrap heap now remains, the other three having been drawn upon as the material was needed for the furnaces.

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DIE-BEDS OR BOLSTERS FOR PRESSES

DORBRO

The subject of die-beds or bolsters is one of considerable importance, and is deserving of greater attention than it often receives in the shop or designing room. It has been the experience of the writer that many of the troubles encountered in the use of press tools are due to this feature being badly designed or poorly constructed. Many a fine die has been ruined because it has not been properly secured in the die-bed and consequently has shifted while in operation; or because the holes in the die-bed through which the blanks or punchings are supposed to pass have not been made large enough to allow them to pass through freely. As a consequence the blanks get jammed in the die-bed and pile up into the die itself and are compressed by the pounding of the punch, until the punch or die breaks from the strain. The principal functions of a die-bed are: first, that of supplying an adequate support for the die, and a holder to hold the die in its proper position to be engaged by the punch; and, second, to furnish a means of attachment to the press. Two of these principal points to be considered therefore in the design and construction of a die-bed are first, the method of securing the die, and second, the method of securing the die-bed to the press. Due consideration, of course, should also be given to proportion and strength.

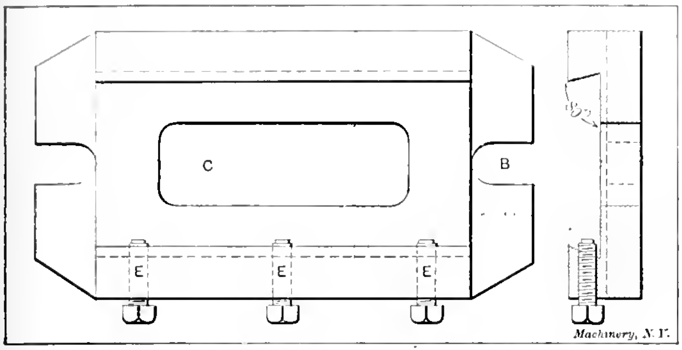


Fig. 1. Die-bed of the Style commonly used in Jobbing Shops

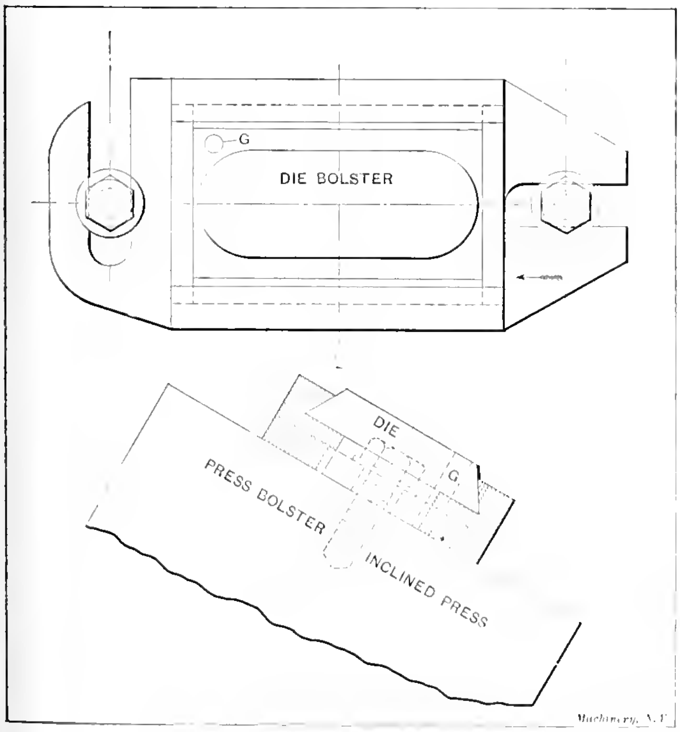


Fig. 2. Die-bed adapted to Inclined Presses

In Fig. 1 we have an illustration of a die-bed of the type generally found in the jobbing shop. The dovetail method of holding the die, with set-screws *E* to lock it in proper position, is employed. It is fitted with a flange *J* on each end with slots *B* to receive the clamping bolts which pass through them into the press bolster. In the center is a rectangular cored hole to let the punchings pass through. This style of die-bed is cheap and convenient for use where several dies are to be used in one die-bed. The dies can be easily slid into place and fastened by means of the set-screws, and are easily removed when another die is to be used. This bed has the following disadvantages: first, that of being held by set-screws which have always a tendency to jar loose in punch press work, and second, the cored hole *C* being necessarily made large to accommodate various shapes of blanks weakens the bed and gives less support to each of the dies. It is always better, if possible, to have a separate die-bed for each die.

In Fig. 2 we have a bed for use on an inclined press. In this bolster the dovetail method of holding the die is used, but without the use of set-screws. The dovetailed opening to receive the die is slightly tapered and the die is driven into place with a copper mallet, and is then made doubly secure by the insertion of a dowel which is driven through the die into the die-bed. The dowel is shown at *G*. The method of clamping this bed to the press bolster is different from that shown in Fig. 1 in that the bolt slot in one flange runs at right angles to that in the opposite flange. By having the slots in this position the die-bed may be attached or removed without the necessity of taking out the bolts, thus not only saving a great deal of time and trouble in setting the tools but also preventing the bolt holes from getting filled with scrap or dirt and the bolts from getting lost. This is an excellent die-bed for blanking and piercing work.

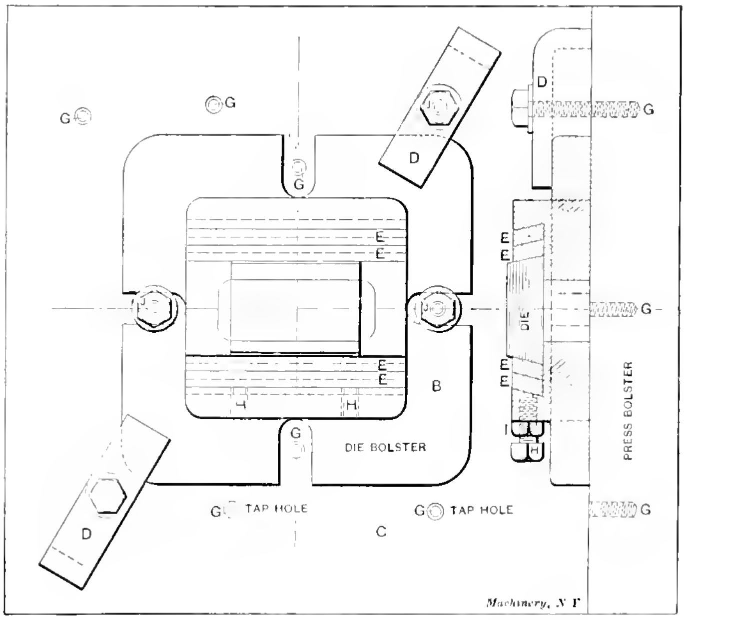


Fig. 3. Improved Form of Die-bed for General Utility

An improved type of die-bed for general utility is shown in Fig. 3. In this bed the dovetail method of holding the die is used. In the illustration it will be noticed that there are four parallel pieces or gibs *E* placed along the sides of the die. The object of this is to provide for dies of various sizes. When a larger die is to be used one or more of these gibs may be taken out. This bolster, in addition to four bolt slots, has a flange *B* all around it so that it may be clamped in any position. The set-screws *H* which hold the die in place should be provided with a lock-nut as shown at *I* to lessen the chances of jarring loose. The great advantage of having a flange all around the bolster will be apparent when it becomes necessary to swing the die-bed around enough to bring the bolt slots out of line with the tap holes in the press bolster. In a case of this kind the die-bed with a flange all around it may be clamped by means of clamps as shown at *D*, using the tap holes *G* located at different places in the press bolster *C*.

In Fig. 4 we have another die-bed of the dovetail and side set-screw variety, but with the additional feature of end-thrust set-screws. This end-thrust arrangement is an original and novel feature. In order to obtain this additional means of holding the die securely, two square grooves *B* are cut in each end of the die-bed at right angles to the opening for the die. Into these grooves a plate *C* is fitted in which is a set-screw in such position as to come in contact with the end of the die. With one of these plates at each end, and the set-

screws screwed tightly against the ends of the die, there is less likelihood of its shifting while in operation. When short dies for simple blanking or piercing are used the end-thrust plates may be used in the inner grooves as shown in Fig. 4, and if it be desired to use a long die such as is used for progressive work where there is one or more piercing operations before the work reaches the blanking punch, the plates with the set-screws may be placed in the grooves further from the center, and thus allow for the increased length of die. When the set-screws are used in these outer grooves, the heads of the screws will come directly over the slots in the flanges where the clamping bolts should be placed; for this reason the bed should be provided with two extra slotted flanges, as shown in the illustration, to be used when necessary.

In Fig. 5 we have an illustration of a die-bed for sectional forming or blanking dies or for split dies. This bed is provided with a square receptacle to receive the dies, and with two set-screws on each side to hold the dies in place. The square forming die shown is made in four sections *B* which are held tightly against each other by means of the set-screws *C*, and are held from lifting up by screws through the bot-

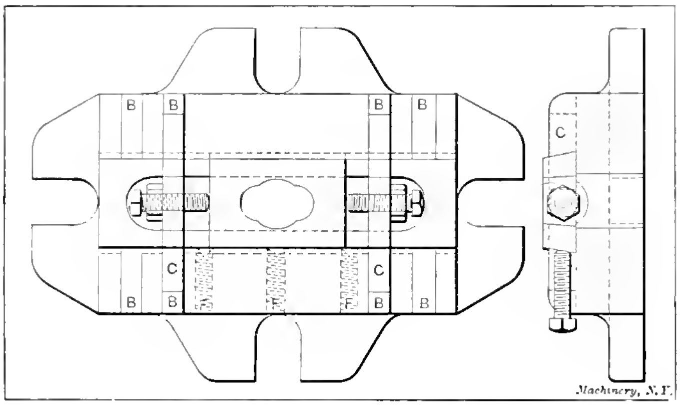


Fig. 4. Die-bed of the Dovetailed and Side Set-screw Type, also secured by End-thrust Set-screws

tom of the die-bed—one in each section of the die. The square recess is cast in the bed so that in preparing the bed for use it is only necessary to plane off the bottom and top of the flanges and mill the bottom of the recess, and drill and tap for the set-screws. The sides of the recess need not be machined as the dies have no bearing on them.

A very simple type of die-bed for bending and forming dies is shown in Fig. 6. It is simply a vise similar in some respects to a milling vise, but having two set-screws to take the place of the movable jaw. The die is simply set in the bed and clamped against the solid jaw by means of the set-screws. This type of bolster is intended for use only on dies that do not require a "push up," but where the bending or forming operations are done on a solid surface. In order to

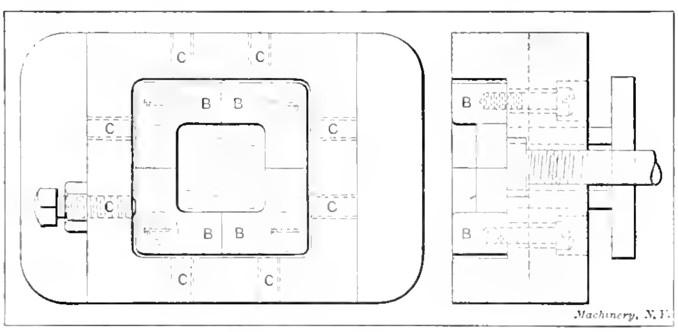


Fig. 5. Die-bed for Sectional Forming or Split Dies

obtain the best results from this die-bed, the complete outfit of punch holder, punch and die of the type shown in the sketch should be used. The punch holder and punch are made just the same as the die and die-bed. They are kept in alignment when in operation by the two guide pins *E* which are secured in the punch and which enter the die at every stroke of the press, making it practically impossible for the tools to shift while in operation. If it be desired to change the tools it is not necessary to disturb the punch holder or die-bed. They may be left in the press, and by simply loosening the set-screws in the die-bed and punch holder, the punch and die held together by the guide pins may be taken out and set aside and another set slipped into their places. There is an infinite variety of light bending and forming operations that can be done advantageously and cheaply with this outfit.

Fig. 7 represents a bolster for combination dies for round drawing work. This bolster requires but little explanation. It is circular in shape with two steps or extensions, two bolt

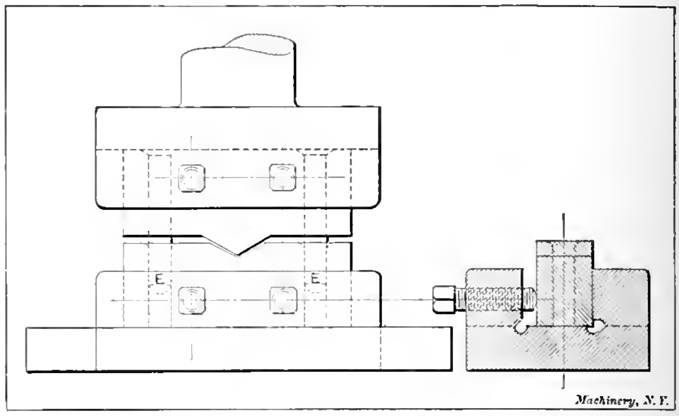


Fig. 6. Simple Form of Die Holder adapted to Bending Die

slots and a flange all around it to allow it to be clamped at any convenient place. When the combination dies are turned in the lathe the bottom die is counterbored to be a driving fit on the extension *G*, and is held down by screws that pass through the bed at *E* into the die.

* * *

STORAGE AREA RESTRICTION PLAN FOR MACHINE SHOPS

In shops where a large volume of heavy work is turned out on a comparatively limited floor space, there is a constant tendency to store work (rough, finished, and in course of machining) in areas which encroach on the passageways re-

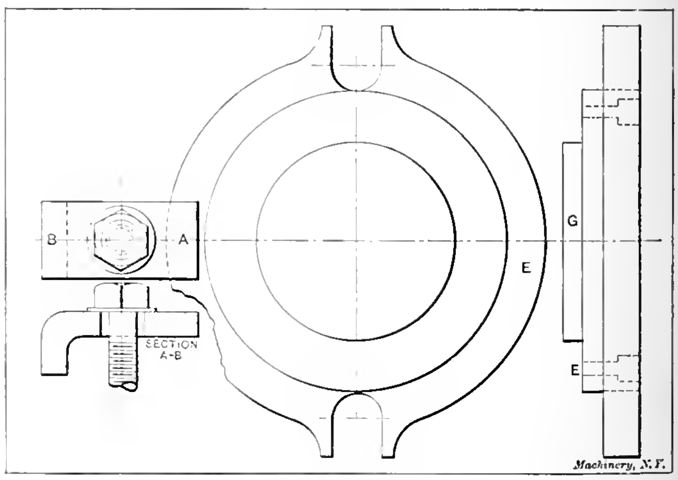


Fig. 7. Die-bed or Bolster for Round Drawn Work

quired for the movement of the parts through the shop. In the works of the Westinghouse Machine Co., at East Pittsburg, Pa., this tendency is restrained in a very simple way. The areas available for storage are marked off on the floor with lines of white paint. These areas provide for grouping work around each machine, and for using all available vacant spaces as well; but they are carefully laid out to avoid checking the freedom of movement of work and workmen. A single glance of the eye reveals any infraction of the regulations, as the lines are kept freshly painted. By this means the management has avoided that state of chronic congestion which is so fatal to economical production.

* * *

Following the example of the English Patents Act of 1907, the Australian Commonwealth has passed an amendment to the Australian patent act, which makes the manufacture of all articles patented in the Commonwealth compulsory under penalty of forfeiture of rights.

A FORMED TOOL PROBLEM

H. V. PURMAN*

One day the man who was making the formed tools came to me and said: "I want to make this master-tool with an angle of 15 degrees from the center line and with a clearance on the front of 25 degrees; and in addition to that I want to give it a side clearance of 2 degrees to keep it from dragging. I will set it in the planer vise tipped forward at an angle of 25 degrees and swing the vise around 2 degrees.

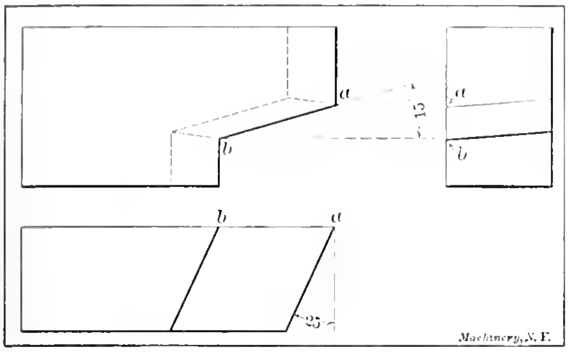


Fig. 1

Then to what angle must I set over my planer head to plane the tool so that it will measure 15 degrees on the cutting face?"

This is a sensible, practical question, but how many of our technical school men, either in or just out of college, could answer it? In the following is given a solution of this problem, worked out by the writer.

The master-tool is shown in three views in Fig. 1, where the plan, or face view, shows the side angle, 15 degrees, and the side elevation shows the front clearance of 25 degrees. In Fig. 2 the tool is shown as set in the planer vise ready for planing. In the top view the 2-degree angle is clearly shown, exaggerated, the vise and pieces being swiveled around as indicated by the divergence of the edge of the tool to be made from the line of the cross-rail. The side view shows the piece as seen from the side of the platen, looking squarely across, and the face view shows it as looked at in line with the platen travel, when the surface in which the points *a*, *d*, *c* and *b* are located appears as a line. This line is at the real angle of the tool-head from the vertical, and its angle with the vertical must be found.

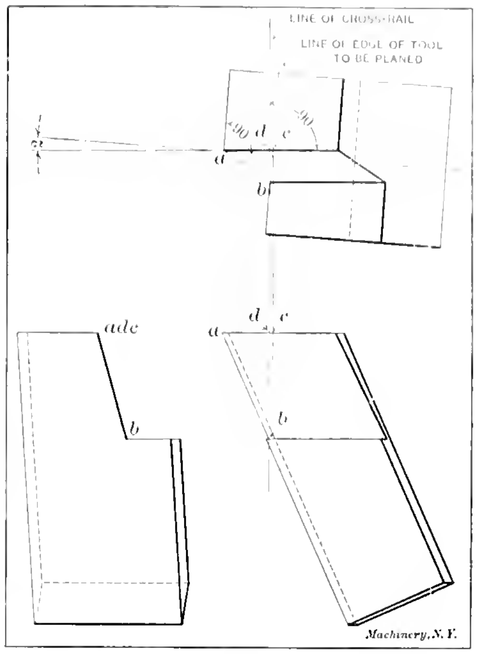
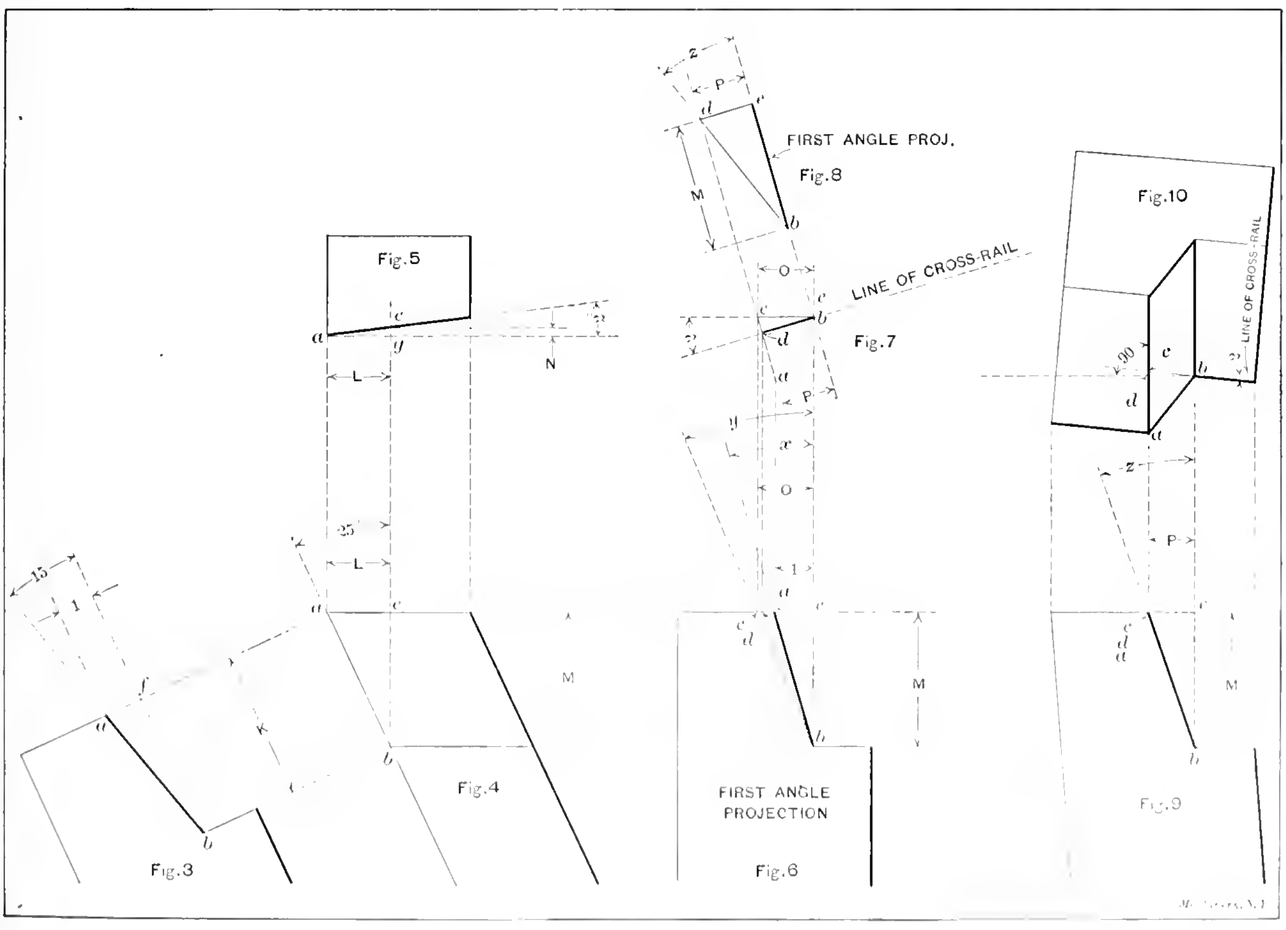


Fig. 2

To do this we will use a series of diagrams, representing the essential lines of the tool in various positions. Fig. 3 shows the plan of the tool, Fig. 4 its side elevation, and Fig. 5 the top of the tool in the horizontal plane when the tool is tipped forward. Fig. 6 shows the face of the tool merely inclined but not swiveled; Fig. 7 shows a portion of the edge receding from the corner, when swiveled, and Fig. 8 shows a line in the surface of the oblique side of the tool, each of these last two diagrams showing also the lines needed to calculate the angles and distances involved. Figs. 9 and 10 represent the surfaces, front and top, of the tool inclined and swiveled, as in Fig. 2.



Figs. 3 to 10

Referring again to Fig. 2, it must be noted that point *c* is in the vertical plane containing point *b* and the edge terminating in *b*, while point *d* is in the vertical plane contain-

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ing point b and parallel with the cross-rail, while a, d and c are all in the edge of the tool receding from a, hence in a straight line, as clearly shown in the side elevation; they therefore appear as a single point adc in the front elevation. Now ab is the cutting edge of the tool, and db is the line of feed of the planer tool, since the work is swiveled.

Throughout the views and diagrams the same points are designated by the same letters, but in the diagrams additional letters (capitals) are used to denote dimensions, for ease in calculation, and for clearness and accuracy, since the points appear in projection at different distances in different views.

Let the distance af, Fig. 3, or the actual amount the edge of the tool slants to the left, or the short side of the 15-degree triangle, be considered as unity, for simplicity, then

$$\frac{K}{1} = \cot 15°, \text{ or } K = \cot 15°,$$

$$L = K \sin 25° = \cot 15° \sin 25°,$$

$$M = K \cos 25° = \cot 15° \cos 25°,$$

and $\frac{M}{1} = \cot x$, or $M = \cot x$.

Angle x is the apparent or projected angle of the edge, or the angle of tool travel were the shoe not swiveled; but because of the swiveling, the tool travels over farther in rising a given height, that is, takes off more metal, and gives more clearance, and we must find what this added distance is. It is the distance cg, Fig. 5, equal to ca, Fig. 6, where g is the point directly behind a and on the line ce.

Let $cg = N$, then

$$\frac{N}{L} = \tan 2°; \quad N = L \tan 2° = \cot 15° \sin 25° \tan 2°.$$

$$\text{Now } O\ (= ce, \text{ Fig. 6}) = 1 + N, \text{ and } \frac{O}{M} = \tan y.$$

Angle y is the apparent or projected angle of tool travel when the 2 deg. clearance is given, and we look squarely at the face of the tool. But this is not the actual angle, which must be seen in the line of platen travel, as in Figs. 2, 8 and 9. The actual side motion, then, of the tool, in rising a vertical height cb or M, is $de = P$, Figs. 7, 8 and 9.

$$\frac{P}{O} = \cos 2°; \quad P = O \cos 2° = (1 + N) \cos 2°$$

$$= (1 + \cot 15° \sin 25° \tan 2°) \cos 2°.$$

In Fig. 8, $\frac{P}{M} = \tan z$. This triangle appears in Fig. 9 also, and angle z is the actual angle sought. Then

$$\tan z = \frac{P}{M} = \frac{(1 + \cot 15° \sin 25° \tan 2°) \cos 2°}{\cot 15° \cos 25°}$$

[The formula above can be generalized and somewhat modified as follows: If w = angle on face of tool (here 15°),
v = clearance angle in front (here 25°),
y = side clearance angle (here 2°),

$$\text{then } \tan z = \frac{(1 + \cot w \sin v \tan y) \cos y}{\cot w \cos v}.$$

But $\tan y = \frac{\sin y}{\cos y}$; substituting this in the formula and reducing, we have

$$\tan z = \frac{\cos y + \cot w \sin v \sin y}{\cot w \cos v}.$$

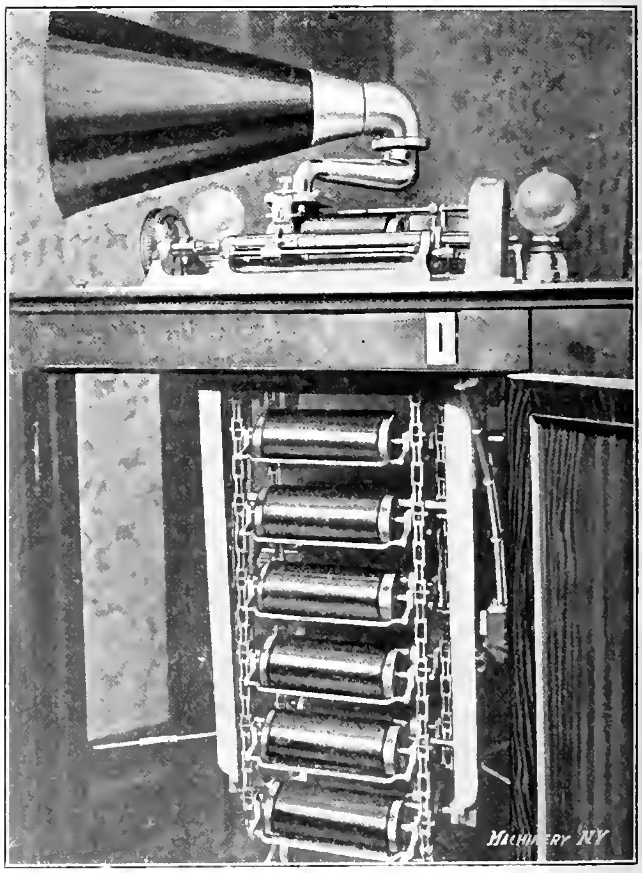
It will be seen that this formula is identical with the one given for planing Acme thread tools in the May, 1905, issue of MACHINERY.—EDITOR.]

By substituting the values for the angular functions in the formula above, we find $\tan z = 0.31174$, which gives us $z = 17$ deg. 19 min., nearly.

The result found can best be used by grinding an angular cutter to this angle as accurately as needed, gaging with a vernier bevel protractor, stoning it, and scraping the master tool with it. This was done, and the angle obtained was so close to 15 degrees that the closest inspection with the magnifying glass failed to show any error in the tool.

CONTINUOUS PERFORMANCE PHONOGRAPH

Thorns grow with roses—evil may come out of good. It is not quite unknown that even the humble and industrious phonograph can be diverted from its peaceful pursuit and used, alas! as an instrument of torture. Many defenseless neighbors have been serenaded by conscienceless individuals with ragtime, classical and religious selections until their nerves and tempers were badly "frazzled." The drawback to the use of the phonograph for such unneighborly acts is the constant attention required of the tormentor to change the records, wind the machine and set it in motion. His own endurance may flag after hours of performance and, perforce, he will seek his bed in sheer weariness of evil-doing without, it may be, having reduced his enemies to a state of complete physical, mental and moral collapse. What is needed for this sort of warfare is a "continuous performance" machine, driven by a motor, that can be started on a choice selection of the "gold molded" and left in the solitude of its chamber, the



The Iddings "Multinola," or Continuous Phonograph

horn facing the open window to do its malevolent work through the long hours of the stilly night without rest—or hesitation at the most frightful threats.

It is characteristic of American ingenuity to discover and fill wants before they are even vaguely felt by the mass of unthinking humanity. Lo! the wished-for machine is even now in our midst, and the dreadful tortures that were dimly forecasted by hand-worked phonographs will soon, no doubt, be realized by many writhing victims who, cursing inventors and all their works, die miserably to the sound of phonographic ragtime. Behold in the illustration of the "Multinola" by Dr. George L. Iddings of Cleveland, Ohio, a devilishly ingenious mechanism that changes its own records with cunning and despatch, and proceeds relentlessly, having no bowels of compassion whatsoever. The roosters crow and crow again at the dawn; the dogs bark when the moon is full; the cuckoo clock cuckoos, and is done, but the continuous phonograph goes on like the brook—forever. Yea, verily!

* * *

Contracts have been awarded for steam turbines to drive the new 26,000-ton battleships *Wyoming* and *Arkansas*. It has been stated that a combination of turbines and reciprocating engines was considered, but the authorities decided in favor of Parsons turbines.

OLD NEW ENGLAND WATER-WHEEL

ALLEN HAMMOND*

Some interesting features of an old water-wheel which was built by the Franklin Foundry & Machinery Co., of Providence, R. I., and erected in the New England company's mill in the year 1860, are shown in the accompanying engravings. The wheel was started in November of the year of its erection, and, with the exception of about a year, it has run regularly since that time. In spite of its forty-eight years of service, the wheel was in such good condition at the time of its removal, judging from the appearance of the woodwork, that it was capable of running for twenty-five years more. It was of the type known as a breast wheel, and was 24 feet in diameter by 18 feet in width.

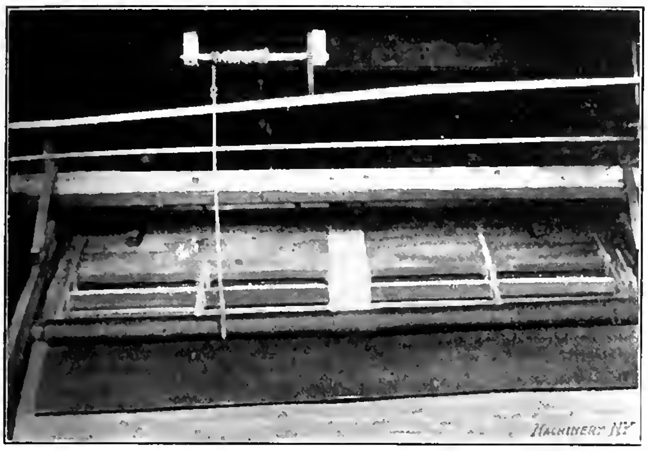


Fig. 1. Curtain Gate which, in conjunction with a Governor, controlled the Flow of Water to the Wheel

The breast or bottom of the flume through which the water entered into the buckets, was approximately 5 feet, 10 inches above the center of the wheel. The flow of water was regulated by a governor having a differential gear which gave power enough to work a long roll on which an "apron," extending across the breast, was wound and unwound up or down on the convex face of the breast. This apron, which is shown in Fig. 1, was made of sheet rubber and was fastened at the lower edge so as to be water-tight. The roll was

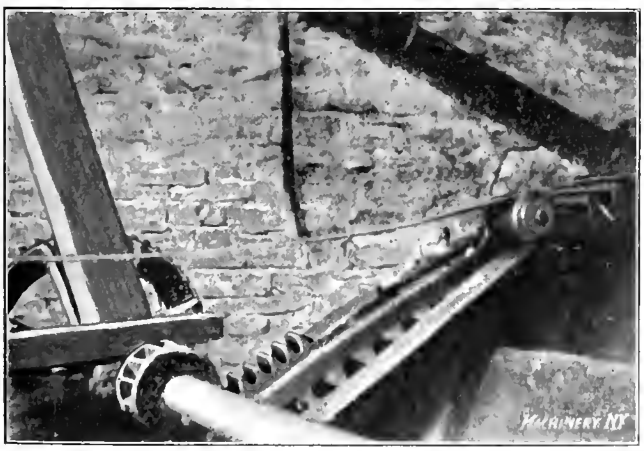


Fig. 2. Rack and Pinion by which the Curtain was wound or unwound

counterweighted and it was moved by a shrouded pinion which meshed with a rack free to move on the face of the breast. This rack had the teeth cut away at each end, and when the pinion came to this smooth surface, the roll reached the limit of its travel, owing to the lack of teeth on the rack which prevented further movement. The end of the rack was provided with a flange-like tooth or projection, which prevented it from moving out from under the pinion. Both pinion and rack are shown quite clearly in Fig. 2. The counterweight attached to the roll was heavy enough so that after the latter reached the limit of its travel, the pinion would be kept in contact with the rack; hence the teeth of the pinion readily came into engagement with the rack when its motion was reversed by the governor.

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Guide vanes were inserted in the breast so that the water entered the buckets perpendicularly. These vanes, which may be seen in Fig. 1, were made of wood which was driven into castings that formed part of the breast. They were 6 inches

Fig. 3. View of the Back of the Wheel showing part of Driving Gear and Method of Bracing Buckets

wide and $3\frac{1}{2}$ inches apart. The space between the buckets at the top was 10 inches and at the bottom 4 inches, and the angle between each bucket and periphery of the wheel was 36 degrees.

To prevent the air from being pocketed in the buckets, openings were made in the bottom which allowed the air to

Fig. 4 Spokes and Bracing at the Center of the Wheel which was without a Shaft

escape and the lower buckets to be partly filled. These buckets were set into grooves in the rim and were secured in place by spacers and bolts, as shown in Fig. 3, which is a view of the back of the wheel. In this illustration the driving segments on the rim are also shown.

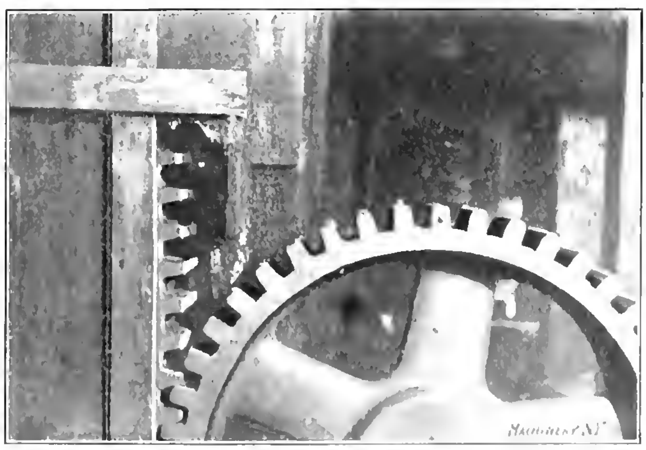


Fig. 5. Section of the Driving Gear, and "Jack" Gear with which it meshed

One unusual and interesting feature of this wheel is that it had no shaft, as will be seen by examining Fig. 4, which quite clearly shows the construction. The spokes and braces rested on flanges which were separated by wooden spacers through which long bolts passed from one side of the wheel to

the other, clamping it together. One of these bolts is clearly shown in the view just referred to. The spokes were 11½ inches by 4¾ inches, while the braces were 4½ inches by 5 inches. The segments of the rim were 11 inches by 12 inches. The bearings or gudgeons of the wheel were 10 inches in diameter by 11½ inches long.

Fig. 5 shows a section of the segment on the rim and also the "jack" gear, which was one of a set of three gears that was used for driving the mill. This gear had 44 teeth, 2½ inches circular pitch, and a face width of 7 inches. The second gear of the train had 114 teeth, and it was meshed with one having 38 teeth. The drive from the second shaft was by belts which ran over pulleys or drums, and some of these belts were as old or nearly as old as the wheel itself. In fact, one is said to have been older, it having been in use since about 1847. This wheel has worn out several sets of segments during its long and useful life.

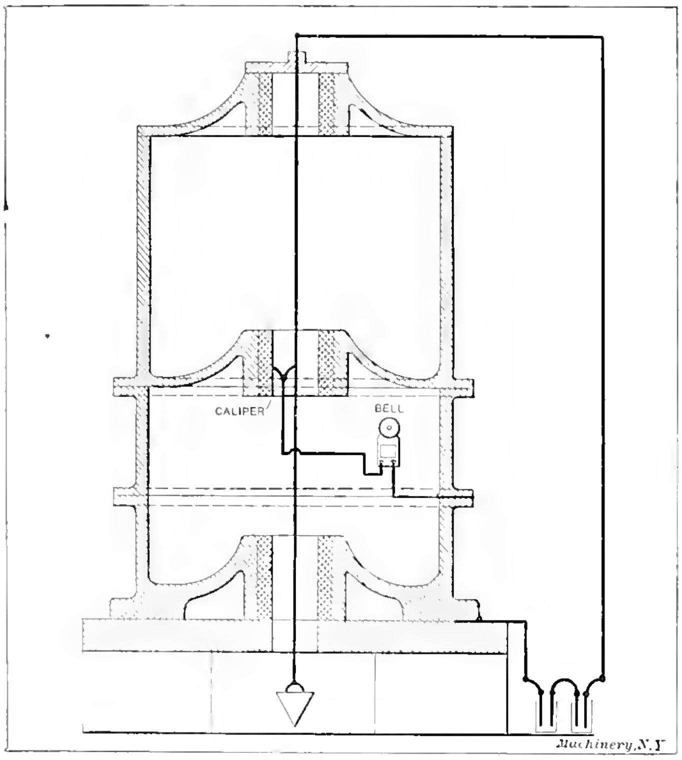
* * *

ASSEMBLING VERTICAL HIGH-SPEED TURBINES

HOWARD M NICHOLS*

The following method of assembling and lining up vertical steam turbines is employed in one of the large turbine works, and the same general scheme could be used in erecting most any large vertical machine.

The bed-plate is set on a special iron erecting floor and is very carefully leveled, and the turbine is then assembled



Aligning Vertical Turbine Bearings by the Aid of an Electric Caliper

without the shaft and rotating parts. The wheel casing, bearing brackets, bearings, generator stator, and all other stationary parts are bolted in place. The bolts are left a little slack so that the parts can be slightly shifted during the process of lining up. A length of steel piano wire is weighted with a heavy plumb-bob and is suspended from the exact center of the top bearing, as shown in the accompanying illustration. Since the machine has been carefully leveled during the process of erection, the piano wire will locate the exact center of the shaft. The wire is suspended from the top bearing by a block of hard wood and is not allowed to come in contact with any metal part. The end of the piano wire is connected to one pole of a few cells of dry battery, while the other pole of the battery is grounded onto the frame of the turbine. One binding post of an electric bell is also grounded onto the turbine frame, and the other is connected to a pair of inside calipers by a long flexible lamp cord as shown. These calipers are used to locate the middle and lower bearings central with the center of the turbine shaft, as represented by the piano wire.

In calipering, whenever the calipers just touch both the inside of the bearing and the piano wire, the bell will ring and thus give the workman a better indication than he could obtain by the sense of touch. If it is so desired, a small battery lamp can be used in place of the bell with equally good results. After the bearings are located exactly central with the center of the shaft, the parts are doweled together and then taken down and reassembled with the shaft and other rotating parts in place.

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* * *

GAS ENGINES IN SHOPS

A. S. ATKINSON*

Generally speaking, the gas engine is rapidly becoming an important factor in machine shop work, and the facility it furnishes in operating cutting, stamping and machine tools, makes it of widespread importance to the trade. Until quite recently the installation of any kind of gas engine for shop and factory purposes was of such limited scope that the question of cost and maintenance was not seriously considered; but now that the gas engine for small as well as large shops has come to stay, any data that will throw light upon the subject should be of more or less value.

Economy in operation is the one thing aimed at, and this, in the case of the gas engine, means an economy in fuel. In my experience with gas engines in shops where only a part of the whole number of machines are in use at one time, the mistake is frequently made of installing an engine which is too large. Suppose, for example, a shop with half a dozen machines requires a full 15-horse-power engine to drive them all at once; but an examination of the records shows that only half these machines are in operation for the greater part of the time, and only occasionally does the work demand the running of them all at once, and then only for a limited period. What power engine should such a shop have to produce the most economical results? This is a point that engineers and manufacturers differ on. One will say the full 15-horse-power, and another ten or even eight, which will allow a fair margin over the average requirement. Here is an experience of the writer. A shop that had run along nicely with an 8-horse-power gas engine was enlarged by the addition of three more machines. The question arose as to the increase of the power. One engineer advocated the withdrawal of the inadequate 8-horse-power engine and the substitution of a 15-horse-power engine. Another recommended the installation of an auxiliary engine of 7 horse-power. A compromise was made by purchasing a small 6-horse-power motor, which could be coupled and uncoupled by belt to the line shafting as needed. The economy of this was shown in the first year's work. The auxiliary engine was used only 120 hours that year. For the rest of the time the old 8-horse-power engine did all the work, for the work was of such a character that only a part of the total number of machines was in use at once during the greater part of the time.

There must be some allowance for overload made in every shop, or otherwise work during rush times must be handicapped. It is unsafe to depend upon an 8- or 10-horse-power engine in a 15-horse-power shop, but does not the single big engine waste fuel where a medium-size one and a smaller auxiliary will save it? This is a question that a shop manager must consider carefully. To get fuel economy out of an engine, it should be run at something like its normal capacity. We cannot expect economy in using an engine twice as large as is required to do the normal work. On the other hand, in a shop where nearly all of the machines are needed in operation for the greater part of the time, the problem is easier of solution. The big engine is then more economical than two smaller engines, as there is less waste through friction and slipping, and less expense in operation in other ways. The cost of maintenance of two small engines is greater than a single big one of equal horse-power.

The location of the gas engine is also of importance. It should be somewhere near the middle of the long line of

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shafting if the different machines require about the same amount of power. An engine installed at one end of a line of long shafting must of necessity lose much of its effectiveness. Where a smaller auxiliary is used this should be installed with a view to running special machines not often in use. These should be grouped, so far as possible, at one end of the shafting, and in such a way that when the auxiliary is started up it will exert its power directly upon these machines. This means an equipment which will permit the cutting off of at least a part of the line shafting when not needed. It costs a little more in the initial installation to secure this result, but the saving in fuel far more than counterbalances it in the end. If there is a heavy planer at one end that requires considerably more power than any of the other machines, the engine should be located pretty close to it, but on the side nearest the other group of machines.

The gas engine has not been satisfactory in many shops through the inability of the operators to understand the new power plant. Gas engineering is a distinct and new branch, and it is impossible for an old steam engineer or one accustomed to electric drives to change to the gas engine without experiencing some difficulties. Not infrequently, engineers look upon the gas engine as such a simple machine that anybody can understand its operation without much previous study and experience. It is one of the simplest and easiest engines to operate, but it does not follow that it can be run by an ignorant man, and without some technical skill. To some extent the gas engine manufacturers are largely at fault; in their zeal to advertise their goods they say that a child can run their engines and that it takes no skill to manage them. Nothing is further from the truth. Your gas engine can get out of order and run poorly, consuming twice as much fuel as it should, if you do not understand it. The symptoms of gas engine troubles should be understood just as much as those of the steam engine or electric motor. In my experience with gas engines for shop work I have found that the symptoms of trouble are generally indicated by pounding, excessive fuel consumption, back firing, heavy explosions at the exhaust, smoke, poor speed regulation, difficulty in starting, and general lack of power. These symptoms of trouble should all be understood by the engineer, and if understood the difficulty can be quickly regulated. The life of a gas engine depends entirely upon how well it is handled at all times, and here is where the skill of the operator counts. With a thorough knowledge of the meaning of the different symptoms of trouble, the engineer can quickly apply the remedy. Pounding is generally due to the fact that the engine and gasoline are too cold. This trouble is particularly noticeable in winter and in cold climates where the engine is exposed. In a shop where the heating is good it is not so noticeable. The air intake pipe may be too cold, and the gasoline for the first charge may also be too cold. Sometimes the pounding at starting is due entirely to the jacket water being turned on too freely or too soon.

Where there is excessive fuel consumption it can be stopped by a little study of the conditions. The most common cause is the use of poor or dirty gasoline which has not been strained. Straining of the fuel should always be attended to. Water in the gasoline or cylinder will cause excessive waste. Sometimes the waste is due to defective cylinder or cylinder head castings; in such cases there is no remedy except to put it up to the manufacturers and make them furnish new parts. Again the excessive consumption of fuel may be caused by cylinder gaskets being leaky or, as sometimes happens, by their being blown out. The remedy may be applied in such cases without much trouble.

Back firing is often simply the result of incorrect setting of the spark or valve mechanism, and until this is remedied the trouble will persist. If back firing is noticeable, look for the cause first in the spark, and see if it is not out of time; in the make-and-break system the spark points may not touch. If the ignition system is all right, then examine the exhaust valve which may be out of time, or as often happens, may not close or fully open. Finally, see if the governor mechanism is not out of adjustment. Any one or all of these troubles may be caused by incorrect setting at the beginning, and proper adjustment will remove the whole difficulty. Heavy explosions at the exhaust may be due to defective ignition or because the mixture is too weak. Smoke at the end of the exhaust pipe generally means that lubricating oil is being wasted. If the smoke is of a bluish color this is quite evident, but if it is black it indicates that the mixture is too rich. If the smoke appears at the open end of the cylinder there may be a sand hole in the cylinder or a leak past the piston ring.

Poor speed regulation may be caused by defective ignition or because the governor is not properly adjusted. Again it may be caused by lack of proper lubrication of parts, or incorrect mixture. Sometimes moving parts are gummed and bind so that the regulation is very poor. If there is any lost motion in the moving parts the speed regulation must be imperfect.

Difficulty in starting is sometimes experienced and causes a great deal of trouble. This may be due to any one of many troubles, the removal of which may prevent other troubles developing later. First ascertain whether the fuel is being supplied in sufficient quantities. This is the most fruitful cause. Next examine the ignition system, and then ascertain if the mixture is properly proportioned. A cold engine or cold gasoline will sometimes cause difficulty in starting. If batteries are too weak, the spark coil defective, or if the sparking circuits are short circuited by dust and dirt, naturally there will be trouble. Too much emphasis cannot be placed upon the necessity of keeping the ignition system clean and in perfect order. This is the main part of the system, the nerves of the engine, as it were.

General lack of power may be caused by insufficient fuel or incorrect mixture also. Overheating and friction of engine parts are other fruitful causes. Likewise insufficient cooling water and insufficient lubrication will cause general lack of power in the engine. Frequently the whole trouble can be traced to a poor grade of lubricating oil which gums the moving parts and prevents free action. Heating of the piston by pre-ignition has caused many an engine to give poor results. Another thing to look for is the heating of the piston by escaping gases. There may be leaks in the compression chamber which may be the result of worn or bent valve stems or weak or broken valve springs. In new engines this trouble will not be noticeable, but others equally important will show. For instance the piston rings may not be true in circular form or they may be set with all breaks in line, thus causing a leak. In new engines sometimes the piston rings stick in the grooves and cause a constant leak. If the valve cages are not properly packed or ground into place there will be a general lack of power. In old engines dust or dirt in the carburetor, air passages, or admission valves, may be responsible for the trouble.

One does not have to study these possible defective points long before being convinced that an intimate knowledge of the gas engine and its parts is essential to good economical operation. Many times the same defect shows itself in one or more symptoms, and to remove the cause is to give the engine immediate freedom of action. Sometimes, for example, an exhaust pipe causes all of the symptoms. It is too long, too small, or has too many bends in it to permit a free expulsion of the exhaust gases. As a result the engine is constantly clogged in its operation, and other troubles will quickly set in. The only way to handle a gas engine is to find out the trouble when the first symptom shows itself. Then its life will be greatly prolonged, and there will be an economy of operation.

* * *

What are claimed to be the two largest shears of the lever type ever built have recently been completed by the Mesta Machine Co. for the Indiana Steel Co., to be used at the steel plant at Gary, Ind. The knives of the shears are 36 inches long and will make 12 cuts per minute, cutting off cold soft steel $6\frac{1}{2}$ inches square or 7 inches round. Each of the machines is driven by a 150 horse-power induction motor. The total weight of each shear, not including the motor, is $112\frac{1}{2}$ tons.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1910

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

IMPRACTICABLE IDEALS IN INDUSTRIAL EDUCATION

There is danger that the leaders in the movement for industrial education will aim too high, and that the courses of instruction will suffer from the same false reasoning which has based our high school courses on college entrance requirements. There is grave danger that the primary aim will be to enlarge on fundamental principles in a way that would appeal to the exceptional boy who is to become a superintendent or general manager, instead of helping the average workman directly with the problems of his daily work.

The danger of such a course lies in two directions. In the first place, it is exceedingly difficult to keep boys interested in studies which they see no opportunity to apply practically. In the second place, there is the ever-present possibility of spoiling good workmen by inspiring them with ambitions for positions which they are incapable of filling.

There is no injustice to the exceptional boy in this setting of a low standard for industrial education. He can readily be interested in the instruction, elementary though it may be, and once in contact with other students of lesser abilities, his own attainments stand out in high relief, permitting him to be picked out from the bunch and given such advice and assistance as he may need in preparing himself for better things.

Don't aim too high.

* * *

APPRENTICESHIP CONDITIONS

The difficulties which surround the apprenticeship question have been a subject of discussion for many years, and will continue to be until employers and apprentices get closer together than they now are on some points of difference. On the manufacturers' side we hear of the reluctance of young men to learn a profitable trade, and the difficulty of holding them to the terms of apprenticeship contracts. The young men look at the low wages they receive as apprentices, and make no allowance for the time spent in teaching them a trade which will greatly increase their future earning capacity. If the average young man can earn a couple of dollars a week more in some other and possibly easier occupation, he is seldom likely to sacrifice that amount of money to acquire a trade at which in a few years he can earn twice as much as in some occupation that offers little chance of development. The question really narrows down to this—Is the manufacturer willing to pay more than his apprentices' services are worth to him, either on account of the general benefit to his industry, or because it will pay him in future to educate such employes for his own organization? That this policy does pay has been satisfactorily demonstrated by many of the largest concerns in the country, who still maintain their apprenticeship system at more or less loss to themselves. The present need is for an action of the employers which will attract the boys and hold them.

The indentured apprentice of fifty years ago would be as much out of place under present conditions as the spinning lathe, the hand loom and the flail of our grandfathers' time. The master-and-servant situation was but one step removed from the days of the bond slave, and many of the cruelties of slavery were felt by the old-time apprentice. He was poorly paid, had to work long hours, often slept in the master's house and ate at his table, and could be corporally punished for delinquencies. To-day, of course, most of these conditions no longer exist. The manufacturing business has developed beyond the wildest dream of the old-time employer of a few men, and the apprentices of to-day are treated as well as journeymen in the matter of working hours, shop surroundings and other working conditions. But in addition to these improvements, apprentices of the desirable sort apparently must be attracted to the machine shop by higher wages and an educational campaign which will clearly make known to the average boy and man the possibilities that lie before the good machinist and toolmaker, as compared with other trades or the professions. Although in some places trade union rules are a strong deterring force, low wages at the start and ignorance of the chances for improvement are much to blame for the reluctance of young men to enter these trades. The boy sees chiefly the grime and the forbidding conditions that are common to many shops, and does not understand that brains and ability count for as much in those gloomy interiors as in the counting house or department store, with the chances for rapid promotion and good wages much greater.

* * *

THE FUTURE OF THE MACHINE TOOL INDUSTRY

A prospectus recently sent out by one of the great New York banking houses setting forth the stability and value of a new security which they are offering to investors, inspires a comparison between substantial enterprises of that character which offer legitimate opportunities for investment, and the machine tool industry as a whole.

The development of manufacturing in America is still in its infancy, notwithstanding the enormous investment already made therein and the number of men employed. Every increase in its many ramifications will call for more and more of the tools required for building all kinds of machinery—that is, machine tools. The automobile industry alone has absorbed a large number, and will continue to absorb more for some time to come, although no doubt in a diminishing ratio. Then, supplementing the demand from automobile manufacturers, will come that of the automobile and gas engine repair shops which in time will dot the country roads in somewhat fewer numbers, perhaps, than the blacksmith shops now employed in shoeing horses and repairing wagons and farming utensils—and each of the former will require at least one lathe, shaper, drill and grinder.

The railroads are large users of machine tools already; but their potentiality as buyers in the machine tool market is enormously greater. The present equipment of many railroad repair shops is of the poorest character imaginable, the tools frequently being of a type obsolete twenty or thirty years ago. The development of high speed steel and the great increase in power and capacity of locomotives, have already put many of these old tools out of commission, and still greater numbers must be thrown out and replaced by modern tools as soon as railroad earnings warrant the necessary expenditure.

In several other directions we can see a great and widening demand for machine tools—a demand that will be larger than the present manufacturers can supply unless the capacity of their plants is greatly increased. Many new concerns will therefore start the manufacture of standard and special machine tools within the next decade, because the industry is a stable and profitable one, and as the field widens its product is less liable to fluctuations in demand than heretofore. The machine tool business is therefore one to inspire the confidence of hard-headed business men who want to know that their money is safely invested where it will yield a fair return and multiply.

Much depends in the machine tool industry on business ability,—more than mechanics generally think; but the talent required for the organization and management of new machine tool concerns exists in the trade, and the next ten years will doubtless see many mechanics who have the ambition and ability leave the bench and strike out for themselves, at the head of new enterprises.

* * *

HAND AND AUTOMATIC TURRET LATHES

In December MACHINERY we published an article on shop practice which included many excellent examples of operations on the hand-operated turret lathe. In the current number is an article containing descriptions of several equally interesting operations performed on the automatic turret lathe. While the work in the two cases is somewhat different, it is conceivable that if these two shops should swap managing officers, the methods of machining would change with the management, and that the work, in time, would be changed from hand to automatic machines and *vice versa*.

The condition mentioned is an important one. It meets every machine manufacturer in the country, and a close understanding of the subject is most essential. There is, of course, no fundamental competition between the two methods of machining. Each is supreme in its own field, and it is only on work which is on the border land between the two classes that any uncertainty should be felt. We are going to try to present, briefly, the considerations which should guide the manufacturer in deciding to which class his work belongs.

First let us consider the advantages of hand-operated machines. The hand turret lathe receives constant supervision which renders it less liable to shut-downs from any cause save that of neglect of duty. Accuracy in the work can be maintained with more rapid tool deterioration, and consequently with heavier cuts, due to the feature of constant supervision, combined, in a well-designed machine, with ease in changing and adjusting the tools. Changes of tools and adjustments can be more quickly made, and less complicated tools are required, profitably adapting the machine to smaller lots than the automatic machine can be rigged up for. The same factors also facilitate changes and improvements in the product.

Another and most important advantage of the hand machine is the higher output possible per dollar of capital investment, because the machine itself and the tool equipment are less expensive, and under many conditions a higher output per machine is possible. Again the profitable use of the hand machine on small lots permits the rapid flow of work through the shop, with a consequent reduction of the capital tied up in work in progress. All these factors—the less expensive machines and tools, the possibly smaller number of machines, and the smaller stock of rough and finished parts—are reflected in smaller and more compact buildings, with the consequent reduced expense for interest, insurance, taxes, salaries and other overhead expense.

The advantages of the automatic machine may be summarized as follows: It makes possible a lower labor cost per piece, and this is true practically in all the conditions under which the automatic machine would be considered. It may be arranged to take full advantage of the possibilities of using multiple tools, and on a large proportion of turret machine work this means that the hand machine will be unable to produce the same output per machine, in spite of the closer personal supervision which the latter receives from the workman. In the matter of accuracy it may be assumed that with properly arranged tools and proper setting up, the invariable mechanical action of the automatic machine is highly suited to the production of accurate work, uniform in all its important dimensions.

Besides those just mentioned, the automatic possesses other advantages over the hand machine which must appeal to shop managers from the standpoint of administration. It does not cease to be productive, even if the operator leaves it for a time, and it does not stop until its work is completed. One skilled mechanic can supervise the work of a large number of machines, and the direct attendance of the machine, for keeping it supplied with work and inspecting its operation, can be left to a less expensive grade of labor. This consideration means also a more flexible organization, as it is easier to shift men from one machine to another.

High production for a given piece on the hand turret lathe comes in part from the skill of the operator on that particular piece, and is checked for the time being by shifting to work of another character. The same considerations also apply in the matter of breaking in new men to the work. Attendants for the automatic machine, sufficiently skilled for its requirements, can be obtained with little trouble. The importance of these considerations can best be understood by those actively engaged in shop management.

In balancing the various advantages and disadvantages mentioned above, the shop manager should take into consideration the conditions covering his particular case, among which may be mentioned the following: Is the work of such a character that the multiple cuts obtainable from the automatic machine can be used? Are changes in the design or character of the work sufficiently frequent to make the adaptability of the hand machine an important consideration? Is the product built in sufficiently large lots to make automatic machines profitable? Is the capital available for the business sufficient to warrant larger initial expense when the more expensive machines figure out to be cheaper in the long run? Is the product of the shop, as determined by careful analysis of accurate cost accounts, of such a character that the labor cost is relatively high, or relatively low, as compared with the charges for material, overhead expense and interest? What are the labor conditions? Are wages for good men relatively high or low? Is the working population a shifting one, and is there a large supply of skilled workmen to be drawn on?

It will be seen that this problem is one difficult to solve by purely logical, mathematical processes of reasoning. The factors are too many and too complicated. Reasoning will carry the shop manager part way toward his conclusion. But when all the facts in the case have been gathered, in coming to a final decision from them that necessary and indefinable attribute we call "judgment" will have to be invoked.

We cannot refrain from calling attention to one point in which the automatic machines, in general, have a fundamental advantage over hand-operated machines engaged in the same work. This consideration may be criticised as being a purely ideal one which ought not to be considered in a practical discussion of the subject such as we have been carrying on. It is a consideration, however, which inevitably strikes the mind of the observer who has an opportunity to compare the conditions in two shops where both classes of machines are being operated with high efficiency. With hand operation, the workman tends to become the servant of the machine. The possibility of increase of production through constant supervision is so great that the operator is kept constantly on the alert in changing feeds, speeds and adjustments. With automatic operation, it is the man who is the master, and the machine the servant. It is a sight distinctly inspiring to see banks of automatic machines steadily chewing away, while the operator walks leisurely from one to the other, putting in a new piece here, examining the condition of the tool there, and occasionally changing the adjustment. This consideration, we believe, brings the automatic machine directly in line with the current of human progress.

* * *

Why don't the grinding machine operators wake up and write something of general interest on grinding?

PRACTICAL SAFEGUARDS IN THE NATIONAL CASH REGISTER CO.'S PLANT*

ETHAN VIALL†

No plant in the world is more up-to-date in every respect than is that of the National Cash Register Co. at Dayton, Ohio. It has been looked upon as a model for years, and its fame as such has attracted visitors from all over the world, over fifty thousand being shown through the various departments annually.

Every effort has been put forth and no expense spared to beautify the factory grounds, a noted landscape gardener being employed for the purpose. Employes are encouraged to buy their own homes and are given expert advice as to the best way to make them attractive. Good wages are paid, and women employes are given shorter hours than men and a recess twice a day. Rest rooms are also provided for them, and a doctor and trained nurse are within easy reach. The men are allowed twenty minutes for one shower bath a week in winter, and forty minutes or two a week in summer at the company's expense, there being 228 series of showers in the factory. No person with a contagious disease is allowed to work. Four-fifths of the wall space is glass, affording plenty of light and saving the employes' eyes. The ventilating system is as nearly perfect as modern science can make it. The company has its own laundry and furnishes clean towels and aprons twice a week, and in every possible way the employe is taken care of, not merely because the company wants to be philanthropic, but because it is sound business policy. The old, revolting idea that found expression in: "When he's dead we'll get another man just as good," has no place here; but the policy toward the employe might be expressed in this way: "We have spent time and money to train this man (or woman) in our way of doing work, and it is far easier and better to take care of him and keep him in good shape physically and mentally, than it is to neglect or mistreat him and, in consequence, have to break in a new one every few weeks or months, thereby lowering our average of efficiency, quality and output." The different ways by which all this is accomplished are almost infinite, but it isn't within the scope of this article to deal with anything more than those methods or devices by which life or limb are protected, though in many cases the margin between mechanical safeguards and sanitary ones is so narrow as to be practically indistinguishable and no attempt will be made to hold strictly to mechanical devices as such are usually defined.

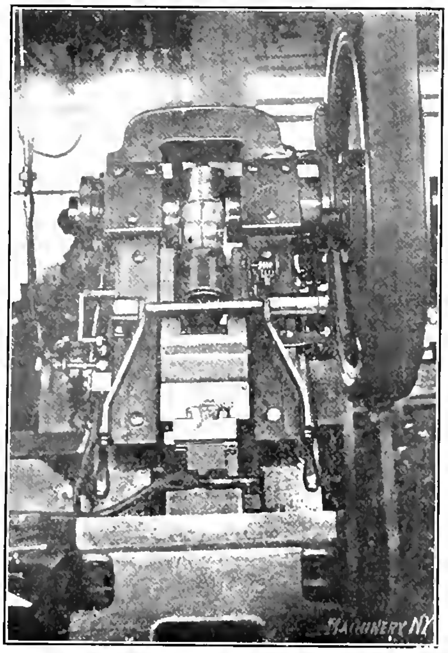

Fig. 1. Two-handed Trip for Punch Press, which proved Defective

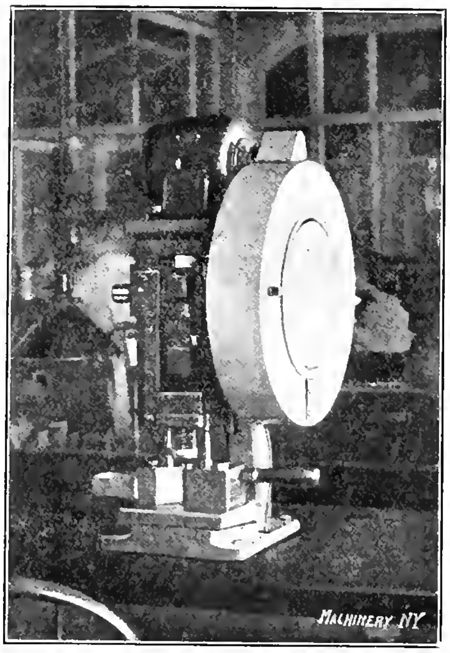

Fig. 2 Guard over Pinion and Gear of Motor-driven Press

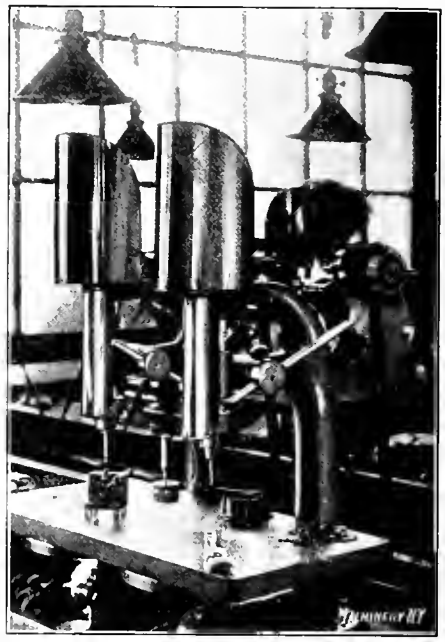

Fig. 3. Hair Guards on Small Drill Presses which are operated by Women

Probably no class of machines, unless for woodworking, has been the cause of more serious accidents than punch presses, yet no other class of machinery has had fewer successful safety devices. In many cases, on the more powerful machines, even the gearing, now almost universally covered on other machines, is left without a guard or shield of any kind, a man's finger or his arm hardly being considered worth looking out for, regardless of the fact that one damage suit is likely to cost enough to buy a hundred or even a thousand guards. Carelessness and indifference on the part of employes has, to some extent, been responsible for the lack of proper safeguards, for what an employe doesn't insist on or doesn't want, isn't usually given him, especially if it costs the employer anything. Instances are common where an operator, after a press has been fitted, at considerable expense, with an automatic lever or guard to protect the fingers or

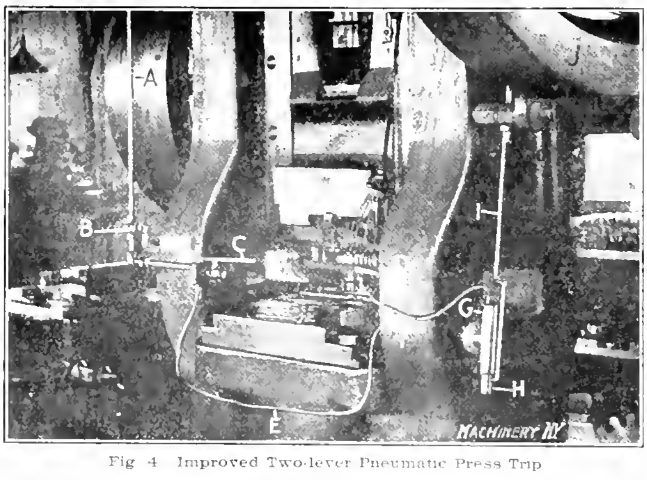

Fig 4 Improved Two-lever Pneumatic Press Trip

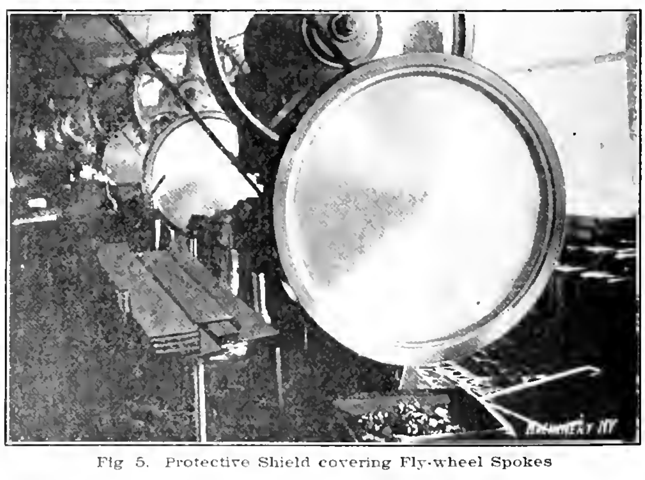

Fig 5. Protective Shield covering Fly-wheel Spokes

* See note referring to the safety appliances used by the U. S. Steel Corporation, in MACHINERY, February, 1909.

† Associate Editor of MACHINERY.

hands from the descending punch, has, at the first opportunity, thrown it aside and gone back to the old unguarded way. Too much trouble is the verdict, but it *isn't* too much trouble if the device is going to save a man's hand or arm, no matter what he says of it.

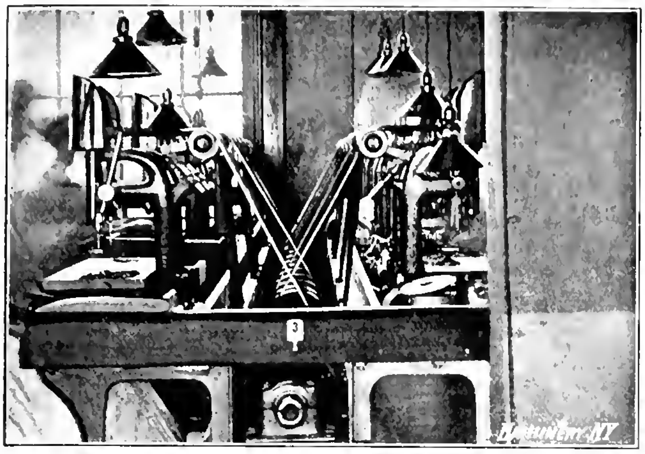

Fig. 6. Hair Guards and Arrangement of Belts and Pulleys on Small Drills

Only a few instances of discarded devices serve to convince a thinking foreman that any appliance intended to prevent a man getting his fingers under a punch, must be absolutely "fool-proof," and to devise something of this kind has been one of the hardest problems that the shop officials of the National Cash Register Co. have had to solve, but recently they hit upon what appears to be the only really successful, fool-proof appliance yet devised. It has taken a long time to work out and correctly apply the idea involved, but the principle is very simple, the whole idea being to *make the operator use both hands to trip the press and to make it impossible for him to do so unless he does use both hands.* That is the whole thing in a nutshell, and the idea is being applied to every punch press in the plant and, of course, in compelling a man to use his hands to trip the press, the dangerous foot treadle is discarded and one great source of accidents thereby eliminated, for it is so easy for something to fall on the treadle at the wrong time or for a man to stumble on it or else press his foot down unintentionally.

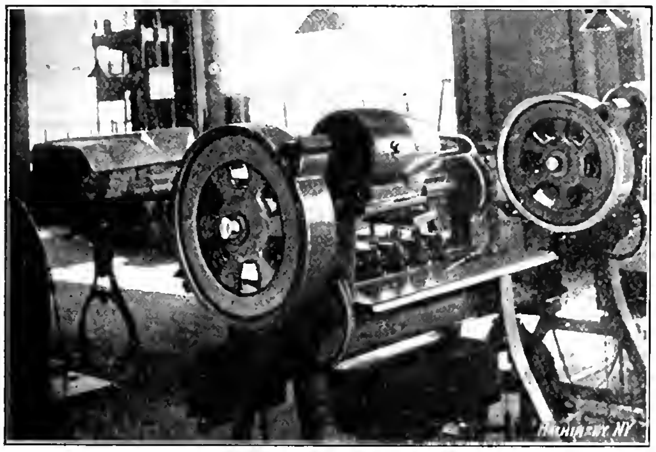

Fig. 8. Neat Style of Gear and Pinion Covers

Fig. 10. Corner of a Rest room for Women Employes

The first application of a device embodying the two-handed trip idea was on a punch press fitted with a forming punch and die, and is shown in Fig. 1. This was purely a mechanical device. Both levers had to be pulled to trip the press, as the pulling of one alone would not accomplish it, but as this device soon proved to be anything but fool-proof, it will not be described in detail. An additional safeguard on this machine consisted of an automatic air valve mechanism (shown on the left side of the press frame) and a hose which was so arranged as to direct a powerful jet of air onto the punching and blow it out of the die as the ram raised. The principal reason for condemning this lever system was that the operator, to gain a fraction of a second, would, unless watched, prop out one of the handles with a stick and work the trip with one hand, for which there was no valid excuse as the company's piece work rates allowed a very liberal mar-

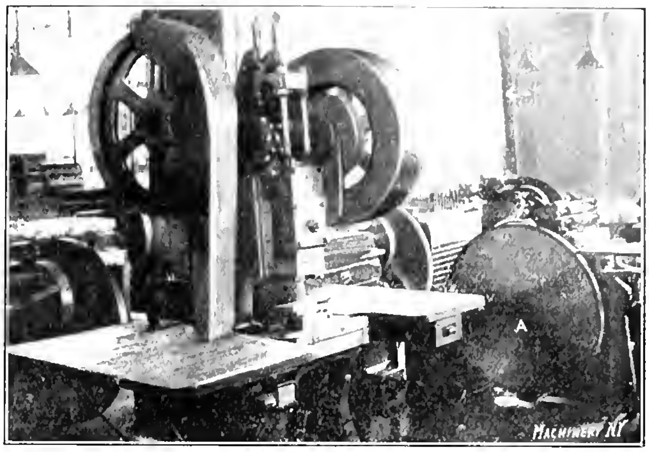

Fig. 7. Belt Guard and Fly-wheel Dress Guard

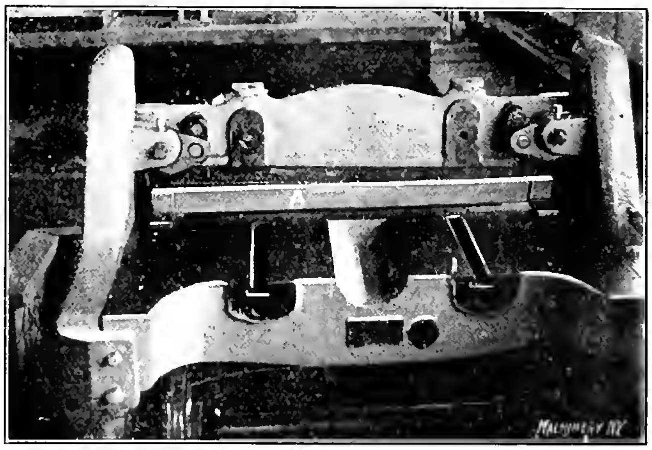

Fig. 9. Finger Guard on Small Trimming Shears

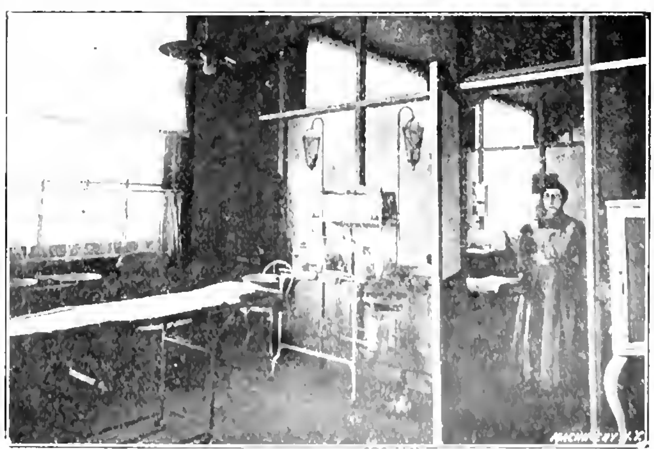

Fig. 11. View of a Corner in the Shop Hospital

gin; nevertheless the fact remained that the levers could and would be tampered with at the first opportunity, so the next move was the fitting of the pneumatic device to the presses, shown in Fig. 4, and this is practically the form of trip that is being put on all the machines at the present time. Refer-

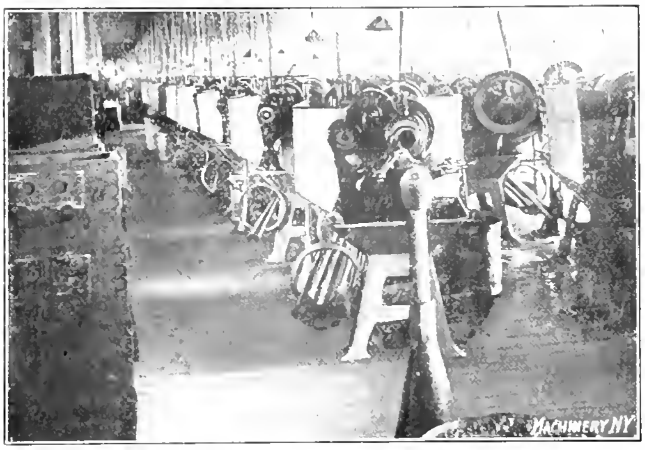

Fig 12. Battery of 340 Automatic Screw Machines, equipped with Splash Guards

ring to the engraving, A is the air supply pipe containing air under heavy pressure; B is a cut-off valve; C is the left-band trip-valve lever, and D is the right-hand trip lever. Both trip-valves are of the same pattern, and are connected by the small air pipe E. The air pipe F leads from the valve D to the

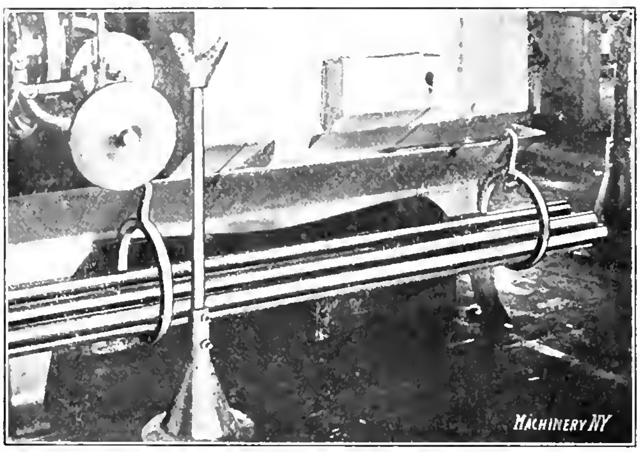

Fig. 13. Safety Stock Rack on Screw Machine

cylinder G, which is so arranged that when air is let into it the plunger H is forced downward, pulling the rod I with it, and thus causing the press to trip. Now to operate this trip, the line valve B is first opened, letting the air in as far as the valve C; but the pulling of lever C cannot trip the press,

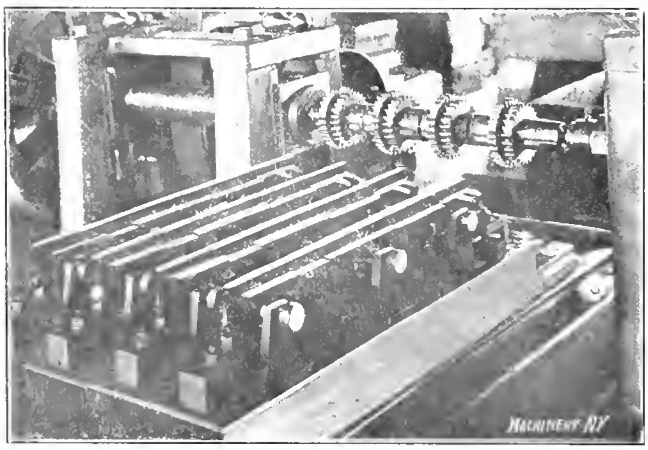

Fig 14 View of Jig on Milling Machine, showing Clearance between it and the Cutters

as the air cannot reach the cylinder until lever D is pulled, and on the other hand, the pulling of lever D alone cannot trip the press, since valve C closes automatically and shuts off the supply. It is plain, then, that if both valves are arranged to close automatically the instant the levers are released, it is impossible to trip the press unless both are held open at once. The form of the levers themselves and the angle at which they project when the valves are open, make it highly improbable that they can or will be successfully propped open. At J, in this engraving, is also shown a partial view of an excellent type of gear guard. Not only are all gears guarded as they should be, but all fly-wheel spokes are covered, where they are low enough to catch anything, as shown in Fig. 5.

In Fig. 2 is shown a good example of a covered gear and pinion on a small motor-driven press in one of the women's departments. Wherever women are employed in a shop, additional safety precautions must be taken on account of long fluffy hair and flowing skirts, and in Fig. 3, are shown two small drill presses with shields to prevent hair catching in the spindles or belts, and in Fig. 6 is shown a compact battery of these drill presses equipped with hair guards. These guards are also very effective in preventing oil being thrown

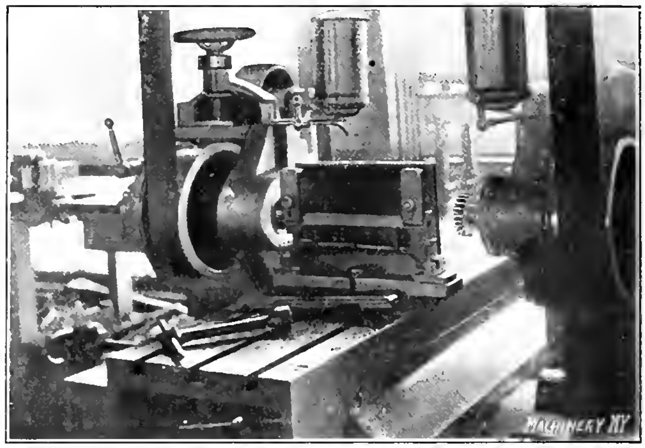

Fig. 15. View showing Position of Milling Fixture with Reference to Cutter, when Stationary

on the operator. The driving belts and pulleys are arranged in such a way that it is impossible to get caught in them in any manner.

At A, Fig. 7, is shown how the low fly-wheels are guarded to keep the skirts from catching in them, and at B is shown a

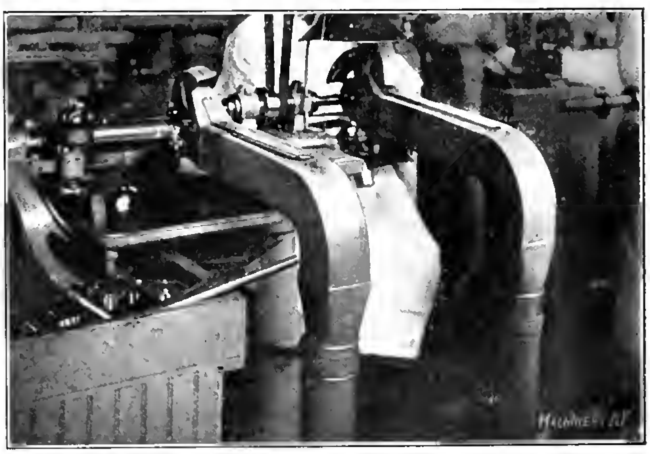

Fig 16. Dust Pipes and Wheel Guards on Universal Grinder

good belt guard. No overhead belts of any kind are allowed in the women's department, all driving being done by carefully boxed motors, and where these motors are mounted on the machines, they are carefully covered as in Fig. 8, and if belted in any way, the belts are guarded.

To keep the operator's fingers from under the blade of the light trimming shear, Fig. 9, the guard A, has been fastened to the bed, the opening being high enough for any possible work, but not high enough for fingers.

In connection with the brief mention of the employment of women, one of their rest rooms is shown in Fig. 10, which is provided with chairs, cots, lounges and other comforts so that they may rest or lie down at any time, if sick or indisposed In Fig. 11 is shown one corner of the hospital, where a trained nurse is always on duty during working hours, and a regular physician is within call at any time in case medical or surgical aid of any kind is needed. He also comes to the shop

hospital at a certain time each morning to prescribe for minor ills, if necessary.

Going now to the automatic screw machine department, with its three hundred and forty automatics, we find guards over gears and every other dangerous part of the mechanisms, and huge pans at the back and front of the machines, as in Fig. 12, to prevent the floor from becoming slippery and dan-

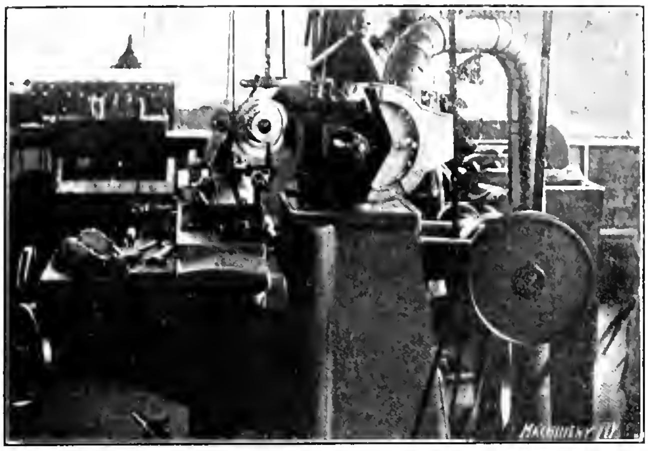

Fig. 17. Dusthood and Exhaust Pipe on a Swivel-head Grinder

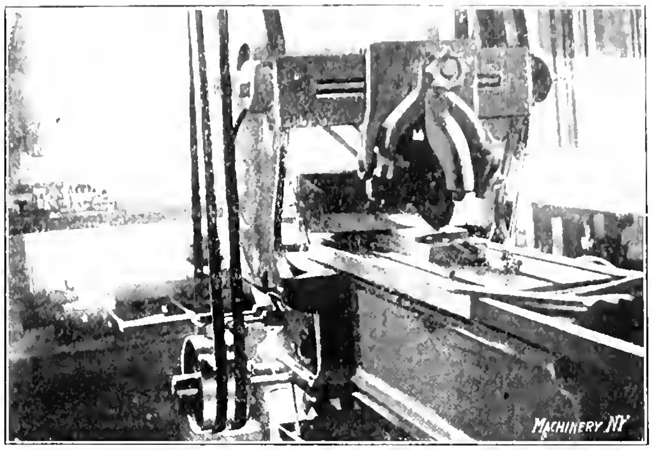

Fig. 18. Surface Grinder with Wheel Guard and Dust Funnel

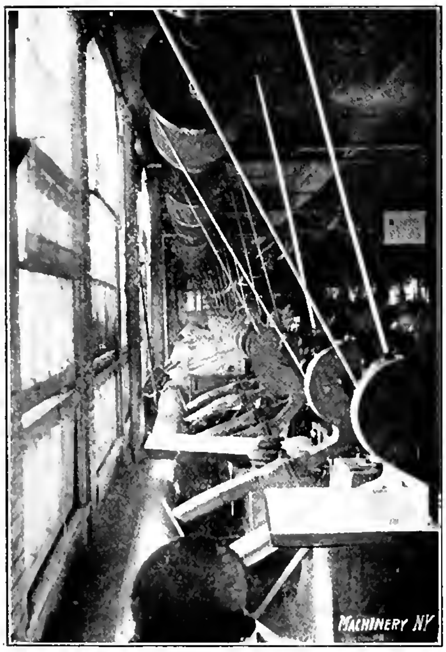

Fig. 19. Exhaust System in Polishing Room

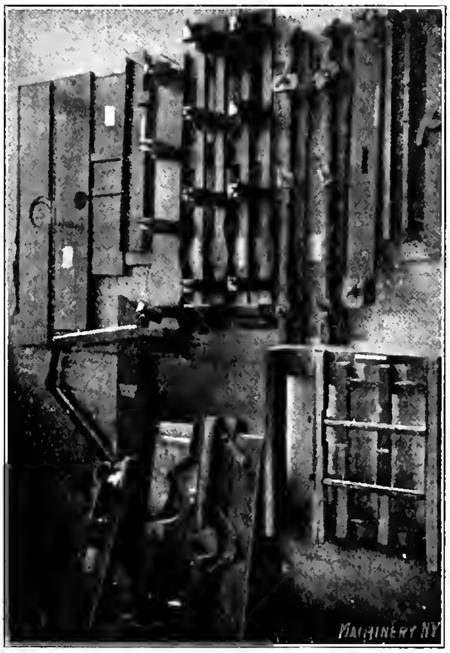

Fig. 20. Wood-working Jigs and Guards

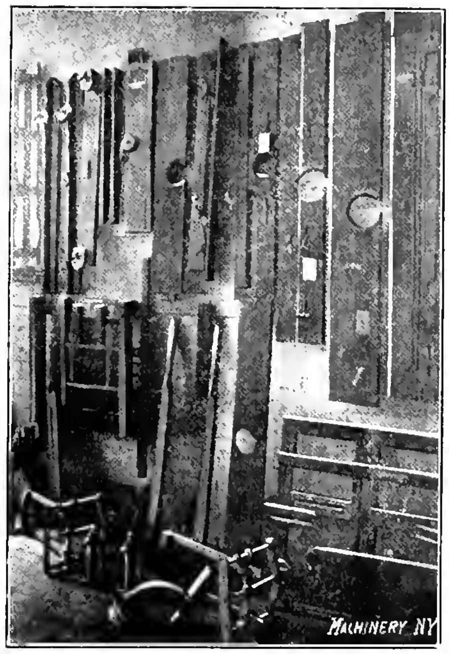

Fig. 21. Other Wood-working Jigs and Guards

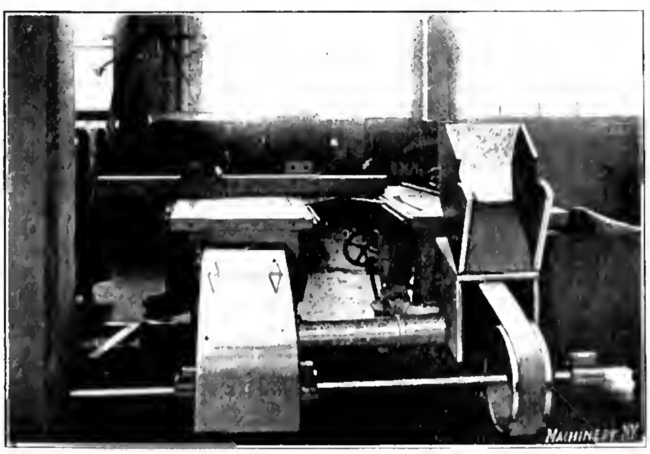

Fig. 22. Belt and Pulley Covers in the Wood Shop

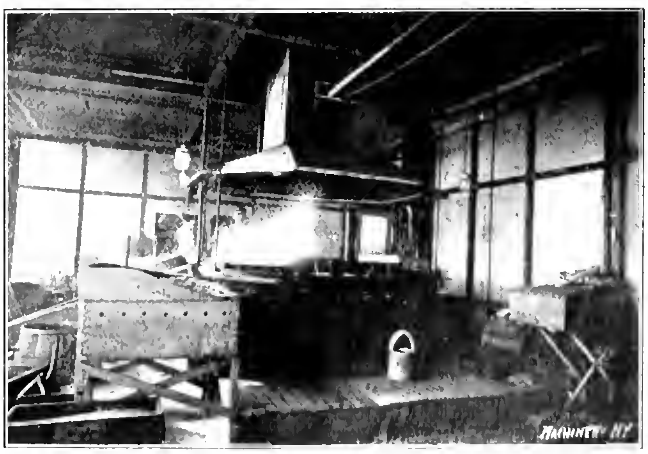

Fig. 23. Exhaust Fan and Hood over Acid Vat

gerous from spattered lubricant. Stock for immediate use is kept off of the floor by using the hook brackets shown in Fig. 13. Not only is this done for neatness and convenience, but also to prevent accidents caused by stepping on bars that are likely to roll.

All jigs used on milling machines and the like, are so arranged as to be drawn back and well away from the cutters while placing or removing the part. A good example of this type of jig is shown in Fig. 14. In many cases the reversing of the table is automatic, but in all cases plenty of clearance is insisted upon, and where possible the jig, when at rest, is back of the cutters as in Fig. 15.

Great care is taken in the tool grinding room to have the exhaust pipes arranged so as to carry off all dust. In Fig. 16 is shown the adjustable wheel covers and telescoping tubes used on the regular two-wheeled universal grinders, while in Fig. 17 is shown the method of piping a grinder with a swiveling head. Every wheel in this large department is thoroughly equipped and the air is as free from dust as in any other place. Fig. 18 is a surface grinder of the planer type equipped with a wheel guard and a large suction funnel just back of the

wheel, that catches and carries off all the metal and emery.

In the polishing department, a splendid exhaust system is in use as shown in Fig. 19, and here even the overhead pulleys have the spokes covered in order to avoid the fan action as much as possible.

In the woodworking department, there are guards of all kinds to prevent accidents, and special devices are used to cover as much of the cutters as are not actually in use. Wooden jigs are used for holding various parts while machining them on shapers, saws, etc., in order not to get the hands too close to the tools. A number of these jigs and special guards are shown in Figs. 20 and 21. All dangerous parts or

Fig. 24. View showing Suction Openings in Plating Room

places in the wood shop are painted a bright red, belts and pulleys are boxed as in Fig. 22, and band-saws are covered as much as possible.

Acid and other fumes in the plating or lacquering rooms, are drawn off through hoods placed over the vats or tanks as in Fig. 23 or else by suction hoods at the back of the tanks as in Fig. 24, the powerful suction being shown by the way steam is drawn in from the tank next to the window.

The big potash tanks are equipped with mechanical dipping devices, so that the men will not get their hands into the biting stuff. This dipping machine is shown in Fig. 25. It consists of a series of cages or frames fastened by chains running over pulleys, to a reciprocating bar worked by a pulley and crank, in such a way that the cages dip up and down in

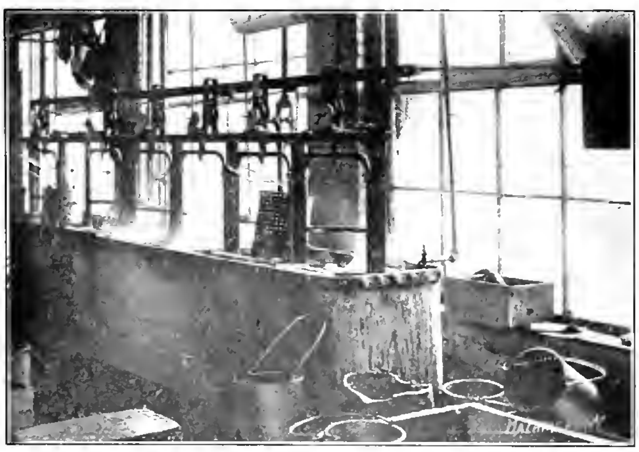

Fig. 25 Dipping Machine and Potash Tanks

the tank continually unless caught and held up by a hook or latch at the top of the framework. All but one of the frames are shown "hooked up" in the engraving. The perforated pails containing the oily parts, are placed in one of these cages and the hook pulled back; the cage then proceeds to automatically dip in and out of the potash until the operator again hooks it up. The parts are then allowed to drain awhile, after which they are removed from the bucket. Not only does this machine save the men's hands and bodies from the principal effect of the potash, but it also prevents the inhaling of the fumes that is the inevitable accompaniment of hand dipping. The machine is also a great time saver.

Going up the stairway from one floor to the other, one notices how even the stairs are railed and guarded with heavy wire screen as in Fig. 26, and in many places where trucks have to be run up long inclines, strips or belts of a cork-like material are laid in the floor to walk on and to prevent slipping and consequent injury.

While gathering material for this article, I was greatly assisted by Mr. Reeder, manager of the Welfare Department; Mr. Sager, machine supervisor; and Superintendent Oswald, and my thanks are especially due to the last-named gentleman, whose permission and kindly interest made possible this article.

* * *

JEWELERS' WAX

ARTHUR A. RACICOT*

To make jewelers' wax, take common rosin and heat it in a vessel until it flows freely; then add plaster of paris, stirring continually while adding the powder. Care should be taken not to make the mixture too stiff. When it appears of the proper consistency, pour some of it on a slate or marble slab and allow it to cool; then insert the point of a knife under the flattened cake thus formed and try to pry it off. If it springs off with a slight metallic ring, the proportions are right; if it is gummy and ductile, there is too much rosin; if it is too brittle and crumbles, this indicates that there is too much plaster.

Fig. 26. Railed and Guarded Stairway

This is what is sold for jewelers' cement at thirty cents for a half pound cake. It is used for filling gold headed canes, umbrella handles, cementing stones in ring settings, and also for holding very thin pieces of metal on a face-plate for drilling, cutting disks, or turning off the surface.

I gave this formula to a friend who had some very artistic tile for a fire-place, and after having set as many as he could one evening, he forgot that the wax only needed rewarming in order to use it the next day, so in order to keep it fresh he poured water in the iron pot; in the morning the wax had become insoluble owing to the action of the water on the plaster. So it is advisable not to wet the wax until it is put to its final use and place.

* * *

Iron castings that are too hard to machine or which have hard spots destructive to tools may be nicely annealed by packing closely in covered cast iron boxes with black manganese, and heating to a temperature of 1,500 or 1,600 degrees F. until thoroughly heated through. A large box packed in this manner with a closely-fitted cover luted with fireclay must be heated for several hours to raise the interior to the annealing temperature. To be sure of getting the interior heated properly, a number of witness wires should be placed in the box, projecting through the cover where they can be conveniently grasped with tongs and pulled out one at a time to show how far the heat has progressed. When the interior has reached a bright red heat the box should be hauled out and covered with ashes so that it will cool slowly. It is claimed that hard spots in gray iron castings can be softened with black manganese by applying the manganese and heating to a dull red, using a blow-torch or any other convenient means of heating.

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ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER—2

ALFRED SPANGENBERG*

In the previous article it was stated that the principal points to be observed in planer erection are: housings parallel with each other and square with the bed; accurate fit of all sliding members and truth of all plane bearing surfaces; proper mesh and smooth working of gears; and a system that permits the various parts to be easily and quickly assembled, and avoids the necessity of fitting the members together for the laying-out operations. In the first article boring and drilling the bed, drilling the housings, and testing the housings were described, and in this, the concluding part, we will take up laying out the arch bars, assembling operations on the bed, setting the housings, assembling the driving, feed and arch members, laying out and setting the cross-rail and the final test and inspection.

Laying Out the Arch Members

The first drilling operation on the arch is for the housing bolts, the jig for this being shown at *C*, Fig. 4; then the arch

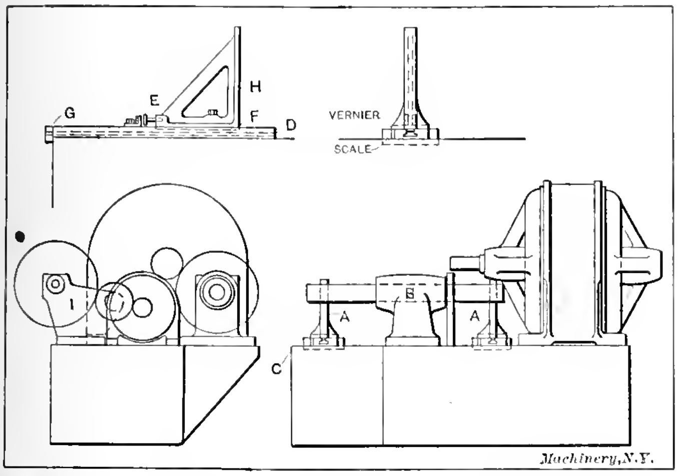

Fig. 8. Arch with Bracket Members and Motor in Position for Laying Out

is set under the drill in its normal position and the brackets and motors are located for marking off the bolt holes, as illustrated in Fig. 8. When these holes have been drilled and tapped, the arch members are bolted in place for drilling the dowel pin holes, this time more care being exercised in the setting. This is another instance where the varying character of the parts precludes the use of drill jigs, and a method of laying out the work must be resorted to. For convenience in obtaining accurate measurements, and to facilitate the work, a pair of adjustable angle-plates are used, as shown at *A*, the idea being to use an arbor in the bracket hole *B* and to provide a positive locating surface at each end, against which the arbor just touches.

The location endwise not being as particular, a line is scribed on the arch the correct distance from end *C*, and the bracket, with a scale held against the end, is set so that the edge of the scale coincides with the line just mentioned. As will be seen from the detail view, the angle-plate is adjustable on its base *D*, and may be turned end for end and clamped in any position as the case may require, fine adjustment being made by the screw *E*. Fastened to base-plate *D* is a scale, while attached to angle-plate *F* is a vernier, this combination enabling very accurate settings; all readings are taken from the lip *G* to surface *H*, and it is necessary, of course, to add half the diameter of the shaft to obtain the center distance. Bracket *I*, for the top elevating shaft, is set in the same manner, except that the angle-plates are reversed on account of the bracket being so close to the edge of the arch. With both brackets bolted fast and pinned, and their gears in place supported on short arbors, the motors are set so that their pinions mesh properly with the respective gears; then the motor clamping bolt holes are marked off, drilled and tapped, and the motors reset for pinning. In case the design is such that the entire top surface of the arch casting is not planed, *i. e.*, where finished seats are provided for the brackets and motors, additional spots are required for the angle plates. These spots are conveniently located on the casting and are finish planed with the other seats.

Assembling Operations on the Bed

The first assembling operations proper on the bed consist of drilling the various set-screw and oil pipe holes; drilling and fitting the track oiling device, a drill jig for which is shown in Fig. 9; and assembling the rack gear, its shaft, and the two intermediate compound gears and shafts. These operations, together with placing the housings on the bed, are done before the leveling operation, as otherwise the consequent hammering and additional weight of the housings might throw the bed out of level.

During erection, the bed is supported on cast iron parallel blocks placed about six feet apart along the whole length of the bed and also under the housings. Planed cast iron wedges, having screw adjustment, are placed between the parallel blocks and the bed, thus enabling very accurate leveling to be accomplished. The arrangement of all the blocking is such that none of it will interfere with the driving and feed mechanism during erection, and as these details vary in different machines, the blocking must be arranged to suit each machine.

Several methods may be followed in leveling a planer bed, any one of which will give good results if the work is carefully done. The prime requisites are, of course, a first-class, sensitive, spirit-level—one at least 18 inches long—and an accurate parallel that will reach across both tracks. It is obvious that since the tracks in a new bed are not worn, just as good results are obtained in leveling, by using the top surface on the tracks, as by using either V-shaped parallels or cylindrical pieces in the ways. The leveling is done as follows: The level is used on the top surface of one track, and that side of the bed is carefully leveled by moving the instrument short distances at a time, over the entire length. Then, by placing the level on the parallel, the bed is leveled crosswise; the operation of first leveling one side and then cross-leveling to the other is repeated several times, or at least until no further errors can be detected.

Setting the Housings

Fig. 10 is a top view of the planer, and shows the general method of setting the housings; the operation involves the

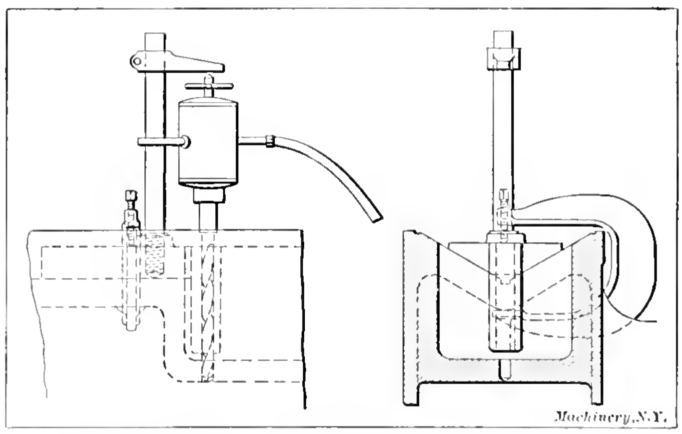

Fig. 9. Combination Drill Jig and "Old Man" for Drilling Hole in Oil Pockets for Oiling Device. Jig Insures Hole being drilled in Center of Way

alignment of the driving shaft bearing in bracket *A* with that in the bed at *B*, and also includes bringing the faces of the housings into the same plane. With the housings bolted to the bed only sufficiently tight to hold them in place, and with driving shaft bracket *A* bolted and pinned fast to the front housing *C*, an arbor *D* is used as indicated. This arbor is ground true and is a wringing fit in the bed at *B*, and, being of smaller diameter where it passes through bracket *A*, permits it to be easily introduced into the bed bearing even though the bracket hole is out of alignment. This condition is possible, of course, since the clamping bolts *E* have 1/8 inch clearance in the housings. Now, with bushing *F* in position to enter hole *G*, the front housing is driven with a babbitt hammer, either forward or backward as the case may require, until the bushing enters the hole freely without springing the arbor.

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To set the back housing, a straightedge is laid across the bed as shown at H, and narrow strips of tissue paper are introduced at I and I_1; then, by moving the back housing until papers I are tight and I_1 can just be moved, it is determined that both housings are in proper alignment. The fact that the outside papers are slightly loose is due to conditions already stated. After reaming the housing dowel pin holes by means of an air drill, and driving in the pins, measurement is taken for arch casting J, and the housings are calipered over surfaces K just above the bed, and at the top, to test their parallelism.

While an attempt is made at interchangeability with respect to the length of the arch member, it sometimes happens that certain elements make it necessary to slightly deviate from the standard measurement. For instance, the above test may show the measurement over K to be from 0.002 to 0.003 inch wide or narrow at the top, in which case the housings are made parallel by means of a jack-screw, or tie-rod, as the case may require, and then the arch is machined to suit. The arch is now bolted in place, and set to match the housings at L and M, after which it is pinned.

Assembling the Driving, Feed and Arch Members

The cross-rail, side-saddles, and the various driving and feed units are assembled in a department separate from the erecting department, and these parts usually are duplicated in quantities and come from the store-room to the erectors completely finished. In all cases where possible in assembling these units, standardization is provided for, and in this way much time is saved by the erectors avoiding unnecessary adjustments.

Referring back to Fig. 1, the feed box E is next bolted in place, and after assembling the driving shaft F with its members, and bolting on the bracket member G, the outboard bearing H is bolted in position. The arch bearing for the flywheel shaft I, already being secured in place, this shaft is red-leaded and tried in its bearings to test their alignment. When proper care is exercised in the aligning operations, very little scraping is necessary on these bearings.

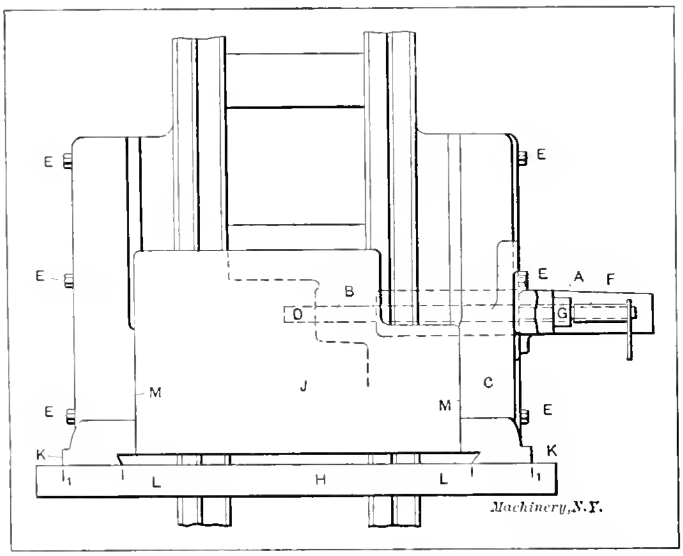


Fig. 10. Method of Setting the Housings. First the Front Housing is set for Alignment of Driving Shaft Bracket "A," then the Back Housing is brought into the Same Plane by means of Straightedge "H"

While work is proceeding in assembling the top works, elevating screws, and motors, other erectors are busy with the side-heads D, rocker mechanism J, and the feed mechanism for the side-heads and cross-rail; each unit is assembled in logical order, and as many operations as possible are carried on simultaneously. The planer is now ready for the cross-rail K and table L, preliminary work on these members being completed far enough ahead so as to cause no delay at this point.

The operations on the table consist of drilling and reaming the stop-pin holes, drilling and bolting on the rack, and rough scraping the tracks; the oil grooves were cut in the machining process. A large motor-driven multi-spindle drill is used for drilling and reaming the stop-pin holes. This machine carries sixteen spindles, arranged in two rows; one row of spindles carries the drills, and the other the combination mills and countersinks. After the first row of holes is drilled and the table is indexed along the space of one row, the combination mills and countersinks are inserted, and the sixteen tools are used simultaneously, thus producing very rapid work. The table is supported on a special truck running on a track between the drill uprights, and a suitable mechanism for moving and indexing the table completes the equipment. Previous to placing the table on the bed, the ways on the latter are also rough scraped, and then the bearing surfaces receive a coat of red lead which serves the double purpose of marking material and lubricant.

Laying Out and Setting the Cross-rail

The stud holes A for the cross-rail gibs are drilled in the manner shown in Fig. 5. As will be seen, spots are planed off at B which serve to square jigs C and C_1, and the holes for

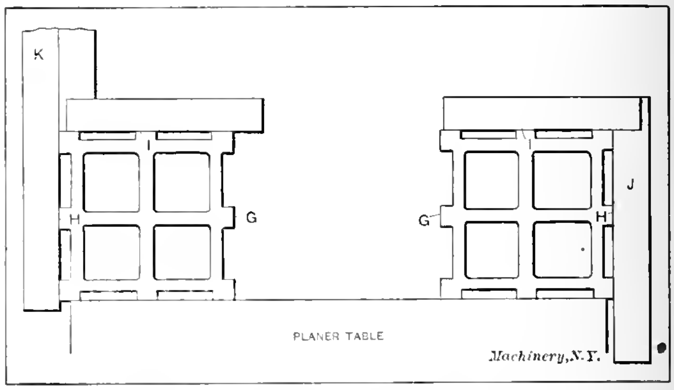


Fig. 11. Method of Testing Accuracy of "Planing Square" when using the Side-heads

the elevating screw nuts are utilized for clamping the jigs by means of bolts D. Endwise location of jig C is determined by matching the end of the cross-rail as shown; then jig C_1 is set by transferring the measurement from the housings by means of the wooden straightedge E. A flat scriber, shown at F and F_1, is used to mark lines on the straightedge which is chalked for this purpose, and when corresponding lines on the jigs coincide with those on the straightedge, jig C_1 is properly set.

When the studs are screwed in place and the back surface of the cross-rail is scraped, the cross-rail is placed in position on the planer and clamped by its gibs. Squaring the cross-rail with the housings is accomplished by holding the bar of a sweep in the angle M, Fig. 1, and applying an indicator to the front housing at N and N_1 (Fig. 1). The low end of the cross-rail is raised a sufficient amount by either moving the teeth in bevel gear O or O_1, as the case may require, in relation to its pinion, or by adjusting one of the nuts on the gear end of the elevating screws, final adjustment being obtained by the latter method. It is always better to raise the low end rather than lower the high end of the cross-rail, on account of the fact that this will take up any lost motion or backlash between the nuts, the feed-screws, and the housings. As the studs have 1/16 inch clearance in the gib, it is necessary to pin the latter after setting the cross-rail.

Final Test and Inspection

With the motors wired up, the belts in place, and the machine thoroughly oiled, the driving works are run for a while before moving the table into mesh with its rack gear, the idea being to prevent possible heating of the bearings by running without load. Next the table is brought into mesh and the bed is again carefully leveled in the same manner as before. When this is accomplished, the ways and tracks are scraped to a bearing, after which the ways are oiled and one or more cuts taken across the table to true it up for the purpose of testing the planer. A straightedge tried on the table crosswise, lengthwise, and across corners, is used to test the truth of the planing.

The side-heads are next tested for "planing square" by the method illustrated in Fig. 11. Two cast iron parallels G are clamped one on each side of the table as shown, and then light cuts are taken down faces H with tools in the side-heads.

Now, with the faces *H* clamped to the table, cuts are taken down faces *I*, after which the parallels are turned back to their original positions and a square tried as at *J*. To "prove" the square, it is used in connection with a straightedge (on the same parallel) as at *K*, any error detected between the blade of the square and the straightedge showing double the amount of actual error.

The accuracy of setting the cross-rail is now determined by taking a light cut across faces *I*, using a tool in one of the cross-rail heads, and testing with the square and straightedge as in the previous case. The object in making these tests is a precautionary measure, for by testing the planer under actual working conditions, the accuracy of the tests made during erection are thus proved.

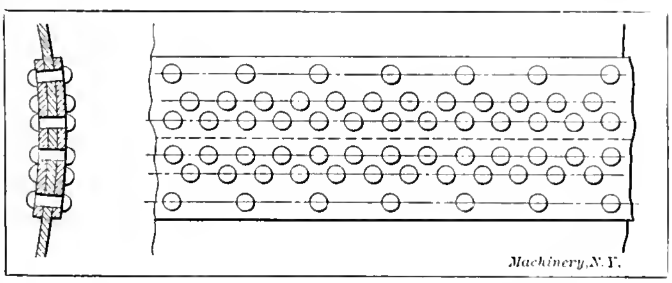
Final inspection includes running the cross-rail to the top of the housings to test the elevating mechanism and ascertain the fact that there is clearance between the cross-rail and arch. All gearing is tested for quiet and smooth running; the fits of all bearing surfaces are inspected; the slides and saddles are run by hand to test the parallelism of their ways and also the ease with which the slides operate, after which the power feed is applied and tested in various ways; the balance of the driving motor armature, and of the fly-wheels and pulleys also, receives careful inspection; in fact, no part is neglected and all errors must be within allowable limits of variation. All tests are made under the personal supervision of an inspector, who enters all data on a form prepared for the purpose, and this report bears the serial number of the planer, and is filed away for future reference.

As opportunity offered during erection, the filling, rubbing down, and priming has progressed, so that after inspection, all that remains to be done is to give the bright parts their final polish, and apply the last coat of paint.

* * *

LONGITUDINAL JOINT FOR BOILERS*

It has been generally accepted in this country that the best form of butted longitudinal riveted joint for boilers is that in which the inside strap is wider than the outside, and has one or more rows of rivets which pass through the shell and the inside strap beyond each edge of the outside strap. The pitch of the first row of outer rivets is double that of the rows that pass through both straps, and if there are other outer rows they may or may not have a still greater pitch. In England, where, until comparatively recently, boiler construction has been superior to ours, this form of joint appears to receive no recognition. It was first devised, as far as known, by Dr. E. D. Leavitt and Edward Kendall, both of Cambridge, Mass., and was first used in 1879 by Mr. Leavitt in some locomotive-type boilers designed by him for the Calumet & Hecla Mining Co. It is, of course, hazardous to state that this joint was never used before, and it is quite possible that it was used in England and discarded.



Recommended Type of Longitudinal Boiler Joint

While every boilermaker has for years been familiar with butt joints, this form made slow progress towards adoption in this country. One form of joint used to avoid the butt joint and get something as good was a lap joint with an inside strap bent at the edge of the lap and riveted on each side of it. This was used on locomotives exclusively, and was of little or no value, as it was simply a somewhat elastic bent tie connecting the two parts of the shell plate. Finally, and fortunately, this joint gave way to the butt joint first described. It has, however, been the author's opinion for some years that a one-sided boiler joint such as that first described, is also poor construction, and may sooner or later cause a crack in the plate. It is evident that unless the outside rivets fill the holes, they do very little good, and when they do fill them they form an overhung connection and to some extent possess, in themselves, the now recognized defect of the lap joint. Moreover the extended inside plate forms a bent connection between the different rivets at different distances from the center line of the joint.

In many cases designers have placed the outside rivets at a considerable distance from the edge of the outside strap, and this is constantly overdone. It is obvious, on careful thought, that the outside rivets should be as near the edge of the outside strap as practicable, thereby diminishing the bent-tie effect. In order to diminish this effect still further, and also to render the overhung rivets more effective, the inside strap should be thicker than usual, and this feature can hardly be overdone. The inside strap should be at least as thick as the shell plate, and great care should be taken to have the holes match and the rivets fill the holes.

When a joint of this kind is tested to destruction in a testing machine, it will be found to fail somewhat in detail, the inside strap bending slightly and the outside rivets being the last to rupture after yielding a little. In a boiler the joint would be weaker than a flat specimen on account of the bent-tie feature. This could be prevented if it were practicable to calk the inside strap as it would thereby be compelled to maintain the circular form. The theoretical efficiency of this joint is greater than of any other kind, but in practice the efficiency is not realized.

In order to avoid the defects of the one-sided butt joint, the author has adopted a joint with both straps of the same width, as illustrated in the accompanying engraving. This has the merit of having all rivets in double shear and the strains all taken care of in the best manner. The efficiency of this joint can hardly be above 84 or 85 per cent, while that of the one-sided joint can be theoretically 91 or 92 per cent; but the certainty that the efficiency of the former is realized in practice is ample compensation for the use of slightly thicker plates. The pitch of the outer rows of rivets is rather great, compelling the use of a thick outside strap in order to stand calking and remain steam-tight. An equally thick inside strap is used in order to diminish the bent-tie effect. This effect is small, however, as the rivets are all near the center of the joint. It can be eliminated by calking the inside strap, which is practicable with this joint, and is done in the best marine practice.

* Abstract of a paper by Mr. F. W. Dean read before the American Society of Mechanical Engineers, December meeting, 1909.

* * *

The manner in which samples of air at high altitudes are collected shows an interesting example of the methods employed by scientists for ascertaining facts which cannot be obtained by direct personal investigation. Samples of air at a height of nearly nine miles have recently been obtained and examined for the purpose of ascertaining the presence of rare gases. The collecting apparatus is carried by a large balloon and consists of a number of vacuum tubes, each drawn out to a very fine point at one end. At the desired height, an electromagnetic device connected with each tube, and operated by a barometer, breaks off the point of the tube, thus admitting the air. Within a few moments a second contact sends current through a platinum wire around the broken end, thereby melting the glass and sealing the tube. The samples thus obtained have shown the presence of argon and neon, but no helium was found in air above an altitude of six miles.

* * *

High speed steel has made a great improvement possible in the speed of threading dies on bolt machines. At the Atlantic City conventions of the Master Mechanics and Master Car Builders' Associations, the Landis Machine Co. exhibited a bolt threader equipped with a Landis high speed die, working at a cutting speed of from 45 to 55 lineal feet per minute. Rough bolts were threaded with startling rapidity, a two-spindle machine keeping a man busily employed all the time when threading 5/8-inch bolts with, say, 1 1/4 inch of thread. The actual time required for cutting the thread of this size and length was only about three seconds.

SHOP PHOTOGRAPHY*

R. F. KIEFER†

The writer has read with interest several articles on shop photography which have, from time to time, appeared in MACHINERY. However, some of these articles disagree, to some extent, and are not as complete as they might have been. This prompts the writer to describe the methods used by him during a ten year's experience in the taking of pictures. When these methods are carefully followed, there is practically no excuse for failure or for poor pictures.

The Camera

For general shop work a double extension camera, equipped with rising, falling and sliding front, swing and reversible back, is recommended. It should be fitted with a level. A small T-level, such as can be obtained for twenty-five cents, is preferable. The best size of camera is 5 × 7 inches. Anything larger is more or less cumbersome and heavy, and if pictures larger than 5 × 7 inches are required, it is a comparatively simple matter to enlarge them. On the other hand, cameras smaller than 5 × 7 inches are apt to require the enlarging of many pictures, and this, of course, would be too expensive. While the best lens is none too good, an anastigmat working at F 5.5 is as fast and good as ordinarily will be required. An automatic shutter is desirable. As regards plates, pictures can be taken rapidly on "fast" plates; the writer is now using a plate which requires only one-quarter to one-third the length of exposure required with the ordinary plate.

The Dark-room

The dark-room is not usually given the consideration which it requires, and this is a fruitful cause of poor pictures. The dark-room should be of ample size to permit working without being cramped for room. It should have red or ruby light for ordinary dark-room work, and opportunity for daylight for printing. Good ventilation is also important, because it is just as difficult to do good work at an excessive temperature in the dark-room as anywhere else. An ordinary desk fan can be placed in a ventilator and used as an exhaust fan. This is a satisfactory and economical arrangement. Cold, running water is essential, and hot water desirable, this latter because trays, graduates, etc., can be quickly washed with hot water, and will be perfectly clean, especially if a few drops of sulphuric acid be added to the water and the utensils left to soak a few minutes. They are then thoroughly rinsed with cold water. If this is frequently done, it will save many pictures which might otherwise be spotted, streaked or stained.

Halation

Halation, which spoils many otherwise good negatives, can be intelligently guarded against. The writer disagrees with a previous contributor who says that "negatives entirely free from halation are as easily and truly made upon glass plates as upon films." This is true only if the glass plate is specified as "non-halation."

In photographs of interiors, the strongest high-lights, such as the windows, or the brilliant polished portions of machinery which in some cases reflect light sufficiently to cause the same results, are almost always blurred at the edges. This is due to halation, or reflection from the inner surface of the glass. When we consider the difference in thickness of a glass plate and film, we can readily understand why films show less halation than glass plates.

In order to overcome halation when using glass plates, it is necessary either to use non-halation plates, or, if they cannot be procured, exceptional care must be used when employing ordinary glass plates. The article in the engineering edition of MACHINERY, January, 1909, entitled "Industrial Photography" gives some good hints in regard to the avoidance of halation when using glass plates. The covering up of windows, for instance, is there mentioned.

It might not be out of place to mention here that in few, if any, shops are the windows kept as clean as they might be, and this fact alone is often of advantage. This is the only place in photography where dirt in any shape is desirable. Even with dirty windows, however, a picture should not be taken with the camera pointing directly toward the light. If a machine, for instance, is placed on the east side of the building, and we must take our picture from the west side, the picture should not be taken in the morning but rather in the late afternoon, at which time the light will be strongest behind the camera, and a much better picture will result. Furthermore, if choice of time is possible, take the picture when

TABLE I. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS

Interiors; Dark-colored Objects

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min.	6 min.	8 min.	10 min	12 min.	15 min.	20 min.	30 min.
F- 5*	2†	3/5	4/5	1⅕	1½	1¾	2¼	2⅜	2½	3	3¾	4½	5	7½	8½	10	12	15	18	20	30	38	45	48	1⅕	1¾
F- 8	4	1⅕	1¾	2½	3	3¼	4½	4¾	5	6	7½	9	10	15	18	20	25	30	38	45	1	1¼	1½	1½	2½	3¾
F-11	8	2½	3¾	5	6½	7½	9	9½	10	13	15	18	20	30	38	45	52	1	1¼	1½	2	2½	3	3¾	5	7½
F-16	16	5	7½	10	12½	15	18	20	20	25	30	36	45	1	1¼	1½	1¾	2	2½	3	4	5	6	7½	10	15
F-22	32	10	15	20	25	30	36	45	45	50	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	15	20	30
F-32	64	20	30	45	52	1	1¼	1½	1½	1¾	2	2½	3	4	5	6	7	8	10	12	16	20	24	30	45	60
F-45	128	45	1	1½	1¾	2	2½	3	3	3½	4	5	6	8	10	12	14	16	20	24	32	40	48	60	90	120
F-64	256	1½	2	3	3½	4	5	6	6	7	8	10	12	16	20	24	28	32	40	48	60	80	96	120	180	240

* British system. † United States System. Figures beneath heavy lines signify minutes; those above, seconds

TABLE II. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS

Interiors; Objects of Average Colors

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min.	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min	6 min	8 min.	10 min.	12 min.	15 min.	20 min.	30 min.
F- 5	2	2/5	3/5	4/5	1	1⅕	1¼	1½	1¾	2	2⅖	3¼	3¾	5	6¼	7½	9	10	13	15	20	26	30	36	48	1⅕
F- 8	4	9/10	1⅕	1¾	2	2⅖	3	3½	3¾	4	5	6½	7½	10	12½	15	18	20	25	30	45	52	1	1⅕	1¾	2½
F-11	8	1¾	2⅖	3¾	4¼	5	6	7½	7½	9	10	13	15	20	25	30	38	45	52	1	1½	1¾	2	2½	3¾	5
F-16	16	3¾	5	7½	9	10	13	15	15	18	20	25	30	45	52	1	1¼	1½	1¾	2	3	3½	4	5	7½	10
F-22	32	7½	10	15	18	20	25	30	30	40	45	50	1	1½	1¾	2	2½	3	3½	4	6	7	8	10	15	20
F-32	64	15	20	30	36	45	50	1	1	1¼	1½	1¾	2	3	3½	4	5	6	7	8	12	14	16	20	30	45
F-15	128	30	45	1	1¼	1½	1¾	2	2	2½	3	3½	4	6	7	8	10	12	14	16	24	28	32	45	60	90
F-64	256	1	1½	2	2½	3	3½	4	4	5	6	7	8	12	14	16	20	24	28	32	48	56	64	90	120	180

Figures beneath heavy lines signify minutes; those above, seconds.

* The following articles relating to shop photography and kindred subjects have previously been published in MACHINERY: Shop Photography, November, 1906; Photographing Drawings, April, 1907; Photographs for Illustration, September, 1907; Photographing Drawings, October, 1907, engineering edition; Shop Photography, December, 1907; Vertical Camera Bracket, February, 1908; Correcting Perspective in Shop Photography, February, 1908; Shop Photography, December, 1908; Industrial Photography, January, 1909, engineering edition; Shop Photography, February, 1909; Universal Camera Bracket, April, 1909.

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the light is the softest or most even, so that the harsh contrasts which are apt to give the soot and whitewashed effects, are avoided. A reasonably soft light, long exposure with small diaphragm, and careful development, will give much better results than strong light, short exposure, and large diaphragm.

The operation of placing the dry plates in the plate holders is usually spoken of as "loading" the holder. Attention should be called to the advisability of cleaning the plate at this time. A soft camel's hair brush should be kept for this purpose only, and all plates should be carefully dusted before closing the slide, so as to remove all particles of dust which would

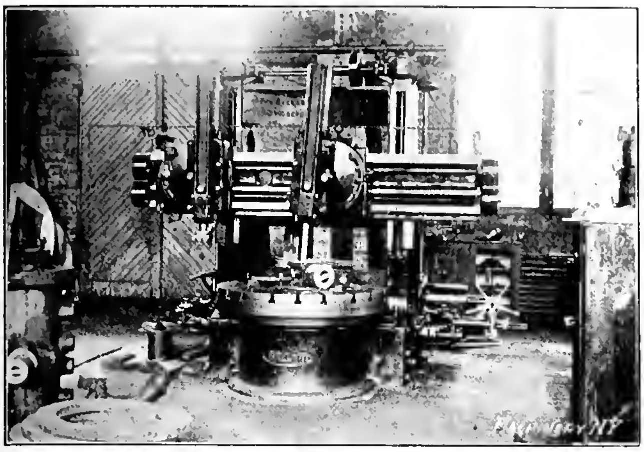

Fig. 1. Photograph taken 4.45 P. M. Diaphragm No. 32, Exposure 45 Seconds. Camera pointed toward the Light

cause spots in the finished picture. The plate holder as well as the slides should also be thoroughly dusted.

Focusing

In shop photography a different result is required than in portrait work, where "softness" is wanted. In machine photographs sharp lines are required. It is advisable to focus with the diaphragm set at No. 4, and after the image is as sharp and clear as possible, adjust to No. 16 or No. 32. This will give a much clearer picture and is well worth the extra length of exposure.

Exposure

A realization of the relation between the light, exposure and development, only comes to the photographer by experience and by a study of his prints. Correct exposure is only a relative term. Approximately correct is about as near as one can get to proper exposure in shop work. Experience and a certain amount of judgment enter into the decision as to the correct length of time. The exposure tables accompanying

Fig. 2. Photograph taken 4.55 P. M. Diaphragm 64, Exposure 2 minutes. Camera not pointed directly toward the Light

this article will, therefore, be found convenient, and if the directions for their use, given in the following, are faithfully followed, very few pictures will be spoiled on account of improper exposure. It is, of course, desirable that the length of exposure be as near correct as possible, as this will tend to make the general average of the results better.

The method the writer uses in arriving at the decision in regard to the length of time for exposure is as follows: Take a fresh strip of standard "printing-out" paper—"Disco," manufactured by the Defender Photo Supply Co., "Solio," manufactured by the Eastman Co., or "Actinos," manufactured by the Lumiere N. A. Co.—and fold it over so that it covers itself in a way to expose only a small portion to the light. This paper should be kept covered until we are ready to take the photograph. Then hold the paper as nearly as possible where the average intensity of light strikes the machine. Uncover it and note the time required for discoloring the exposed portion of the paper so that it just presents a plainly discernible difference from the unexposed portion. This may require anywhere from two or three seconds to half an hour, depending, of course, upon the intensity of the light. In a medium light, from ten to forty seconds will suffice. This length of time is now our "time factor," and by referring to the accompanying exposure tables, it is easy to see what use is to be made of it.

The photograph shown in Fig. 1 was taken at 4.45 in the afternoon, and some halation can be noticed, but this can be overcome to a certain extent by printing the picture somewhat longer. In so doing, however, more or less detail will be lost. Solio paper was used to determine the light factor, which was forty-five seconds; diaphragm No. 32, U. S. system, was used. The machine photographed was painted with the ordinary black color of machine tools; therefore, the required length of exposure is found in Table I, for dark-colored objects, in the column headed "45 seconds" and in the line denoted "F 22 Diaphragm 32" in the left-hand column. The required time of exposure thus is found to be forty-five seconds.

When the photograph, Fig. 2, was taken, "Disco" paper was used to determine the light factor, which in this case was one

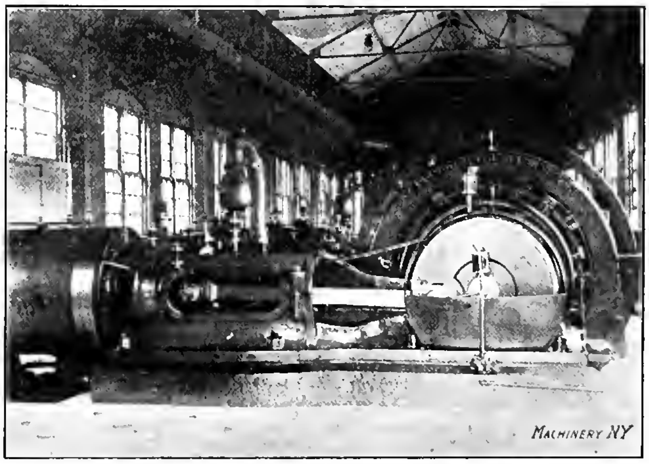

Fig. 3. A Picture taken on a Stormy Day, 11 A. M., with the Plate Reversed in the Holder, thus Reversing the Picture, but Avoiding Halation

minute. No. 64 diaphragm was used, and the length of the exposure was determined from the table in the same way as in Fig. 1, the time required being two minutes, as found in the vertical column headed "one minute" and in the horizontal line denoted "F 32 diaphragm 64." Comparing Figs. 1 and 2 a great difference is noticeable in regard to the tendency toward halation. Fig. 2 was exposed at 4.55 P. M., just ten minutes later than Fig. 1, both pictures being taken in the same shop on the same day. Fig. 1, however, was taken with the camera pointing directly toward the windows, while in Fig. 2 the windows are in a diagonal direction from the camera, this being the cause of the difference. In Fig. 2 the windows at the extreme left are very clear and distinct, while that toward the right, more nearly in front of the camera, shows a very distinct halation. This experiment proves conclusively the advantage of avoiding pointing the camera directly toward the light.

Fig. 3 was taken about eleven o'clock A. M., the sun shining very brightly. While this negative is fully timed there is practically no tendency toward halation. All these pictures were taken on plates. The reason that no halation is shown in Fig. 3, however, is disclosed by looking at the name-plate of the generator, which is reversed, or shows as it would in a mirror. This picture was taken "through the glass," that is, the plate was put into the plate-holder with the glass side out, which, of course, is the reverse of the usual method

This, however, bears out the explanation of halation as being governed by the thickness of the glass plate. The same view taken two minutes later with the camera in the same place with the same length of exposure and the same diaphragm, but with the plate in the holder in the usual way was very badly affected by halation. A non-halation plate would, of course, in this case do away with the difficulty.

The exposure tables (Tables I and II) are intended for the following brands of plates and films: Ansco Film; Cramer Crown; Cramer Instantaneous Iso; Cramer Tri; Defender King Eastman Film; Eastman Extra Rapid; Forbes Instantaneous; Hammer; Kodoid; Lumiere Blue Label; Lumiere Ortho A; Lumiere Ortho B; Lumiere Panchro C; Lumiere Non-Halation Simplex Ortho A; Monarch; Pacific; Premo Film Pack; Record; R. O. C.; Seed 27; Standard Imp.; Standard Ex.

Lumiere New (Sigma) Σ and Lumiere Non-Halation Simplex (Sigma) Σ require but one quarter the time specified in the tables.

Seed 26 x; Cramer Banner; Hammer Non-Halation; and Hammer Fast, require about one-half longer exposure than the tables call for.

Development

Assume that the plate has been exposed and that we are now back in the dark-room, ready to develop the plate. Before doing so, dust the plate again carefully with a camel's hair brush to remove any particles of dust that may have settled upon the plate when the slide was reversed after the exposure. Almost any developing agent will make a picture on a properly exposed negative, yet the writer has found it advisable to use a developer such as recommended by the manufacturer of the plate used. The development is a comparatively simple operation if undertaken in the proper manner. The most desirable color in a negative is a warm black, with possibly a slight tint of yellow through the image. The development should be carried only to the point where the highest lights are of a sufficient transparency to print details. This kind of negative prints quickly, and will be found the most satisfactory for printing on any class of paper. The temperature of the developer should never be allowed to rise above 70 degrees F. or fall below 65 degrees F. An all-glass dairy or bath thermometer, which can be purchased for about thirty cents, is very necessary for all dark-rooms. A too-cool developer produces thin negatives which have the appearance of being under-exposed. A too-warm developer, on the other hand, produces a heavy flat appearance in the negatives.

Table III, for which the writer is indebted to the M. A. Seed Dry Plate Co., gives the proportions of various developers. The numbers in the column headed "Factor" may require some explanation. The "factoral" system of development is a desirable one to use, exceedingly simple in its application, and insures the bringing out of everything that is in the negative. This system is based on the fact that no matter what the exposure, the development proceeds at the regular rate, and the time elapsing from the moment when the plate is placed in the developing solution until the appearance of the first high-lights of the image is a certain proportion of the total time required for the development. Suppose we are using Dianol developer, the factor of which is 18. The first high-lights appear twenty seconds after the plate has been placed in the solution. Then 18×20 seconds or 6 minutes total time is required for the complete development. When developed, the plate is removed from the developer, rinsed in fresh water and placed in the fixing bath.

A number of formulas for other common developing solutions with their factors are given below:

Pyro—Developing Factor 12

A. Pure water, 16 oz.; pyro, 1 oz.; oxalic acid, 10 gr.

B. Pure water, 16 oz.; sulphite of soda, 2 oz.

C. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use one ounce each of the solutions A, B and C, and add seven ounces pure water.

Eikonogen Hydrochinon—Developing Factor 12

A. Pure water, 48 oz.; sulphite of soda, 2 oz.; eikonogen, 240 gr.; hydrochinon, 60 gr.

(For more contrast, the quantity of water in the solution may be reduced to 32 ounces. Use boiling water. In cold weather a little glycerine will prevent precipitation.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use three ounces of solution A and one ounce of solution B.

Metol-hydrochinon—Developing Factor 15

A. Pure water, 64 oz.; metol, 120 gr.; hydrochinon, 120 gr.; sulphite of soda, 2 oz.

(Dissolve in the order given. Metol, to prevent precipitation, should always be dissolved in water before the sulphite is added.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

TABLE III. DEVELOPERS WITH VARIOUS AGENTS

	A			B			Use			
	Pure Water	Seed's Sulphite	Developing Agent	Pure Water	Seed's Carbonate	Potassium Bromide	A	B	Pure Water	Factor
	oz.	oz.	gr.	oz.	oz.	gr.	oz.	oz.	oz.	
Metol*	16	1	120	8	1	..	4	1	5	25
Eikonogen	24	1	150	16	1	..	3	1	..	10
Hydrochinon**	16	1	160	16	2	80	1	1	..	4
Edinol	16	2	80	8	1	..	2	1	..	12
Tolidol	16	1	160	16	1	..	1	1	2	7
Glycin**	32	1	320	48	6	..	2	3	..	8
Imogen	16	1	240	24	3	..	2	3	..	7
Dianol	32	¼	40	..	..	..	..	..	..	18
Amidol	24	½	40	No alkali needed					..	30
Rodinal	To ¼ oz. add 10 oz. water								..	30

* Dissolve metol in water before adding sulphite.

** For hydrochinon and glycin use potassium carbonate and dissolve glycin in hot water. Hydrochinon is a contrast formula for over-exposed plates and for black and white line work. It is not suitable for ordinary use.

If crystal sodas are used, add 15 grains of bromide of potassium to 16 ounces of solution B.

To make the developing solution, use four ounces of solution A, one ounce of solution B, and four ounces of pure water.

Acid Fixing Bath

A. Pure water, 96 oz.; hypo, 2 pounds; C. P. sulphite of soda, 2 oz.

B. Pure water, 32 oz.; chrome alum, 2 oz.; C. P. sulphuric acid, ¼ oz.

See that the chemicals are entirely dissolved, and then pour solution B into A slowly while stirring A rapidly.

Clearing Solution for Pyro Stains

Iron sulphate, 3 oz.; water, 16 oz.; sulphuric acid, ¼ oz.; alum, 1 oz.

Fixing

The fixing of a plate after development is so simple a matter that it is hardly necessary to more than advise the use of an acid-hypo fixing solution for plates, especially in the summer time, in place of the ordinary plain fixing bath. The plates should remain in the hypo bath for ten minutes after all white has dissolved from the reverse side of the negative. Then it should be well washed, say for one hour, preferably in running water.

Before allowing the plates to dry, the film side should be gently and carefully wiped with a wad of absorbent cotton to remove any "specks" which may be on the negative. This is very important, particularly when the water is very hard, as the film side collects a sediment when having been washed for some time, and if it is not removed before the negative is dry, it makes it unfit for printing. After having wiped the surface of the plate, rinse it thoroughly, and set it to dry in a ventilated place free from dust.

Negatives, when drying, should always be so placed that a current of air can pass around, over, and between them. The warmer this current of air is, the more intense the negative will be, and *vice versa*. Never change the location or position of a negative during the time it is drying, as marks and spots are almost sure to appear, owing to the fact that different conditions of air produce a difference in the intensity of the negative.

HARDENING CARBON STEELS*

H. RALPH BADGER†

Originally the name steel was applied to various combinations of iron and carbon, there being present, together with these, as impurities, small proportions of silicon and manganese. At the present time, however, the use of the name is extended to cover combinations of iron with tungsten, vanadium, nickel, chromium, molybdenum, titanium and some of the rarer elements. These latter combinations are quite generally known as the *alloy* steels to distinguish them from the *carbon* steels, in which latter the characteristic properties are dependent upon the presence of carbon alone. The alloy steels are divided into the high-speed steels and the Mushet or air-hardening steels. The specific properties that distinguish these different steels are due in part to their respective compositions, that is, to the particular elements they contain, and, in part, to their subsequent working and heat treatment.

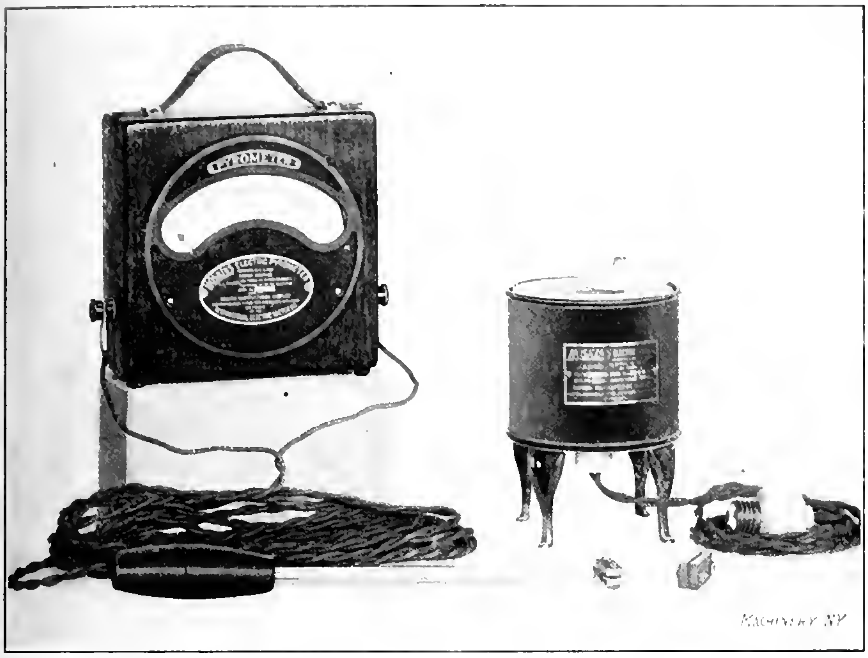

Fig. 1. Hoskins Electric Heating Furnace and Pyrometer used for ascertaining the Decalescence and Recalescence Points of Steel

Effect of Difference in Composition of Steel

In general, any change in the composition of a steel results in some change in its properties. For example, the addition of certain metallic elements to a carbon steel causes, in the alloy steel thus formed, a change in position of the proper hardening temperature point. Tungsten or manganese tend to lower this point, boron and vanadium to raise it; the amount of the change is practically proportional to the amount of the element added. Just as a small proportion of carbon added to iron produces steel which has decidedly different properties than those found in pure iron, so increasing the proportion of carbon in the steel thus formed, within certain limits, causes a variation in the degree in which these properties manifest themselves. For example, consider the property of tensile strength. In a "ten-point" carbon steel (one in which there is present but 0.1 per cent of carbon) the tensile strength is very nearly 25 per cent greater than that of pure iron. Adding more carbon causes the tensile strength to rise, approximately, at the rate of 2.5 per cent for each 0.01 per cent of carbon added.

Carbon steels are divided into three classes according to the proportion of carbon which they contain. The first of these embraces the "unsaturated" steels, in which the carbon content is lower than 0.89 per cent; the second, the "saturated" steels, in which the proportion of carbon is exactly 0.89 per cent; and, the third, the "supersaturated" steels, in which the carbon content is higher than 0.89 per cent.

Effect of Heat Treatment

With a steel of a given composition, proper heat treatments may be applied which, of themselves, will first alter in form or degree some of its specific properties, or second, practically eliminate one or more of these, or third, add certain new ones. Physical properties of size, shape and ductility are examples of the first case; an example of the second case is found in the heating of steel beyond its hardening temperature, which takes away its magnetism, making it non-magnetic; and an example if the third case is the fact that a greater degree of hardness may be added to steel by the process of hardening. In this connection it must be understood that, strictly speaking, hardness is a relative term and all steel has some hardness.

There are three general heat treatment operations, so considered; forging, hardening—with which this article will deal—and tempering. In all of these the object sought is to change in some manner the existing properties of the steel; in other words, to produce in it certain permanent conditions.

The controlling factor in all heat treatment is temperature. Whether the operation is forging, hardening or tempering, there is for any certain steel and particular use thereof a definite temperature point that alone gives the best results in working it. Insufficient temperatures do not produce the results sought. Excessive temperatures, either through ignorance of what the correct point is, or through inability to tell when it exists, cause "burned" steel; this is a common failing, resulting in great loss. Very slight variations from the proper temperature may do irreparable damage.

Due to temperature variation alone, carbon steel may be had in any of three conditions: first, in the unhardened or annealed state, when not heated to temperatures above 1,350 degrees F.; second, in the hardened state, by heating to temperatures between 1,350 and 1,500 degrees F.; third, in a state softer than the second though harder than the first, when heated to temperatures which exceed 1,500 degrees F.

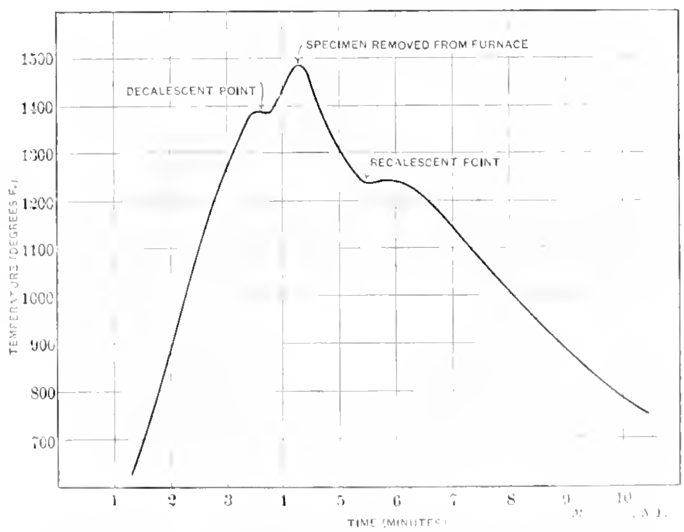

Fig. 2. Diagram showing the Relation between Time and Temperature when heating Steel, and the Critical Temperatures of One-point Carbon Steel

The Hardening Process

The hardening of a carbon steel is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. In the different carbon steels this change, for practical purposes, is effective only in those in which the proportion of carbon is between 0.2 per

* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: Steel and its Treatment, September, October, November and December, 1902, and January, 1903; Pyrometers with Special Reference to the Morse Heat Gage, February, 1904, engineering edition; A New Hardening Furnace, January, 1905, engineering edition; Hardening without Cracking, February, 1906; Method of Hardening Thin Milling Cutters, July, 1907; The Gaging of Heats for Hardening, April, 1908; Indicator for Ascertaining Hardening Temperatures, June, 1908, engineering edition; Local Hardening and Tempering, August, 1908; A Modern Steel Hardening Plant, November, 1908; Temper Colors and Temperatures and Colors for Hardening, December, 1908; Westmacott Hardening and Annealing Furnace, March, 1909; The Heat Treatment of Steel, April, 1909; Leeds and Northrup Hardening and Annealing Pyrometer, June, 1909; and Recalescence and its Relation to Hardening, October, 1909.

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cent and 2.0 per cent, that is, between "twenty-point" and "two" carbon steels, respectively.

When heated, ordinary carbon steels begin to soften at about 390 degrees F. and continue to soften throughout a range of 310 degrees F. At the point 700 degrees F. practically all of the hardness has disappeared. "Red hardness" in a steel is a property which enables it to remain hard at red heat. In a high-speed steel this property is of the first importance, 1,020 degrees F. being a minimum temperature at which softening may begin. This is some 630 degrees F. above the point at which softening commences in ordinary carbon steels.

The process of hardening a steel is best carried out in a closed furnace. Of the many sources of energy capable of producing the required heat, electricity offers the most attractive advantages. The electric resistance furnace, as now built in a variety of sizes of either muffle or tube chamber types, has one fundamental point of superiority over all coal, coke, gas, or oil-heated furnaces. It is entirely free from all products of combustion, the heat heing produced by electrical resistance. This is important. It does away with the chief cause of oxidation of the heated steel. Further, the temperature of the electric furnaces can be easily and accurately regulated to, and maintained uniform at, any desired point. When electric power is generated for other purposes, the increased cost of this form of energy for operating furnaces is not sufficient to argue against it. Even when the current is purchased, the superior quality of work performed by this kind of furnace frequently more than offsets the slightly higher cost of operation.

In the actual heating of a piece of steel, several requirements are essential to good hardening: first, that small projections or cutting edges are not heated more rapidly than is the body of the piece, that is, that all parts are heated at the same rate, and second, that all parts are heated to the same temperature. These conditions are facilitated by slow heating, especially when the heated piece is large. A uniform heat, as low in temperature as will give the required hardness, produces the best product. Lack of uniformity in heating causes irregular grain and internal strains, and may even produce surface cracks. Any temperature above the "critical point" of steel tends to open its grain—to make it coarse and to diminish its strength—though such a temperature may not be sufficient to lessen appreciably its hardness.

Critical Temperatures

The temperatures at which take place the previously mentioned internal changes in the structure of a steel are frequently spoken of as the "critical points." These are different in steels of different carbon contents. The higher the percentage of carbon present, the lower the temperature required to produce the internal change. In other words, the critical points of a high carbon steel are lower than those of a low carbon steel. In steels of the commonly used carbon contents, there are two of these critical temperatures, called the *decalescence* point and the *recalescence* point, respectively.

The decalescence point of any steel marks the correct hardening temperature of that particular steel. It occurs while the temperature of the steel is rising. The piece is ready to be removed from the source of heat directly after it has been heated uniformly to this temperature, for then the structural change necessary to produce hardness has been completed. Heating the piece slightly more may be desirable for either or both of the two following reasons. First, in case the piece has been heated too quickly, that is, not uniformly, this excess temperature will assure the structural change being complete throughout the piece. Second, any slight loss of heat which may take place in transferring the piece from the furnace to the quenching bath may thus be allowed for, leaving the piece at the proper temperature when quenched.

If a piece of steel which has been heated above its decalescence point be allowed to cool slowly, it will pass through a structural change, the reverse of that which takes place on a rising temperature. The point at which this takes place is the recalescence point and is lower than the rising critical temperature by some 85 to 215 degrees. The location of these points is made evident by the fact that while passing through them the temperature of the steel remains stationary for an appreciable length of time. It is well to observe that the lower of

Fig. 3. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1900 Degrees F.

Fig. 4. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1750 Degrees F.

Fig. 5. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1600 Degrees F.

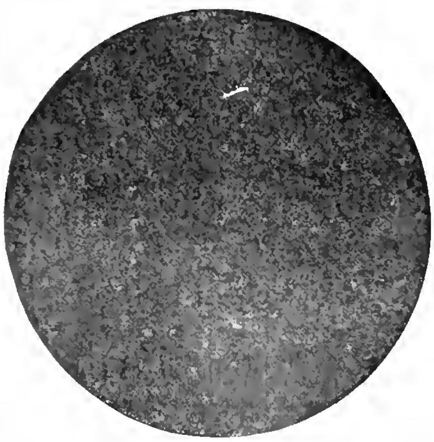


Fig. 6. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1510 Degrees F.

Fig. 7. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1425 Degrees F.

Fig. 8. Micro-photograph (Magnified 22 Diameters) of Steel Quenched at 1385 Degrees F., or 5 Degrees above the Decalescence Point

these points does not manifest itself unless the higher one has been first fully passed. As these critical points are different for different steels, they cannot be definitely known for any particular steel without an actual determination. While heating a piece of steel to its correct hardening temperature produces a change in its structure which makes possible an increase in its hardness, this condition is only temporary unless the piece is quenched.

Quenching

The quenching consists in plunging the heated steel into a bath, cooling it quickly. By this operation the structural change seems to be "trapped" and permanently set. Were it possible to make this cooling instantaneous and uniform throughout the piece, it would be perfectly and symmetrically hardened. This condition cannot, however, be realized, as the rate of cooling is affected both by the size and shape of the treated piece; the bulkier the piece, the larger the amount of heat that must be transferred to the surface and there dissipated through the cooling bath; the smaller the exposed surface in comparison with the bulk, the longer will be the time required for cooling. Remembering that the cooling should be as quickly accomplished as possible, the bath should be amply large to dissipate the heat rapidly and uniformly. Too small a quenching bath will cause much loss, due to the resulting irregular and slow cooling. To insure uniformly quenched products, the temperature of the bath should be kept constant, so that successive pieces immersed in it will be acted upon by the same quenching temperature. Running water is a satisfactory means of producing this condition.

Fig. 9. Micro-photograph of Steel Quenched at 1380 Degrees F. or when just reaching the Decalescence Point

The composition of the quenching bath may vary for different purposes, water, oil or brine being used. Greater hardness is obtained from quenching, at the same temperature, in salt brine and less in oil, than is obtained by quenching in water. This is due to a difference in the heat-dissipating power possessed by these substances. Quenching thin and complicated pieces in salt brine is unsafe as there is danger of the piece cracking, due to the extreme suddenness of cooling thus produced.

In actual shop work the steel to be hardened is generally of a variety of sizes, shapes and compositions. To obtain uniformity both of heating and of cooling, as well as the correct limiting temperature, the peculiarities of each piece must be given consideration in accordance with the points outlined above. In other words, to harden all pieces in a manner best adapted to but one piece would result in inferior quality and possible loss of all except this one. Each different piece must be treated individually in a way calculated to bring out the best results from it.

Theory of Critical Points

The presence of the critical points in the heating and cooling of a piece of steel is a phenomenon. The most reasonable explanation is as follows:

While heating, the steel uniformly absorbs heat. Up to the decalescence point all of the energy of this heat is exerted in raising the temperature of the piece. At this point, the heat taken on by the steel is expended, not in raising the temperature of the piece, but in work which produces the internal changes here taking place between the carbon and the iron. Hence, when the heat added is used in this manner, the temperature of the piece, having nothing to increase it, remains stationary, or, owing to surface radiation, may even fall slightly. After the change is complete, the added heat is again expended in raising the temperature of the piece, which increases proportionally.

When the piece has been heated above the decalescence point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the recalescence point is reached, the temperature falls uniformly. Here the internal relation of the carbon and iron is transformed to its original condition, the work required to do this being converted into heat. This heat, set free in the steel, supplies, for the moment, the equivalent of that being radiated from the surface, and the temperature of the piece ceases falling and remains stationary. Should the heat resulting from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling but will obviously rise slightly at this point. In either event the condition exists only momentarily, but when the carbon and iron constituents have resumed their original relation, the internal heating ceases, and the temperature of the piece falls steadily, due to surface radiation.

Apparatus for Determining the Critical Point

From the foregoing sections it is evident, first, that there is a definite temperature at which any carbon steel should be hardened, and, second, that there results great loss, both of labor and material, unless the hardening is carried out at this temperature. The actual shop problem thus presented is to determine readily and accurately the correct hardening temperature for any carbon steel that may be in use. This can be done by the use of various types of pyrometers; the apparatus illustrated in Fig. 1, which is made by the Hoskins Mfg. Co., of Detroit, Mich., is well adapted for the purpose. This apparatus consists of a small electric furnace in which to heat a specimen of the steel to be tested, and a special thermo-couple pyrometer for indicating the temperature of this specimen throughout its range of heating. The specimen itself should be properly shaped for clamping to the thermo-couple.

The furnace may be operated on either alternating or direct current circuits. The furnace chamber is 2 1/16 inches in diameter and 2½ inches deep. Heat is produced by means of the resistance offered to the passage of an electric current through the "resistor" or heating element which in the form of wire is wound in close contact with the chamber lining. The furnace is designed so that it can be used on standard lighting circuits to which ready connection is made with a twin conductor cord and lamp plug. In operation, it consumes 3½ amperes at 110 volts, and is capable of producing a chamber temperature of 1,830 degrees F., which is considerably higher than required for a carbon steel.

The pyrometer consists of a thermo-couple, connecting leads and indicating meter. The thermo-couple is of small wire so as to respond quickly to any slight variation in temperature. The welded end of this couple is slightly flattened to enable a good contact between it and the steel specimen. The meter is portable and indicates temperatures up to 2,552 degrees F.

The specimen of the steel to be tested should be small, so as to heat quickly and uniformly. A well-formed specimen is made with two duplicate parts, each 1¼ inch long x ½ inch wide x ¼ inch thick. The pieces are clamped by means of two ¼-inch bolts, one on each side of the welded part of the extreme end of the thermo-couple. Care is taken to form a tight contact, though not to cause an undue strain on the couple. The dimensions here given for the test specimen are not essential, though convenient; any pieces which will permit of tight contact with the thermo-couple and of readily heating in furnace chamber, may be used.

With the specimen fastened to the couple as just described, the furnace is connected in circuit and the cover placed over the chamber opening. The temperature within the chamber rises steadily. When it becomes 1,700 degrees F. the end of the couple, with specimen attached, is inserted in the chamber. The steel specimen rapidly heats, its temperature being constantly the same as that of the welded junction of the thermo-couple, due to the intimate contact between them. This temperature, indicated by the meter, will rise uniformly until the decalescence point of the steel tested is reached. At

this temperature the indicating needle of the meter becomes stationary, the added heat being consumed by internal changes. These changes completed, the temperature again rises, the length of the elapsed period of time depending upon the speed of heating. With the furnace temperature kept nearly constant at the initial point, here given as 1,700 degrees F., this "speed of heating" will be such as to allow of readily observing the pause in motion of the needle. The temperature at which this occurs should be carefully noted.

To obtain the lower critical point, the temperature of the piece is first raised above the decalescence point by about 105 degrees F. In this condition it is removed from the furnace and rested on top to cool. The decrease of temperature is at once noticeable by the fall of the meter needle. At a temperature somewhat below the decalescence point, varying with the composition of the steel, as previously mentioned, there is again a noticeable lag in the movement of the needle. The temperature at which the movement ceases entirely is the recalescence point. Immediately following there may occur a slight rising movement of the needle, as previously explained.

During these intervals of temperature lag, both during the heating and cooling of the steel, there may occur a small fluctuation in the temperature. In order to get results that are comparable, a definite point in each of these intervals should be considered each time a test is made. Hence, both the decalescence and recalescence temperatures are taken as the points at which the needle first becomes stationary. As all operations of heat treatment of a steel center around its critical point, the importance of knowing these exactly is realized; to make certain, each test should be checked by a second reading. The time required for this is small. A close agreement of two succeeding readings will give assurance of the correctness of the determination.

Results Obtained from Sample Specimens

In order to show graphically the necessity of working carbon steels at the proper temperature points, a series of specimen pieces of the same steel were treated at different temperatures. The steel used contained exactly 1 per cent carbon, that is, it was a "one-point" steel. A number of test specimens were made of this from adjacent parts of the same bar.

First the critical points of this steel were determined. Temperatures were recorded throughout both the heating and cooling. In the diagram, Fig. 2, these values have been plotted. The curve shows grapically the location of the critical points, and also the slight fall or rise of temperature, as the case may be.

With this data obtained, seven specimens of the same steel were heated, in the electric furnace, each to a different temperature. As these pieces were removed from the furnace they were immediately quenched in water. The temperature of the quenching bath was held constant at 45 degrees F. The hardened pieces were then broken at right angles and the fractured surface of each was photographed under a microscope. These photographs are reproduced in Figs. 3 to 9 in the same size as the originals. Due to magnification, the first five of these engravings represent a circular area, the actual diameter of which is but 0.05 inch; while the piece illustrated in Fig. 8 is of 0.1 inch diameter.

An inspection of these shows at once the serious effects on its structure, and hence on its strength, of overheating a piece of steel. The micro-photograph of specimen No. 1, Fig. 3, shows a very badly "burned" steel, as is evidenced by the extreme coarseness of its grain. Specimen No. 2, Fig. 4, hardened at 150 degrees F. lower temperature, shows less coarseness, but is still badly "burned." The succeeding specimens, Figs. 5, 6 and 7, show a gradual improvement, as the temperature at which they were hardened approaches the decalescence point of the steel. Specimen No. 6, Fig. 8, was quenched just after the hardening change in its structure had become complete, at 5 degrees F. above the critical temperature. The very fine grain and closely woven texture of this fracture show a properly hardened steel, one which has both the desired hardness and the maximum tensile strength.

Specimen No. 7, Fig. 9, was hardened just as the temperature reached the decalescence point. This shows clearly the direction in which the hardening moves, namely, from the exterior toward the interior. This would naturally be expected as the temperature of the surface, which is exposed directly to the source of heat, reaches the critical point first. This illustration shows that the structural change has been completed only in the surface layer of the specimen. Here the grain is fine and the steel hardened, while the interior is still in the unhardened state. This condition indicates the necessity of heating the piece uniformly.

While 1,900 degrees F., the temperature at which the Specimen No. 1, Fig. 3, was hardened, represents, of course, a very excessive heat, yet it is not infrequent that carefully machined parts are ruined by overheating even to this degree. The practice of guessing at hardening temperatures can only result in uncertainty.

Conclusions

The hardening of carbon steels for highest quality and greatest saving entails, then, three things. First, a definite knowledge of what constitutes the correct temperature at which to harden the steel. The second point necessitates a positive means of accurately determining this hardening temperature for any carbon steel. The third consideration is that the correct hardening temperature, once determined, is actually carried out in the hardening work. A simple and effective way of doing this is by checking the temperature of the hardening furnace by means of a pyrometer. When there is a large quantity of work to be hardened, economy dictates a permanent installation of pyrometers. The convenience of such installations is manifest. A thermo-couple is placed in each furnace. A number of these, from three to sixteen, depending upon individual conditions, are connected by wire leads, through a selective switch to one meter. By a turn of the switch, the temperature of any furnace may be read at once from the meter. This makes it possible for the foreman to know definitely, at a single point, the temperatures of all of the hardening furnaces in use.

* * *

An aerial exhibition was opened in the Grand Palais, Paris, the last Saturday in September. Some thirty full-sized aeroplanes were exhibited in addition to a dirigible airship and several balloons. There was a striking likeness between all the heavier-than-air machines exhibited. Of course, two types were represented, the mono- and the bi-plane, but the Bleriot machine is the obvious prototype of nearly all the monoplanes, while all the biplanes show important features of either the Wright, Farman or Voisen branches of the biplane family. There were considerably more monoplanes than biplanes displayed, possibly because of the success of Bleriot's cross-channel trip, and, perhaps, also on account of the greater simplicity and cheapness of construction. Improvements are noted in the monoplanes, but no noteworthy improvements are visible over the already tested types of the biplanes.

* * *

The importance that engineering will play in the future in the destruction of harmful insects is, to some extent, indicated by the experiments which have been carried out with great success at Zittau, Germany. According to the *Scientific American*, the beam from a searchlight mounted on the roof of the municipal electric light plant was played upon a forest several miles distant, and the moths to be destroyed came fluttering up the beam in swarms to the light, behind which was the intake of a powerful suction blower. The moths were drawn in by the suction and exhausted into a wire net cage which was removed as often as filled. In one single night 140 pounds of moths representing, by numbers, some 400,000 were destroyed in this way.

* * *

A treaty has been made between the United States and Canada limiting the total amount of water that may be taken for power purposes at Niagara Falls. According to this treaty the power companies on the Canadian side are limited to 36,000 cubic feet per second, and those on the American side to 20,000 cubic feet. The average total discharge of the Niagara river is 250,000 cubic feet per second.

SOME INTERESTING CAM CONSTRUCTIONS*

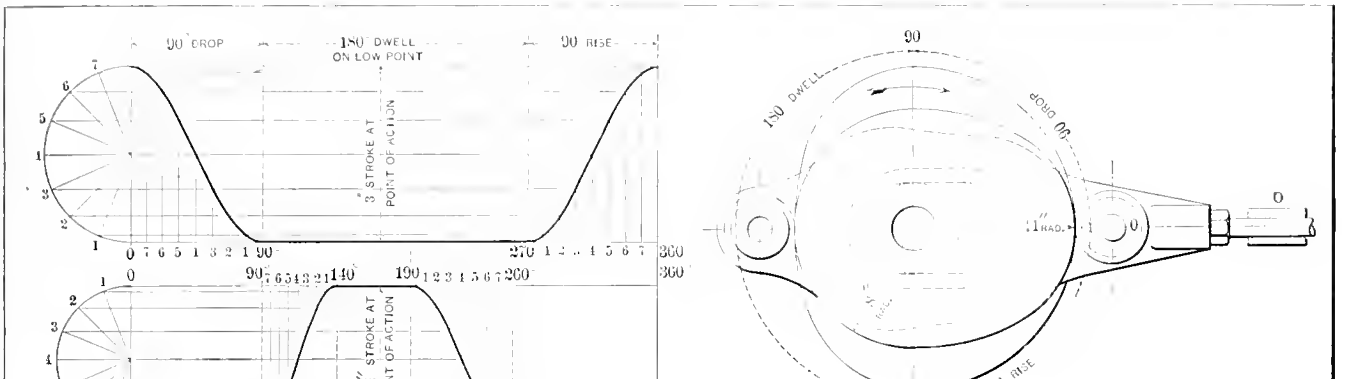
EDWARD PERSON†

When designing automatic machines that are more or less complicated, it is not always possible to avoid the use of cams in order to accomplish the work for which the machine is intended. When several cams are to be used on the same machine, it is necessary to make up a cam chart from which the designer works when laying out the cams. This chart should give the stroke required for the mechanism and indicate what part of the revolution of the cam shaft is required to produce the required stroke, as well as the period of rest. These quantities are given in degrees.

Fig. 1 shows a cam chart for two cams, the curves being crank-motion curves. The first cam, starting at zero, moves the mechanism operated three inches, while turning 90 degrees. There is then a rest or dwell for 180 degrees, and a return movement in the remaining 90 degrees. The mechanism operated by the second cam rests until the cam has turned 90 degrees; the cam then imparts a motion of 2½ inches from 90 to 140 degrees. There is then a dwell for 50 degrees, a return motion during 70 degrees, and finally a 100-degree dwell on the low point of the cam.

The crank-motion curves on the cam chart are constructed as follows: Set off the stroke of the mechanism, three inches in the first case, and two and a-half inches in the second. Construct a half-circle with the length of the stroke as diameter, and divide the half-circle into a certain number of equal parts. Also divide the length representing the drop and rise into the same number of equal parts as that into which the half-circle has been divided. Then draw lines from the dividing points as shown in Fig. 1. The intersecting points will be the points of the curve. It is of importance that these curves be correctly constructed, as this provides for a smooth movement of the mechanism at any point during the revolution of the cam. Of course, these curves do not need to be crank-motion curves, but can be changed to suit conditions.

Figs. 2 and 3 show the constructions of cams laid out from the first cam chart curve in Fig. 1. These cams are working positively in either direction. The construction in Fig. 2 consists of a grooved cam *A*, and a yoke *B* forked over the hub of the cam and carrying the roller *C*, placed in the groove. When revolving the shaft, the yoke, guided by a bushing at *D*, will move back and forth three inches in a straight line. For laying out the cam proceed as follows: Set off from the zero point on the cam in a direction opposite to that in which the cam revolves, 90 degrees, and from this point set off 180 degrees, and then another 90 degrees, which brings us back to the starting point. Determine the highest and lowest points on the cam, which in this case are located 8 and 11 inches from the center respectively. Set off at the lowest point (as shown at the top of the cam in Fig. 2) the radius of the roller and the stroke of the cam, which latter, of course, is the same as the difference between the highest and lowest points. Draw a half-circle having the stroke for its diameter, as shown, divide the circumference of the half-circle into the given number of equal parts, and draw perpendiculars from the division points to the diameter or base line. Then divide the angles for the rise and the drop into the same number of divisions as that of the half-circle, and draw radii to the division points from the center of the cam. From the points where the perpendiculars intersect the base line draw circular arcs with the center of the cam shaft as a center until the arcs intersect the corresponding angular division lines. Take the points of intersection for centers and draw circles having a diameter equal to the roller diameter. The line tangent to these circles is the true crank-motion curve.



Cam Charts and Different Methods of Laying Out Cams

* For additional information on this and kindred subjects, see "Method of Laying Out and Cutting Cams," MACHINERY, October, 1908, and other articles there referred to. See also MACHINERY'S Reference Series No. 9, "Designing and Cutting Cams."

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The second cam construction, Fig. 3, consists of two cams A and C, one on each side of the yoke B, and two rollers E and F mounted on each side of the yoke. The yoke in this case is also forked over the hub of the cams and guided at D. The cam curve for the top cam is identical with the inner curve in Fig. 2, and is laid out in the same manner, as is also the rise and the drop for the bottom cam. The only difference is that when the top cam has a dwell on the high point the bottom cam has a dwell on the low point, and *vice versa*. This, of course, insures a positive movement both ways.

Fig. 4 shows another cam construction laid out from the second chart in Fig. 1. It consists of only one cam, a lever and a roller. This construction is positive only one way and must be actuated by a spring for returning, but it can be arranged to work positively by making a three-arm lever, a return cam and a return cam roller. The point illustrated in Fig. 4 is the variation of the angles of the cam, as compared with those of the cam charts, due to the rise and the drop of the roller on the end of its lever. Instead of turning the cam shaft in the direction indicated by the arrow, assume that we swing the center of the lever pivot in a circle around the center of the cam, but in the opposite direction to the cam motion. To lay out the cam, we must first assume the length of the lever, the stroke of the cam, and the highest and the lowest points on it. The center of the lever pivot, at the start, will be at zero on the cam chart, and the center of the roller will be at zero on the cam. From the zero of the lever pivot, Fig. 4, set off 90 degrees for the dwell on the low point, 50 degrees for the rise, 50 degrees for the dwell on the high point, 70 degrees for the drop, and then 100 degrees for another dwell on the low point. Draw radii from the center of the cam shaft to each of these divisions. Take the points where these radii intersect the circle along which the center of the lever pivot moves, as centers for circular arcs having the roller arm AA' for radius, as shown at BB', CC', DD' and EE'. Then set off, from the center of the cam shaft, a distance equal to the radius of the cam plus the radius of the cam roller at each of these places (at B' the distance set off would be $8+2\frac{1}{2}$; at C' $10\frac{1}{2}+2\frac{1}{2}$, etc.). The points of intersection between these distances and the arcs struck with radii BB', CC', etc., are used for centers for circles having a diameter equal to that of the cam roller. Now it will be seen by measuring with a protractor, that where the dwell occurs the angle of the cam will be the same as the angle on the cam chart, but where a rise or a drop takes place the angles will be different.* In the present case, the 50-degree rise on the cam chart and of the cam lever will be about 53 degrees on the cam, and the 70 degrees drop on the cam chart will be about 67 degrees on the cam. This is of importance when several movements are used, and one movement starts immediately after another in such a relation that one must come to rest before another starts. The curves for the cam can be laid out in a manner similar to that explained in Fig. 2.

* * *

"A full conception of infinity is impossible to the finite mind," said the learned professor to his class, "and it is doubtful if an approach to it even is possible, but to illustrate in terms that will convey to your minds something of its immensity, let us consider infinite time. Suppose that the highest peak in the Himalayas were a solid diamond mountain and that an eagle came to it to sharpen his beak once in a hundred years. In the lapse of untold billions of centuries that diamond mountain undoubtedly would be worn away to dust. That is an illustration of finite time of great duration, but great as it is we cannot use it as a 'time-stick' to gage eternity."

* * *

In a recent address on Business English at Tufts College, Walter B. Snow, publicity engineer, of Boston, chose the modern advertisement in its display of force, terseness, knowledge of subject and consideration of the person addressed, as typical of the elements to be embodied in commercial intercourse and in technical reports, articles, etc.

* For a more thorough explanation of this kind of cam construction see MACHINERY, October, 1908: Method of Laying Out and Cutting Cams.

THE McKINLEY MANUAL TRAINING SCHOOL, WASHINGTON, D. C.*

GEORGE W. SUNDERLAND†

The subject of industrial education is becoming more and more important throughout the United States. It is now recognized that the training of the hand and mind together confers far greater benefits than the training of either separately. The object of industrial education is not necessarily that a boy or girl who has passed through the manual training school must follow any of the trades or vocations of which

Fig. 1. View of Machine Shop, McKinley Manual Training School, Washington, D. C.

they have acquired some knowledge; but education of this kind gives them a broader view of the advantages of a trained hand in combination with a trained mind, and it aids them in determining for themselves what they are best adapted for. Nearly all of the largest cities in the United States now have manual training or technical high schools, where regularly prescribed courses are followed, while in small communities the idea is carried out to some extent, even if sometimes on a reduced scale.

Among the foremost manual training schools in the country is the McKinley Manual Training School of Washington, D. C. The school-building is strictly fireproof and contains seventeen class-rooms, besides three rooms devoted to chemistry, five

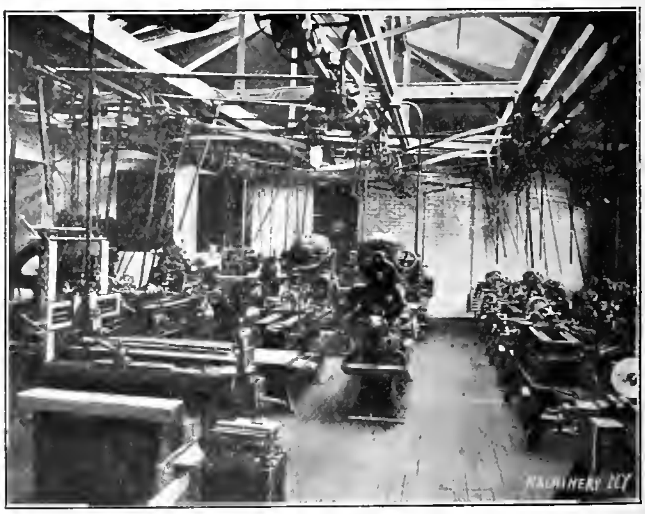

Fig. 2. Another Interior of the Machine Shop

rooms to physics, four rooms to free-hand drawing, two rooms to domestic art, four rooms to domestic science, four rooms to mechanical drawing, one library, one assembly hall with a seating capacity of 700, one art metal shop, one machine shop, one forge shop, two carpenter shops, one engineering laboratory, one shower bath-room, and the necessary lavatories, etc. The very names by which these rooms are designated suggest the purposes for which they are used, but a long and detailed

* For additional articles on this and kindred subjects previously published in MACHINERY, see issue of September, 1907, Education for Industrial Workers, and the articles there referred to.

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description would be required to convey an adequate idea of their complete and substantial equipment.

Three courses of study are provided. A general scientific course, a technical preparatory course (both requiring four years), and a special technical course, requiring two years. In connection with the manual training work, there is given a thorough course in English, French, German, physics, chemistry and mathematics. The part of the course which is of especial interest to the readers of MACHINERY, is the machine shop course. This includes instruction in the use of measuring instruments and tools, and as thorough a course as possible in bench, vise and floor work, drill press, lathe, planer, shaper, milling machine and grinding machine work, as well as instruction in the first principles of gearing.

The school has its own plant for power, heat, light and ventilation. The equipment consists of four Heine safety boilers of 75 horse-power each; one Ames high-speed, direct connected engine of 150 horse-power with a Westinghouse direct-current 100 K. W. generator, 125 volts, 800 amperes, 200 R. P. M.; one American Ball engine and generator, 50 horse-power, 125 volts, 230 amperes, 323 R. P. M.; one General Electric engine and generator, 80 horse-power, 125 volts, 400 amperes, 400 R. P. M.; one Johnson temperature regulator; one Cochrane feed water heater and return tank; two steam pumps for the boilers; two Sturtevant fans connected direct to motors, each 16 horse-power, 110 volts, 114 amperes, 975 R. P. M.; one Westinghouse 15 horse-power steam turbine driving a centrifugal pump.

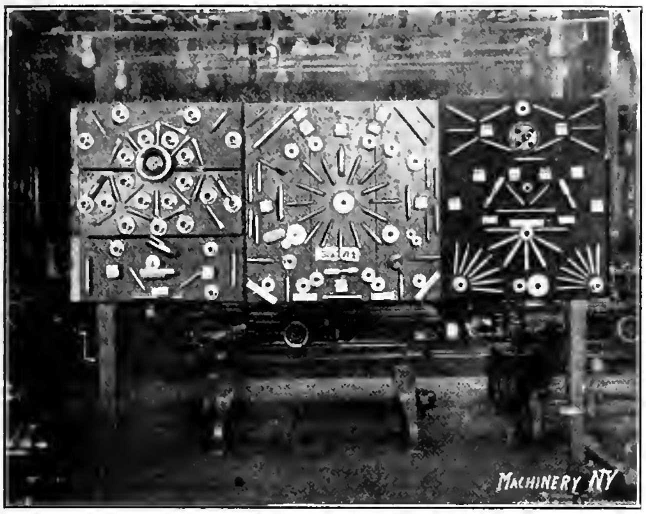


Fig. 3. An Exhibit of Work made by the Students in the McKinley Manual Training School

The equipment of the machine, forge and carpenter shops will no doubt be of interest and value to others interested in the equipment of manual training schools. The following is a list of the machinery in the machine shop:

One 16-inch—10-foot Pratt & Whitney new model engine lathe, motor-driven.

Two 14-inch—6-foot Pratt & Whitney tool-room engine lathes, motor-driven.

One 16-inch—6-foot Hendey geared head engine lathe, motor-driven.

Two 14-inch—6-foot F. E. Reed geared head engine lathes, motor-driven.

Four 14-inch—6-foot F. E. Reed engine lathes, belt-driven.

Six 12-inch—5-foot F. E. Reed engine lathes, belt-driven.

One 14-inch—6-foot Hendey engine lathe, belt-driven.

Four 12-inch—5-foot Hendey engine lathes, belt-driven.

One No. 1 Brown & Sharpe universal milling machine, belt-driven.

One No. 3 Brown & Sharpe universal milling machine, belt-driven, with all attachments.

Three 16-inch Stockbridge shapers, latest type, motor-driven.

Three No. $1\frac{1}{2}$ Brown & Sharpe universal milling machines, motor-driven, with all attachments.

One 16-inch Potter & Johnston shaper, belt-driven.

One 36-inch—6-foot Pease planer, belt-driven.

One 24-inch Prentice drill press, belt-driven.

One $22\frac{1}{2}$-inch Willey drill press, motor-driven.

One 12-inch Willey sensitive drill press, motor-driven.

One Wilmarth & Morman "Yankee" drill grinder, motor-driven.

One No. 3 Brown & Sharpe cutter and reamer grinder, motor-driven.

One No. 2A Landis universal grinding machine, motor-driven.

Two Willey tool grinding machines, motor-driven.

One Walker "Globe" grinding machine, belt-driven.

One Hisey center grinder, motor-driven.

One Willey center grinder, motor-driven.

One Pratt & Whitney centering machine, motor-driven.

One Higley metal saw, motor-driven.

One Chicago gas furnace.

One Greenerd arbor press.

One L. S. Starrett display cabinet.

One Brown & Sharpe display cabinet.

One "Pike" oilstone display cabinet.

The shop is equipped with the necessary benches and vises. The tool-room is stocked with a full line, from a hack-saw to a micrometer, including the Pratt & Whitney Co.'s small tools. The check system is used. The stock-room is furnished with "New Britain" metal racks and metal shelving. It makes the most complete and non-combustible arrangement that can be found. The Higley metal saw is placed in the stock-room to give greater convenience in handling material.

The carpenter shop has a stock- and tool-room and a full line of tools as follows:

Thirty-six Oliver lathes, motor-driven.

One Oliver band-saw, motor-driven.

One Oliver buzz-saw, motor-driven.

One No. 3 Oliver trimmer.

One Oliver jig-saw.

One Oliver band-saw, belt-driven.

Twenty F. E. Reed lathes, belt-driven.

One Brown & Sharpe grindstone, motor-driven.

Two Willey tool grinders, motor-driven.

One demonstration bench for molding.

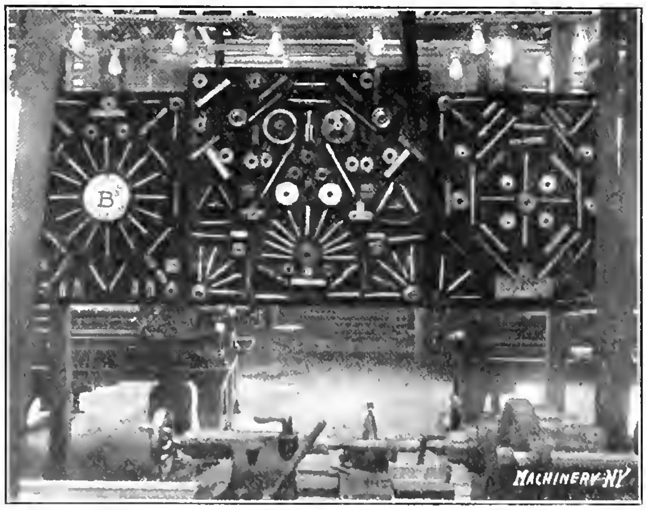


Fig. 4. Another Exhibit of Students' Work

A course in bench work is provided in connection with wood turning and pattern-making.

The forge-shop has the following equipment:

Twenty No. 02 Buffalo down-draft forges.

Ten B. F. Sturtevant ideal down-draft forges.

One No. E1 Dupont power hammer.

Thirty-one anvils.

One Buffalo $7\frac{1}{2}$ horse-power blower, motor-driven.

One Sturtevant, 15 horse-power exhaust fan, motor-driven.

One Norton floor grinder 18-inch, belt-driven.

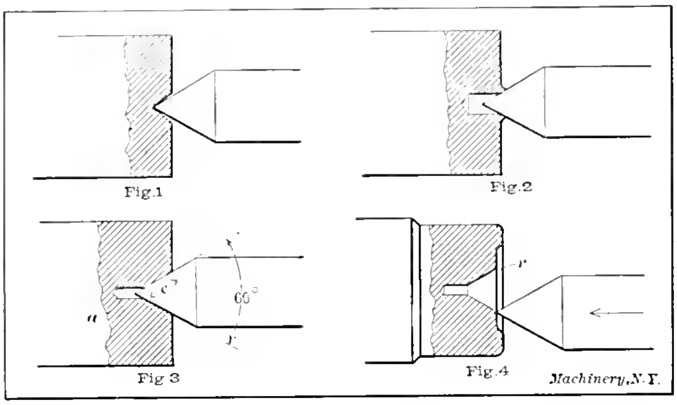
One "McKinley" drill press, belt-driven.

Two of the accompanying half-tones, Figs. 1 and 2, show interior views of the machine shop, and Figs. 3 and 4 illustrate some of the work done by the students. A great deal of the success of the school is due to the untiring efforts of Mr. J. A. Chamberlain, supervisor of manual training of the District of Columbia, who has been with the school since its infancy, and also to Dr. George E. Myers, the principal, who has shown great interest in all matters pertaining to shop work.

MACHINE SHOP PRACTICE*

CENTERING

While the importance of centering work properly, is appreciated by almost every machinist and most apprentices, still, in spite of this fact, inaccuracy in a turned part is often the result of haphazard centering. This is perhaps due more to the lack of care and thought than to anything else. When there are no special tools provided for centering, of course, too much cannot be expected in the way of accuracy; but even though the equipment consists only of a center-punch, there is no excuse for the form of center illustrated in Fig. 1. The center-punch should, however, never be used if it can be avoided. A better method is to locate and mark with a punch, centers in each end of the work and then drill and ream the ends with a combination drill and countersink, such as is illustrated on the Shop Operation Sheet accompanying this number. The center will then appear as shown in the sectional view, Fig. 3. The small straight hole *a* prevents the point of the lathe center from coming in contact with the work and insures that there will be a good bearing throughout the conical surface *c*, providing the angularity of both the lathe and work centers is the same and their axes coincide.



Figs. 1 to 4. Centers of Incorrect and Correct Form

Many shops are equipped with a regular centering machine. If such a tool is available, it is not necessary to locate centers in the ends of the work, as the chuck of the machine is so constructed that it automatically centers shafts of any diameter within its capacity, with reference to the drill. The center shown in Fig. 2, which is formed by simply drilling a straight hole in the end of the work, is, obviously, bad practice in more than one respect. Fig. 4 shows a form of center which is often found in the ends of lathe arbors. As the illustration shows, the mouth of the center is rounded at *r* and the end of the arbor is recessed. This is done to protect the center against bruises. The rounded corner is particularly desirable as the point of the lathe center is thereby prevented from catching on it when, at times, it is moved rapidly towards the work, which is not being held centrally by the workman.

When stock which is to be turned, is bent, it should be straightened before the centers are drilled and reamed. If

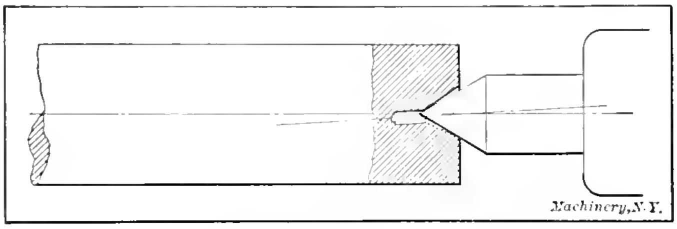


Fig. 5. The Poor Center Bearing shown is the Result of Centering before Straightening

the work is first centered and it is then bent considerably to make it straight, the bearing on the lathe center would be as shown in Fig. 5; consequently, the center would wear unevenly with the result that the surfaces last finished would not be concentric with those which were turned first.

Stock for tools such as reamers, mills, arbors, etc., which need to be hardened, should always be centered so that the rough stock runs approximately true. This is not merely to insure that the piece will be true when it is of the required size, as there is a more important consideration, the disregard of which often greatly affects the quality of the finished tool. As is well known, the degree of hardness of a piece of steel that has been heated sufficiently and then suddenly cooled, depends upon the amount of carbon that it contains, steel

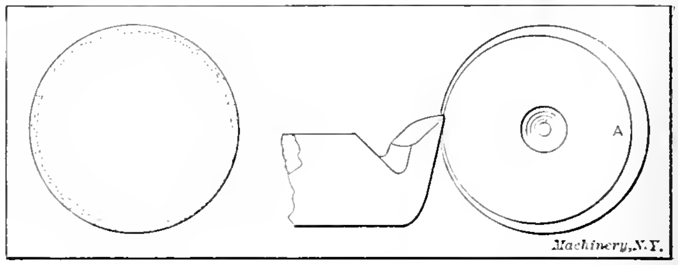


Fig. 6. Tool Steel should be centered Concentric, in order to remove the Decarbonized Outer Surface

that is high in carbon becoming much harder and more brittle than that which contains less carbon. Now the amount of carbon found at the surface, and to some little depth below the surface of a bar of steel, is much less than the carbon content of the rest of the bar, as illustrated diagrammatically in Fig. 6 by the shaded area of the view to the left. (This decarbonization is probably due to the action of the oxygen of the air on the bar during the process of manufacture.) Consequently, stock which is to be used for hardened tools should be enough larger than the finished diameter and so centered that this decarbonized surface will be entirely removed in turning. For example, if when making a reamer, the stock is so centered that the tool removes the decarbonized surface only on one side, as shown to the right in Fig. 6, obviously, when the reamer is finished and hardened, the teeth on the side *A* will be much harder than those on the opposite side. It will thus be seen that stock for such tools should not be too near to the finished size, in order that the decarbonized part will be entirely turned away. The depth to which the carbon is burned out increases with the size of the stock, and also varies somewhat with different pieces of steel. Generally speaking, about 1/16 or 3/32 inch should be removed for diameters near 1 inch, while for sizes of 2 and 3 inches, as much as 1/8 to 3/16 inch in one case and 1/4 inch in the other should be removed, respectively.

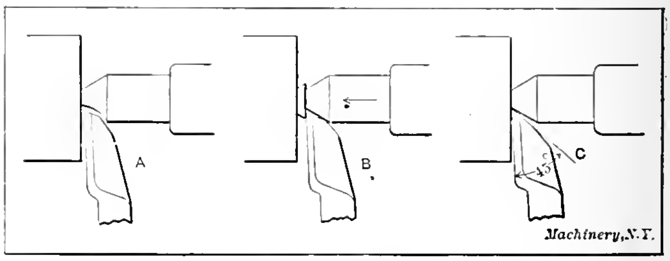


Fig. 7. Three Methods of Facing the End Square

As a piece of work would hardly be properly centered until the ends are faced square, we shall consider this operation, which, though simple, seems to be the cause for considerable comment. Some advocate the use of centers that are cut away, as shown at *A*, Fig. 7, so that the point of the tool may be fed in far enough to face the end up to the center. Others instead of using a special center simply loosen the regular one slightly, and then with the tool in the position shown at *B*, face the projecting teat by moving both tool and center simultaneously as shown by the arrow. This last method hardly represents good practice, but whenever it is employed, care should be taken to remove any chips from the center hole which may have entered. A method which is better than loosening the regular center or employing a special one, is to provide clearance for the tool point by grinding it to an angle of approximately 45 degrees, as shown at *C*. Providing the tool is not set too high, it may then be fed right up to the lathe center and the end squared without difficulty. As for the special center, the use of special tools and appliances in a shop should always be avoided unless they are essential to economical production, or their use makes it possible to accomplish the same end with an expenditure of less energy.

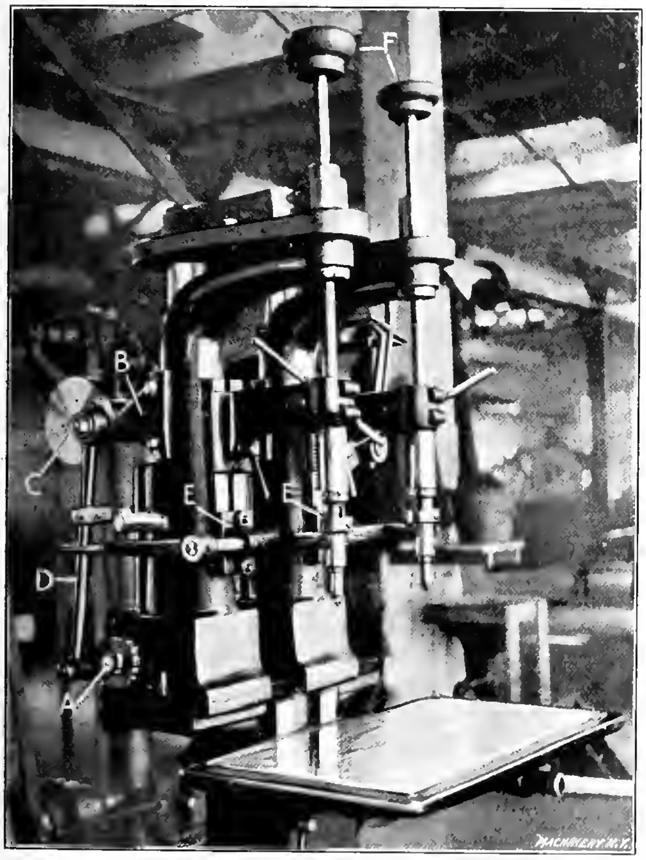
* With Shop Operation Sheet Supplement.

DRILL PRESS VALVE GRINDING ATTACHMENT

A. G. KENYON*

The attachment described in the following was made for the purpose of grinding in the valves of automobile cylinders in a drill press instead of by hand, as has been the practice for some time past. This operation has always been a source of some little annoyance and a time consumer, ever since manufacturers began to build engines in large quantities. A minute saved here and there very often means many more engines built in a month and many dollars saved on the month's expenses. The device shown in the accompanying engraving has proved itself well worth the amount it cost, although it was not at all expensive.

This attachment was designed for and placed on a two-spindle drill press made by the Fenn Machine Co. of Hartford, Conn. The machine is of the type in which the spindles are adjustable for center distance and it has a cross driving shaft *A* through the bases of the upright arms. This shaft is ordinarily driven by a pinion on the driving pulley which,



Drill Press equipped with a Special Attachment for Grinding Valves

together with the loose pulley, is carried on a stud set into the main stand casting. The cross shaft drives vertical shafts which are connected to the spindles of the machine by chains and sprockets. In order to make the attachment, the stud carrying the loose and driving pulleys was removed and also the gear on the end of the cross shaft. Castings *B* were made to fit the upright arms of the press and were cored out to allow for babbitting with the countershaft in place. The same two pulleys that were on the machine originally were placed on this shaft at one end. On the other end there is a disk, *C*, about six inches in diameter, which has a hub on one side to allow for set-screwing to the shaft. In this disk at the proper radius there is a shoulder-stud or crank-pin as shown. On the lower cross shaft *A* two ratchets are mounted, one made right- and the other left-hand. These ratchets are pinned to the shaft and in between them is placed a link or lever which carries two pawls to engage with the ratchet teeth. This lever also has a pin at its outer end and is connected to the upper shaft crank-pin by a connecting-rod *D*. The stroke of this connecting-rod is of the proper length to give the cross-shaft enough turn to move the spindles just half way around and then back again, the same as a workman does when he grinds valves by hand. One ratchet has twice as many teeth on its circumference as the other, and this one is placed on the inside. The pawl that drives this inside ratchet has a hardened pin on its side that trips over a block cut to the proper shape to cause it to disengage at nearly the bottom of the stroke. In this way the spindles of the machine make a full half revolution in one direction and then reverse and make almost a half revolution in the other. The result is that the valve, in the course of grinding, is advanced around its seat every other move, so that the seating is absolutely perfect. The reason for having one ratchet with twice as many teeth as the other, is to provide for the movement due to the momentum of the driven parts at the end of a stroke, so that the pawl will engage at almost any point on the circumference. In this way lost motion is largely eliminated, and consequently, there is no knocking or vibration while the machine is running.

As it is common practice with mechanics to place a spring under the valve head, while grinding, to raise it occasionally in order to let the grinding-in compound settle and change in the seat, this is done in this case. Two castings *E* were made to fit the front T-slot, and these support a rod three-quarters of an inch in diameter on which is placed three forgings, two of which are forked at the end and straddle the spindles of the machine as shown. The other is forked at the end and straddles the connecting-rod. Collars were made to fit the spindles and a clip was also made to fit the connecting-rod. This clip is so adjusted that when the connecting-rod is at the bottom of the stroke, it strikes the forked lever and causes it to move down. This brings the forked levers at the spindles in contact with the collars on the spindles and, consequently, raises them slightly. As the pressure is then removed from the valve, it rises just the same as it would if it were being ground by hand. These levers are so located with reference to the collars on the spindles, that none of the grinding pressure is removed from the valves except at the time of lifting. The grinding pressure is obtained from two cast-iron weights *F* on the spindle shafts. The drivers are like a screw-driver, except that in the center of the blade a center is left projecting so that it will settle in the countersunk lathe center usually left in the heads of valves. These drivers are placed in old drill shanks that fit the sockets of the spindles. These drill shanks are bored out a little larger than the shank diameter on the driver and a pin is placed through them that fits loosely in the driver shank. This gives the driver a sort of floating action and allows the valve to find its own seat and center, which it would not do if the valve center was not quite in line with the spindle center and a rigid driver were used.

The cylinders, the valves of which are ground with this fixture, have four cylinders cast "*en bloc*" with the valves all on one side. As the distance between the spindle centers is adjustable, they are set to the first and fifth valves so that it only takes four moves to complete the grinding of one set of valves. Either spindle can be raised independently of the other at the will of the operator by the ordinary means for raising a drill press spindle, which was not interfered with in the least in attaching the device. Either spindle can be stopped also by simply shifting a lever on the back of the machine to a neutral point. This is also a part of the regular equipment of the press that was not interfered with.

This device has been in use now for some time and has repeatedly ground all eight valves in a cylinder, perfectly, in seven minutes. It positively does not ring the valve, nor does it chatter the seat in the least, and in every way it has proved successful beyond our expectations. The engraving shows how comparatively simple the device is to make and attach, if a shop has a drill press of this make or style. This fixture has solved the valve grinding troubles in our own shop for some time and we hope that if anyone else builds one, it will be as successful as ours has been.

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* * *

The Prussian state railways have specified that 214, or about 35 per cent, out of 611 locomotives ordered to be delivered between October, 1909, and March, 1910, are to be provided with Schmidt superheaters.

SOME ECONOMIES IN MAKING DRAWINGS

W. E. WILKINSON*

The engineering staff connected with a manufacturing establishment is usually regarded as a necessary evil because it is not directly remunerative, and it is tolerated only because it cannot well be dispensed with; this is because drawings and designs are not an end in themselves, but a means to an end—a graphical representation of ideas, more or less thoroughly depicted, for the conveyance of the same to others to be wrought out; concrete thoughts in a universal language, if one chooses to put it that way. Whatever ways and means of shortening processes and eliminating unnecessary expense, that can be emplóyed without depreciating either the quality or quantity of work produced is of interest to all concerned with such offices. With these objects in view the following suggestions are made, which are thought to be generally applicable in any engineering office or drawing room, whatever the size may be.

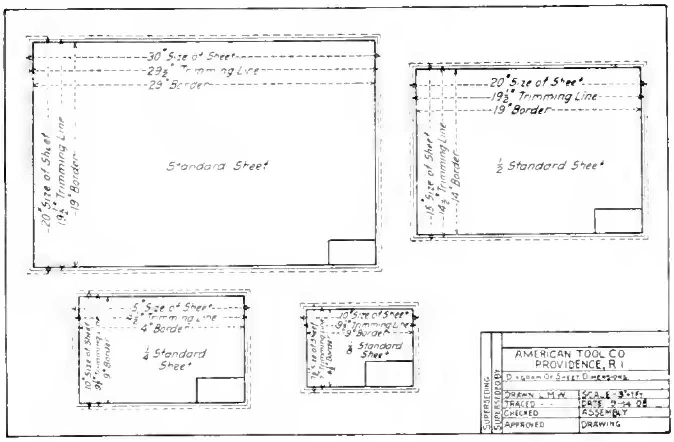

Fig. 1. Dimensions of Standard Drawings

The best general practice seems to be to have competent designers for making general plans who will pencil the work only; detail draftsmen and tracers to complete the work; efficient checking and inspection of each part; all drawings to be made to scale and on standard-sized sheets invariably; each detail made separately with as many views on the sheet as may be needed to make the subject clear. The advantages of small size sheets are that they are more convenient in the shops and if subsequently changed—as most are—the changes do not affect other detail sheets. The smaller sheets should be subdivisions of the larger, as shown in Fig. 1, so that if desired the entire construction, including the details, may be blueprinted on large sheets and the whole suitably bound into uniform-sized folios or booklets.

The first suggestion is that each sheet of tracing cloth be given to the tracer with the border and title stamp printed on it. The advantages are that the sheet will be smooth and flat at the start, absolutely uniform in size, appearance, title and all that pertains to it, and only the blanks in the title will need to be filled in by the detailer. The prime advantage is the saving in time, which will range from 10 to 25 per cent in average cases, and even more on small sheets, where the work detailed is comparatively quickly executed. Hand-written titles are an abomination unless done by an expert, whose time should be better employed. Rubber stamp work is seldom satisfactory and no good substitute for a properly printed title is thought to exist. The first expense may seem heavy, as it means the purchase of a considerable amount of cloth at one time, but there is no waste or time lost in cutting, which will more than counterbalance the slightly increased cost of having the material cut and printed in quantities.

A second economy lies in the use of properly prepared lists of every possible small part, such as screws, bolts, nuts, washers, pins, etc., using a symbol for the same in place of making detail drawings. In fact, this list system is capable of almost indefinite expansion, limited only by the special requirements of the particular factory in which the work is to be done; besides serving as economizers of time, they materially prevent errors and mistakes and also serve to avoid the drawing of a multiplicity of small parts, which are almost duplicates. Such lists may have at their head a drawing representing the object and a symbol, as a letter, used exclusively for it. In place of dimensions on the object, let the same be given symbolically and the list so arranged that all of its proportions beginning with the smaller sizes, preferably, can be determined and a distinguishing mark, as a numeral, be united to the subject symbol so that its relative size may be known at a glance.

Another suggestion, perhaps more applicable to larger objects having a greater number of dimensions, is to have printed sheets bearing a representation of the object, the dimensions being left blank to be filled in by the draftsman as may be required. In place of printed objects, which would be expensive if but few of a kind were required, the same results may be attained by well executed tracings, filling in the blank dimensions on the prints, the same as would be done on original drawings (see Fig. 2). Don't forget to file a duplicate, however, for future reference.

Where mere sketches are required, cross-section paper, a sheet of carbon and a hard copying pencil may be utilized, but this will not do very well for permanent records and is a make-shift at best.

A further economy in any engineering department may be effected by the use of a record file, kept carefully and fully up to date. The time lost in hunting for some mislaid drawing is not productive of profit or pleasure to any concerned, yet it is the too common experience. Possibly if less cheap (?) labor were employed and this work more generally in the hands of competent persons, made responsible for the instant production of any drawing, the results would justify the expense.

Of course a blueprint machine is installed if the office is of any considerable size, but how about the facilities for washing and drying prints? A sloppy sink may answer for the first, but on a dull or rainy day, wet paper dries slowly and a delayed print often means direct loss by reason of holding up the mail, a customer or a machine. A steam coil or electric heater can generally be readily arranged and will save its cost many times over in a short time.

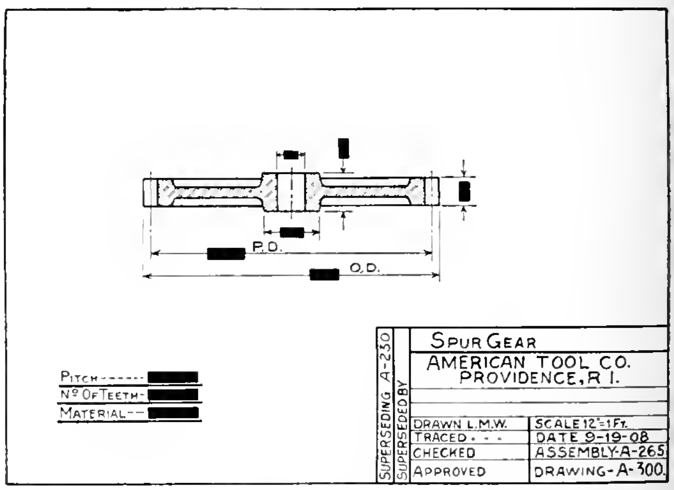

Fig. 2. Printed Sheet with Representation of Commonly used Part and Blank Spaces to be filled in by the Draftsman

A mistake frequently made is to change tracings, involving erasures and re-inking; generally the tracing is spoiled and in any case is lost as a record. It is far better to retrace wholly, making such changes as are desired, as less time is likely to be required and better results attained, while both the old and new tracings may be preserved.

The use of tracing paper is also thought to be a mistake, as it is so easily crumpled, torn and rendered useless for permanent records; the practice can only be condoned on the possible score of extreme urgency.

In conclusion, as time is the most important factor in drawing-room expenses, it should be the duty of some one constantly within reach to see to it that supplies are immediately available to such as require them, and that sufficient data be given so that workmen do not have the common excuse of waiting for this or that, when idle, be it an article of use or a word of explanation or information.

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FORMERS FOR CUTTING BEVEL GEARS*

The most common method of making bevel gears at the present time is, perhaps, that of using formers for shaping the gear tooth. The pin or roller, controlling the part in which the cutting tool is held, guides this so that a tooth of the same shape as that of the former will be cut by the tool. It would seem at first that a great many different formers would be required in order to make possible the cutting of bevel gears of different pitch diameters, pitch and pitch cone angles. It is the object of the following analysis to show that correct bevel gear teeth may be planed by the use of a comparatively small number of formers.

In Fig. 1 a bevel gear is shown, and at the left is indicated the former, the path of the cutting tool being guided by a pin moving over same. The gear here shown has a comparatively wide face. Imagine this gear cut up into a number of gears with narrow tooth face. These gears would then have the same number of teeth, but they would have different pitch diameters, and consequently would be of different pitch; yet all being a part of and identical with a single gear which can be cut by a single former, it is clear that a single former is sufficient for cutting all bevel gears within the capacity of the machine without regard to the pitch, provided the gears have the same number of teeth and the same pitch cone angle.

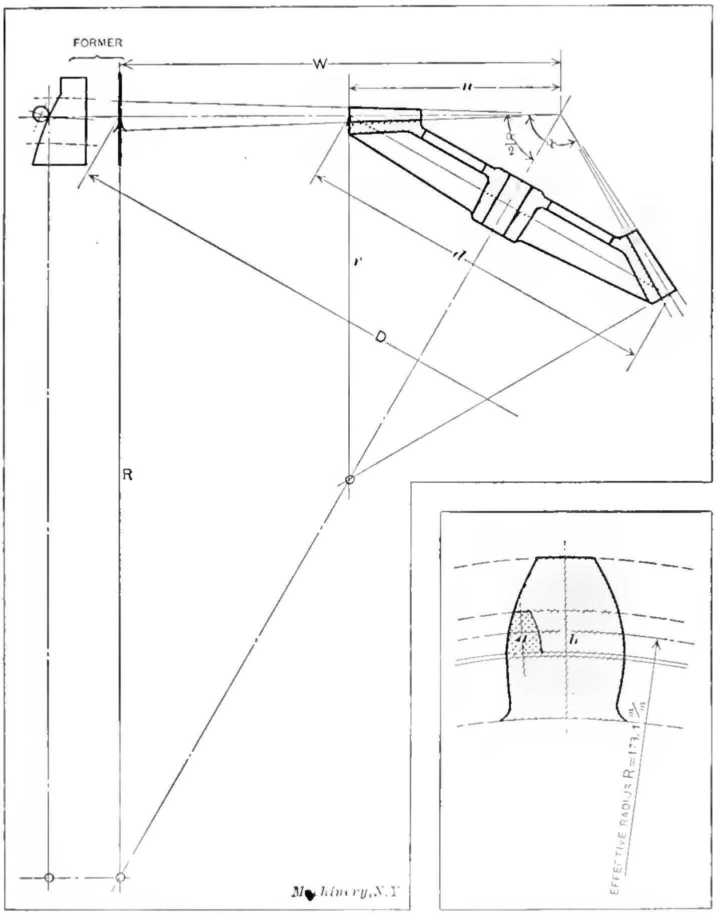


Fig. 1. Diagram for Proving that the Shape of the Former is Independent of the Pitch of the Bevel Gear

Fig 2. Diagram showing that the Same Former can be used for Planing Different Numbers of Teeth

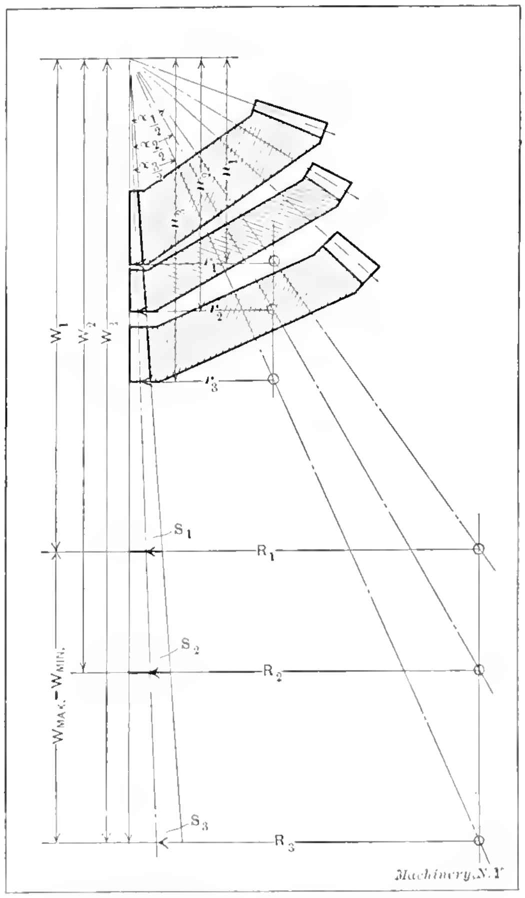


Fig 3. Diagram showing how Correct Bevel Gear Teeth can be cut with a Limited Number of Adjustable Formers

On account of its simplicity, the involute form of tooth is almost exclusively used for bevel gears, and the following investigation will cover this form of tooth only. The form of the involute curve depends entirely on the length of the radius r (Fig. 1). This radius equals $\frac{d}{2}$ divided by cosine $\frac{a}{2}$. In the following this radius r will be known as the *effective radius*.

In Fig. 2 are shown two teeth from gears having widely different pitch. The illustration indicates how the same former can be used for both teeth provided the former is large enough so that the full length of the tooth flank of the larger tooth can be formed from it. It is clear that if the bevel gear planing machine is so constructed that the former can be adjusted for planing the opposite side of the tooth, then the same former will be suitable for cutting all gears having the same effective radius, irrespective of the number of teeth in the gear; therefore the conclusion previously arrived at may be further extended by saying that within the capacity of the machine, all bevel gears having an equal pitch cone angle can be cut with the same former irrespective of the pitch or the number of teeth. In other words, the shape of the former depends on the angle of the pitch cone only.

The question of the angular limits of the pitch cone angle between which each former can be employed without serious inaccuracy in the tooth form is a highly important one. In other words, it is necessary to determine how many formers will be required for the full capacity of the machine, assuming, for instance, that it will commence to cut gears with a pitch cone angle of about 10 degrees up to 160 degrees. Certain (German) makers of milling cutters for spur gear teeth make these in sets of 15, this giving a very close degree of accuracy for all numbers of teeth. It would be reasonable to base calculations for limits of tolerance for bevel gear formers on the same basis as has been used for determining the number of teeth for the 15 cutters in a set of spur gear cutters. An example may illustrate this more clearly. Assume that the bevel gear planing machine has a capacity for cutting all bevel gears up to a modulus of 20 and with pitch cone angles of from 10 to 160 degrees. Assume that the smallest number of teeth is 12. Then we have the required circular pitch for the former (see Fig. 1):

$$\text{Circular pitch} = \frac{W \sin \frac{a}{2} \times 2\pi}{\text{Number of teeth}}$$

and the modulus is

$$\text{Modulus} = \frac{\text{Circular pitch}}{\pi} = \frac{2W \sin \frac{a}{2}}{\text{Number of teeth}}$$

In this case then the modulus equals 61.5, W being equal to 1,500 millimeters and a being assumed as 30 degrees, this

* Abstract of an article by H. Becker, *Werkstatts Technik*, September, 1909. See also an article entitled Adjustable Former for Bevel Gear Planing, MACHINERY, December, 1906.

being the greatest angle that ought to be used when the number of teeth equals 12. The modulus found is the greatest one for any former for the machine, and from this one the other formers must be determined.

We have previously said that the involute form depends only on the pitch cone angle, or on the length of the effective radius r. The number of teeth in the present case corresponding to the largest pitch cone angle $a = 160$ degrees would be

$$\text{Number of teeth} = \frac{2W \sin \frac{a}{2}}{\text{Modulus}} = \frac{2 \times 1{,}500 \times \sin 80^\circ}{20} = 148.$$

TABLE GIVING PITCH CONE ANGLES FOR DIFFERENT FORMERS

No. of Spur Gear Cutter (or Corresponding Bevel Gear Former)	No. of Teeth for which Spur Gear Cutter is intended	Pitch Cone Angles for which Former can be Used	Exact Angle to which Former Corresponds
1	12	98° 48'— 10° 35'	10°
1½	13	10° 36'— 11° 25'	10° 55'
2	14	11° 26'— 12° 13'	11° 55'
2½	15— 16	12° 14'— 14° 1'	13°
3	17— 18	14° 2'— 15° 27'	14° 30'
3½	19— 20	15° 28'— 17° 3'	16°
4	21— 22	17° 4'— 18° 37'	17° 30'
4½	23— 25	18° 38'— 21° 1'	19° 30'
5	26— 29	21° 2'— 24° 9'	22° 20'
5½	30— 34	24° 10'— 28° 3'	26°
6	35— 41	28° 4'— 33° 23'	30° 30'
6½	42— 54	33° 24'— 42° 53'	37°
7	55— 79	42° 54'— 59° 27'	49°
7½	80—134	59° 28'— 87° 53'	70° 30'
8	135— 00	87° 54'—180°	122°

From this equation, solved for $\frac{a}{2}$ we can easily determine the angles which correspond to the numbers of teeth for which the spur gear cutters are made; and in this manner, by comparing with a list of cutters for spur gears and seeing the number of teeth for which each cutter is intended, we can determine the limits of the pitch cone angles for which each former should be used. The accompanying table shows the results obtained from these calculations, and also gives the angle for which each former should be made.

While a machine provided with formers made with the limits indicated will cut gears which are practically correct, it would be advisable to have special formers made for such ratios as 1 to 1, 1 to 2, 2 to 2, 2 to 3, etc., so that in these cases absolutely correct teeth can be cut.

One of the most interesting considerations in connection with this subject is yet to be mentioned. While the formers are made for a certain pitch cone angle, and it therefore would appear that it would not be possible to make a bevel gear with perfectly correct teeth, except if it had a pitch cone angle corresponding to the angle for which the former had, in particular, been made, it is possible by a method now to be described, to produce theoretically correct teeth for all pitch cone angles with the formers mentioned. In Fig. 3 are shown three bevel gears with different pitch cone angles; the effective radii r_1, r_2, r_3, however, are equal for the three bevel gears. Therefore,

$$n_1 \tan \frac{a_1}{2} = n_2 \tan \frac{a_2}{2} = n_3 \tan \frac{a_3}{2}$$

From what has previously been said, it is clear that for producing the teeth in these gears one can use the same former, provided the distances W from the former to the apices of the pitch cones be made to correspond. If, for instance, on a certain machine W equals 1,000 millimeters, and an adjustment of 300 millimeters is possible, then $W_{max.}$ equals 1,300 millimeters. If the former corresponds to a pitch cone angle of 90 degrees when W equals 1,000 millimeters, then it will correspond to a pitch cone angle of 75 degrees 20 minutes when W equals 1,300 millimeters. It is also clear that when passing from 1,000 to 1,300 millimeters the former comes into intermediate positions corresponding to all angles between 90 degrees and 75 degrees 20 minutes. This arrangement has the advantage that a very few formers make it possible to cut theoretically correct teeth for every angle within the limits of 10 to 160 degrees, even when the limits of the adjustment of the former on the machine are small. If the limit of adjustment of the former on the machine increases, it is evident that the required number of formers will decrease correspondingly, and a very few formers will be required for cutting correctly all bevel gears, whatever the pitch, pitch cone angle, or number of teeth.

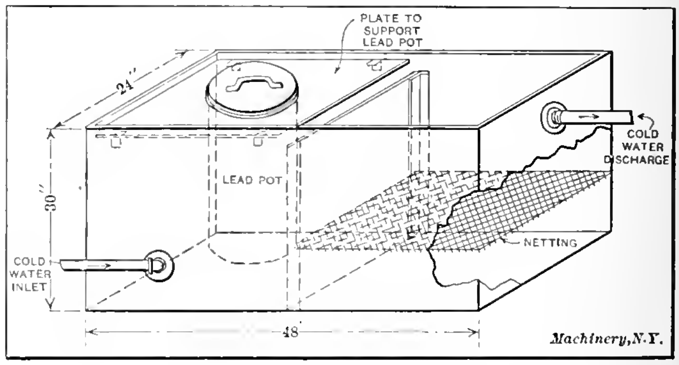
* * *

PROCESS FOR HARDENING CAST IRON

R. F. WILLIAMS

An improved process whereby cast iron in the rough or in the finished state may be hardened or tempered, the hardness extending completely through articles of comparatively large dimensions, is described in the following. One of the principal objects of this process is to provide a cheap and simple method of rendering iron castings so hard that they may be used for many purposes in the place of steel, thus reducing the manufacturing cost of a large number of articles. The various steps of the process and the manner of carrying it out are here described. The castings which are to be treated by this process may be completely finished as regards machine work before they are hardened, and it will thus be seen that the wear on the machine is greatly reduced and the necessary labor is also less than where similar articles are made from hardened steel.

The casting is first heated in any suitable or convenient heating device, until it reaches a temperature sufficient to cause the casting to glow, or, in other words, to what is known as a cherry red heat. It is then dipped in a bath which consists of practically anhydrous acid, of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of arsenic. The ingredients of the bath are sulphuric acid of a specific gravity of about 1.84 and red-arsenic (As_2S_2) in the proportions of ¾ of a pound of red-arsenic crystals to one gallon of sulphuric acid. The castings may be either suddenly dipped in this mixture and then taken out and cooled in water, or they may be left



Cooling Tank and Hardening Bath for Cast Iron

in the bath until cooled. It has been found, however, that dipping the castings in the bath and holding them there for some time, which varies according to the size of the casting, and then completely cooling in water, is quite as satisfactory, and produces a material which is just as hard as if the castings were allowed to remain in the bath until cooled, and this method is preferable if a large number of castings are to be hardened, as the bath is thus prevented from becoming overheated. In preparing the bath, when sulphuric acid and red-arsenic are used, we find that better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using, the reason probably being that the bath becomes more saturated with the arsenious compound when the dissolved red-arsenic has been long in the sulphuric acid.

It is not necessary that the casting be machined completely before hardening, as rough finished castings may be hardened equally well. The change which takes place in the metal is in the nature of a molecular re-arrangement or re-crystallization coincident with an increase in the combined carbon at the expense of graphitic carbon, and in this change

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lies the difference between the results obtained by this bath and ordinary case-hardening processes, in which a certain portion of the carbon contained in the material of the bath is actually given up to the metal.

It is found that the more rapid the cooling of the metal, the harder it will become. For this reason the bath must be of high heat-conducting power, and this requirement is obtained by the use of the ingredients referred to. Furthermore, the bath must be practically free from water, as it is found that when the acid contains water in any considerable quantity, a steam cushion is formed between the acid and the metal which prevents their coming in contact, with the result that the cooling is less rapid, and, consequently, the iron is not so hard.

A cylindrical jar made of lead should contain the bath, the size varying according to the work to be done. A jar about 10 inches in diameter by 18 inches deep, will be about right for ordinary small work. This lead jar should be enclosed in an outer vessel through which water is caused to continuously circulate in order to keep it cool. It might be further pointed out that if it is desired to harden one portion of a casting and leave the remaining portion soft, this may be accomplished very readily by immersing only the part to be hardened.

Such a hardening equipment has proved very satisfactory in locomotive work for hardening bushings, etc., and many other uses could no doubt be found for it. The whole equipment can be homemade, consisting as it does simply of a steel tank divided into two compartments, and the lead jar for the bath, as shown in the illustration. The water circulates in the first chamber around the lead vessel, keeping it cool, and then passes to the second chamber, into which the castings are dropped, when taken from the bath, to cool off. The water then passes into the sewer or other suitable containing device. There is a screen placed in the second compartment to keep the castings from falling to the bottom. A lead cover should be made for the bath to keep the acid solution from evaporating, and a little care exercised by the workman so as to prevent the solution from splashing on him.

* * *

TIME OF EXPOSURE FOR DRY-PLATE PHOTOGRAPHY

In the January, 1909, issue of MACHINERY, engineering edition, an abstract was published of a paper on "Industrial Photography," by Mr. S. Ashton Hand, read before the American Society of Mechanical Engineers at the December, 1908, meeting. A contribution to the discussion on this subject was made by Mr. Charles W. Hunt, who submitted some interesting records of experiments made by himself for the purpose of estimating the proper time of exposure for dry-plate photography. The accompanying tables are based on this series of experiments. As a preliminary step, the altitude of the sun was calculated for each hour of the day from sunrise to sunset on the first day of each month of the year and the results plotted.

In June, 1905, a series of exposures was made with a Watkins exposure meter at each hour of the day, and a tentative table of the relative exposure time for each hour from sunrise to sunset was made. Using this tentative table, a series of similar exposures was made with dry plates. The plates were each developed the same length of time and in the same strength of developer. From these tests the tabular time was corrected. A table was then made giving the estimated time of exposure for each hour of the first day in each month in the year, basing the time of exposure largely upon the tests and the altitude of the sun in the different months. During the ensuing year this table was tested from month to month, and revised as experience indicated, in order to get the best attainable negative at any hour of the day in any month of the year. Table I is derived from the results of the above tests, with the formulas corrected to correspond with exposures made on Eastman films of 1908.

The time for a theoretically perfect exposure that will result in the best printing negative that the subject will give, cannot be expected from any formula that takes into consideration only the most prominent factors affecting the problem. These rules may, however, be expected to give a reasonably close approximation to a perfect exposure. In making exposures where it is unusually important to secure a good negative, and the exposure cannot be repeated, make three exposures as follows: The first exposure with time as computed; the second, with one-half the computed time; the third, with double the computed time.

For less important cases, but where great uncertainty exists as to the proper time of exposure, proceed as above, but make only two exposures, the slowest and the fastest, omitting the computed time exposure. The latitude of the plate will give a satisfactory negative if the theoretically perfect time of exposure lies within very wide limits.

An exposure should not be made in a fog, and in hazy weather only of nearby subjects. Good negatives may be made during a shower if the weather is otherwise clear. Generally, if contrast in the negative is desired, underexpose; if definition in the shadows is wanted, overexpose. When in doubt, it is safer to overexpose. Stops number 64 or 128 are excellent for general outdoor exposure; number 32 or 16, for indoor work. If it is desirable to emphasize a specific part of a machine, focus carefully with a large stop, and shorten the exposure to correspond with the stop.

TABLE I. COEFFICIENTS "A" FOR PHOTOGRAPHIC EXPOSURES IN THE LATITUDE OF NEW YORK

Month	Hour of the Day				
	7 to 8 or 5 to 6	8 to 9 or 4 to 5	9 to 10 or 3 to 4	10 to 11 or 2 to 3	11 A. M. 12 M. 10 P. M.
January-December...	..	2	4	6	7
February-November..	..	4	5	7	8
March-October.......	2	5	6	8	12
April-September......	4	6	9	12	16
May-August..	5	8	12	18	28
June-July...........	7	10	16	24	32

The following formulas and tables are based on normal light conditions and ordinary subjects. If either or both are abnormal, the operator must make allowance in the duration of exposure as computed by coefficients from Tables I, II and III:

TABLE II. WEATHER COEFFICIENTS B

Clear, sunshiny weather..............................	1.0
Floating, white fleecy clouds.........................	1.0
Overcast, but a light day...........................	1.5
Cloudy, dull day	2.0
Lowery, heavy clouds...............................	4.0

TABLE III. SUBJECT COEFFICIENTS T

Shop interior, dark and poorly lighted................	1000.0
Shop machinery fairly well lighted..................	400.0
Shop machinery placed near a good window light......	150.0
Machinery under sheds with one side open, or covered areas	15.0
Machinery outdoors to give details in the shadows....	2.0
Machinery outdoors, general views....................	1.5
Groups or portraits outdoors.........................	1.0
Buildings and nearby landscape......................	1.0
Distant structures or landscape views................	0.5

Time Exposure

Assume a stop suitable for the subject and call it H; then the seconds to expose will be

$$\frac{H \times B \times T}{32 \times A} = \text{seconds exposure for an } H \text{ stop.}$$

Bulb Exposure

A "quick" bulb exposure is a time exposure of about 1/5 to 1/4 second. To compute the number of the lens stop, use the formula:

$$\frac{8 \times A}{B \times T} = \text{stop for a "quick" bulb exposure.}$$

* * *

A non-shrinking alloy can, according to the *Scientific American*, be made by melting together equal weights of tin and zinc. The alloy is hard when a good grade of zinc is used. Two parts of bismuth by weight to 50 parts of tin and 50 parts of zinc, will render the alloy very fluid and make it possible to pour it at a lower temperature.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

MILLING INDEX DIALS

The charts shown in the accompanying illustrations, together with the following explanation, show how a rather complicated job of indexing was simplified to enable an operator who was familiar with only plain milling operation, to carry on the work.

It will be observed by referring to the drawing of the dial, Fig. 1, that the index lines, notches and set-screw must be in a fixed relative position. An index plate with a 54-hole circle was selected, and the degrees between the notches and lines on the dial were reduced to turns and holes for each movement as follows: As it requires forty turns of the crank to make one complete turn of the work, there is, in this case, $40 \times 54 = 2{,}160$ holes to one turn of the work, and a movement of one degree equals $2{,}160 \div 360 = 6$ holes. It is now only necessary to multiply the number of degrees given on the charts by six, to get the number of holes for each movement, and then divide by 54 to reduce the movement to turns

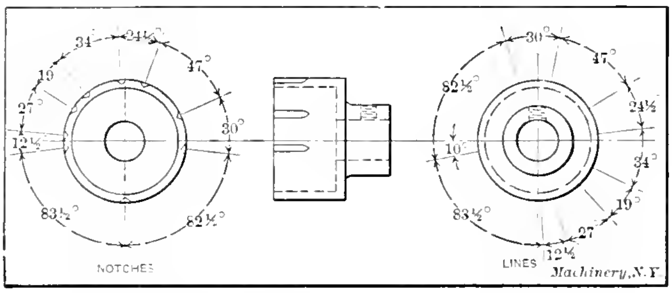
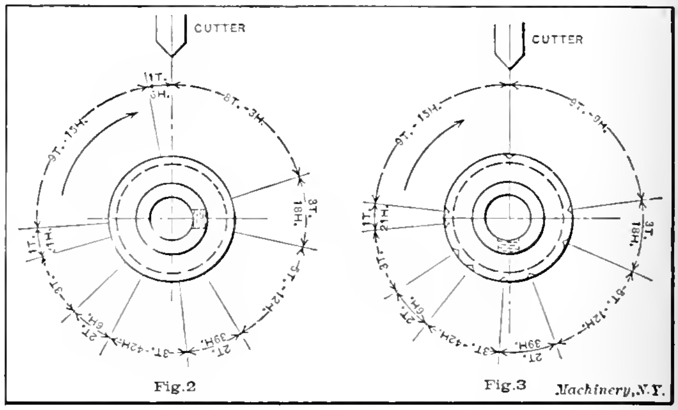


Fig. 1. Index Dial in which Notches and Lines are to be milled

of the crank and additional holes in the plate. For example, 10 degrees $\times$ 6 $=$ 60 holes, or 1 turn and 6 holes.

The work of milling the index lines and the index notches was divided into two operations to avoid confusion, and two charts were made as shown in Figs. 2 and 3. The lines were milled first, and in starting great care was exercised to get the center of the set-screw exactly on the horizontal center line, and to the right, as viewed from the hub end. Now by indexing ten degrees, or one turn and six holes, we are in position to mill the first line, the cutter having been previously set central. Then by indexing, in the direction of the arrow, the required number of turns and holes for each successive cut as indicated on the chart for milling lines, it is a simple



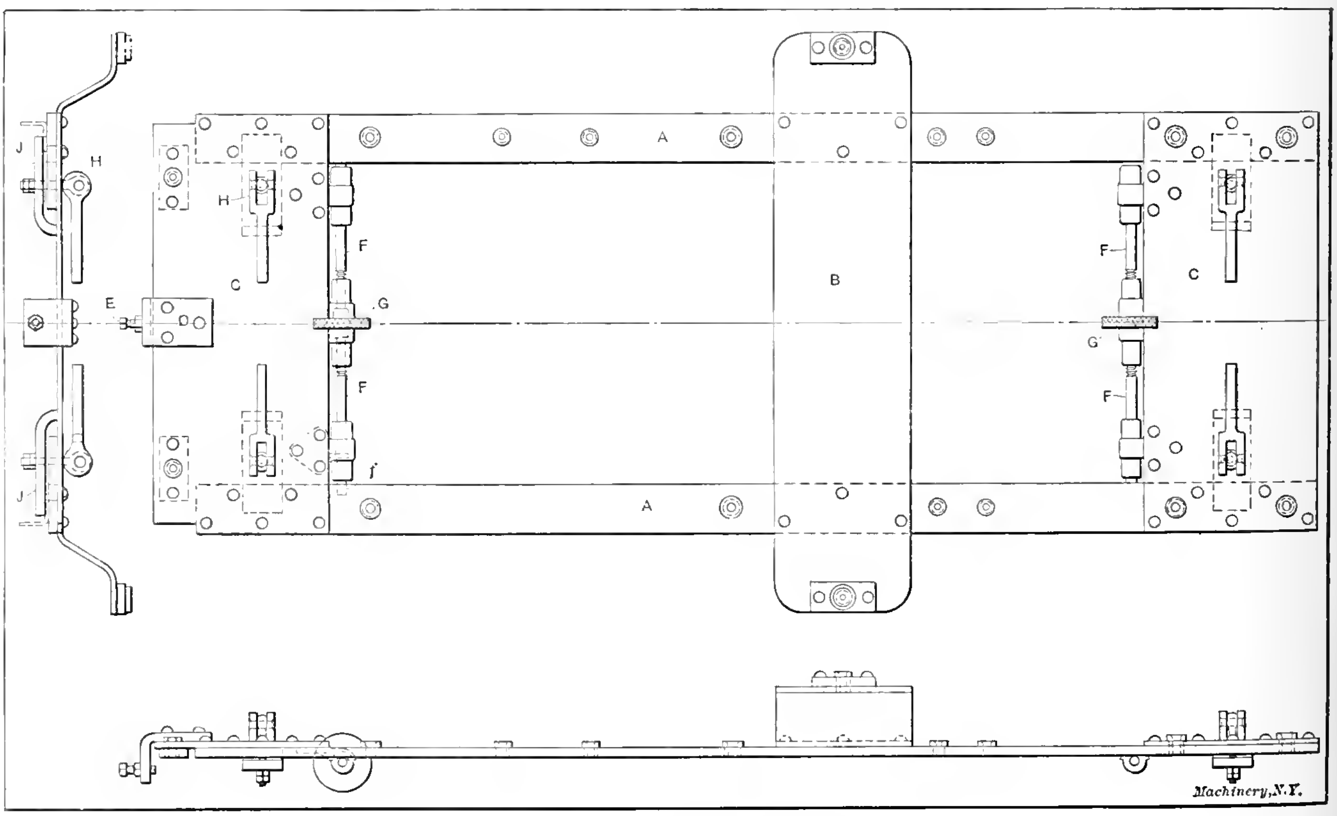
Figs. 2 and 3. Charts for Milling the Lines and Notches

matter to finish that operation. The work will then be in the original position. By referring to the chart for indexing the notches, it is found that one of them is in line with the set-screw hole. As this point makes a convenient starting place for the second operation, the work is indexed one-quarter turn or 90 degrees by ten turns of the crank. This brings the work in the proper position for starting the first cut. Then, by indexing in the direction of the arrow, as shown by the chart in Fig. 3 for milling the notches, the second operation is finished.

C. G. H.

JIG FOR DRILLING AUTOMOBILE FRAMES

A jig for drilling automobile frames is shown in the accompanying engraving. This jig is designed for drilling the holes for the motor and transmission feet, dash anchor plate, radiator, clutch, and shifting yoke holes, all at one setting. The frames, when received, are riveted and have all the holes drilled, except the ones mentioned.



Adjustable Jig for Drilling Automobile Frames

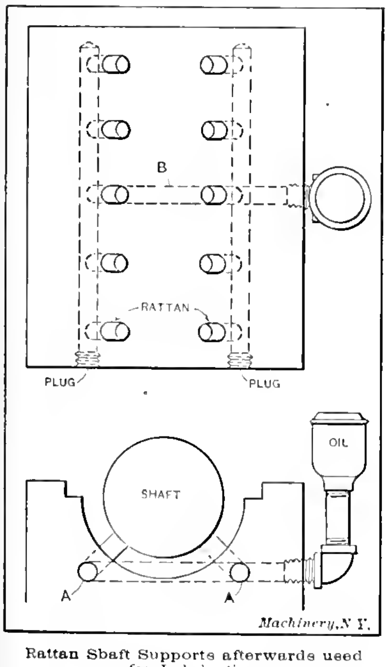
The jig consists, principally, of two side members, *A*, made of ½ x 2½ inch machinery steel; one cross member *B*, made of ¾ x 7-inch machinery steel; and two cross members *C*, made of ¼ x 9-inch machinery steel. The parts are put together with 5/16-inch rivets. The bracket *D* is riveted to the front cross member *C* and it holds the jig in the proper position lengthwise. The screw *E* allows for adjustment. Bracket *D* is made of 1½ x 2½-inch machinery steel and it is riveted to the cross member *C*. The jig is centered by the four adjusting rods shown at *F*; the points *f* bear against the inside of the sub-frame. Adjustment is made by hand-nuts *G*, right- and left-hand threads being employed. Four eccentric levers *H*, in conjunction with the clamps shown at *J*, are used for securing the jig to the frame. After the various members were riveted together, the holes were laid out, drilled and fitted with hardened bushings. This jig proved to be light and accurate.

After experimenting with various styles of drilling machinery, the writer found an elbow bracket drill to be the most convenient and rapid.

Detroit, Mich. J. F. RICHMAN.

SUPPORT FOR SHAFT WHEN BABBITTING

An excellent support for a shaft when babbitting, which may be used afterward for lubricating purposes, is made by inserting pieces of rattan in two rows of holes drilled in the casting, as shown in the accompanying illustration. The holes should be about ¼ inch in diameter, and the rattan cut long enough to support the shaft in the proper position. Two holes *A* should also be drilled lengthwise of the bearing to connect the bottoms of the holes in which the rattan pieces are inserted. The ends of these holes *A* are plugged as shown. After the babbitting is finished, a hole *B* should be drilled across the bearing to connect the oil cup with the supply channels *A*. When the shaft is in place and in motion, it draws the oil through the rattan pieces which wear eventually and which are always in contact with both the shaft and the oil in the supply channel below. This feeding action is due to capillary attraction combined with gravity.



Rattan Shaft Supports afterwards used for Lubricating

S. C. SMITH.

BORING MILL INTERNAL GEAR REPAIR

A 10-foot boring mill table with a broken internal gear is shown inverted in Fig. 1. This table is of cast iron, and the gear was cast integral with it. The breaking of this gear was caused by a broken tooth which jammed in the pinion, causing it to break out a section of the large gear at each revolution. As a new table would cost $385 in addition to a probable delay of several weeks, it was decided to repair the old one, and this was done in the following manner: A locomotive tire was found that would finish approximately to the correct size, and there was also stock enough for an inner flange for bolting the finished gear to the faceplate. A 15-inch Dill slotter with a table graduated into 360 degrees, was used to cut the teeth. As there were 120 teeth in the gear, the table was moved three degrees for each indexing. While the teeth were being cut, the tire was fastened to an old driving wheel center, to which it had been fitted in the same manner as it was to be held in position on the boring mill table. A recess about ½ inch deep was turned in the wheel center,

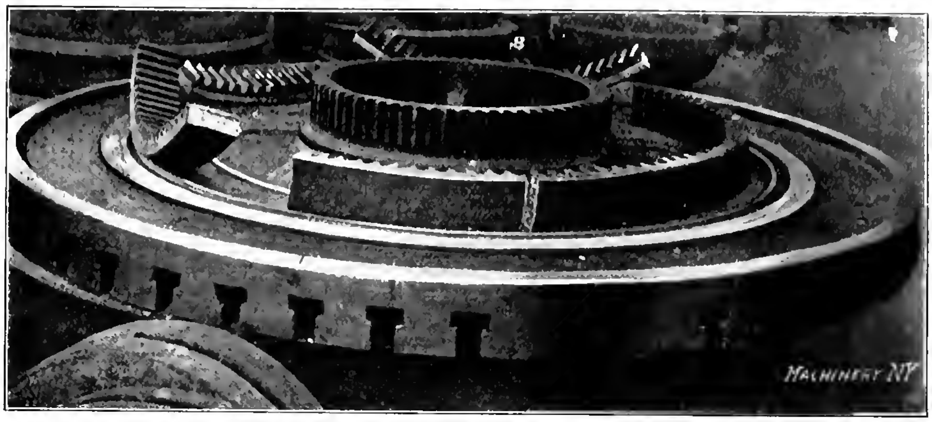


Fig. 1. The Boring Mill Table with its Broken Gear

and cap-screws were used to hold the work in place. The wheel center was also turned out on the under side to fit down over the outside of the slotter table. A roughing and finishing tool of the proper shape for the teeth was made to fit the slotter tool-bar, and the whole job was completed at a labor cost of less than $35. While this gear would probably **not** suit our friends, Mr. Grant or Mr. Bilgram, still it is doing the work for which it was intended, and is a fairly good job.

Battle Creek, Mich. M. H. WESTBROOK.

SUGGESTION DEPARTMENT IN THE SHOP

I would like to learn what the opinions of some of the readers of MACHINERY are on the merits and demerits of a suggestion department in shops, such as many stores and manufacturing concerns have, where prize money is paid to employes for suggestions submitted by them and adopted by the concern, that will be of value. I think that it is a good thing if good sense and judgment are exercised in submitting the suggestions; and if conducted properly, it is an important factor toward the goal of commercial supremacy. I know of a number of highly prosperous concerns who acknowledge that much of their success is due to the suggestions submitted by their employes through the suggestion department.

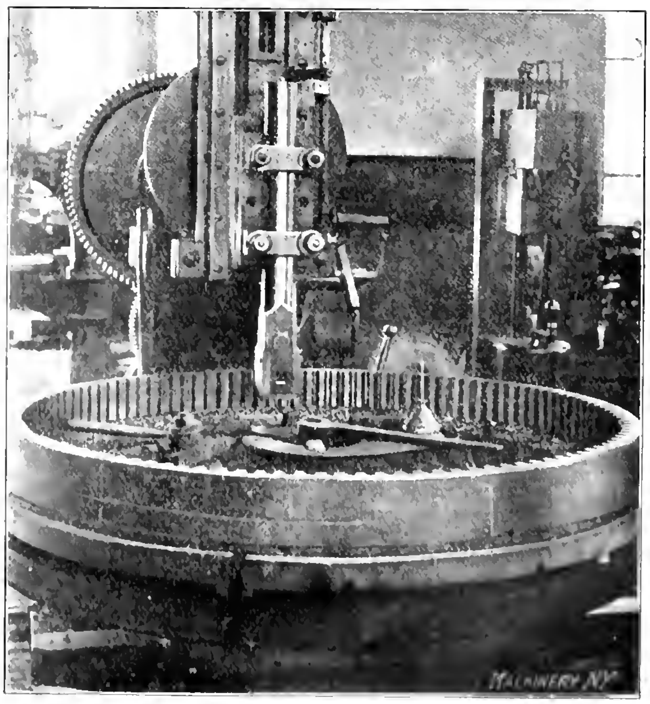


Fig. 2. New Gear being made from Old Locomotive Tire

Encouragement to employes from a concern for suggestions induces men to take an interest in their work and in the welfare of their employer. The ability of each man whose support is enlisted is also developed. Men engaged in a line of work day in and day out are often more likely to see the need of an improvement, than the foreman or superintendent.

When a suggestion is submitted by an employe through the suggestion department, he and not the foreman receives the credit for any improvement. A superintendent or foreman who is opposed to and refuses to accept or encourage suggestions from his men for improvements on a method or process, whether the suggestions come through a department or not, is, more than likely, impelled by jealousy and conceit and is burdened with an exaggerated sense of his own importance and ability. Obviously, such men should not be entrusted with important positions, as they are not qualified for the handling of men and the affairs of a concern. If a superintendent or foreman does not like to have it known that men under him can improve on his methods or system, it should spur him to so improve them that there will be no chance or room for suggestions.

Peoria, Ill. ARTHUR Z. WOLGAMOT.

LOCATING WORK WHEN BORING IN THE MILLING MACHINE

It often happens that accurate boring, drilling and reaming must be done on jigs, dies, fixtures, etc., in a milling machine, that cannot be relied on as to the accuracy of the measurement indicated by the adjusting screw dials because of lost motion between the screw and the nut. By the following method, the most run-down milling machine can be used for such work, and accurate results secured.

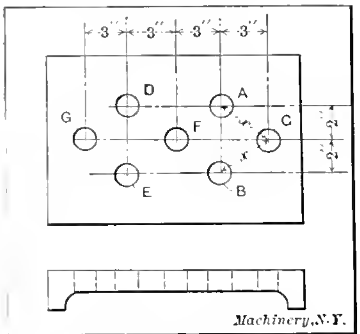


Fig. 1. Jig-plate to be bored as indicated

A jig-plate is represented in Fig. 1 that is to be drilled and bored for jig bushings as indicated. This will serve to illustrate the method of setting work on a milling machine that cannot be relied on. It is assumed that the plate is finished on the edges, and that it is fastened to an angle-plate, which is secured to the table and set square with the spindle. A piece of cold rolled steel or brass is first fastened in the chuck (which is mounted on the spindle) and turned off to any diameter. This diameter should preferably be an even number of thousandths to make the calculations which are to follow, easier. The turning can be done either by holding the tool in the milling machine vise, as shown in Fig. 2, or by securing it to the carriage with clamps. In either case, the tool should be located near the end of the table, so as to be out of the way when not in use.

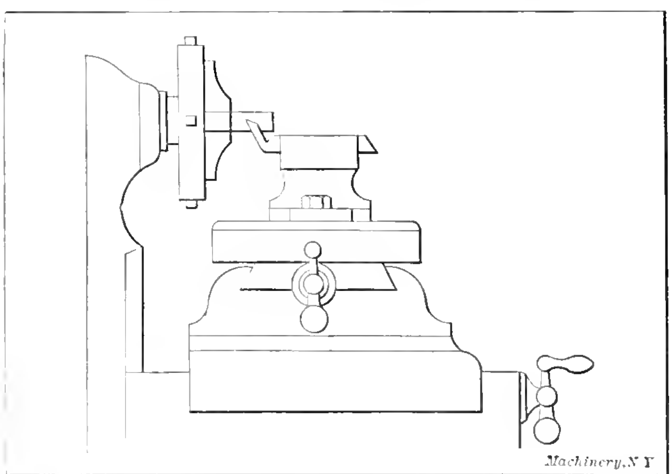


Fig 2. Turning Plug used for Setting Jig-plate

After the piece in the chuck is trued, the table and knee is adjusted until the center of the spindle is in alignment with the center of the first hole to be machined. This setting of the jig-plate is accomplished by measuring with a micrometer depth gage from the top and sides of the work to the turned plug as illustrated in Fig. 3. When taking these measurements, one-half the diameter of the plug in the chuck is, of course, deducted. When the plug is properly set, it is removed from the chuck and the first hole A is drilled and bored or reamed to its proper size. The plug is then again inserted in the chuck and trued with the tool. After which it is placed in alignment with the second hole B; this is done by inserting an accurately fitting plug-gage in hole A and measuring from this gage to the turned piece in the chuck with an outside micrometer as in Fig. 4. Allowance is, of course, again made for the radii of the two plugs. The horizontal measurement can be taken from the side of the work with a depth gage as before. The plug is then removed and the hole drilled and bored to the proper size. Without changing the adjustment, the plug is again inserted in the chuck and turned true; the table is then moved vertically to a position midway between A and B, and then horizontally to the proper position for hole C as indicated by the depth gage from the side of the work. The location can be verified by measuring the center distances x with the micrometer. In a similar manner holes D, E, F and G are accurately located.

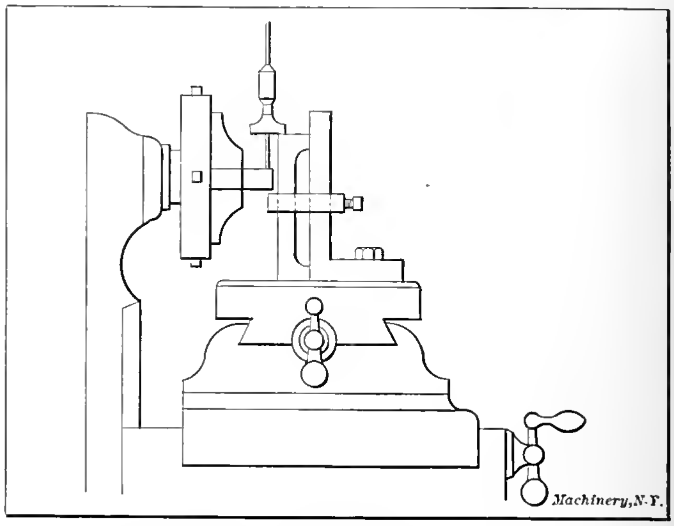


Fig. 3. Setting Jig-plate by measuring to Turned Plug with Depth Gage

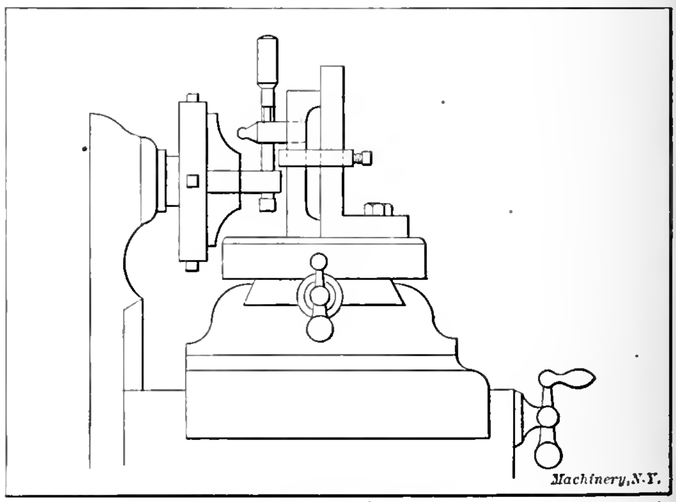


Fig. 4. Obtaining Accurate Center-to-center Distance by the Use of Plugs and Micrometer

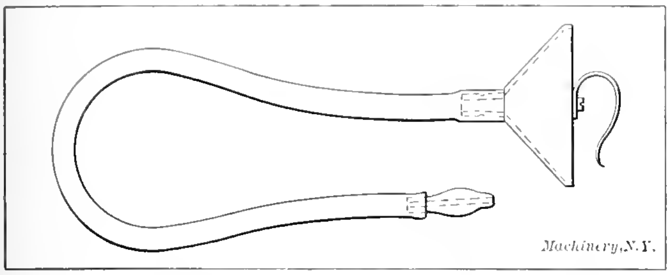
If the proper allowances are made for the variation in the size of the plug, which, of course, is made smaller each time it is trued, and if no mistakes are made in the calculations, this method is very accurate. Care should be taken to have the gibs on all sides fairly tight at the beginning, and these should not be tightened after each consecutive alignment as this generally throws the work out a few thousandths. If the reductions in the size of the plug, each time it is turned,

are confusing, separate pieces can be cut off and trued up to one side. If the center distances x are not given, it is, of course, far more convenient to make all the geometric calculations before starting to work. L. E. KRAMER.

Newark, N. J.

MECHANICS' STETHOSCOPE OR SOUND TRANSMITTER

The engraving shows how a simple stethoscope or sound transmitter is made. Its use is adapted to small work and particularly to bench lathe boring, grinding or lapping. It is composed of a piece of ¼-inch rubber tubing with a hard rubber ear-piece and a conical brass cup with a thin steel disk for a diaphragm soldered to the large end. In addition, there is a spring clip fastened to the diaphragm with a screw. Suppose a small hole 0.015 inch in diameter is to be lapped;



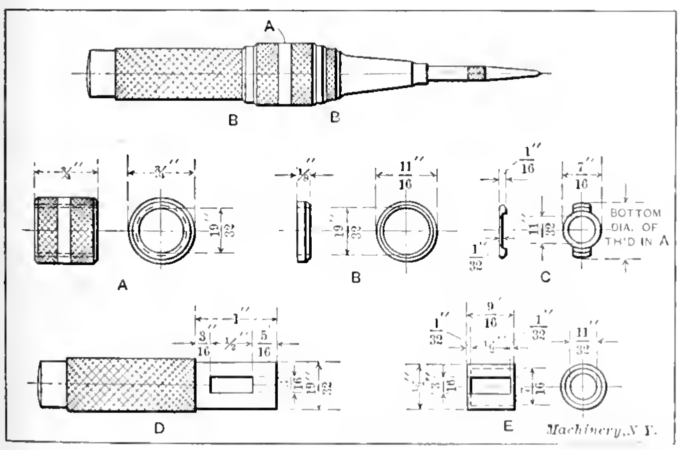
Simple Instrument for Transmitting Sound

then the spring clip on the diaphragm is slipped on the outside of the spindle bearing in which the lap is being used, and as soon as the lap is set in motion and adjusted, the finest touch can be detected with this instrument. I have seen many mechanics use the cover of a round tin box with a wire rod soldered to it. This transmits the sound fairly well, but the operator must hold his head in one position to listen, whereas the instrument shown in the sketch, because of the rubber tube, allows the operator to hear and also move so he can see what he is doing. A. J. DELILLE.

Elgin, Ill.

ADJUSTMENT FOR AUTOMATIC CENTER PUNCH

The following article describes an adjustment which may be fitted to a Brown & Sharpe plain automatic center punch. The advantages claimed for it are, a wider range of adjustment and the absence of projecting nuts on the ends of the



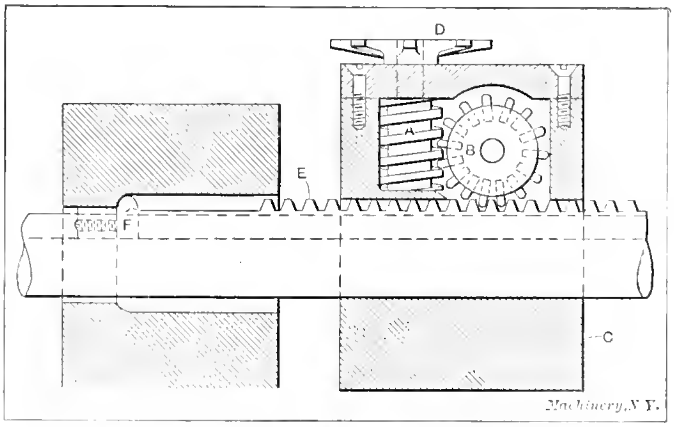
Parts for Making a Plain Automatic Center Punch Adjustable

punch. Its range of adjustment is from the full stroke of the punch down to no movement at all, as the release of the striking block is made adjustable, instead of the compression, on the spring.

At the top of the accompanying engraving the punch is shown assembled, and I do not think that it loses any of its neatness by the addition made to it. Parts A, B, and C are the extra parts required. The handle D is turned down on the end as shown, and two slots are cut through. Two slots of the same size are also cut in thimble E, so that when it is in position inside the handle, these slots are in line. Knurled sleeve A is bored to fit over the end of handle D, and it is threaded inside, 16 threads per inch, V thread. A nice smooth thread is required. Collars B, of which two are needed, are merely to keep sleeve A from screwing up on the knurled handle, as the shoulder is so small. Part C is made a nice sliding fit inside of thimble E, and the two projections pass through the slots in E and D. The ends of these projections are bevelled to fit the thread inside of A, so that, when the parts are assembled, and the sleeve A, which is fixed endways, is revolved, the part C moves up or down inside of E. The bore of part C is the same as the bore of the inside flange on thimble E, this flange releasing the striking block. It is obvious that by revolving sleeve A until part C is at the bottom, the center punch is practically solid. When part C is at the top, the stroke is practically the same as in the plain center punch, and any stroke between these limits can be obtained. T. H. N.

SPECIAL BORING TOOL

We ran up against a snag at one time which made it necessary to design a special boring head and tool, and as the tool worked so satisfactorily I consider it entitled to a brief description in MACHINERY. This special tool was made necessary by a cored bearing which had to be bored, as there was no room around the shaft for babbitt. This shaft was fixed so that we could not get an end movement (or feed), and the bearing was also fixed, but we could drive the shaft by power when it was applied.



Special Boring Head and Tool

The accompanying illustration shows the construction of the special boring head used. It was made as cheaply as possible, and the parts were obtained from every available source. The worm A was taken from an old S-wrench, and the body C was made from a piece of scrap shafting. The cavity in which the worm A and wormwheel B were inserted, was cut with an end mill of practically the same diameter as the worm. This wormwheel was also made from a piece of scrap shaft, cut the right length to fit into the chamber. The teeth were formed by driving pieces of drill rod into holes drilled for the purpose. The part D is an eight-pointed star wheel, which was used for feeding the bar at each revolution of the shaft. The rack E was made from a piece of common key stock, of a size to fill the spline which happened to be in the shaft. The boring tool F was inserted in a hole in the end of the rack, and secured with a headless set-screw which allowed for adjustment. After the job was finished, it was found that by making two sets of brackets to support the ends of a permanent bar which was made to suit the head C, this tool could be used in many an out-of-the-way place, especially on repair work. H. E. WOOD.

Newark, N. J.

MAKING ACCURATE AUTOMOBILE ENGINE PISTONS

In a large shop that was turning out a great number of automobile parts on contract, they had trouble in setting accurately finished pistons, and after trying several different plans, the following was found to be most satisfactory.

Fig. 1 represents a chuck which is made of two gray iron parts; namely, the body A and the closing ring B. The body

was screwed on the spindle of an engine lathe by a spanner wrench which engaged the holes *C*. Fig 2 represents the finished piston. These pistons after having been entirely machined, except grinding, were placed in this chuck and a fine finish cut was taken in the mouth. When the piston was placed in the chuck, closing ring *B* was screwed tight by a spanner wrench which engaged holes *D*. The ring being a good fit at *H*, remained true when drawn back by the threads; and as the chuck body *A* was beveled to match the

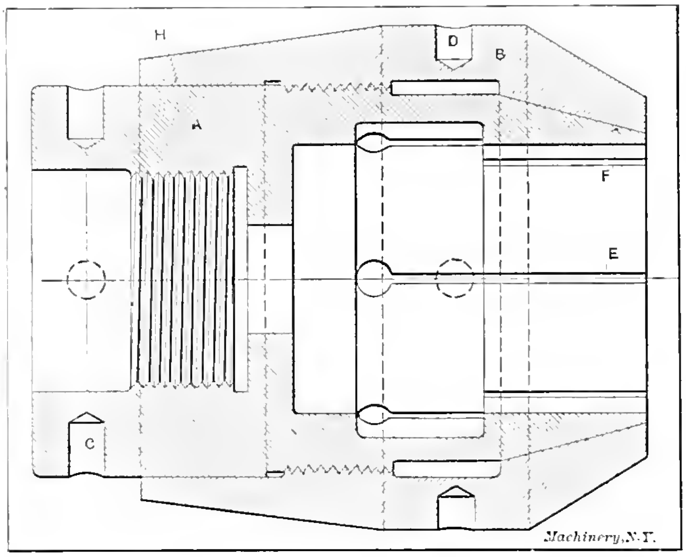


Fig. 1. Chuck for Holding Pistons while Boring Mouth

closing ring and saw-divided at *E* into three equal parts, it closed tightly on the piston and held it true so that the finish cut was true to the outside of the piston.

The cross bore in pistons which had previously been machined in a jig that fitted the outside diameter of the piston was, therefore, at right angles to the finished outside. Thus the cross bore, the mouth bore, and the outside diameter were made exactly true to each other. This much being accom-

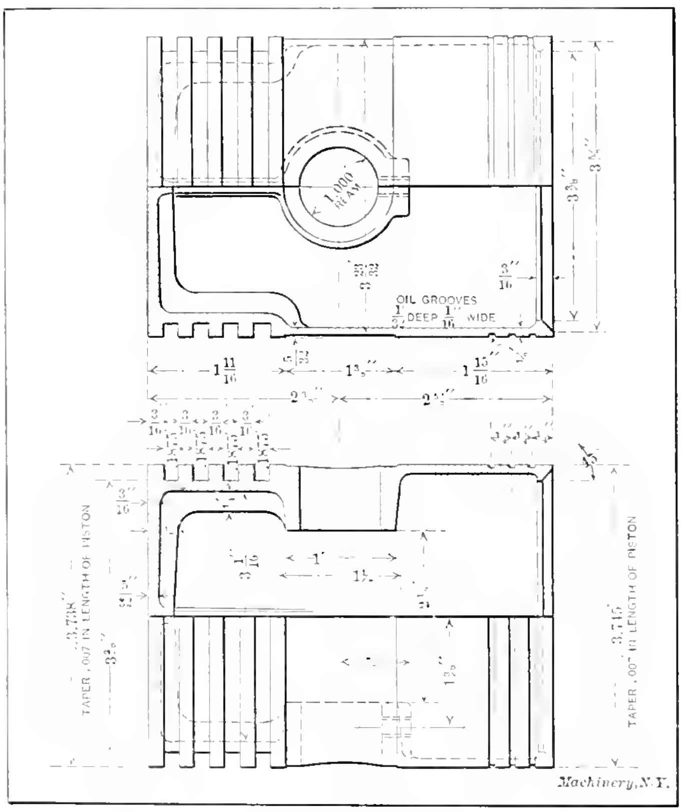


Fig. 2. Automobile Engine Piston

plished, the finish grinding was made perfect by the mandrel shown in Fig. 3. This consists of a finished forging *J*, a pin *K*, that is a close fit in the cross bore of the piston and in forging *J*, and a cylindrical part *L* that is fitted accurately to the forging *J* and that also is a close fit at *O* in the finished mouth of the piston. By tightening nut *M*, shoulder *P* is brought square against the end of the piston. It is now evident that with the piston center on one center of the grinder, and the centered end of forging *J* on the other grinder center, with pin *N* acting as a driver, that an accurately ground pis-

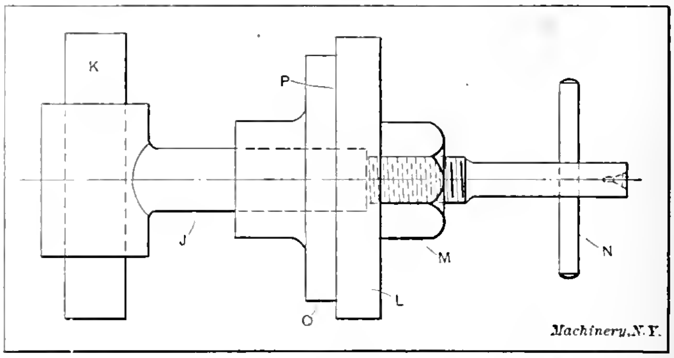


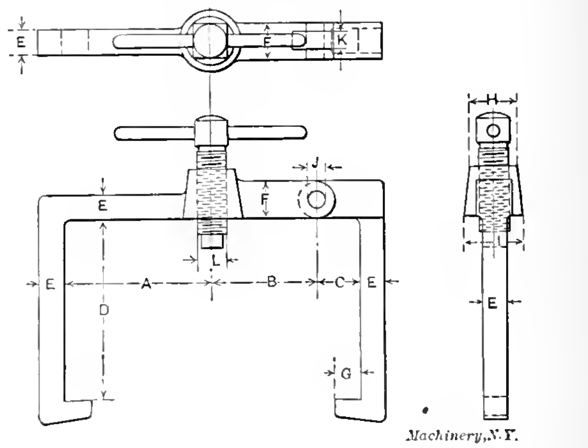
Fig. 3. Mandrel on which Pistons are held while being ground

ton would be the result. We found this method a little slower than some others, but the extreme accuracy obtained and the small number of pistons rejected by the inspectors, made the gain all in favor of the fixture.

JIG AND TOOL DESIGNER.

HANDY SET OF CLAMPS

We had some work to clamp in a drill jig, and as the ordinary C-clamp required too much time to operate, the type of clamp shown in the accompanying illustration was designed. A common squared-head cap-screw with a dog point is used to



Size No.	A	B	C	D	E	F	G	H	I	J	K	L
1	3	2 1/8	7/8	2 1/4	1/2	3/4	9/16	1	1 1/4	3/8	3/8	5/8
2	3	2 1/8	7/8	2 1/8	1/2	3/4	9/16	1	1 1/4	3/8	3/8	5/8
3	1 7/8	1 1/4	5/8	1 3/4	1/2	3/4	9/16	1	1 1/4	3/8	3/8	1/2
4	2 1/4	1 1/2	3/4	2 1/4	1/2	3/4	9/16	1	1 1/4	3/8	3/8	5/8

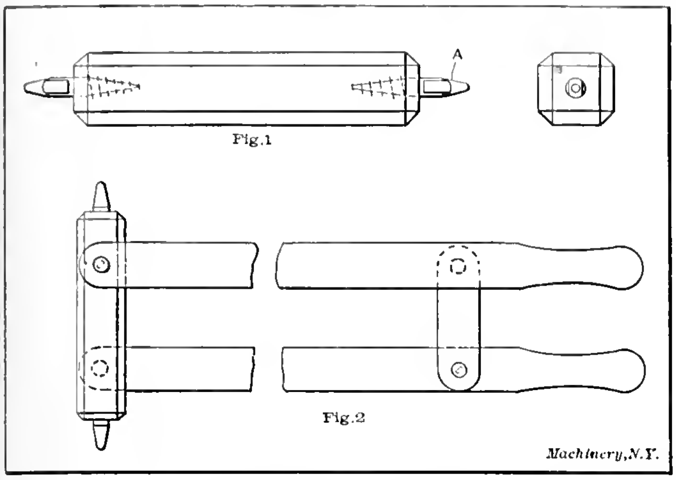
tighten the clamp after the movable side is swung into place. A 1/4-inch pin, 3 inches long, passes through the head of the clamping screw, which makes it unnecessary to use a wrench for tightening. The swinging side of the clamp is pivoted to the main part by a pin which passes through a hinge fitting, as shown. Dimensions for four different sizes of clamps of this type are given in the table below the engraving. These clamps are very convenient, quick-acting, and they may be used for many purposes.

E. H. PRATT.

DEEP HOLE CALIPERS

In response to the editor's request, in the December number, for descriptions of deep hole calipers, I submit the following and the accompanying sketch, as a possible solution of "J. W. M.'s" problem. Fig. 1 represents a point or inside caliper similar to those used in the U. S. arsenals on large gun work. The body of the caliper or "stick," as it is called in the shop, is made of a piece of wood, and the points *A* are made from wood screws, the heads being cut off and the body

turned down as shown. Two flat places are filed on each point so that a wrench may be applied to adjust the points in or out for any required size within its limits. These sticks have many advantages over the usual methods of obtaining inside measurements: They are easily adjusted to outside micrometers or verniers and it is only a few minutes' work to make one of any desired length; the wood acts as an insu-



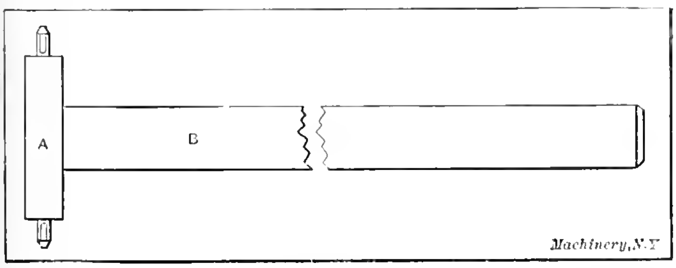
Figs. 1 and 2. Inside Caliper and Same Tool with Handles for Deep-hole Work

lation from the heat of the hand and furnishes a convenient place on which to mark the size to which it has been or is to be set in the inspection department. Fig. 2 shows how I would rig up one of these sticks to caliper the size at the bottom of a deep hole such as J. W. M. mentions, and with it I believe it would be an easy matter to ascertain the size within 0.00025 providing, of course, an outside micrometer of the required size is convenient. However, if the pieces are to be measured in large quantities, a star gage would be much quicker.

T. Covey.

DEEP HOLE CALIPERS

Through the "How and Why" page of the December, 1909, number of Machinery, J. W. M. asks for the best means of accurately determining the size at the bottom of a bore approximately 4 inches in diameter and 12 feet long. The best and cheapest way of measuring the diameter that I know of, is to take two wood screws, cut off the heads, point them,



Improved Deep-hole Caliper

file a flat on each side of the body so that they can be turned with a wrench, and screw one in each end of a piece of wood *A* about ¾ inch square by 3 inches long. A wooden handle *B* of the required length should be attached to the center of the cross-piece *A*, thus forming a T. The flats on the screws make it easy to adjust them in or out until they are set to the diameter of the work. Of course, the caliper must be withdrawn each time an adjustment is made.

Poughkeepsie, N. Y. George H. Desrochers.

CENTERING A SHAFT WITH A MILLING CUTTER

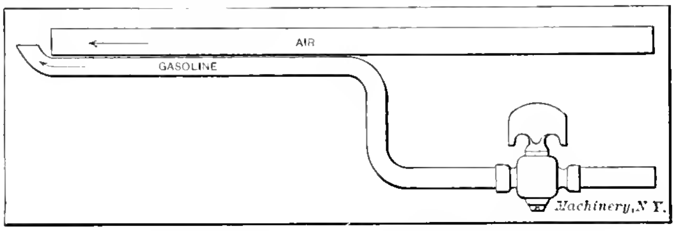
The method of centering a shaft with a milling cutter when key-seating, described by Mr. H. E. Wood in the October number, is a very good one, and one that I have used many times. It is also a good way of centering work with the cutter when milling spirals. By this method the centers can be set central with the cutter before swinging the table to the angle of the spiral. Another good method of centering the cutter when milling spirals, is to set the pointer of a surface gage to the height of the center, and then scribe a line across the end of the work, which is then indexed a quarter turn so as to bring the scribed line in a vertical position. The cutter may then be set with reference to this line. Still another method I often use when key-seating is as follows: The shaft is first adjusted so as to bring it within a few thousandths of being against the side of the cutter; then, if the cutter runs out laterally, it can easily be detected by sighting down over it while it is revolving. With the cross feed, the shaft is then set so that it just touches the side of the cutter. If the latter runs out of true, that part which is midway between the two points that run out the most should be set against the shaft. The dial on the screw is then set to zero; the table is locked, and the shaft is moved in a distance equal to one-half its diameter. The side of the cutter will then be in the same vertical plane as the center of the shaft. The dial may then be again set to zero so that the work may be moved a distance equal to one-half the cutter width. The shaft will then be exactly central with the cutter.

Arthur Z. Wolgamot.

Peoria, Ill.

CLEANING AUTOMOBILES

As a foreman and mechanic in the automobile industry, I have been called upon many times to repair very dirty machines, a job which is sometimes annoying to the men. The device shown in the accompanying illustration has been found very effective for removing the dirt from automobiles, and it doubt-



Air and Gasoline Nozzle used for Cleaning Automobiles

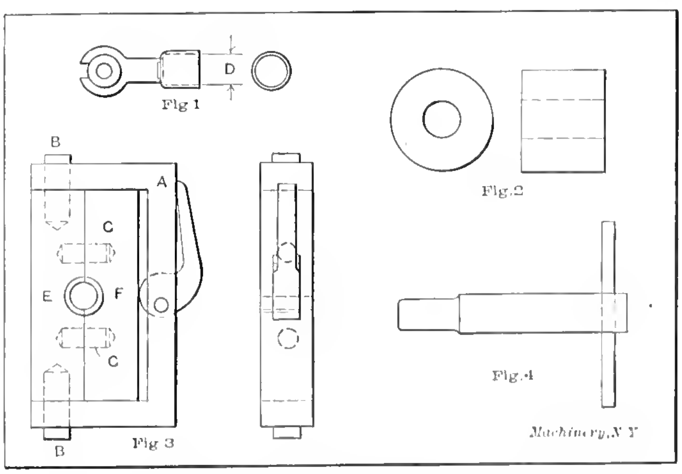
less would prove useful in connection with other work. This device consists of an air and gasoline nozzle, which is made of two pieces of tubing about fifteen inches in length. The sizes of these tubes are ⅜ and ¼ inch for the air and gasoline, respectively. Care should be taken to make the end of the gasoline pipe come exactly central with the air outlet, as shown in the illustration. By means of hose, one nozzle is connected with the compressed air and the other to a gasoline can. A valve can be placed on the gasoline pipe to regulate the amount of gasoline to be used. With a heavy air pressure, one gallon of gasoline will clean an entire automobile very effectively in an hour or so, and better than by any other method known to the writer.

J. B. Kemp.

Indianapolis, Ind.

DIE FOR REDUCING MAGNETO CABLE ENDS

A handy fixture is shown below, which the writer had occasion to use for re-forming the spark-plug end of magneto cables used on automobile engines. Magnetos with cables were bought from one company, and after some time a change



Figs. 1 to 4. Die for Reducing Spark-plug End of Magneto Cable and Sample of Work

was made in the cables and it was found that the new cables were 1/16 inch smaller in diameter. As a result, the terminal for the spark-plug end of the cable was too large and scraping this piece was out of the question, as this would involve considerable delay, which at the time could not be tolerated. In Fig. 1 is shown the cable end, the diameter *D*, being, as before stated, 1/16 inch larger than required. Fig. 3 shows the die for reducing the diameter. This die was split in order to be able to place the work into it. The part *A* of the die was pivoted on the pins *B* which were fastened into the half of the die marked *E*. The other half of the die was held by the eccentric which pivoted in *A*, the pins *C* locating this half. Fig. 4 shows the punch, and Fig. 2, a guide for the punch. This work was done by a boy, in a small hand press. After the piece was forced through the die and reduced, it was trimmed on the end, this being necessary because of the redrawing of the metal.

St. Louis, Mo. C. T. Schaefer.

EFFICIENT TYPES OF MILLING FIXTURES

With reference to W. A. Sawyer's "Efficient Type of Milling Fixture," illustrated and described in the October number of Machinery, in the Letters Upon Practical Subjects department, I would like to offer a little friendly criticism. I consider that there are at least three weak points in the design, *viz.*, (1) Work is not properly clamped. (2) Fixture is hard to keep clean. (3) Fixture is slow to operate.

To prove the claims—First, the work is clamped on one side of the cutter only and there is nothing to prevent the cutter from lifting the unsupported side at the beginning of the cut, unless the operator is very careful in advancing the work to the cutter. Again, if the work is not of a uniform thickness, one piece will be clamped close to the cutter while the other is clamped at some distance from it. The engraving Fig. 1 will serve to illustrate this.

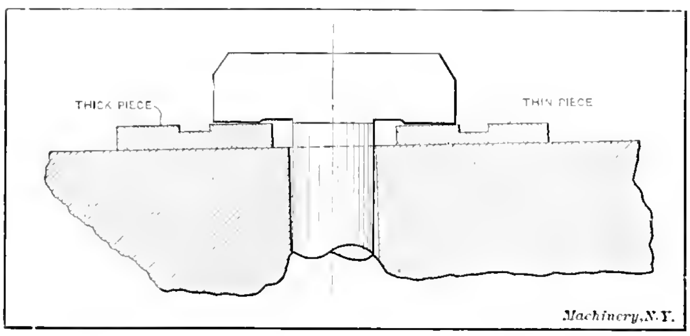
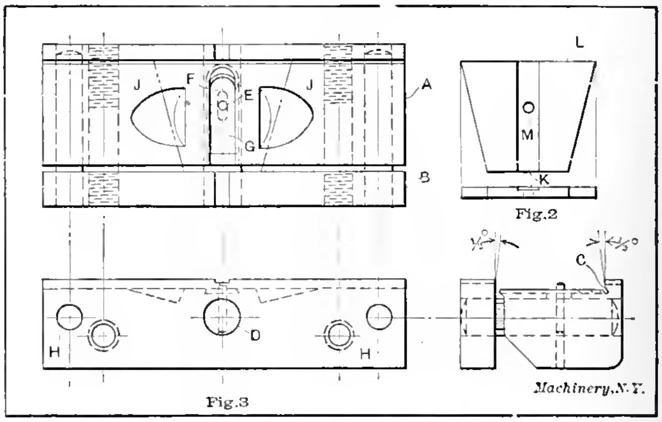


Fig. 1. Pieces of Different Thicknesses held by a T-clamp

Second, to clean the fixture it must be taken apart, and this the writer considers a bad feature in fixture design, unless the construction is very simple. Any one studying Mr. Sawyer's design and noting the number of moves required to clean the fixture, will admit that the time required for cleaning is long compared with the time required to perform the cutting operation. I am, of course, assuming that Mr. Sawyer's sketch is proportional. The clearance slot for the pin *C* is unprotected from chips during the cleaning operation, and, in time, would become choked up. The foregoing objections would also apply to the third weak point, since it cuts down the output. It would be interesting to know what the latter would be per hour.

If a reliable vise is available, a pair of vise jaws could be made similar to Fig. 3 which would perform the operation satisfactorily. Jaw *A*, which is stationary, supports the work to within 1/32 of an inch of its width. *B* is a plain jaw. A slight angle of about ½ degree is given to the faces of both jaws to insure the work being held securely at the upper edge. A slight clearance check or groove is cut at *C*. *D* is a sliding pin which is an easy fit in both jaws. Into this pin is inserted pin *E* which locates the work. This pin is free to slide in jaw *A*, while slot *F* is protected from chips by means of a sheet metal piece *G*, which is dovetailed into *A* and slides with pin *E*. Clearance cuts *J* assist in lifting the work from the jaw. Lining pins *H*, which are driven into jaw *B* and slide in jaw *A*, prevent any lifting effect when tightening the vise.

It will readily be seen that a design of this type will embody what the writer considers the five most important features in fixture design, *viz*: Simplicity, efficiency of clamping device, ease with which it is cleaned, quickness of operation, and durability. A design such as is suggested would not cost more than 25 per cent of the cost of Mr. Sawyer's fixture, and while it is only a single fixture, there is very little time saved in making it multiple, as the cut is comparatively short and shallow and the time saved by being able to remove work and brush away chips quickly will more than counterbalance the advantage of milling two pieces at once; thus the output would be greater than with a fixture of Mr. Sawyer's design.



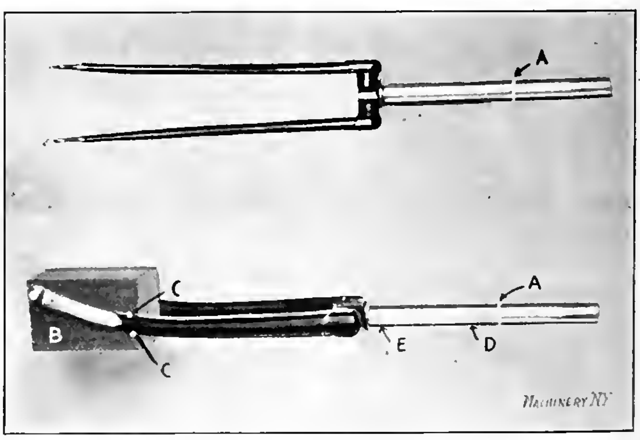
Figs. 2 and 3. Work and Fixture for Holding it while Groove "K" is being milled Square with Edge "L" and Central with Hole "M"

If a suitable vise is not available, a special vise with cam movement could be made at small cost to take a pair of jaws of the above type. The jaws can also be case-hardened and ground, thus adding greatly to their life. Where conditions will warrant the expense, and the output is increased, special fixtures are often advisable. Nevertheless there are many cases like the foregoing, where vise jaws will not only be cheaper but better in other ways.

Montreal, Canada. Irwin Jenkinson.

TURNING A BICYCLE FORK

As the fork of my bicycle was broken, I tried one from an old wheel to see how it would fit, and found that it was suitable in every respect except the length of the stem, which needed to be cut off at *A* and be re-threaded. This work was done without difficulty by the following method: A block of wood *B* was fitted in between the tines of the fork and was held rigidly by a bolt which passed through the tines and block. It was further secured by wire nails driven in at *C*. The fork was then placed in the lathe, the block of wood giving a good center for the live center of the lathe. After the steady-rest was placed at *D* the stem was easily cut off. The steady-rest was then changed to position *E*, the end of the work was supported by the dead center, and the thread cut, thus completing the job. Stephen Courter.



Bicycle Fork with Block fitted between Tines to permit turning in the Lathe

Paterson, N. J.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

COLBURN "NEW MODEL" BORING AND TURNING MILLS

The Colburn Machine Tool Co., of Franklin, Pa., has developed a line of boring and turning mills, which we herewith

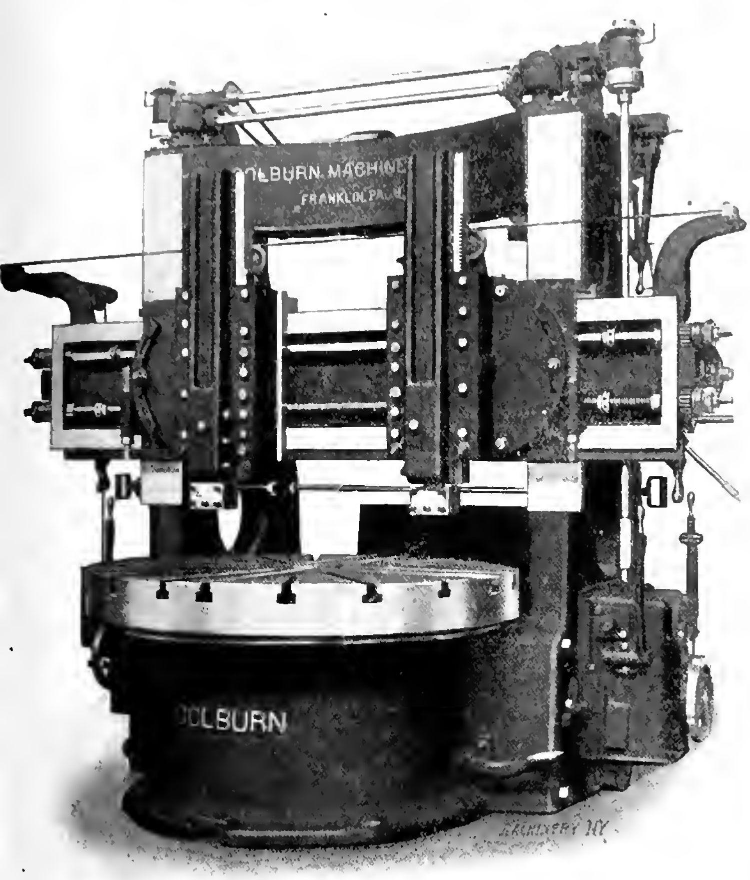


Fig. 1. "New Model" 60-inch Colburn Boring Mill

illustrate and describe. The name "New Model" is used to designate this design. In its general lines it does not differ from the older designs of the same builders but there have been important improvements in detail made throughout which materially increase its convenience and capacity. There are five sizes in the entire line, these being 42-, 48-, 50-, 60 and 72-inch swing, respectively. Practically the same features are incorporated in all the sizes, and a description of any one size applies to the rest. The illustrations here shown are mostly taken from the 60-inch machine.

The main framework of the machine is of standard construction as may be seen from the illustrations. The parts have been carefully designed to permit the taking of heavy cuts without vibration or deflections. The cross-rail, in particular, has been strengthened, having been given a heavy arched box section which is exceedingly rigid. The saddles have unusually liberal bearing surfaces on the cross-rail, with adjustable taper gibs to compensate for wear. The swivels, which are of large diameter and ample bearing area, are provided with an angular adjustment by means of a worm and gear, which also acts as a positive locking device making it impossible for the heads to accidentally fall over sideways when the clamping bolts are released. The ram (see *A*, Fig. 9) is very massive and has a steel rack set into its side. The cored opening is extended all the way to the top so that extra long boring-bars can be used. Clearance is provided to permit the rams to be raised within the guides.

The Main Spindle and Drive

Figs. 3 and 4 show clearly the construction of the spindle and the table drive. The spindle *A* has a massive angular thrust bearing which makes it self-centering. This, in conjunction with the two large cylindrical bearings *D*, effectually resists vertical, angular and horizontal strains. All these surfaces are lubricated from a common supply, this being the oil bath in which the angular bearing revolves. The lubricant is kept at the proper height by the oil gage and filler at the side of the base, connected to the spindle bearing by piping as shown in Fig. 3. The constant flow of oil along the conical thrust surface of *A* is maintained by the motion of the spindle. The lower part of the bearing is immersed in the reservoir of oil *B*, which is carried upward to the outer edge of the bearing and into the annular channel there, from which it is returned through suitable grooves to *B* again. By this means the bearing is automatically flushed, and the oil flows over into the cylindrical bearings. A circular safety pad of felt *E* contains enough oil to keep the cylindrical bearings *D* from becoming dry, even if the supplying of the reservoir is neglected for a long time.

The table is driven by a spur gear *F* of large diameter, attached directly to it. No lifting tendency is possible with this style of drive. As shown in Fig. 3, an internal gear is used on the 60- and 72-inch mills, while an external gear, as shown in Fig. 4, is used on the three smaller sizes. The table pinion *G* is mounted on a vertical shaft, which is oiled by a suitable reservoir and wicking as shown. In this case, as in the other important bearings, care is taken to provide a design which will give satisfactory lubrication, even though the oiler neglects the machine for continued periods.

The Speed Changing and Controlling Mechanism

The drive is by means of 5-step cone pulleys of large dimensions connected through a speed or back-gear box with the horizontal shaft carrying bevel gears

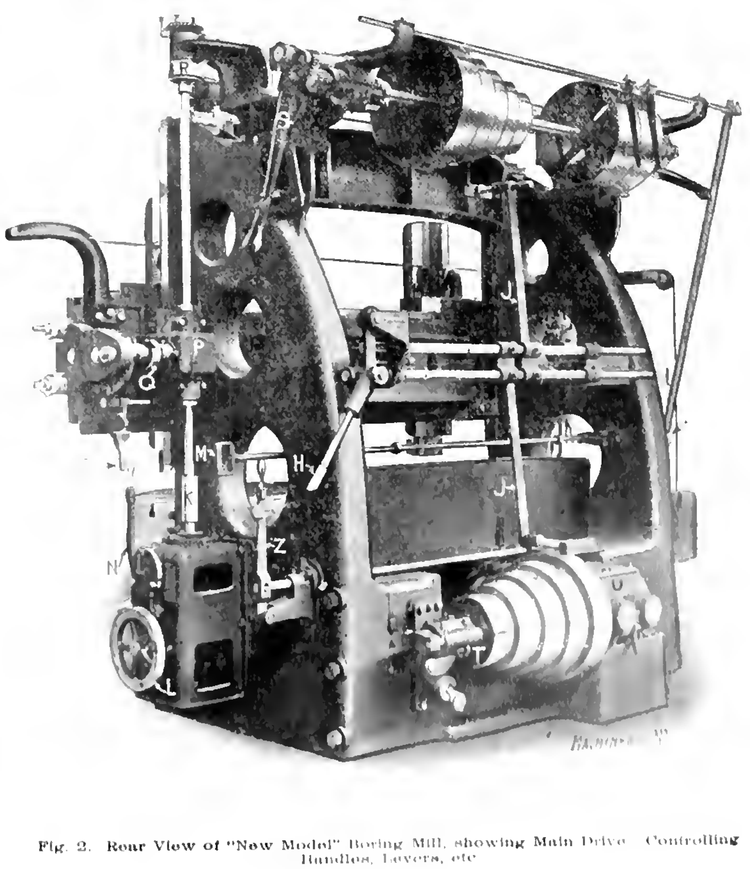


Fig. 2. Rear View of "New Model" Boring Mill, showing Main Drive, Controlling Handles, Levers, etc.

meshing with the vertical table pinion shaft shown in Fig. 4. The driving arrangement is best shown in Fig. 2, while details of the back-gear mechanism and the speed box are shown in Fig. 5. A belt shifter is shown which is simple, effective and easily operated, and avoids the necessity of the complicated mechanism and multiplicity of parts used on many geared speed-changing arrangements. By means of lever *H* (see Fig. 2) controlling belt shifters *J*, *J*, the belt can be changed from one step of the cone pulley to another with great rapidity and without any injury to the belt. In actual operation the change for the entire range of speeds given by the 5 steps in the cone pulleys has been obtained in eight seconds, going from the slowest to the fastest step and back again, and stopping momentarily at each speed.

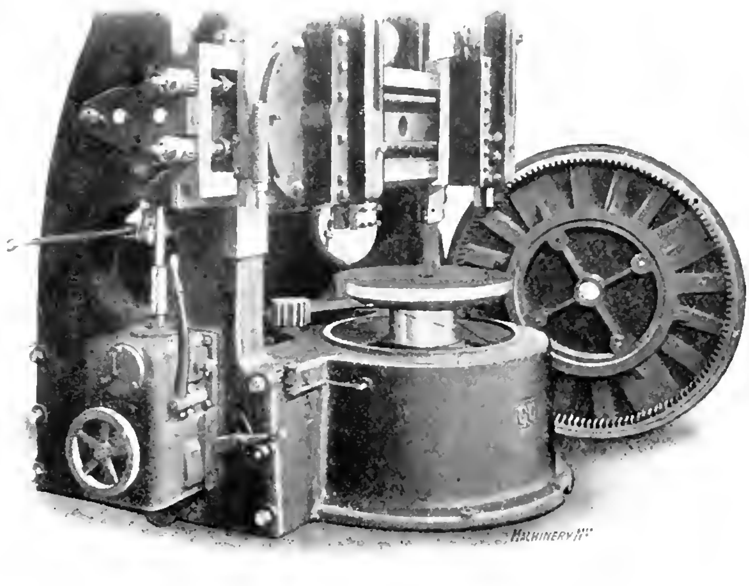


Fig. 3. Details, showing Construction of the Spindle Bearing and Internal Gear Drive used on the 60- and 72-inch Mills

The countershaft is attached directly to the upper parts of the housings by means of brackets having ring oiled bearings. It thus becomes a part of the machine itself. It carries the upper cone pulley and tight and loose pulleys. The loose pulley is provided with bronze bushings and is made smaller than the tight pulley, so that the strain of the belt is removed when the machine is not running. The machine may be controlled from either side of the mill by means of a horizontal rod connected with the shifter, having a spade handle at each end. One of these handles is shown at *M* in Fig. 2.

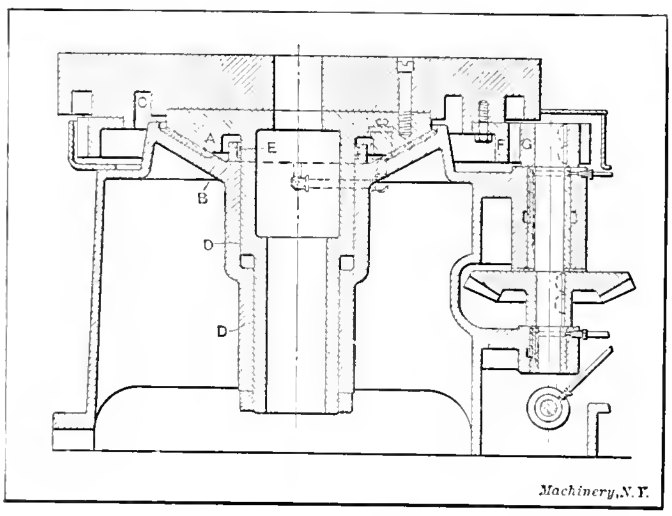


Fig. 4 Construction of the Taper Spindle Bearing and Provision for Oiling

The cone pulley is mounted on the driving shaft of the gear box, as shown in Fig. 2. This mechanism takes the place of the back-gearing ordinarily used. The speed change is made by gears and clutches which are constantly immersed in a bath of oil. The slow speed is thrown out and in by means of lever *Z*, conveniently located at the side of the machine. This, with the five-step cone pulley, gives 10 speeds, all in geometrical progression.

The speed box, when assembled, is oil-tight, and the proper height of oil is shown at all times by the glass gage and oil filler on the outside. All the bearings are bushed with phosphor-bronze and are provided with ring oilers for additional protection. The oil runs into the oil box from the main reservoir. By removing the single plug under the oil feed cup, the entire box can be drained dry. At any time it is necessary to make repairs the mechanism can be removed from the machine in its entirety, so that every part is accessible.

A brake is furnished which enables the operator to stop the machine with the table in any desired position. It is operated by a foot-treadle placed within easy reach on the working side of the machine. This brake, as shown at *B* in Fig. 9, is provided with taper friction surfaces, formed with hard maple shoes and wedges. It is applied to the inside of the cone pulley, as seen at *T* in Fig. 2. The conical type of friction prevents any distortion of the bearings; since it is operated directly on the prime mover, all shock and jar is eliminated and the braking effect is practically instantaneous.

The Feed Mechanism

The feeding mechanism for each head is contained in a separate case, one on each side of the mill, permitting each to work independently of the other. By turning the hand-wheel *L* one revolution, five changes of feed are obtained. The further movement of the multiplying lever, projecting from the front of the gear-box in Figs. 1 and 3, permits hand-wheel *L* to be revolved and gives five more changes, making ten in all. The vertical feed shaft *K*, extending upward to the feed case, engages the mechanism on each end of the rail, which conveys motion to the horizontal rods and screws in the cross-rail operating the heads horizontally, and vertically. The usual slip gears on the ends of the rods and screws are eliminated, and quick-adjusting positive clutches are substituted (see *D* in Fig. 9). This enables the operator to instantly change the feed from vertical to horizontal and *vice versa*.

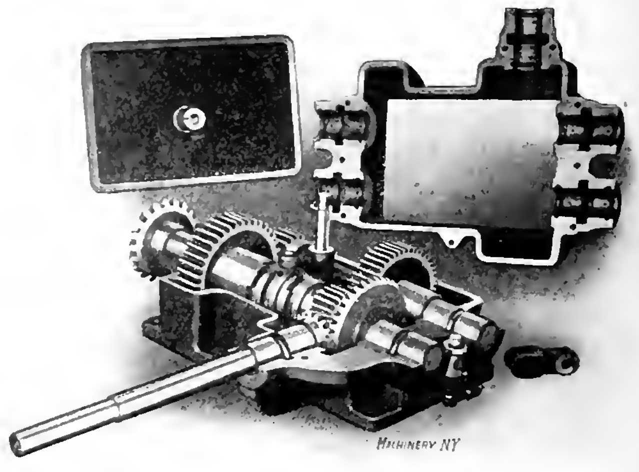


Fig. 5. Speed Box, showing Enclosed Mechanism and Ring Oiling Bearings

Either feed can be reversed by lever *O* at each end of the rail which controls a clutch playing between a set of reversing bevel gears in box *P*. These gears are connected with the feed shafts through a safety shear pin device shown at *Q* in Fig. 2, and in detail in Fig. 6. At the left of the latter engraving it is shown in position, while at the right it is shown taken apart. The connecting shaft is made in two sections with little couplings on their ends, adjoining each other. The motion is transmitted from the driving member to the driven one by a small pin passing through each flange of the coupling. Any abnormal strain on the feeding mechanism in excess of that necessary on the heaviest cuts will

shear this pin off, and thus protect the mechanism from breakage.

When a pin shears, one-half of the coupling is turned half around until the slots are opposite the broken pins, which are then readily removed as shown at the right of Fig. 6. The couplings are then turned until the holes are in line again, when a new pin is inserted and the mill is ready to run. The whole operation of taking out the old pin and putting in a new one only takes a few seconds. There is nothing to adjust or to get out of order in the device. A supply of pins is sent out with each machine, but in case these are exhausted, new ones can be readily obtained, as they are made from the ordinary wire nails found around any shop.

Power Rapid Traverse

An important feature of this machine relates to the construction of the power rapid traverse. This is provided for all the movements of the tools, whether in a horizontal, vertical or angular direction. It is obtained from the same vertical

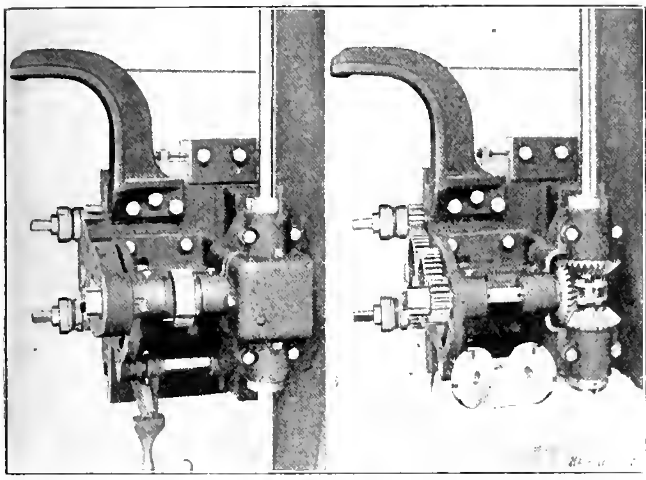


Fig. 6. The Safety Shear Pin Device for Protecting the Feed Mechanism, showing Ease of Replacing Shearing Pin

shaft K as the feed, and is controlled by the vertical lever N (see Fig. 2) at the side of the feed-box. This lever has two operating positions—either pulled in or pushed back. The regular gear feed is always engaged when the lever is in the back position, and if the feed is thrown in, the tool will then move in the direction determined by the position of the feed reverse lever O at the end of the cross-rail. On the other hand, the rapid traverse is always engaged and the gear feed is thrown out when the lever is in the forward position, and the tool will then travel rapidly in the opposite direction from that given by the gear feed.

It may take a word or two of explanation to show the advantage of this construction. It makes it impossible for

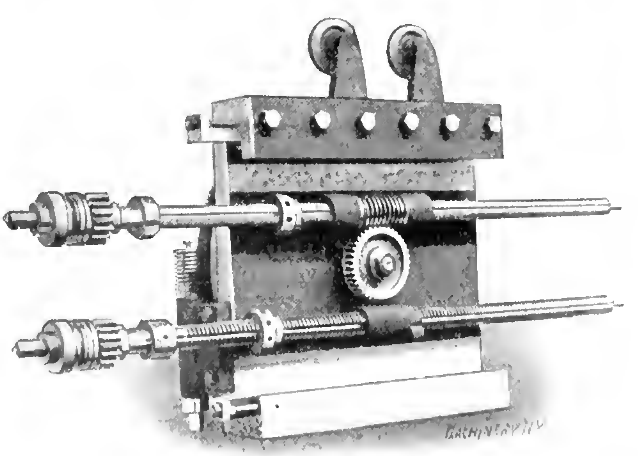


Fig. 7. Rear View of Saddle for Swivel Head, showing Large Diameter of Rods and Screws and the Fine Adjusting Collars for the Tool Movements

the operator to throw in the rapid traverse the wrong way, and thus avoids all chance of accident. For illustration, suppose the tool is feeding horizontally along the rail, taking a facing cut on a piece of work. Having reached the end of the cut, say with the tool up against the shoulder, the operator desires to disengage the feed and return the tool to the starting point again for a finishing cut. He simply pulls the rapid traverse lever forward. No mental effort is required, and he does not have to stop to think for a second which way to pull it, as there is only one direction in which it can be moved. It makes no difference whether the tool

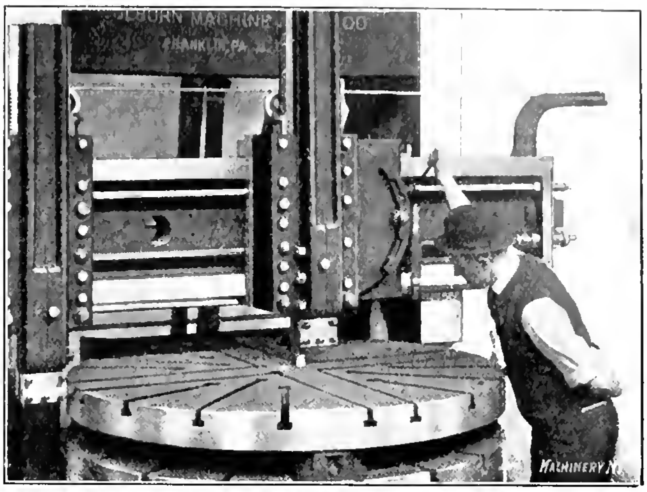


Fig. 8. Method of Making Minute Adjustments, which permits Close Observation of the Tool at the Same Time

is feeding to the right or to the left horizontally, or up and down vertically, the same lever controls the feed and rapid traverse in every case, and pulling the lever always throws the gear feed out and the rapid traverse in, at the same time reversing the direction of the travel of the tool. The rapid movement is obtained from the shaft at the top of the machine through vertical cones having cork inserts, of which one is shown at R in Fig. 2, and in detail at C in Fig. 9. This con-

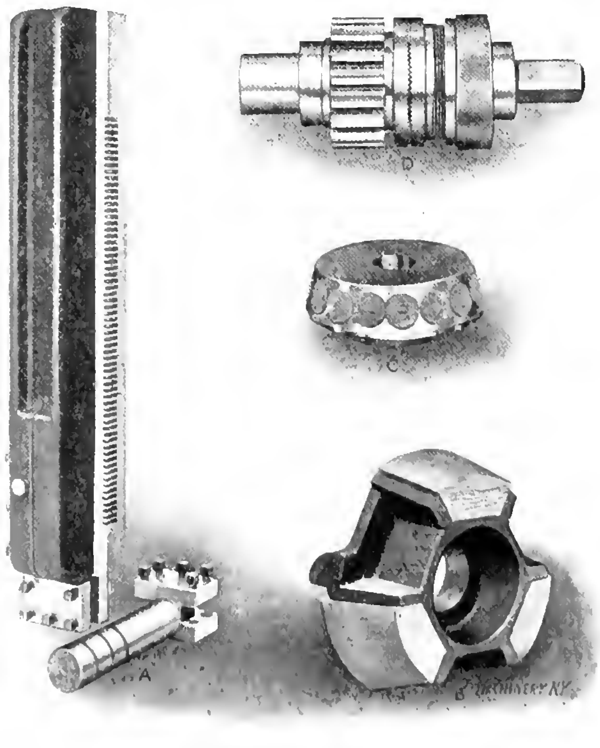


Fig. 9. Various Details. A—Ram. B—Brake Cone with Maple Shoes Treated with Paraffine. C—Cork Insert Clutch Member for Rapid Traverse. D—Quick-adjusting Clutch for Controlling Cross and Down Feeds

struction, which has proved its value in automobile design, does away with the necessity for flooded lubrication at this point.

The fine adjusting collar construction illustrated in Figs. 7 and 8, in connection with the rapid traverse just described, does away with the necessity for hand-cranking, although, of course, the ends of the shafts and screws in the cross-rail are squared so that a crank can be used in an emergency, or whenever the operator prefers. To permit the fine adjustment which the rapid traverse does not give, it has usually been necessary to go to the end of the cross rail and use the

crank-handle. In this design, however, both the feed-screws and the rods in the cross-rail are splined and each has a capstan collar fitted thereto with keys, and free to slide on them. By turning the capstan collars with a small lever furnished for this purpose, the rods and screws are turned also.

The operator can stand close to his work, as shown in Fig. 8, and by placing the capstan collars in the most convenient position, he can make fine adjustments of the tools in any direction without having to go to the end of the rail where he could not readily observe the movement of the tool point. When the heads are moved to the extreme outer position on the cross-rail, these collars do not in any way interfere, as is apparent in Fig. 1, so that it is not necessary to make the rails any longer for the sake of having the fine adjustment.

Attachments and Extra Equipment

Another attachment not shown here, is provided for thread cutting. When this is used, the feed change wheel L is set to a predetermined point at which the table and vertical feed shaft revolve in unison. A single tooth clutch, connected with the rapid traverse lever N, is used for returning the tool quickly to its starting point: and when this is again thrown in to connect the mechanism for threading, the tool must always catch the thread. This is the familiar construction used on certain types of engine lathes in which the lead-screw and not the work is reversed for thread cutting. While the gear connection for threading is not furnished regularly it can be put on at any time. It is attached to the bracket at the end of the cross-rail, always on the right-hand head. The change gears provided allow all threads to be cut between 2 and 14 per inch. For drum scoring, special arrangements are made which allow leads as coarse as one turn in 2 inches to be cut with the same facility as for the finer pitches.

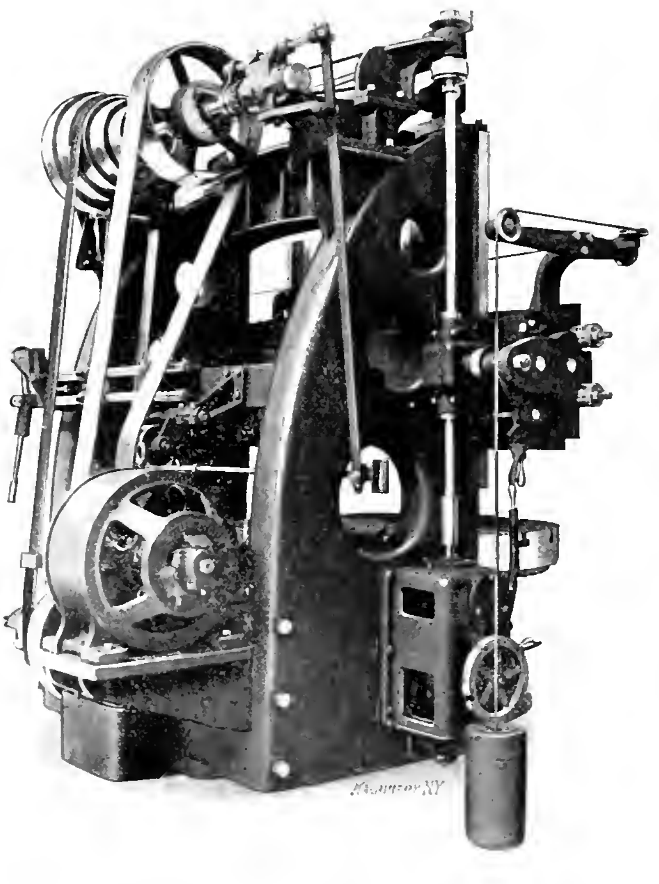


Fig. 10. Constant-speed Motor-drive for Colburn "New Model" Boring Mills

The self-contained countershaft construction described in the beginning of the article particularly adapts the machine to motor-drive. The 5-step cone, mechanical belt shifter and the speed box, furnish a wide range of speed changes so that a constant speed motor is recommended. The motor is mounted, as shown in Fig. 10, on a bracket in the rear, and is belted to a pulley on the countershaft. In order to enable the operator to stop or start the mill without stopping the motor, a clutch pulley replaces the regular tight and loose pulleys, and is operated by the same levers, with handles M (see Fig. 2) on both sides of the mill.

All the various features of design thus described apply to the whole line from the 42-inch to the 72-inch swing. There are some slight changes in the smaller sizes. As explained in connection with Figs. 3 and 4, for instance, an external spur gear is used for the table drive on the smaller sizes in place of an internal gear. Besides this the feed box is of different design on the 42-inch mill, as shown in Fig. 11. This change was made for the sake of securing compactness and to prevent the gear-box from extending out beyond the ends of the cross-rail where it would interfere with the movements of the operator. Turrets will be provided for the right-hand head, in the three smaller sizes if required by the purchaser. One of these is also shown in Fig. 11.

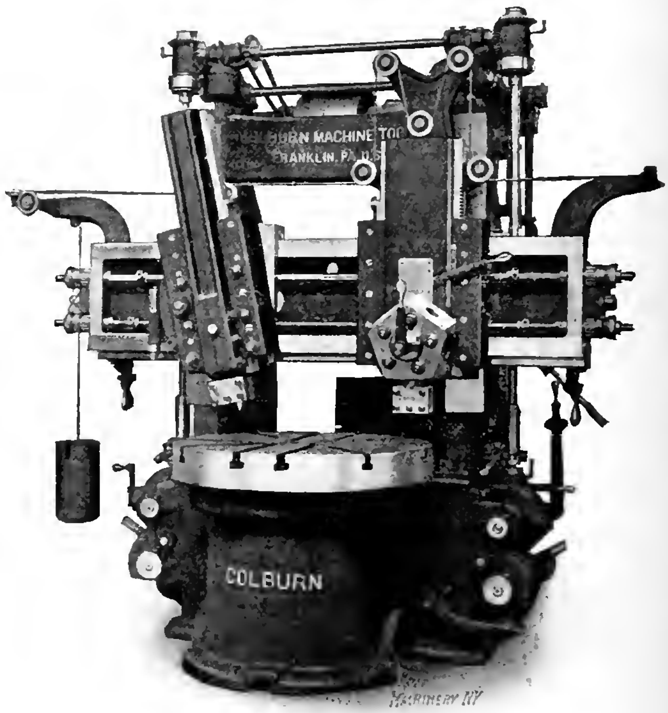


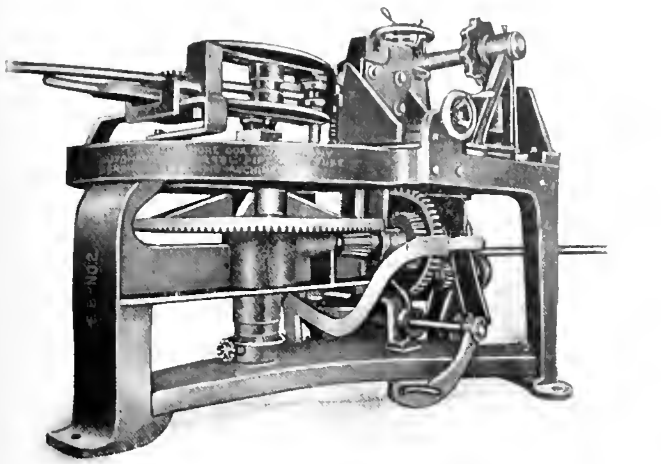
Fig. 11. The 42-inch Machine, showing Alternative Form of Feed Box and Turret on the Right-hand Head

COX PIPE AND TUBE BENDING MACHINES

A series of pipe and tube bending machines is being brought out by J. Fillmore Cox & Co., Bayonne, N. J. These machines, of which one known as "Gem—Type B-No. 2" pipe and tube bending machine is shown in the illustration, embodying several interesting features, of which the most important is that the machine is capable of bending pipe and tubing cold, without the use of an inner filling, to any desired shape without injury to the metal in the pipe. Machines are being built that will take sizes from ⅛-inch tube up to the largest size which is likely to be required to be bent. The machine is, in many respects, a radical departure from previous designs of pipe bending machines, and in view of the rather crude and expensive methods and devices used in many places for bending pipe, it will undoubtedly prove of value to manufacturers who have a great deal of pipe bending to do. When bending pipes, a special collapsible plug is used in connection with a patented flexible chain operating the mandrel. The pipe is bent around rollers with specially shaped grooves, and levers are provided for certain operations with graduated adjustment for setting the bending rollers, so that certain predetermined bends will be produced.

The machine is gear-driven, and a "twin pinion" system of gearing has been incorporated which prevents any possible chance of backlash or lost motion, so that at all times a steady power is obtained, which is not generally possible with

other methods. An automatic stop arrangement is provided by means of which it is possible to obtain exact duplications of bends. A safety stop is also provided for the power mechanism. The main vertical shaft has been made of heavy dimensions so as to be able to easily withstand the heavy stresses to which it is subjected when in operation. In cases where a great number of pipes are to be bent in the same way, they may be cut to the same length and placed in a



Pipe Bending Machine, built by J. Fillmore Cox & Co., Bayonne, N. J.

magazine attachment from which they are fed gradually to the working mechanism. Radial bends, for instance, may be automatically made when the magazine attachment is provided. Such bends as a conical helix and regular helical coils may be performed on this machine by the use of special attachments. Outside of its application to the bending of pipes, the machine may also be used for other kinds of bending, such as the bending of steel rails, angle irons and other structural shapes.

ROCKFORD MULTIPLE SPINDLE DRILLS

We have previously described the sensitive drills both of the floor and bench types made by the Rockford Lathe & Drill

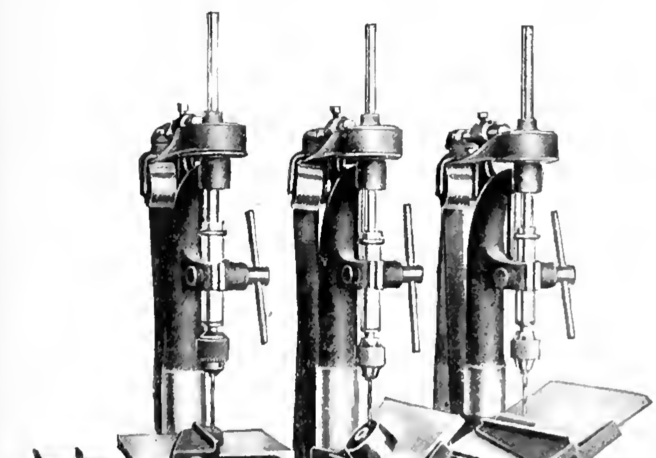


Fig. 1. Rockford Three-spindle Bench Drill, showing Use of Tilting Table and Adjustable Gage

Co., of Rockford, Ill. Both of these machines can now be furnished in the multiple spindle type as shown herewith. All the advantages of the single spindle machines are retained and a number of new features of design are added.

Fig. 2 shows the floor type of multiple spindle drill. The single spindle machine was first illustrated and described in the June, 1908, number of MACHINERY, under the old firm name of "Rockford Machine & Shuttle Co. As may be seen, the tool is provided with a substantial base and column, carrying, in the case shown, four spindle heads. It will be furnished as a two- or three-spindle machine when desired. Among the points that should be noticed is the self-contained countershaft with tight and loose pulley and convenient belt shifter. The work-table is adjustable for height, being counterbalanced inside the column. Another important improvement consists in mounting this table on a three-point adjustable bearing, making it possible to keep its surface in alignment with the spindle under all conditions. The two outer supports are adjustable by the threaded studs and nuts shown. Belt guards are provided for the spindle-driving pulley. The stop collars for the depth of the drilling are mounted on the upper ends of the spindle as shown.

The bench machine shown in Fig. 1 was illustrated as a single spindle machine in the New Tools department of the

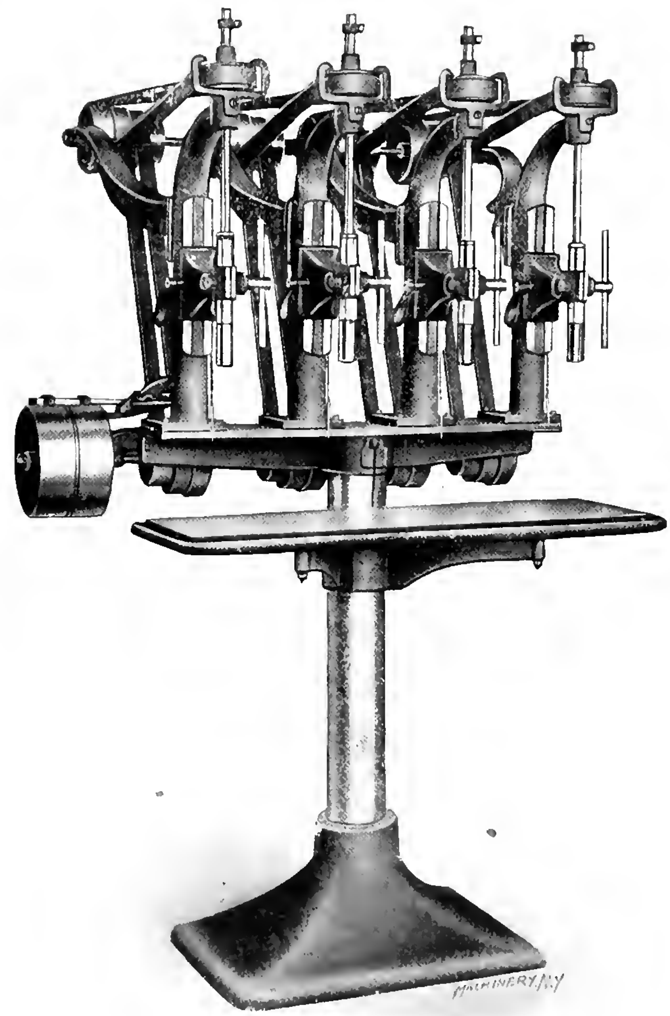


Fig. 2. Four-spindle Floor Type of Drill

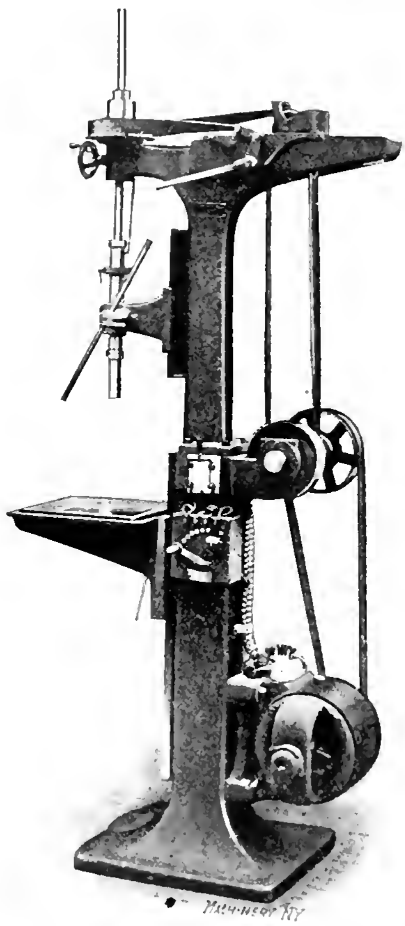
November, 1909, issue of MACHINERY. In this case, also, a self-contained countershaft with a convenient belt-shifter is provided. A two-step cone for each spindle is mounted on the countershaft from which the belt is led over the tightener pulleys to the spindle driving pulley above, permitting the separate spindles to be given speeds appropriate to the diameter of hole drilled. The machine will work to the center of a 10-inch circle. The stop for depth is located in this case on the spindle sleeve.

Fig. 1 illustrates very plainly the usefulness of one of the special features of this make of drills. The work-table can be swung around the column to any point desired, or can be turned, as shown in the case of the central and right-hand heads, to any desired angle about a horizontal axis. The usefulness of this adjustment is increased by the provision of a squared block or gage, which may be adjustably clamped to the table as shown. Reading from the left, in the first case

this is being used simply to locate a block so that the hole will be drilled at the desired distance from the edge. In the second case this gage is used to support a pulley while an oil or set-screw hole is drilled at an angle, the table being tilted for this purpose. In the third case the gage, in conjunction with the surface of the table, provides a V-block for drilling holes into round work. The use of this device makes it unnecessary to rig up temporary holding contrivances out of blocking, bolts, clamps, etc., and greatly increases the range of the machine.

MOTOR-DRIVEN AVEY SENSITIVE DRILL PRESS

A sensitive drill press made by the Cincinnati Pulley Machinery Co., Cincinnati, Ohio, was illustrated and described in the February, 1909, issue of MACHINERY. The machine then illustrated was provided with loose and fast pulleys and was intended to be driven from a countershaft. In the accompanying engraving the same machine is shown provided with individual motor drive, the motor being mounted on a bracket on the lower part of the column and driving the intermediate cone pulley shaft by means of belting. The starting box is placed on the side of the column, as shown. This arrangement is very simple and compact, and makes it possible to apply motor drives to these drill presses when required without making any change in the general design of the machine. The bracket on which the motor is mounted has vertical adjustment on the column so that proper belt tension can be secured at all times. The motor shown in the illustration is a General Electric ½-horse-power motor.

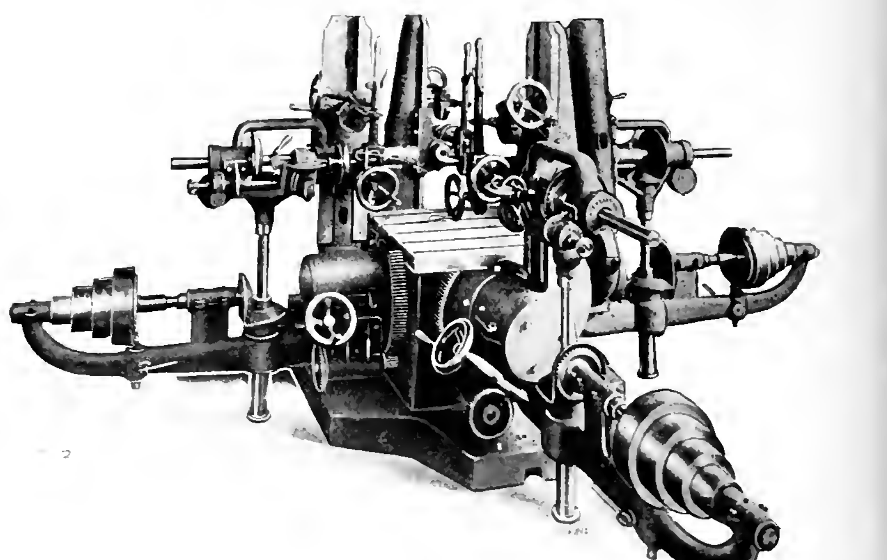


Avey Motor-driven Sensitive Drill Press, built by the Cincinnati Pulley Machinery Co.

It will be recalled from the previous description of this machine that the particular feature of it is the driving arrangement. Of additional features may be mentioned that it runs on ball bearings throughout, and has a graduated spindle sleeve with a stop collet having a clamp screw which requires no wrench or screw-driver; the graduated spindle sleeve makes scale measurements for depth of holes unnecessary. The spindle has a motion of 13½ inches, and a rack feed of 6 inches. The maximum distance of the spindle from the table is 35½ inches. While the drill is shown in the illustration as a single spindle machine, it may be provided with two, three and four spindles on the same base column, if required. The machine has a capacity for using drills provided with a No. 2 Morse taper, the largest diameter of drills with this taper being 29/32 inch.

BARNES HORIZONTAL RADIAL DRILL WITH FOUR HEADS

A horizontal radial drill built by the W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill., was illustrated and described in the December, 1908, issue of MACHINERY. This type of drilling machine has been found especially valuable for boring jigs, as the horizontal table is much better adapted for holding large irregular castings than is the vertical angle plate. The accompanying illustration shows a special machine of this type recently brought out by the company. This machine is provided with four heads, as shown, one on each side of the table. Each of the heads is of the same design and construction as the head used with the regular No. 3 horizontal radial drill, the special part being the table which has a top 30 inches square. The machine was built especially for boring, tapping, and other operations on a casting containing two different sized holes on each of its four sides. By having four heads working at once, the casting can be strapped to the table and left in this position while the heads which are adjustable both vertically and radially can be set so that the spindles come into proper positions to perform the operations required on the casting. It is readily seen that a large range of work can in this way be taken care of by machines designed with two or more heads mounted on the same table. The manufacturers often furnish the heads only, the customers making their own base or table to suit various requirements. The total weight of the machine shown in the accompanying illustration is 9,000 pounds.



Horizontal Radial Drill, made by the W. F. & John Barnes Co, Rockford, Ill.

As will be recalled from the previous description of the regular machine, the spindle is capable of all the movements and adjustments of a regular radial drill, but it has its spindle horizontal instead of vertical. The only adjustment which is not provided is that corresponding to the raising and lowering of the radial arm which, however, is not required, owing to the fact that the horizontal table allows the work to be clamped in any position relative to the spindle so that in this way the vertical adjustment of the arm in the ordinary radial drill is taken care of. The maximum distance from the table to the centers of the spindles is 29½ inches, the minimum being 2⅜ inches. The spindle which is provided with a No. 5 Morse taper hole has a horizontal travel of 18 inches. The drilling capacity is up to 3-inch holes in cast iron and 2-inch holes in steel, with a tapping capacity of 3-inch regular, and 2½-inch pipe taps.

The increasing tendency to use special machinery for operations which can be more rapidly handled in machines especially adapted for the purpose, will doubtless make machines of this type popular with manufacturers of interchangeable machine parts.

TOLEDO PRESSES OF UNUSUAL SIZES

The accompanying illustrations, Figs. 1 and 2, show two powerful presses of unusual dimensions recently designed and built by the Toledo Machine & Tool Co., Toledo, Ohio. These presses are constructed for cutting and forming the steel bodies and frames for automobiles. The press in Fig. 1 is intended for pressing up or forming the side and cross channels for the lower or under frame. This work has formerly been done on hydraulic presses, but the best results obtainable may be produced by the use of the press illustrated.

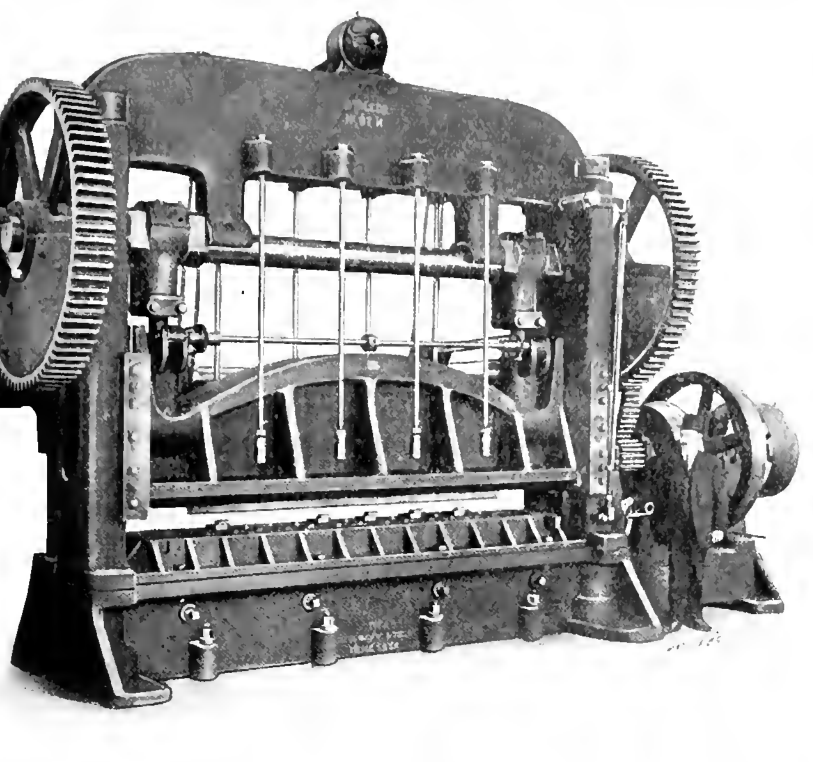


Fig. 1. Large Press for Automobile Frame Work, built by the Toledo Machine & Tool Co., Toledo, O.

In the illustration, the dies are shown in position for performing the work. The lower die is fitted with a pressure attachment, having a capacity for exerting a pressure of about 500 tons. This prevents the distortion of the strip while being formed. The press itself has a capacity or ram pressure of nearly 900 tons. It operates at the rate of eight strokes per minute.

As shown in the illustration, the press is fitted with twin gears on the crankshaft. Engaging with these gears are two pinions on the heavy pinion shaft driven through gearing from the main driving shaft. A powerful friction clutch with hand lever control is provided between the driving pulleys and the gearing, giving the operator complete control of the press stroke at all points. An interesting feature in connection with the press is the motor-driven elevating attachment for adjusting the slide, this being required on account of the size and weight of the sliding parts. This attachment is operated by a four horse-power motor mounted on the top of the frame arch, as shown in the engraving. The power is transmitted down to a rear shaft, by means of sprockets and link belts, and from there is carried over to the worm shafts, on which are mounted worms engaging with worm-wheels on each of the right- and left-hand pitman screws. This arrangement is plainly shown in the engraving. A reversible friction clutch is provided for this attachment, just below the motor, and is attached to the rear of the arch. As the illustration shows a front view of the machine, this clutch is, therefore, not in view. The lever and segment by means of which it is controlled, however, is shown to the right in the illustration, directly beneath the man's hand.

Some of the more important dimensions and weight of the machine are as follows: The stroke or slide motion is 8 inches; the ratio of the gearing is 40 to 1; the size of the main gears is 86 inches diameter by 10 inches face. The width between the housings is 14 feet 4 inches, and the height from the floor line to the top, 15 feet, the bed extending 2 feet below the floor line. The floor space required over all is 9 feet 4 inches by 25 feet 10 inches. The power required for operating the press is 40 horse-power, and the total weight of the press as illustrated is 185,000 pounds.

In Fig. 2 is shown a machine designed for pressing the parts for automobile bodies, including the seats and panels for touring car bodies. An unusual distance from the bed to the slide is consequently provided, in order to accommodate the dies necessary for pressing up large steel backs and seats. A stroke of 24 inches is necessary for this purpose. An additional sub-base or bed is attached to the top of the main bed of the machine. This sub-base is not shown in the illustration. It is 40 inches high, and when in position reduces the height or distance between the bed and the slide to what would ordinarily be required for regular work. The bed-plate or bolster which is used on the main bed of the press will fit on the sub-base also. The same applies to the drawing attachment which is used in connection with the bed for operating the drawing and forming dies necessary for this class of work. These attachments are made removable and may be changed from one bed to the other, in a reasonably short length of time. The machine is provided with clutch arrangement and gearing similar to the press previously described.

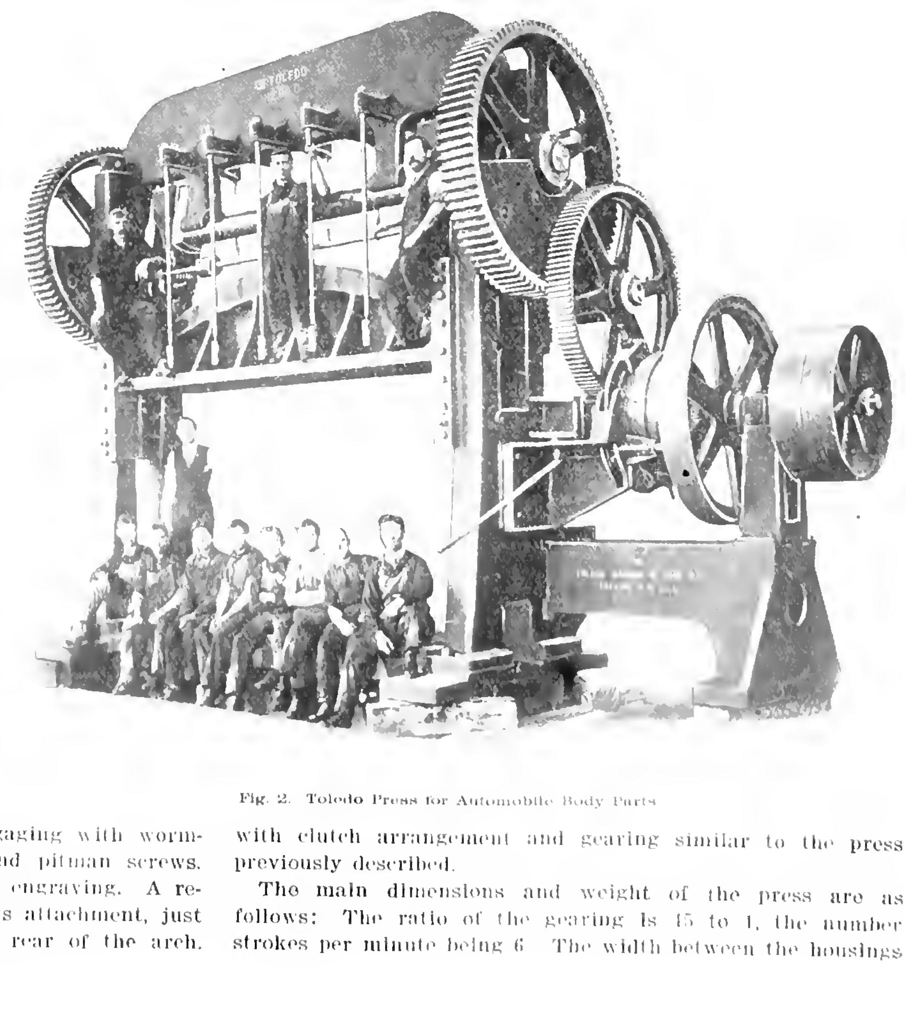


Fig. 2. Toledo Press for Automobile Body Parts

The main dimensions and weight of the press are as follows: The ratio of the gearing is 15 to 1, the number strokes per minute being 6. The width between the housings

is 12 feet 4 inches and the total height above the floor line is 16 feet. The bed extends 40 inches below the floor line. The floor space required is 8 feet 4 inches by 23 feet 4 inches. The total weight of the press is 165,000 pounds.

ROWBOTTOM CAM CUTTING MACHINE

The Rowbottom Machine Co., of Waterville, Conn., is building the cam cutting machine shown herewith. Among other interesting features this machine has the advantage of being universal—that is to say, it will cut plate and face cams, or barrel cams, without requiring the use of attachments or separate heads. It is also provided with unusually convenient adjustments which increase its adaptability for difficult work, as will be explained.

The machine comprises, primarily, a rigid bed on which are mounted a head for the master cam H, a swiveling work-head F for the cam K being cut, and a slide on which is mounted the cutter spindle and its driving mechanism and the adjustable bracket J for the master cam roll. The master cam spindle and the work-spindle are fixed in place in the bed and revolve together with the feed mechanism. The master cam roll and the cutter spindle, being mounted on the same slide, receive motion from the master cam, which thus gives an appropriate form to the cut taken in the work. The weight D connected to the slide holds the follower roll against the master cam.

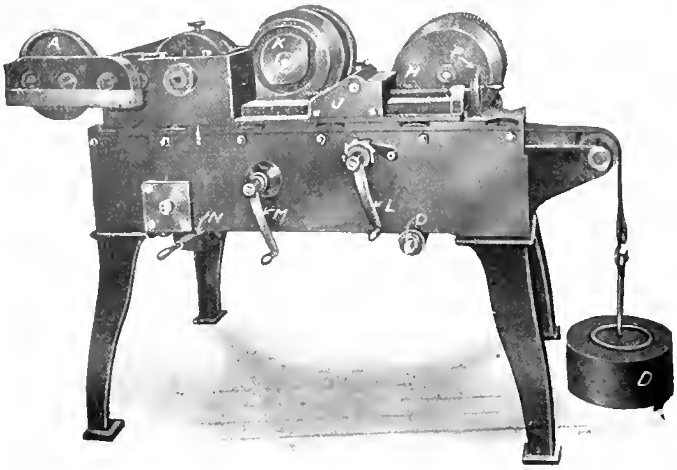


Fig. 1. The Rowbottom Universal Cam Cutting Machine

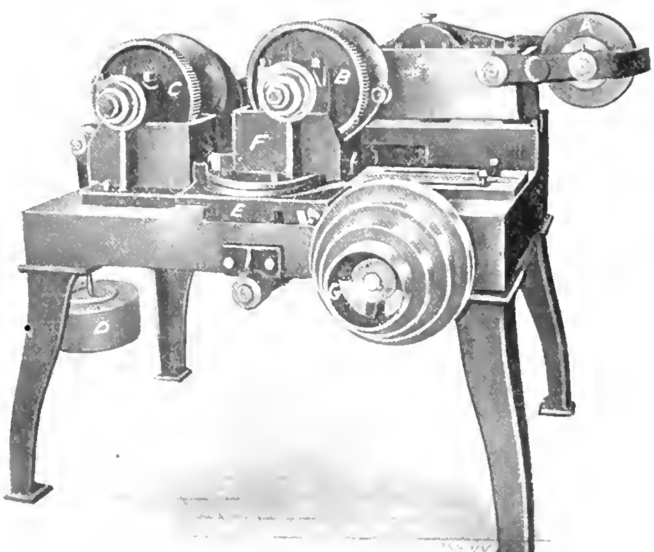


Fig. 2. Driving Side of Machine, showing Adjustment of Follow Roll Bracket on Cutter Slide

The spindle is driven by pulley A, which is mounted on a pivoted yoke. The pulley and the gearing contained in this yoke are heavy enough so as to keep the driving belt tightened to the proper degree throughout the movement of the slide, under the influence of the master cam. The gear-box, which is shown with cover removed, provides two changes of speed. This with the two on the double driving pulley A, gives four in all. All the gearing in the gear-box runs in an oil bath.

The rotation of the master cam and work-spindles is effected through cone pulley G, which is connected by gearing with

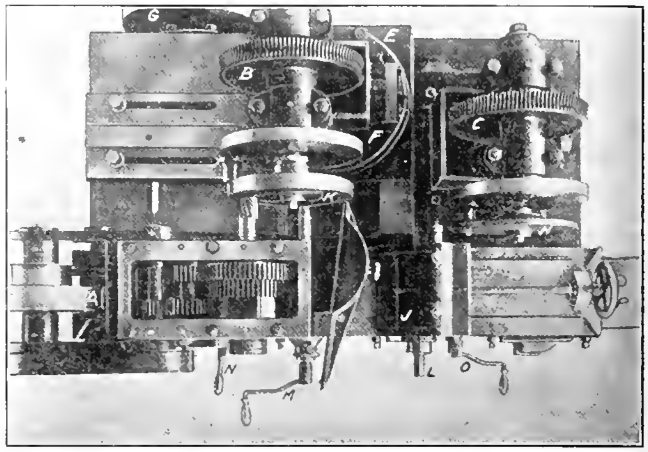


Fig. 3. Machine set up for Cutting Face and Plate Cams

worms meshing with worm-wheels B and C. Lever N controls this automatic feed, throwing it in or out. When it is thrown out, it may be operated by hand by placing the crank on feed shaft O. The handle on M operates the cross-slide screw by means of which the work-slide E, carrying the swivel work-head F, is fed in toward the cutter to give the required depth of cut. This adjustment is provided with a micrometer dial. By placing a crank on shaft L the slide carrying the former roll and the cutter spindle can be rapidly

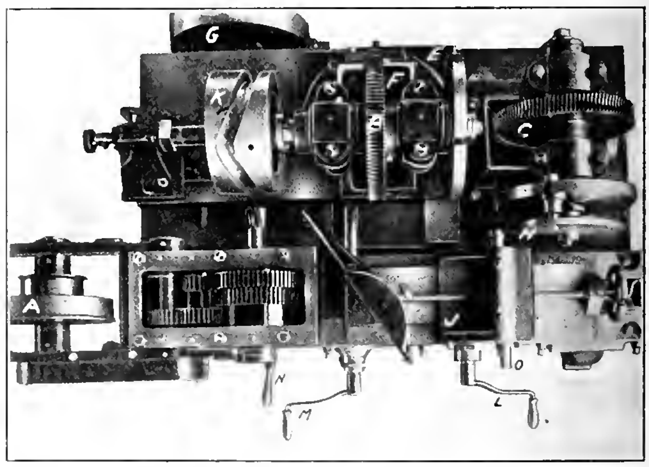


Fig. 4. Machine set up for Cutting Barrel Cams

drawn back against the tension of weight D for the purpose of inspection, removal of work, etc.; this movement is effected by a pinion on the shaft engaging the rack on the under side of the cutter slide. The ratchet shown on shaft L serves to support the slide in this position against the pressure of the weight. This ratchet has, of course, to be raised to allow the former roll to come back to its bearing on the cam. When ready to start, the pawl is thrown back from the ratchet, allowing the weight to be brought back into contact with the former roll and the periphery of the cam.

The particular construction of the machine, as described, offers certain advantages which are best seen from an inspection of Figs. 3 and 4. The master cam is always of the plate variety. This means that it is made in the least expensive way and in the way which permits the greatest accuracy. It is only the work-head F which is altered to permit the cutting of plate, face and barrel cams as may be required. This change from face to barrel cams, as has been explained, is done without the use of attachments of any kind, it being only necessary to swivel the head around at right angles. It is shown in the two positions in Figs. 3 and 4. This construction also fits the machine for cams cut on conical surfaces—a construction met with once in a great while. For

this work the head is simply swiveled to the angle required by the cone on which the cam is to be cut.

Another exceedingly useful adjustment is that of the former roll bracket *J* along the cutter-slide. This is controlled by a screw operated by handwheel *P*. It serves two purposes: For one thing, it may be used in connection with the quick traverse shaft *L* to adjust the forming roll and cutter to such a distance apart that the latter will center with a roughly cast groove in a barrel cam. By rapidly turning shaft *O* by hand, it can be found whether or not the cutter is centered with the rough cast groove, and if any adjustment is required, this is easily effected by handwheel *P*. Another advantage of this adjustment is that it permits the cutting of cams of very steep pitch. The master-plate made for the contour is cut on a much larger diameter than that desired for the finished work. This larger diameter will give easier rises, permitting the cutter-slide to be moved back against the weight with a smoothness and precision impossible where the pitch is too steep. Graduations are provided for the movement of bracket *J* on the slide, which show how much wider the distance between the cutter-slide and the roll is than the distance between the two spindles as set up in Fig. 3. When the master cam is made to a radius larger by a given amount than that desired for the finished cam, the setting of bracket *J* to this dimension on the cutter-slide brings the work to the desired diameter.

Fig. 5. Cams Cut on the Rowbottom Machine

The machine, as may be seen, is very rigidly constructed. For large work, slide *E* may be locked to the base after each feeding in to depth, so that heavy cuts can be taken. It will be seen that the machine is universal in its adaptability within the limits of size for which it is designed. In Fig. 5 is shown a variety of examples of its work.

IMPROVEMENTS IN CINCINNATI LATHE

The Cincinnati 16-inch engine lathe, built by the Cincinnati Lathe & Tool Co., Cincinnati, O., was illustrated and described in the September, 1908, issue of MACHINERY. Several improvements have now been introduced on this type of lathe, including a double-walled apron, as illustrated in Figs. 1 and 2, and a new arrangement of carriage and taper attachment, illustrated in Fig. 3.

The apron is of the box type, which gives a double and an especially rigid support to all shafts and studs mounted in it, and provides for accuracy as well as long life of all the working parts in the apron. The gears are of ten diametral pitch, thus having ample strength. The motion to the rack pinion is transmitted by compound gearing, as indicated in Fig. 2. The longitudinal and the cross friction feeds can be started, stopped or reversed while the lathe is running, but they cannot be engaged when cutting screws; this latter provision is an important safeguard when the machine is in the hands of inexperienced operators. The handwheel is provided with a thread chasing dial which permits the half-nuts to be opened, the carriage to be run back by hand, and the thread to be caught or picked up at any point. An automatic stop is also provided for throwing out the feeds.

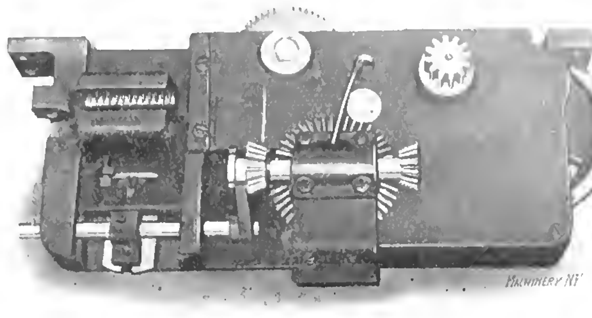


Fig. 1 Rear View of Apron of Cincinnati Lathe & Tool Co.'s 16-inch Engine Lathe

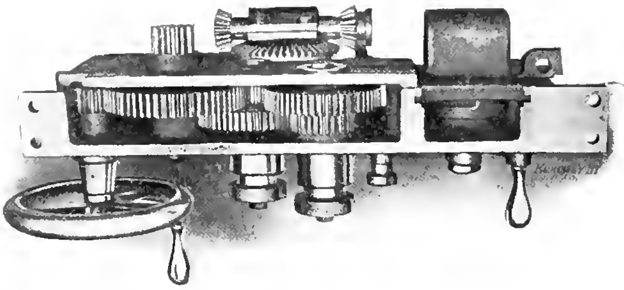


Fig. 2. View from the Top of the Apron of Lathe, showing Arrangement of Gearing

The taper attachment shown in Fig. 3 is provided with graduations at both ends, and can be firmly clamped in any position desired within its range by two heavy clamping bolts, one at each end. The carriage is gibbed both in the front and at the back and bears for its entire length of 22 inches on the V's of the bed. Both plain and compound rests are provided. Due to the heavy construction of the machine in general, as well as to the correct proportioning of the carriage details, very accurate work can be carried out on the machine. As an example, it may be mentioned that it is possible to bore holes on these lathes within 0.00025-inch in 8 inches of feed. As regards the cutting capacity of the lathe, it may be mentioned that it is used regularly in the shops of the makers for reducing 50-point carbon steel shafts as much as 7/8 inch in diameter with a feed of 1/32 inch per revolution, at a cutting speed of 60 feet per minute.

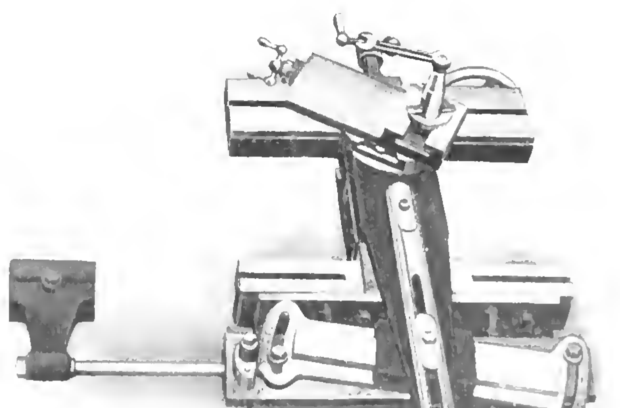


Fig. 3 Carriage Swivel Rest and Taper Attachment

It will be recalled from the previous description of this machine that it is furnished with a quick change gear-box either for screw-cutting or for feed changes. It may also be furnished either with a 3-step cone pulley and double

back-gears or with a 5-step cone pulley and single back-gears. With a two-speed countershaft this provides for eighteen or twenty changes of speed, covering a carefully selected range.

FIFIELD HEAVY ENGINE LATHE

The accompanying illustrations show an example of a new line of heavy engine lathes made by George W. Fifield, of Lowell, Mass. The lathes of this design range from 40 to 96 inches swing over the ways. They are of modern construction and are intended for heavy and accurate work and rapid production.

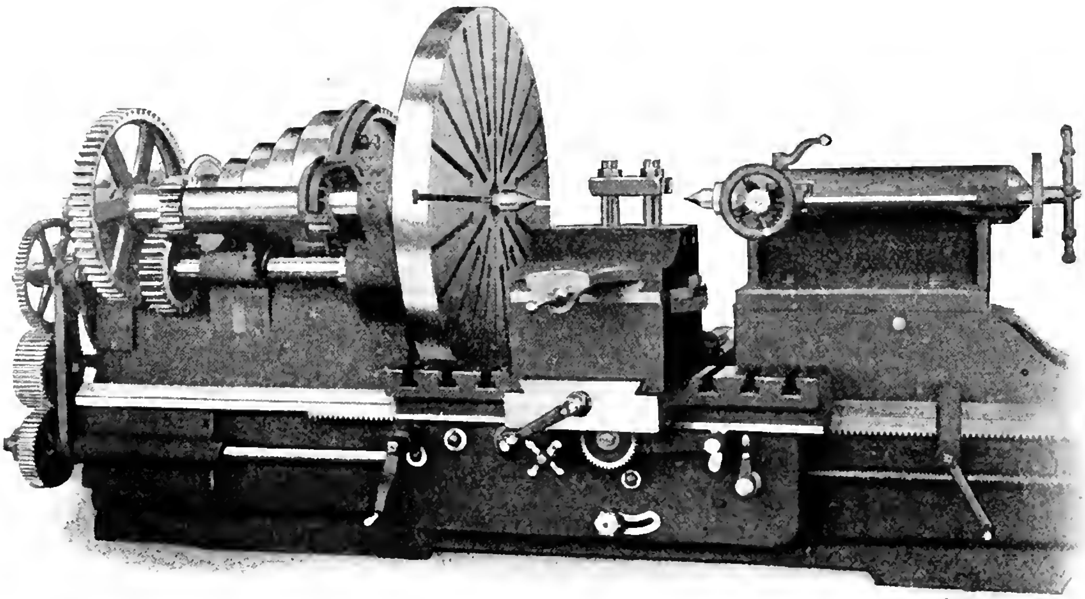


Fig. 1. An Example of a New Line of Heavy Engine Lathes

The illustrations show the general features of the design very plainly. The headstock is of the triple geared type with the "back-gearing" mounted on the front to facilitate operation. Power may be applied either directly from the cone pulley to the shaft, through back-gears in the usual manner, or through the lower or "triple gear" shaft, which carries a pinion meshing with the internal gear on the back of the faceplate. To connect with this faceplate drive, the lower shaft is thrown to the right by turning with a wrench the square-headed stud shown projecting from the left-hand bearing. This stud has pinion teeth cut in it meshing with grooves in the shaft which act as rack teeth. When the shaft is moved toward the right, the pinion on its outer end is thrown into mesh with the internal gear teeth, and the gear at the other end is moved into mesh with the middle pinion on the back-gear quill. When so set, the right hand pinion on the back-gear quill must, of course, be moved out of engagement with the spindle gear.

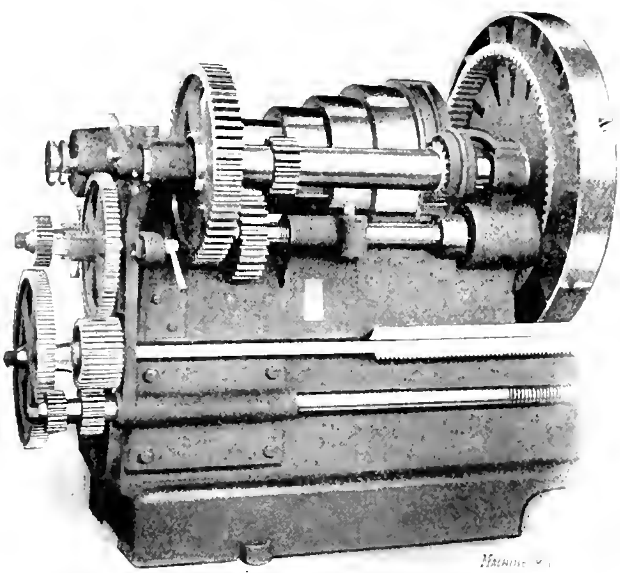


Fig. 2. Driving and Feed Gearing of Fifield Lathe

The connections at the end of the headstock provide for three changes of feed without a change of gearing. On the gear stud beneath the spindle in back of the first of the regular threading change gears, is mounted a cone of three gears. On a sector swinging about the splined lead-screw is mounted a large spur gear, adjustable to three positions longitudinally to correspond with the positions of the three members of the cone gears on the stud; a wide-face idler gear between it and the pinion on the lead-screw makes provision for this change of position. The sector is, of course, thrown in or out and clamped into position to agree with the diameter of the gear which is engaged at the time. The connections for thread cutting are made in the usual way.

The feed is reversed in the carriage. The top of the carriage is provided with a series of T-slots to hold special rests, and to clamp work for boring-bar and similar occasional operations. The tool-rest is of the four-stud type, this being most suitable for heavy work. A compound rest is furnished, and the power feed may be applied to both the cross-slide and the compound rest movements.

The 40-inch lathe is driven by a 4½-inch belt on a 5-step cone pulley whose largest diameter is 20 inches. The back-gearing is in the ratio of 1 to 13, while the triple gearing is in the ratio of 1 to 42. The weight is about 12,000 pounds. For the 96-inch swing lathe, the largest of the line, a 6-inch belt is used, running onto a 6-step cone pulley, whose largest diameter is 40 inches. The gearing ratios are, respectively, 1 to 32 and 1 to 250. This tool weighs approximately 70,000 pounds. All lathes are furnished with large faceplates, center-rests, change gears, wrenches and friction countershaft.

BAIRD WIRE-FORMING AND STAMPING MACHINE

The Baird Machine Co., of Oakville, Conn., makes the wire forming and stamping machine herewith illustrated. While this was intended originally for work such as shown in Fig. 2 (suspender loops, buckles and similar parts), the builders have found a wide range of use for it in general work. It is applicable wherever wire parts have to be bent and flattened out or stamped. The machine is essentially a combination of the standard wire-forming machine and a small punch press, the latter part of the mechanism being shown at the left-hand side of the bed.

The machine automatically takes wire from the coil, straightens, feeds and cuts it off, and then forms and stamps it. Work of the character described is made, complete, and dropped into a suitable receptacle at the rate of from 60 to

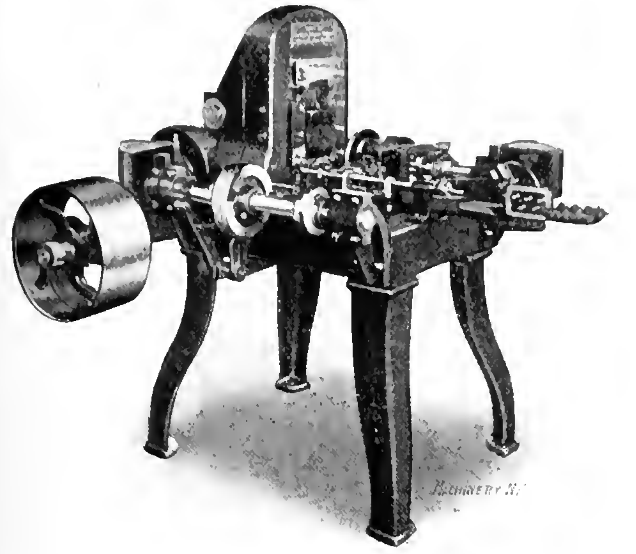


Fig. 1. An Automatic Machine for Bending and Stamping Work made from Wire

80 per minute according to the size and shape. No further attention is required than that of removing the finished work and keeping a supply of wire on hand.

High-grade materials and workmanship are used in the construction. All the bearing surfaces, such as cam linings, pins, etc., are of hardened tool steel. The sliding surfaces are

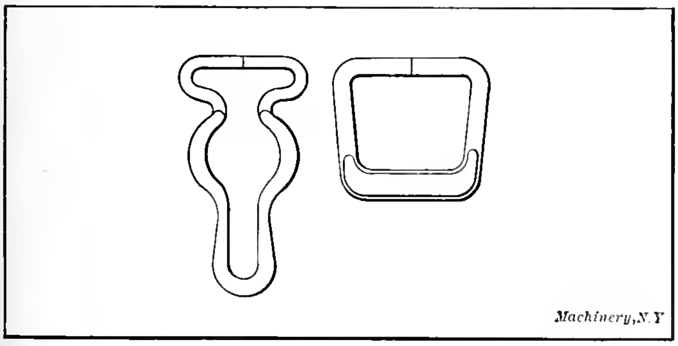


Fig. 2. Examples of Work Done on Machine shown in Fig. 1

hand-scraped to a bearing. The machine is regularly built in two sizes, the smaller of which is designed for articles which do not require more than 6 inches of wire with a maximum diameter of 0.125 inch. The larger size will make use of wire up to 9 inches long and 0.200 inch diameter.

LEIMAN ROTARY BLOWER AND VACUUM PUMP

A new design of rotary blower which is also intended to be used as a vacuum pump, has been brought out by Leiman Brothers, 62 John Street, New York. A diagrammatical view of the design of the device is shown in the line engraving, Fig. 1. In Fig. 2 the blower is shown driven by an electric motor and used as a vacuum pump; it has exhausted the air from a No. 20 gage galvanized iron tank, braced on the inside, which has collapsed on account of the vacuum produced.

As will be seen from Fig. 1, the design of the machine is very simple; the working parts consist only of a central drum or piston, and four wings attached to it by means of hinges. As soon as the machine is in motion, the outer end of these wings will come into contact with the cylinder walls, due in the first place to centrifugal action; but when the machine is in operation, the air that becomes compressed between the wings also tends to keep them in close contact with the cylinder walls, thus preventing leakage. This is one of the principal advantages of the machine, as there is no packing required, and the wings automatically, so to speak, take up their own wear. When each wing reaches the top where the air is exhausted it is kept close to the inner cylinder wall, so as to insure but a small amount of clearance, as an excessive amount of space here would impair the efficiency of the pump. At the top, the wing still presses against the cylinder wall, the bearing point gradually shifting toward the wing center. Obviously, when considerable wear has taken place on the wings as well as on the cylinder surface, the wings will still conform to the shape of the cylinder, and the efficiency of the device, even when worn, is practically unimpaired. The absence of springs and delicate parts which may break or get out of order, and also of special tips on the ends of the wings which would require frequent renewal, reduces the cost of maintenance to a great extent.

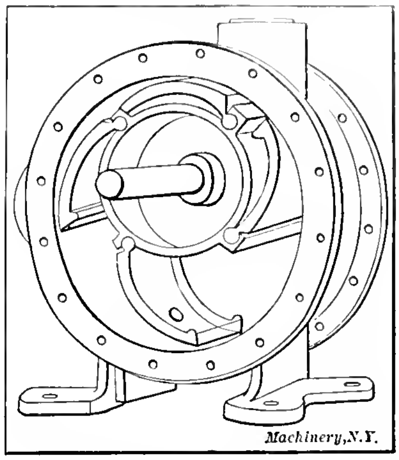


Fig. 1. Diagrammatical View, showing Design of Leiman Blower and Vacuum Pump

The main shaft bearings are provided with a double ring oiling device. The cylinder is oiled by means of the oil hole at the inlet on the side, but the use of a sight-feed oil cup is recommended. Each blower is supplied with loose and tight pulleys, and can be driven either from an individual motor or from a line-shaft. When the machine is used as a blower, it will produce a maximum pressure of 10 pounds per square inch, but if it is in constant operation it is not advisable to run it at higher speed than to produce a pressure of 6 pounds per square inch. It is made in seven sizes known by the letters A, B, C, D, E, F and G. When used as blowers, the capacity of the various sizes varies from 17 cubic inches of air delivered per revolution for the smallest size, up

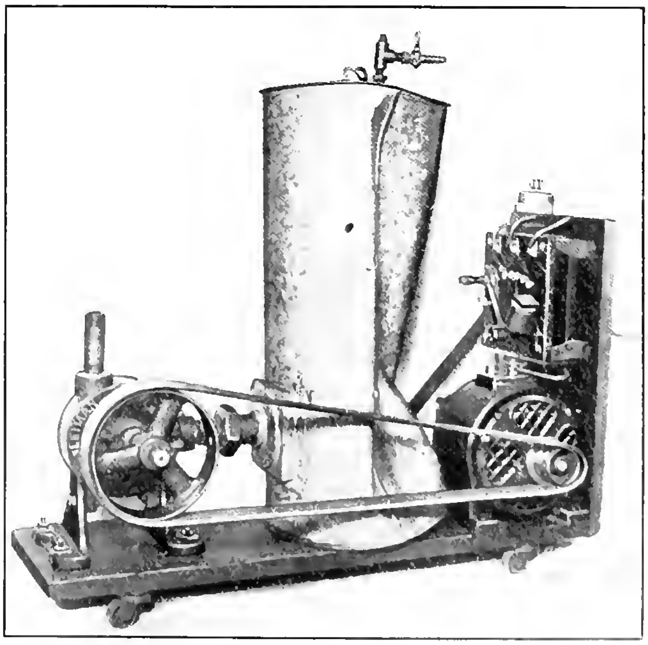


Fig. 2. Leiman Motor-driven Rotary Blower, having exhausted the air of an Internally-braced Tank, causing it to collapse

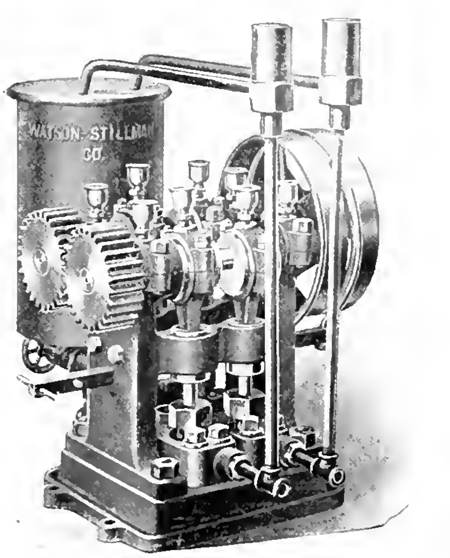
to 1,400 cubic inches for the largest size; the approximate horse-power for the smallest size is 1/10, and that for the largest size 2½. The maximum revolutions per minute vary from 600 on the smallest size to 200 on the largest, and the sizes of inlet and outlet from ½ to 2½ inches.

When used as a vacuum pump, the maximum vacuum is 20 inches, and the displacement per revolution corresponds to the air delivered per revolution by the machine when used as a blower. The approximate horse-power required for the vacuum pumps is the same as that for the blowers. The floor space of the smallest machine is 6 x 10 inches, and that of the largest 24 x 31 inches, the weight of the smallest being

only 20 pounds, while the weight of the largest size is 400 pounds. The vacuum pump is especially intended for all uses where a vacuum of 20 inches is sufficient for the required purpose, as, for example, in vacuum cleaners.

WATSON-STILLMAN SMALL HYDRAULIC PUMP

The accompanying illustration shows a four-cylinder hydraulic pump brought out by the Watson-Stillman Co., 192 Fulton St., New York. In the arrangement shown, two pressure lines are served independently of each other, from a common reservoir; but the type of pump illustrated permits of two, three or four pressure lines being independently served. Each pressure line has a separate pressure chamber, safety valve, and release line, and is served by a separate pair of cylinders with eccentrics set so as to produce a continuous flow. The diameter of the cylinders is ½ inch, by ½ inch stroke. Any pressure up to 600 pounds per square inch may be delivered into any line, the limit being determined by the setting of the safety valve which opens at excessive pressures and lets the surplus liquid through the release pipe to the reservoir. Any pressure line may be thrown out of service by opening the safety valve, in which case all the liquid will be pumped directly back into the reservoir. The design of the one, two, three and four pressure line pumps is practically the same, except, of course, that the bed-plate and the through shafts are longer. The pump may be provided with an electric motor instead of the fast and loose pulleys for belt drive shown in the illustration.



Four-cylinder, Two-pressure Line Small Hydraulic Pump, made by the Watson-Stillman Co. New York

STEEL SHELVING AND STORAGE EQUIPMENT FOR SHOP USE

The advantages of steel shelving in stock-rooms and store-rooms in machine shops are becoming more and more recognized. One of the most important advantages is the saving in space, as steel shelving requires to be but a fractional part of the thickness of wooden shelving to have an equivalent strength. It also reduces the fire hazard, is easier to keep clean, and the cost of maintenance is reduced to a very considerable extent. It is also possible to provide for interchangeability between the different racks and shelving systems in a way that is not possible when wooden shelving is used, and, in addition, it is easier to provide for adjustability as regards the height of the various shelves.

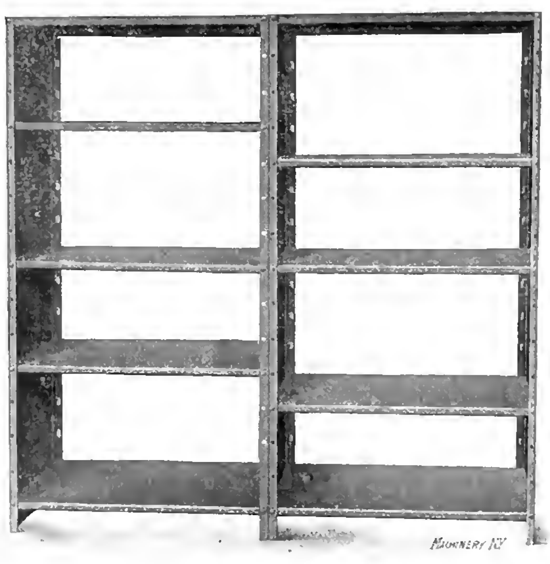


Fig. 1 Two Sections of Terrell's Steel Shelving for Shop Storage

Fig. 2. Rack especially adapted for Die and Tool Storage

The Terrell's Equipment Co., of Grand Rapids, Mich., has placed on the market a stock-room rack, bin rack and racks for die and tool storage, as well as a number of portable tool racks, trays and boxes provided with roller casters and with one or more shelves. In Fig. 1 are illustrated two sections of the regular stock-room rack. The end uprights are made of No. 20 gage steel, riveted to two strips of 1 by 1 by ⅛-inch reinforcing angles. In the front, the uprights are provided with holes for ¼-inch bolts, the vertical distances between the holes being 3¾ inches from center to center. In the back of the uprights, the angles are provided with catches stamped in them and located opposite the holes in the front. By this means rapid adjustment of the shelving is made possible, the space between the various shelves being adjustable to suit the tools stored upon them. This is clearly indicated in Fig. 1. The standard sizes of the uprights for this type of shelving are from 12 to 30 inches wide and from 3 to 15 feet high.

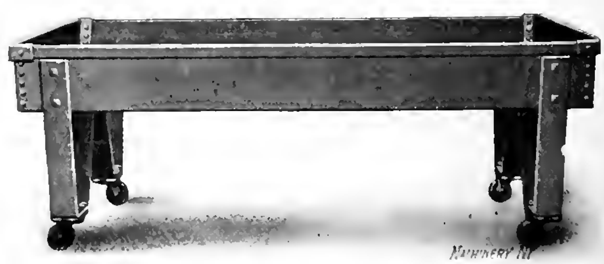


Fig 3 Box for Material in Process of Manufacture, Tools and Finished Stock

Storage shelving for dies, tools, etc., is usually provided with a back as shown in Fig. 2. The backs are made of No. 18 gage steel and catches are stamped in the backs corresponding with the holes and catches in the uprights. This construction insures a close contact between the shelves and the back so that no material can fall down between. The shelves are made from 24 inches to 40 inches long, the width, of course, corresponding to that of the uprights. They are flanged on the sides and ends, and the front and back edges are double folded to provide for the required strength. In addition to this, the front edge is reinforced with a strip of ¾ by ¾ by ⅛ inch angle which is placed inside the fold.

In Fig. 4 is shown a portable tool rack which is made with or without the drawer shown. The corner posts of this tool rack are made of 1¼ by 1¼ by ⅛ inch angles. The trays are made of No. 16 gage steel, double folded at the top edges, and attached to the corner post with set-screws so that the whole arrangement can be easily taken apart and assembled, and thus be shipped "knocked down." The drawer is made of No. 18

gage steel and is attached to the bottom of the top tray by a steel slide, permitting the drawer to slide easily.

In Fig. 3 is shown a steel box placed on casters, which is made in a large variety of sizes and intended for stock-room, tool-room and shop use for raw material being in process of manufacture as well as for finished stock. The tray or box is made of different gages of steel according to the size. The sides and ends are triple folded and the corners provided with additional reinforcement.

CLEVELAND DRILL CHUCK

The drill chuck shown in the accompanying engraving has been placed on the market by the Cleveland Collet & Machine Co., Cleveland, Ohio. It is designed for holding a drill to the limit of its torsional strength, yet it is easily released by hand. No wrench is necessary as the resistance of the cut is utilized for increasing the grip on the drill, while, when the pressure is relieved, the jaws open easily by turning the chuck body by hand. The chuck consists of a shank part threaded into the knurled chuck body, to the end of which latter a tapered sleeve ring is attached. Three jaws slide with their back faces against the inside of the sleeve ring. The jaw holder rotates independently of the body only when a drill is not locked between the jaws; but when the drill is in place, it is locked in the jaw holder and the jaw holder in the sleeve by screwing up the chuck body on the shank, thereby producing the required pressure on the back of the jaws by means of the tapered surface in the sleeve ring. A ball thrust bearing is provided for taking the axial thrust, and in this manner the thrust on the thread on the shank is minimized. Another valuable feature of this ball bearing is that it prevents the drill and jaws from becoming so tightly gripped that it would not be possible to release the grip by the hand alone. The construction of the tool is simple, and as there are but few working parts, it is not likely to get out of order. This is an important consideration, as the time lost in repairs is often considerable when tools are unnecessarily complicated.

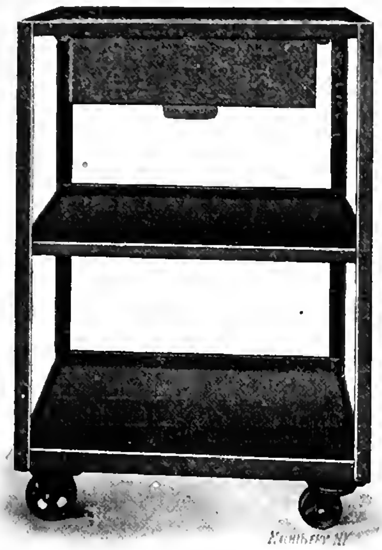
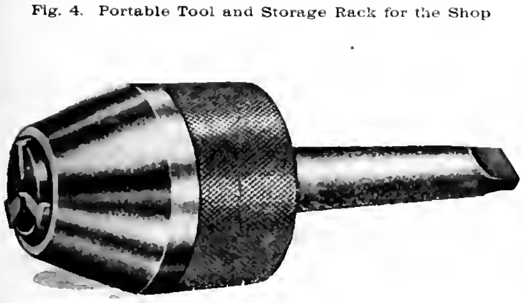


Fig. 4. Portable Tool and Storage Rack for the Shop



Drill Chuck made by the Cleveland Collet and Machine Co.

BLISS POWER PRESS FOR HEAVY COLD STAMPING

The straight-sided single-action press shown herewith was recently built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for the Hydraulic Pressed Steel Co., of Cleveland, O. As indicated by the firm name of the customer, this tool was designed to replace the hydraulic machine on work of a character which has not hitherto been done by a crank machine. Its advantage, of course, lies in doing the work much more rapidly than is possible with hydraulic motive power, and more accurately as well, since the dies are bedded in long slides, gibbed with great care.

This press is of the makers built-up type, in which four vertical tie-rods of large diameter are depended on to receive the tensile stress imposed while the press is in operation, thus relieving the frame columns of all stress of this character. The columns are of heavy cross-section, giving great rigidity to the machine. Heavy extended feet are provided, so that ample stability is insured.

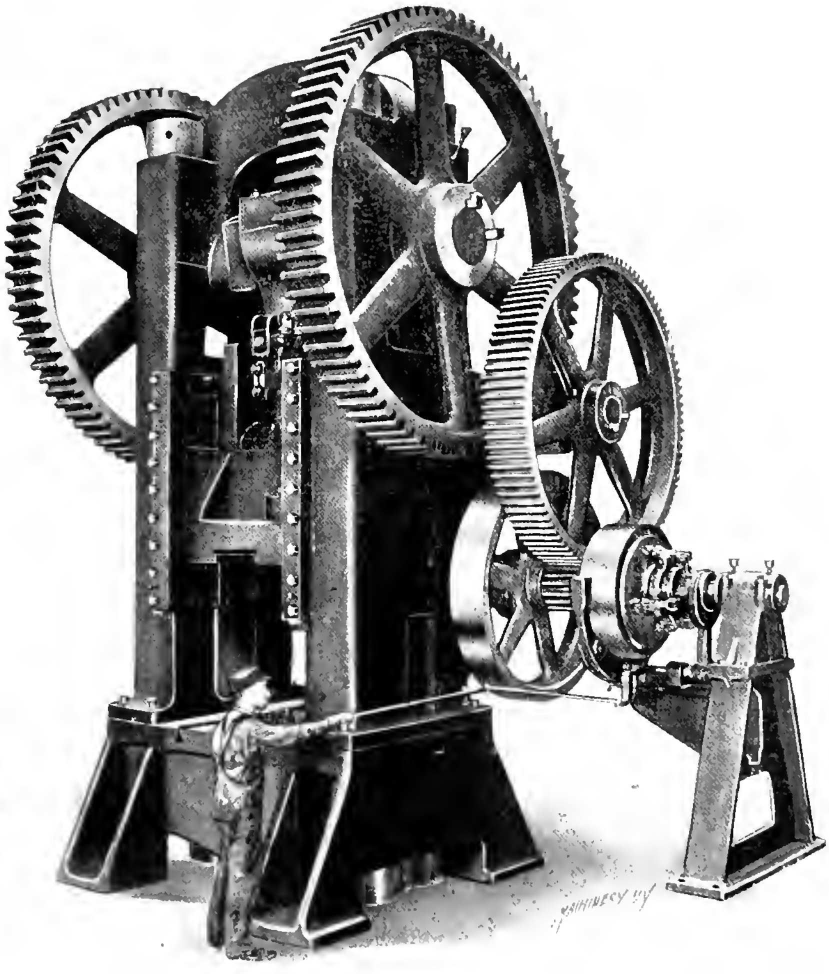


Fig 1. A Crank Press designed for Work formerly done on the Hydraulic Press

Some idea of the massiveness of the construction may be obtained from Fig. 3, which shows the slide, weighing over seven tons. Fig. 2 shows the crankshaft with its two main gears, one at each end. These weigh over 6 tons apiece. The double drive reduces the bending and torsional strain on the crankshaft. The driving gearing throughout is of steel, compactly arranged, and with machine cut teeth. The machine is controlled by a hand-lever, operating a combined friction clutch and brake. The clutch is of improved type with heavy rigid friction surfaces, arranged to be relieved of rubbing contact when not driving. A safety coupling attached to the fly-wheel permits it to free itself in case the press is subjected, through accident or carelessness, to a pressure greatly in excess to that for which it is intended.

The bed of this machine has an area of 60 by 48 inches. The crankshaft is 16 inches in diameter. The total weight is 161,000 pounds. It is believed to be the largest machine of its type ever built. Large double crank presses and drawing presses are not unusual, but this tool is designed to enter a

new field for the power press, in the cold forming of sheet metal of extra heavy gages. It is particularly adapted to such work as stamping sheet steel brake drums, axle housings, etc., for automobiles. On such work it gives more accurate results and a much higher production than the hydraulic press can attain.

BEAMAN & SMITH NO. 10 BORING AND MILLING MACHINE

The tool herewith illustrated and described is made by the Beaman & Smith Co., of Providence, R. I. It is of the type which has come into such extensive and well-deserved popularity in the past decade, in which the work is mounted on a table provided with longitudinal and cross movements, while the spindle is mounted in a saddle which may be adjusted

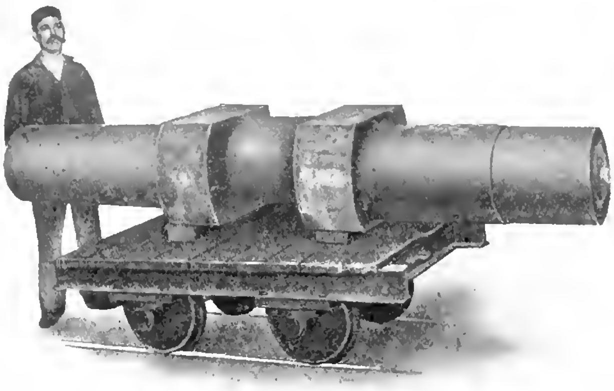


Fig. 2. A Crankshaft 15 inches in Diameter

or fed vertically on the face of an upright column. This arrangement supports the work and the boring-bar under the most favorable conditions for a wide range of operations.

A distinctive point in the design will be seen at once from an inspection of the engraving. This relates to the form of all the main castings of the machine. A tubular section has been used throughout, this being applied to the bed, the column, the outboard bearing and the feed bracket for the boring-bar. It is not necessary to expatiate on the stiffness of this form of section in resisting torsional strains or bending strains. It would seem to be especially suited for machine members of this kind, and its use gives the whole machine a distinctive and pleasing appearance, which is even more evident in the machine itself than in the photograph which we have reproduced.

The feed and speed changes are obtained by gearing from a constant speed pulley. There are 18 changes of speed, obtained through the gear-box shown at the extreme right of the engraving, in conjunction with the back-gear handle shown projecting through an opening in the gear guard at the top of the saddle. The changes range from 4.34 to 125 revolutions per minute, giving suitable speeds for the drilling of small holes and for large facing or heavy milling operations as well. Ample power is provided by the 5-inch belt drive on the 14-inch pulley, running at 230 revolutions per minute. The gearing ratios vary from 1 to 1.8 for the fastest speed, up to 1 to 52.5 turns of the pulley to one of the spindle for the slowest speed given above. The spindle has a No. 5 Morse taper hole with a driving slot across the end.

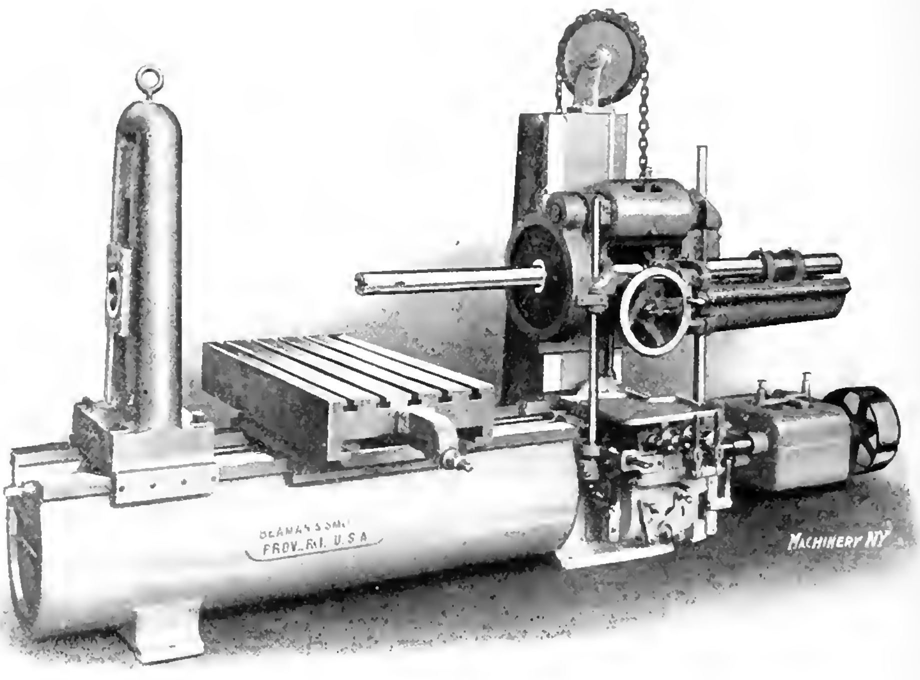


Fig. 1. Beaman & Smith Horizontal Boring and Milling Machine

The boring-bar has a continuous traverse of 30 inches and a maximum traverse of 60 inches by shifting its position. Eight feeds are provided, operated by the quick change gear mechanism shown at the foot of the column. These range from 0.009 to 0.252 inch per revolution of the spindle for drilling and boring. For milling, the speeds range from 0.56

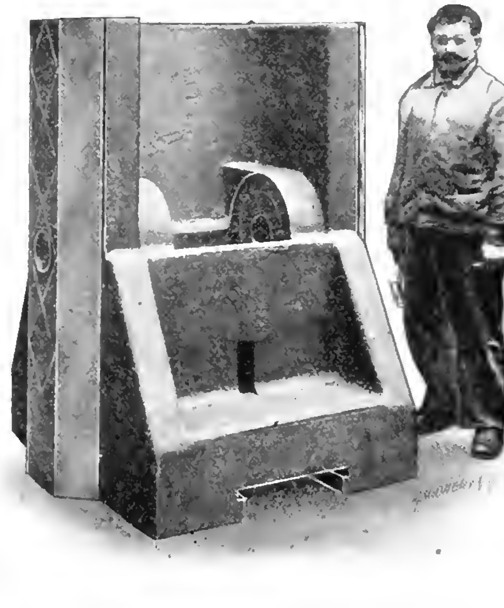


Fig. 3. A Massive Slide, weighing over Seven Tons

to 15.7 inches per minute at any spindle speed. It will be seen from this that the feed is connected with the constant speed driving shaft when milling, and with the spindle when drilling and boring, so that the arrangement of the feeds is exactly suited to each of these two operations. This construction is, so far as we know, a new one in machine tool design, machines having hitherto been constructed so that one of the two connections was made, but not so that both of them were available. For milling, the feeds are applicable to the cross-feed of the table as well as to the vertical feed of the saddle on the column. Power rapid traverse is also provided for these movements.

The outer support has a bushing hole 4½ inches in diameter, and is connected in unison with the head saddle so that the two are always in line, whether the adjustments are made by hand or power. The bushing block is carried between uprights, instead of on the side, so that the maximum of rigidity

is provided. Longitudinal adjustment on the bed is effected by a screw.

The general construction of the machine is of the highest grade. The sliding surfaces are accurately scraped. The adjusting screws are of generous dimensions. All gearing is cut from the solid, the bevel gears being generated by the Bilgram process. Bearings are bronze lined, wherever necessary. Spindles and shafts are accurately ground to size. As to the capacity of the machine, the least distance from the center of the spindle to the top of the table is 3 inches, and the greatest 25 inches; the vertical adjustment is 22 inches. From the spindle driving gear, which is 18 inches in diameter, to the outer support, the shortest distance is 27 inches and the greatest 5 feet 6 inches. The 24- by 48-inch table has a cross feed of 36 inches and a longitudinal movement on the bed of 40 inches. The weight of the machine is approximately 11,000 pounds.

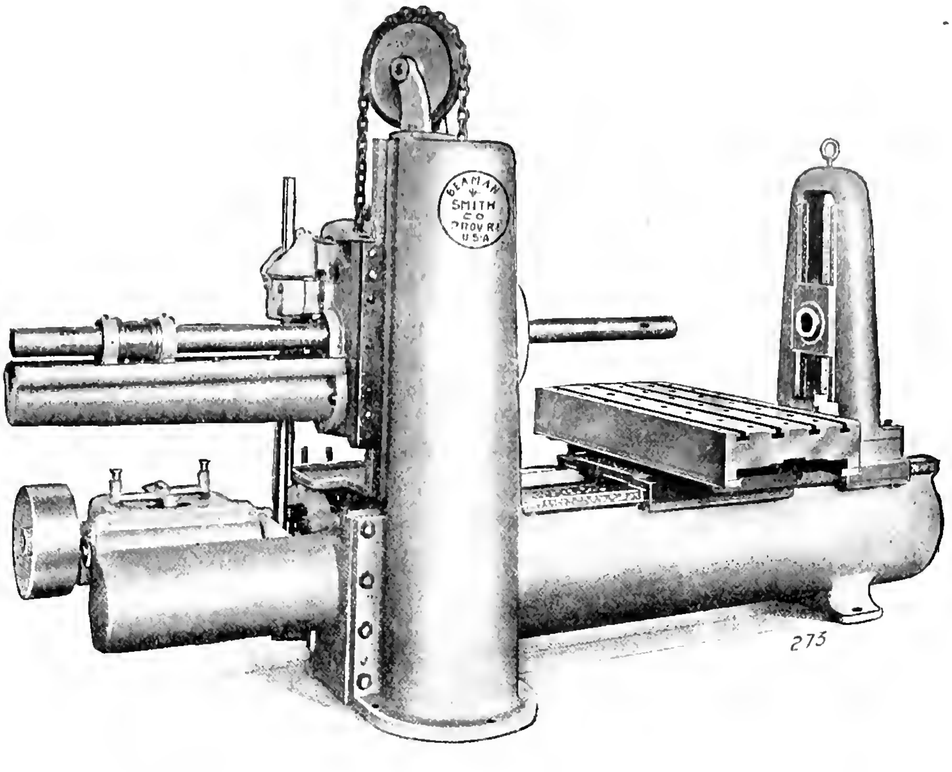
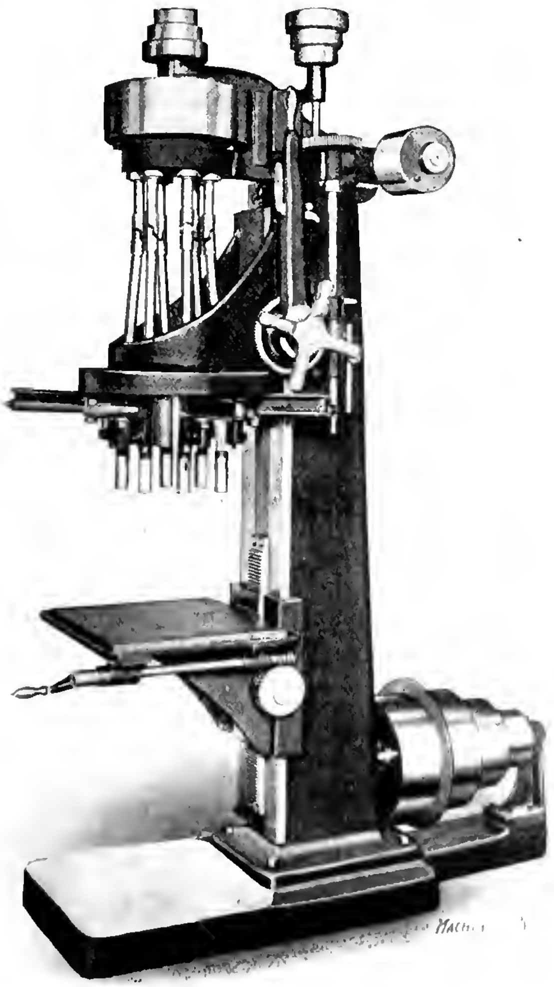


Fig. 2. Rear View showing Tubular Section used throughout in the Construction of Machine Members

FOX MULTIPLE SPINDLE DRILL

The tool herewith illustrated is one of a line of multiple spindle drilling machines built by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. These machines are designed especially for using high-speed drills, and will be found useful for automobile and gas engine work, and for general manufacturing.



Multiple Spindle Drill of the Adjustable Lay-out Type

The particular machine illustrated is the No. 1 size, provided with a round head. This is fed downward along the face of the column, inside of which is a weight for counterbalancing the movement. The power feed movement of 5 inches is transmitted through the swinging vertical shaft, which carries a worm engaging a worm-wheel on a rack pinion shaft. An automatic knock-off disengages the gearing at the end of the drilling operation. The hand lever shown provides for manual operation in the case of light work.

An exclusive feature of this machine is the design of the spindle bearings, mounted on the adjustable supporting arms. The construction gives a long stiff bearing, and one which is at the same time adjustable in a vertical direction without disturbing the setting of the other spindles. Patents are pending on this construction.

The base of this machine is 4 feet 6 inches by 18 inches. The table is 16 by 16 inches, having a vertical adjustment by a worm and worm-gear as shown in the engraving. Three spindle speeds are provided—262, 525 and 1050 revolutions per minute, respectively. The automatic feed has three changes, giving 0.0038, 0.0059, 0.0098 inch per revolution of the spindles, respectively. The driving connections by which these changes of feed and speed are obtained are exceedingly simple, and will be readily understood from the engraving.

* * *

During the month of August, 194 automobiles valued at \$333,960 and parts valued at \$114,973 were imported into the United States. Of the 194 cars imported, 109 came from France, 52 from Italy, 9 from Germany, 8 from the United Kingdom, and 16 from other countries. During the same month 360 automobiles were exported, valued at \$567,964. During the first eight months of the year 2,110 cars, valued at \$5,107,953 were exported. An interesting thing to note is the high average price of the exported cars, which is about \$2,500, indicating that the United States is rapidly taking a place among the nations exporting high grade automobiles.

* * *

The ordinary incandescent lamp with carbon filament requires about 3 watts per candle-power; the incandescent lamp with tungsten filament, 1.25 watt; the arc lamp, 1 watt; and the Cooper-Hewitt mercury vapor lamp ½ watt.

NEW MACHINERY AND TOOLS NOTES

No. 7 Disk Grinder: Gardner Machine Co., Beloit, Wis. This is a disk grinder of the same design as followed by the maker in the older members of his line, but intended for larger disks up to 30 inches in diameter. Greater belt power is also provided.

Furnace for Lead and Cyanide Baths: United States Gas Furnace Co., Providence, R. I. This furnace is intended particularly for heating baths of various substances for hardening steel parts. When used for lead, an open fire is permitted, but for cyanide a hood is fitted to carry the fumes away.

Die Sharpening Machine: National Machinery Co., Tiffin, O. This little tool is designed for threading dies or chasers for bolt and pipe work. It grinds these dies to uniform depth, giving them a proper cutting angle and clearance, so that each chaser will have the same amount of work to do. A 6-inch wheel is used, mounted on a spindle running in bronze bearings. Suitable graduations are provided for setting the machine.

Small Motor-Driven Shaper: L. E. Rhodes, Hartford, Conn. The Rhodes small shaper is now provided by its makers with a substantial iron base and a motor-drive, whenever required by the customer. A Lincoln motor is used, giving a 6 to 1 speed range; it is connected to the driving shaft by chain and sprockets. This combination should be useful in manual training schools, for model makers and others whose work is similar.

Oxy-acetylene Welding Apparatus: Oxy-Carbi Co., New Haven, Conn. This firm makes apparatus for the continuous generation of oxy-acetylene under suitable control, so as to be generated and mixed at the time it is used. The apparatus is made in either portable or stationary form. Suitable welding and cutting torches are furnished for the wide variety of work for which this process has been found adapted in the past two or three years.

Alligator and Combination Wrenches: W. S. Ducharme, Johnstown, Pa. The combination wrench made by this firm may be used as a pair of pliers or as a screw-driver, in addition to its use as a wrench. As a wrench it is self-adjustable, the jaws automatically closing as the pull increases. The alligator wrench is also adjustable, by means of a thumb-screw, adapting it to a wide range of sizes. A reversible jaw allows the wrench to be used in either direction.

Precision Spirit Level: Izard-Warren Co., 136 No. 12th St., Philadelphia, Pa. This style of precision level is built in six sizes, ranging from 2 to 24 inches in length. The bulbs are carefully made and are so ground as to indicate a variation of one-thousandth inch in the length of the level. A cross bulb is provided to make sure of the proper setting of the instrument. The body is of cast iron and the top of brass. The tool goes under the name of "Sterling Machinists' Precision Level."

Motor-Driven Precision Lathe Outfit: Rivett Lathe Mfg. Co., Brighton, Boston, Mass. This is a Rivett precision lathe mounted on a special cabinet with countershafts, etc., and a motor-drive enclosed in the base. The cabinet is of quartered oak, nicely finished, with a top surface which takes the place of the work bench on which the lathe is usually mounted. The whole arrangement provides places for the storing of attachments, tools, etc., in a way that is very convenient for a user of a precision tool.

Cold Heading Machine: Waterbury Farrell Foundry & Machine Co., Waterbury, Conn. This firm has lately produced what is supposed to be the largest cold heading machine made, being adapted to automatically produce work up to 7/8 inch in diameter and 4 inches long. The weight of the machine is over 42,000 pounds. It embodies the principles of the smaller machines of the same line, but changes have been made in details to cover the greater massiveness and rigidity required for heavy operations.

Improved Bevel Protractor: L. S. Starrett Co., Athol, Mass. This protractor is intended to be a member of the makers' well-known combination square sets, being used in connection with a graduated rule or straightedge. The improvement in the construction consists in the fact that its head extends on both sides of the blade, permitting angles to be transferred from either side of the frame without resetting. The readings indicate the supplement of the angle as well as the angle itself, thus facilitating the use of the tool.

Punch Press: Atlas Machine Co., Waterbury, Conn. This is a power-driven machine designed for light punching and stamping operations, and intended to take the place of the orthodox foot press, producing a more even pressure and more uniform work, and obviating the fatigue of the operator. The machine is controlled by a one-revolution clutch, connected to a treadle. The distance from the top of the bed to the lower end of the ways is 6 inches. The bed surface is 7½ by 12 inches. The total weight of the press complete is 500 pounds.

Scroll Chucks with Adjustable Jaws: D. E. Whiton Machine Co., New London, Conn. These tools are really a combination of independent and scroll chucks, inasmuch as they permit an individual adjustment for each jaw, this being provided by a screw mounted in the base of each which adjusts the scroll nut with relation to the jaw. This arrangement permits keeping the chuck true, without repeated grinding or boring of the jaw faces. These tools are also made with four jaws, so located that they may be used either as two-jaw or three-jaw chucks.

Adjustable Planer Gage: Tip Top Tool Co., 78 Vernon St., Worcester, Mass. This planer gage is of the type in which an anvil is adjusted up or down the inclined surface of a wedge, so as to form a measuring block having parallel surfaces which may be set for any distance apart from 3/16 inch to 1½ inch. This wide range is permitted by the fact that the measuring block has two steps of different heights. No graduations are furnished, it being designed to set the block by the aid of micrometer calipers. A fine adjustment is provided similar to that used on vernier calipers.

Nine-Spindle Milling Machine: Beaman & Smith Co., Providence, R. I. This firm has recently equipped its planer type of milling machines with a set of special heads carrying nine spindles. The side heads are provided with three spindles each, and the crossrail head has two on the front and one in the rear. This arrangement permits the machining simultaneously of the sides of the flange of automobile cylinders, the faces of the upper and lower valve openings, the spark plug boss and the inlet and exhaust connection bosses. The time required for finishing them is thus materially reduced.

Hack-Saw: Massachusetts Saw Works, Chicopee, Mass. This saw has a number of improvements in construction, of which the most notable one is a provision for adjusting the stroke automatically with the size of the work, so as to use, at all times, the full length of the saw blade. This adjustment is connected with the sliding vise jaw, so that no attention is required to it on the part of the operator. The blade is automatically relieved on the return stroke, which is made with an increased speed, due to the use of a quick-return mechanism. An automatic knock-off is provided to stop the machine when the cut is finished.

Universal Collet: Cleveland Collet & Machine Co., Cleveland, O. This is a chuck or collet of the draw-in type, intended for application to the engine lathe. Its principal advantage lies in the fact that it is adjustable for a wide range of work, it not being necessary to provide a large number of separate spring collets to cover the range, as is usual. The work is held by jaws which are opened or closed for a change in diameters, in a manner somewhat similar to the ordinary scroll chuck. The tightening of these jaws on the work, however, is effected as usual by a handwheel at the rear end of the spindle, acting on a tube passing through the latter.

Coil Clutch: Farrel Foundry & Machine Co., Ansonia, Conn. This clutch is of the type in which frictional contact is produced by the tightening of a heavy steel spring, which forms one member, about a drum or barrel, which forms the second member. As is well-known, this construction gives a very heavy gripping power for a slight pressure in the tightening of the spring. This particular design has been built for powers as high as 8,000 at 60 revolutions per minute in one English installation. The spring is hand-forged from a high-grade of steel and the drum is of chilled iron, making a very durable and substantial construction. The line covers a wide range of sizes.

Variable Speed Sensitive Drill Press: Villinger Mfg. Co., Williamsport, Pa. This drill press is a simple machine with a number of new features, among them being a connection of the feeding handle with a friction disk drive in such a way that this handle serves to vary the rate of speed as well as to feed the drill. Pushing the handle to right or left changes the speed, while drawing it down feeds the drill as usual. In addition, connections are provided which stop the spindle when the feed lever is turned back to its upright position. A key is provided which holds the table central with the drill at whatever vertical height it is adjusted. This key can be withdrawn, however, to permit swinging the table from one side to the other as may be required for special cases.

Crank Planing Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This is a tool which has found much favor in railroad and locomotive shops and other places where cuts are to be taken on comparatively small pieces of tough metal. The framework of the machine is of the planer type, but the table is actuated by a crank motion of variable stroke driven by a Whitworth quick return movement, similar to that used in many designs of shapers. The saddle is provided with power cross-feed on the rail, and the tool slide has a vertical or angular down feed on its slide. The machine is very strongly and ruggedly built, and is capable of taking heavy cuts, owing to the fact that all cutting strains are rigidly resisted by the disposition of the metal in the framework.

Cam Grinding Attachment for Standard Grinding Machines: Norton Grinding Co., Worcester, Mass. This attachment may be applied to the maker's standard type of grinding

machine. The desired outlines on the surfaces to be ground are produced by master cams or templets, which swing the work in toward the wheel or away from it as may be required to give the desired contour. A series of templets is provided, one for each of the different cams on the shaft, so that each is of the proper shape and properly located to give the correct timing. The whole arrangement is very simple, and easily applied and operated. It should result also in the production of cam surfaces of a high grade of accuracy. Provision is made in the device for grinding the templets or master cams from models, which are thus exactly reproduced in the contour of the work.

Blueprint Storage Tube: G. Chalmers Brown, New London, Conn. This tube is intended for the storage and use of blueprint paper from the roll. It may be fastened to a bench or side of the wall. The roll of paper is inserted in the end of an inner tube, after which this inner tube is turned around so that the opening in its side is out of line with the opening in the outer tube. The paper is thus safely sealed against the entrance of light. In removing the paper, the inner tube is turned around until the openings register and the paper is pulled out through the slot thus provided. A tape-measure is mounted on the apparatus which is pulled out at the same time with the paper, accurately measuring the length of the sheet removed. The paper is torn by drawing it cornerwise across the sharp edge of the opening. This tube should find favor on the score of economy and convenience in the use of blueprint paper.

36-Inch Radial Drill: Dreses Machine Tool Co., Cincinnati, O. This machine resembles the previous designs of the same builders in the construction of the spindle head, feed, etc. It is provided, however, with a new driving connection between the horizontal shaft on the arm and the vertical shaft inside the column, which does away with a considerable amount of mechanism, including two spur gears, a shaft and two bearings. The elevating screw is placed in a recess in the front of the column where it does not lessen the swing of the machine. An improved clamping device is provided which binds the column, the table and the stump together by a single movement of the lever. The table may be adjusted to keep it always perpendicular to the spindle. The machine will be furnished either with cone pulley or gearbox drive, or with constant or variable speed motor drive. It drills to the center of 73-inch circles, takes 78 inches between the center and the base and weighs about 3,600 pounds.

Lester Automatic Screw Machine: Davis Sewing Machine Co., Dayton, O. This is a multiple spindle machine involving a number of novel features in its construction. For one thing, it has three stock spindles in place of the usual four or five. The indexing and cam movements are so arranged that these three spindles, on simple work, can be made to form three pieces at each revolution of the cams, without indexing; these pieces may be alike or different as may be required. On plain work, it may thus be seen, the machine has a very high capacity. Another new point in the design is the large number of tools provided. There are six stations in the tool-holder and three cross-slide tools, this making nine cutting operations possible for each piece; and as many of these operations may be arranged to make use of multiple cuts, the range of work to which the machine is adapted is very large. The size of machine at present built has a capacity for stock up to 1 inch diameter, and a length of feed for turning up to 4 inches.

Machine for Testing Running Balance: The Norton Grinding Co., Worcester, Mass. The obtaining of standing balance in a rotating part is a comparatively simple operation, it being common to roll the work along knife edges or between centers, and mark the heavy side as indicated by the position in which the part comes to rest. The obtaining of a running balance, however, is another matter. It has always been done by homemade contrivances, more or less clumsy and slow. The Norton Grinding Co. has recently devised a piece of apparatus for this work which greatly simplifies the operation and permits it to be done much more quickly and accurately than ever before. Briefly, the part to be tested is provided with two supports, one on each end, on which it is rotated rapidly by an electric motor. These supports are floating, and indicate every vibration by means of a lever magnifying arrangement. Provision is made for marking the high side at each support to show the running out permitted by the floating bearing. By reversing the rate of ratio the lag due to the inertia of the floating and indicating parts is compensated for. For long and slender work provision is made for supporting and indicating at one or more intermediate points as well as at the ends. The whole apparatus is well-designed and conveniently arranged, and should prove especially useful in automobile work, high-speed drums and pulleys, and in woodworking machinery building in general.

* * *

The Pennsylvania R. R. tunnels from Bergen Hill, N. J., to Long Island City were practically completed December 3 when the final section of concrete was placed in line D, the fourth and last of the tunnels under the East River, to the Sunnyside Yard, Long Island City.

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GEORGE WESTINGHOUSE

ARTHUR WARREN

The new president of the American Society of Mechanical Engineers needs no introduction to engineers of any branch, nor to the general public the world over. He has been famous and honored everywhere these forty years, for it was in 1868, and at the age of twenty-two, that he brought forward his great invention, the air brake, which it has been said "ranks next to the press and the locomotive among those forces to which the material developments of the present age primarily are due." The evolution of the air brake under his personal inventiveness in the years that have passed since he first originated the device has made the modern railroad possible. Without the control which the air brake gives, high speed, frequent service, long trains, huge cars, heavy loads, would be unknown. The air brake, therefore, is not only a safety device; it is also a most important operating device on a railroad.

George Westinghouse was born October 6, 1846, at Central Bridge, Schoharie County, in the state of New York, a son of George and Emeline Vedder Westinghouse. His father was a manufacturer of agricultural machinery at Schenectady. Out of school hours the boy taught himself engineering, and it was his idea of a holiday and a vacation to work in his father's machine shop. Before he was seventeen he enlisted for the Civil War, serving first in an infantry regiment and next with the cavalry. Then, passing an examination for the purpose, he was transferred to the Navy where he served during the remainder of the war as an Assistant Engineer. In the same year that he returned to civil life, 1865, he entered Union College and invented a device for placing derailed cars on the track. Three years later he thought out and patented the air brake. He had to guarantee the railroad which made the first trial with the brake that he would pay for any damage that might be done to the train as a result of equipping it with the apparatus and running a trial trip. Instead of damaging the train, his brake prevented a fatal accident on the trial run and then the skeptical railroad officials expressed astonishment and enthusiasm, and men who had thought it "impossible to stop a train with air" were eager to buy the invention.

Young Westinghouse, however, declined to sell. He formed a company, took a workshop in Garrison Alley, Pittsburg, and began to manufacture the remarkable contrivance which he had invented. In a year the new works had thirty-six employes, including clerks and office boy. From that modest beginning have grown the great works of the Westinghouse Air Brake Co. at Wilmerding, Pa., and the town of Wilmerding itself. From the fruits of the inventor's genius, energy and capacity as an organizer of industry have developed thirty companies, of which he is president, employing 50,000 men, $120,000,000 of capital, and manufactories at East Pittsburg, Swissvale, Trafford City, and Wilmerding, in Pennsylvania, in London and Manchester, England, and in

France, Germany, Italy, Austria and Russia. There is not a civilized country in which the name Westinghouse is not familiar. Air brakes, electric motors and generators, steam and gas engines, steam turbines, railroad switches and signals, and a multitude of other things testify to the inventive and industrial energy of this distinguished man.

After inventing the brake he took up the study of railroad signals and switches and showed how these could be operated with compressed air. Having done this, he combined electricity with the pneumatic operation of these devices. Thus he was led further and further into the pursuit of the then new electrical art. Convinced of the practicability of conveying electrical currents over great distances, he resolved to develop the alternating system for that purpose. From Europe he acquired the patents of Gaulard and Gibbs. He brought Tesla to Pittsburg, backed him financially, placed laboratory and workshop facilities at his disposal, and the result was the invention of the induction motor for utilizing the alternating current for power purposes.

The great successes of Mr. Westinghouse have not been gained without opposition. His strength of character, mind and resource, however, has always been brought forth in encounters, and he has always won. Opposition to the alternating current system developed to an extraordinary extent. Men who should have known better, and do now, declared that the alternating current was impracticable, and that if ever made practicable its use would be deadly and a menace to the public welfare. Legislation was invoked against it in many states. These efforts were really meant to be, whatever the legislators may have thought, a systematic attempt to check George Westinghouse in his plans for bringing electricity within the reach of all. And to prove to the populace the "danger" of the system which he advocated, some of the opponents prevailed upon the authorities to use an electrical death-chair for the execution of convicted murderers! The originators of this brilliant idea, and of the campaign against the alternating current system, found themselves as impotent as King Canute when he commanded the incoming sea to retreat. Scientifically, commercially, and in every way, the alternating system proved to be what the world required for the general adoption of electric currents on a large scale, and the opposition was defeated. Similarly, in the hard times of the early nineties, men who desired to monopolize the manufacture of electrical machinery took advantage of the generally depressed conditions of affairs throughout the country, and endeavored to drive Mr. Westinghouse into a corner, and to obtain control of the electrical manufacturing company which he had founded, organized and built up into a great center of industry; but the attempt to overcome him was unsuccessful. The panic of 1907 caused a renewal of this kind of attack, but as Andrew Carnegie is reported to have said, "George Westinghouse is a genius. You cannot keep him down!" What is more, you cannot get him down. He is one of the world's strong men.

At the time of the Chicago exhibition the electrical illuminations of that vast and beautiful undertaking were the most remarkable that had ever been seen. George Westinghouse offered to take the electrical contract for a million dollars less than the figure which the exposition authorities were on the point of agreeing to pay the bidders who seemed to be the most successful. "It cannot be done," the competing bidders said to the exposition authorities. "But I will do it," said Westinghouse. And then they undertook to show that they monopolized the lamp patents of that time. This they thought would make him powerless in the matter, but he persuaded the authorities to postpone the decision, and they, glad enough to save a million dollars, and having faith in the man, consented to the postponement. Mr. Westinghouse returned to Pittsburg, invented a lamp, returned to Chicago, secured the contract and saved the exposition a million.

George Westinghouse has invented many things, and has encouraged invention in the engineers associated with him. He devised a system for mechanically controlling the flow of natural gas, and piping it over long distances for use as fuel in the industries and homes of Pittsburg. He built the first ten great generators for Niagara, and those for the elevated and subway lines in New York, and for the Metropolitan Railway in London. It is impossible within the present space to enumerate either his inventions or his business achievements. His work has frequently taken him into many countries, and distinguished men of all callings and sciences are, and long have been, among his personal friends. Of these, Lord Kelvin was the first recipient of the John Fritz medal. George Westinghouse, by the way, was the second person to receive the John Fritz medal. The French Republic, the late King Leopold of Belgium, and the late King Humbert of Italy decorated Mr. Westinghouse. The Königliche Technische Hochschule of Berlin gave him the degree of Doctor of Engineering. He was, in 1905, selected as one of the three trustees to hold the voting power of the stock control of the Equitable Assurance Society, being associated in this important trust with ex-President Grover Cleveland, and Justice Morgan J. O'Brien. He is president of the American Society of Mechanical Engineers, is one of the two honorary members of the American Association for the Advancement of Science, and an honorary member of the National Electric Light Association.

The latest activity of Mr. Westinghouse is the bringing before the attention of the marine engineers of America and Europe the reduction gearing and "floating frame" invented by Rear-Admiral Melville, ex-Engineer-in-Chief, U. S. N., and John H. Macalpine. The purpose of this invention is to enable high-speed steam turbines to drive the propellers of steam vessels, thus obtaining from the propellers and the turbines their highest efficiency. Mr. Westinghouse supplied the means for constructing and testing this important invention, and at the same time developed a marine turbine of his own which is said to be a great improvement over any now in use. This turbine has been used in the tests of the Melville-Macalpine gear, tests which are reported to be of a remarkably satisfactory character.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The thirtieth annual meeting of the American Society of Mechanical Engineers was held in New York, December 7 to 10 inclusive, the Engineering Societies Building, 29 West 39th St., being the headquarters. The registration of members was 638, and including guests, 1063. The program was substantially as follows:

Tuesday.—President Smith's address, "The Profession of Engineering," and the introduction of President-elect George Westinghouse, followed by a reception held by the president, president-elect, Secretary Rice and Honorary Secretary Hutton with their ladies.

Wednesday.—Annual business meeting, reports of membership, standing and special committees and gas power section. In the afternoon a large party went through the new Pennsylvania R. R. terminal and passenger station at 7th Ave. and 31st and 33d Sts. In the evening an interesting stereopticon lecture was delivered by L. W. Ellis of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., entitled "The Era of Farm Machinery."

Thursday.—"Tests on a Venturi Meter for Boiler Feed" by Charles M. Allen; "Pitot Tube as a Steam Meter" by George F. Gebhardt; "Efficiency Tests of Steam Nozzles" by F. H. Sibley and T. S. Kemble; "Electric Gas Meter" by C. C. Thomas; "Tan Bark as a Boiler Fuel" by David M. Myers; "Cooling Towers for Steam and Gas Power Plants" by J. R. Bibbins; "Governing Rolling Mill Engines" by W. P. Caine; "Experience with Leaky Vertical Fire Tube Boilers" by F. W. Dean; "The Best Form of Longitudinal Joint for Boilers" by F. W. Dean; "Testing Suction Gas Producers with a Koerting Ejector" by C. M. Garland, A. P. Kratz;; "Bituminous Gas Producers" by J. R. Bibbins. In the evening the members of New York and vicinity gave a reception to the officers and members of the society, their ladies and guests at the Hotel Astor.

Friday.—"The Bucyrus Locomotive Pile Driver" by Walter Ferris; "Line Shaft Efficiency, Mechanical and Economic" by Henry Hess; "Pump Valves and Valve Areas" by A. F. Nagle; "A Report on Cast Iron Test Bars" by A. F. Nagle.

Besides the excursion mentioned there were other excursions of much interest as follows:

International Steam Pump Co., Harrison, N. J., to inspect a modern plant for the manufacture of pump and hydraulic machinery; General Electric Co., Harrison, N. J., to inspect incandescent lamp manufacture; Interborough Rapid Transit Co., W. 58th and 59th Sts. and west side of 11th Ave., to inspect a large central electric light and power station for public service; National Phonograph Co., Orange, N. J., to inspect the manufacture of Edison phonographs and records; De La Vergne Machine Co., E. 138th St., New York, to inspect a new type of oil engine; New York Telephone Co., 61 Irving Place, New York, to inspect the Gramercy and Stuyvesant central telephone exchanges; Crocker-Wheeler Co., Ampere, N. J., to inspect a modern plant for the manufacture of electric generators and motors; Westinghouse Lamp Co., Bloomfield, N. J., to inspect incandescent lamp manufacture; New York Edison Co., E. 38th to E. 40th Sts., New York, to inspect the Waterside electric light and power stations Nos. 1 and 2 for public and private service; Brooklyn Rapid Transit Co., Kent Ave. and Division St., Brooklyn, to inspect a modern central electric power station for public service; Rockland Electric Co., Hillburn, N. J., to inspect gas engines and producers in a modern public service plant; Singer Mfg. Co., 149 Broadway, to inspect the power plant and view the city from the tower 548 feet above the street; Trenton Iron Co., Trenton, N. J., to inspect a modern electric generator plant operated by gas engines; Watson-Stillman Co., Aldene, N. J., to inspect a 300 horse-power Riverside gas engine operating in connection with a Tait producer; Metropolitan Life Insurance Co., E. 23d St. and 4th Ave., to inspect the power plant and view the city from the tower.

The excursion through the Pennsylvania R. R. terminal was of extraordinary interest. The terminal, which is part of one of the world's greatest engineering works, occupies four blocks in the heart of New York, lying between 31st and 33d Sts. and 7th and 9th Aves. It is 784 feet long and 430 wide. Its average height above the street is 69 feet, and maximum height 153 feet. The main waiting room is 277 feet long, 103 feet wide and 150 feet high in the dome. At the track level the station covers an area of 7.74 acres and the total trackage is 16 miles. The number of standing tracks at the station is 21, and the number of passenger platforms is 11. The power house adjacent has a boiler capacity of 5,000 H. P.

The New York terminal extension consists of the Pennsylvania R. R. Tunnel and Terminal Roads forming a connection with the New York division of the Pennsylvania R. R. near Harrison, N. J., which runs over the meadows, under Bergen Hill, North River, Borough of Manhattan and East River through the Sunnyside yards to the Long Island Railroad near Woodside Ave., Queens Borough, Long Island. The total length of the extension is 14.9 miles, including 1.25 mile in the Harrison yard. Of this, 2.78 miles are land tunnels, 2.29 miles river tunnels. The terminal is really a way station on the connecting link between the Pennsylvania R. R. system and the Long Island Railroad system. The terminal building is a beautiful structure lined with Carrara marble and of most impressive proportions.

The large number of interesting excursions and other extraneous features incident to the meeting tended to detract from the value of the technical proceedings. The members generally neglected the sessions, the result being that they were poorly attended and the discussions largely perfunctory. It is a question whether a programme of papers could have been prepared that would have drawn more attendance in view of the manifold outside attractions. If not, it would seem that a change should be instituted in the entertainment and conduct of the meetings if the best interests of the society are to be conserved.

The following officers were elected: George Westinghouse, president; Charles Whiting Baker, W. F. M. Goss, E. D. Meier, vice-presidents; J. Sellers Bancroft, James Hartness, H. G. Reist, managers; William H. Wiley, treasurer.

* * *

Don't use wet or green timbers for countershaft hanging, without tightening up the bolts every week or two, for a while.

PERSONALS

H. L. Pelz is now foreman of the foundry of the Chicago & Alton R. R. at Bloomington, Ill.

L. Fleishfien has been put in charge of the machine department of the Chicago & Alton R. R. shops at Bloomington, Ill.

Fred H. Robinson, with the Bailey Automobile Co., Springfield, Mass., has been promoted to position of foreman of the machine shop.

A. L. Myers, a department foreman of the LeBlond Machine Tool Co., Cincinnati, Ohio, has been made assistant superintendent.

Walter C. English, manager of the Boston office of the *Iron Age* and associated publications, has retired after twenty-six years of service.

C. L. Woodward, mechanical engineer and designer, of the Bailey Automobile Co., Springfield, Mass., has been appointed superintendent of the factory.

The headquarters of Ethan Viall, western editor of MACHINERY, will be 1811 First National Bank Building, Cincinnati, Ohio, after January 15.

J. H. Stevens, who has been in the employ of the LeBlond Machine Tool Co., Cincinnati, Ohio, for some time, has been promoted to the position of machine tool foreman.

C. H. Tucker, recently of the Case Crane Co., is now in charge of the new department of the Toledo-Massillon Bridge Co., devoted to the manufacture of cranes, hoists, coal and ore-handling machinery, etc.

James Healy, for the past three years foreman of the gear-cutting department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned and taken a similar position with the Pierce-Arrow Co., Buffalo, N. Y.

H. A. Isaacs, formerly master mechanic of the Chicago & Alton R. R. at Kansas City, Mo., and later with the Michigan R. R., has been appointed master mechanic of the Chicago & Northwestern Ry., with headquarters at Clarion, Iowa.

Charles Robbins, who for ten years has been employed in the industrial and power sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in connection with the sale of industrial motors, was recently appointed manager of this department.

George M. Vial, for the past five years in charge of the wood pattern department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned to take charge of the wood-working department of the public manual training school of Chicopee, Mass.

Clark W. Parker, for the past three years employed by the Lamb Knitting Machine Co., Chicopee Falls, Mass., designing special automatic machinery, has resigned to become president and manager of the Parker Transmission and Appliance Co., Springfield, Mass., which is to manufacture and market one of his inventions.

S. J. Rowe, president of the Rowe Motor Co., Waynesboro, Pa., has been for the past fifteen months designing self-propelled fire apparatus for the American-La France Fire Engine Co., Elmira, N. Y. Mr. Rowe resigned his position with the company, to take effect January 1. He will hereafter devote his entire time to the business of the Rowe Motor Co.

E. P. Haight, well known in electrical circles as the treasurer of the Sprague Electric Co., was elected president of the Electric Trade Association of New York, of which Mr. Franz Neilson, 80 Wall St., is secretary. Mr. Haight's experience in the electrical trade and his energy and enthusiasm doubtless will make his administration of the society unusually successful.

Samuel A. Chase, who for the past few years was a detail and supply salesman in the New York sales office of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., recently resigned, and has taken a position with the White Investment Co., of New York, a financial investment company handling stock of many organizations. Mr. Chase will be in charge of the Chicago office of the company.

G. Brower Griffin was recently appointed manager of the sales policy of the detail and supplies sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in which department transformers, motors, switches and switch-boards, railway line material, etc., are sold. Mr. Griffin was assistant manager of the sales department for six years previous to his promotion to the position of manager, having previously been connected with the sale of detail apparatus, in the Boston office.

S. Nicholson was recently appointed general sales manager of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., and has taken charge of the policy of the entire company. He has been with the company for eleven years in different capacities. He is perhaps best known to electric motor manufacturers as the organizer and president of the American Association of Motor Manufacturers, an organization which has done much in the two short years of its life to improve the art of motor manufacture.

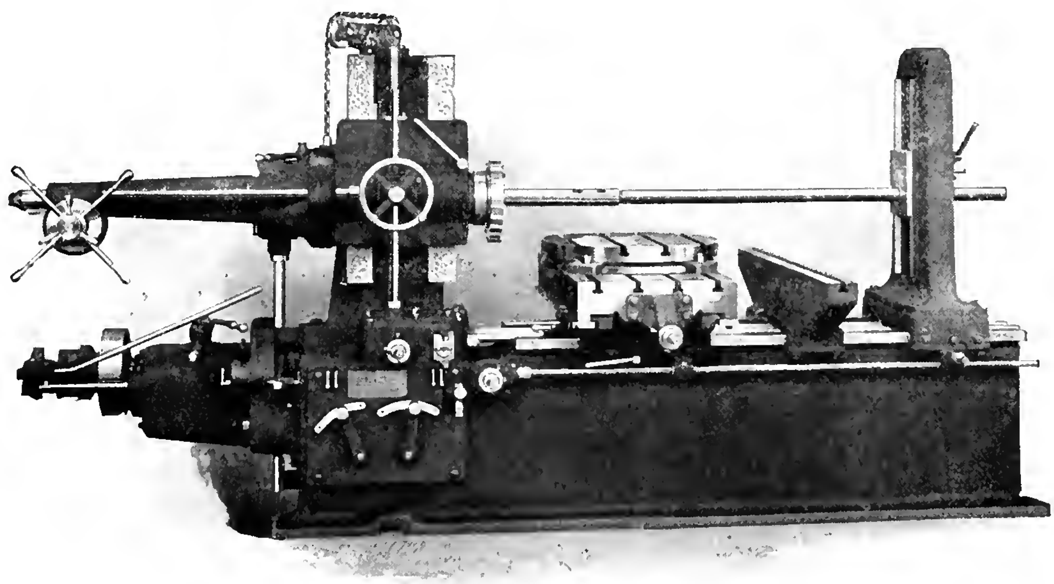
SOME gentleman with plenty of time at his disposal has figured that ONE TON OF IRON, after going through the necessary processes to make it into hair springs for watches, would be worth

TWENTY MILLION DOLLARS!

Made into almost any kind of a MACHINE it would be worth more than if made into SASH WEIGHTS.

We don't know just how much it would be worth per ton if made into a

"PRECISION"



Boring, Drilling and Milling Machine

because we don't particularly care and have never taken the time to figure it.

The DISTRIBUTION of metal concerns us more than its WEIGHT.

The metal in our machines is distributed as well as we know how to do it today, and if we can find a better way tomorrow to distribute it, WE SHALL DO IT.

Lucas Machine Tool Co., Now and always of Cleveland, O., U.S.A.

EUROPEAN AND AUSTRALIAN AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest. E. McCray & Co., Sydney, Australia.

Paul M. Chamberlain has opened an engineering office at 1522 Marquette Building, Chicago, Ill. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888 and Cornell University in 1890. For several years he was in practical work with the Brown Hoist Co., Cleveland, Ohio; Frick Co., Waynesboro, Pa.; Hercules Iron Works, Aurora, Ill. He then became assistant professor of mechanical engineering at the Michigan Agricultural College, and at the opening of the Lewis Institute at Chicago he took charge of the engineering work and brought it up to its well-known standard of excellence. Mr. Chamberlain has made a special study of boiler-room equipment, economy in fuel burning, and smoke abatement, and will devote his time principally to new designs and improvements in existing installations.

Franklin E. Snow, for twenty-nine years connected with the Wells Brothers Co., of Greenfield, Mass., and for a great part of that time its treasurer, has retired from the active management. F. O. Wells will continue as president and will also act as treasurer. Mr. Snow will be vice president and Edward Blake, Jr., who has been sales manager for some years, has been elected a director. Mr. Snow has been one of the most prominent factors in the development and prosperity of the Wells Brothers Co., and the growth of the business from a small concern on Mill Street to the present large plant on Sanderson Street has been coincident with his connection. Mr. Snow is also interested as a stockholder in a number of other Greenfield manufacturing enterprises, to the success of which his business ability has contributed in a marked degree. In the enjoyment of a well-earned rest he will doubtless still find time to perform, in his quiet and genial way, the various duties which fall to the lot of the public spirited citizen.

Charles H. Kirchhoff, for twenty years editor-in-chief of the *Iron Age*, retired December 1. Mr. Kirchhoff graduated from the Royal School of Mines, Clausthal, Germany, and before entering journalism in 1877 he was a mining engineer and metallurgist. He worked as a chemist for the Delaware Lead Refining Co., Philadelphia, Pa., from 1874 to 1877, and during that time began contributing to the *Metallurgical Review*, and later became its assistant editor, remaining on its staff two years. Leaving the *Metallurgical Review*, he joined the staff of the *Iron Age* as assistant editor, and after two years service became editor of the *Engineering and Mining Journal*. In 1884 he returned to the *Iron Age* as associate editor, and in 1889 became its editor-in-chief. Mr. Kirchhoff is generally regarded as an authority on metallurgy and steel manufacture. He has a wide acquaintance among the steel manufacturers, and his personality undoubtedly has been a potent factor in the success and prestige of the journal that he conducted so long.

* * *

OBITUARIES

Joseph Campbell, president of the Diamond Saw and Stamping Works, Buffalo, N. Y., died November 29.

John B. Chapman, senior member of J. B. Chapman & Co., brass founders, coppersmiths, and machinists, Springfield, Mass., died at his home in that city December 6, aged fifty-five years.

F. L. Gallagher secretary and treasurer of the Modern Tool Co., Erie, Pa., died suddenly November 29, aged forty-one years. Mr. Gallagher was formerly with the Metric Metal Works, with which concern he was employed as bookkeeper until about nine years ago, when he became manager and treasurer of the Modern Tool Co. He was a man of much popularity.

Alden Sampson, 2nd, proprietor of the Alden Sampson Mfg. Co., maker of automobile and automobile trucks, Pittsfield, Mass., died at his home, December 3, aged thirty-one years. Mr. Sampson contracted a cold which developed into double pneumonia while on his homeward trip from France in the middle of November, where he had gone to observe the use of automobile trucks in army manœuvres.

Dr. Charles B. Dudley, the well-known chemist in charge of the Pennsylvania R. R. Co.'s testing work, died at Altoona, Pa., December 21, of typhoid-pneumonia, aged sixty-seven years. He held the position with the Pennsylvania R. R. Co. since his graduation from the Sheffield Scientific School in 1874. He was twice president of the American Chemical Association, and was a vice-president of the American Institute of Mining Engineers. He was also president of the American Society for Testing Materials for several years.

William Metcalf, a pioneer steel manufacturer and one of the best known metallurgists in the United States, died at his home in Pittsburg, Pa., December 7, aged seventy-one years. During the Civil War Mr. Metcalf was in charge of the Fort Pitt foundry, Pittsburg, where much of the heavy artillery used by the Northern armies was made. It was in this foundry that the Rodman cannon were cast, the Rodman process being the first effort of importance to make cannon with the internal layers in a state of compression due to cooling the core rapidly. Mr. Metcalf was head of the Braeburn Steel Co., which he organized in 1897. He was the author of several books on steel and metallurgy; his book on tool steel was for many years the only authoritative American work on the subject. In 1880 he was elected president of the American Institute of Mining Engineers, and president of the American Society of Civil Engineers in 1893. He was also vice-president of the American Society of Mechanical Engineers in 1882-1884.

* * *

COMING EVENTS

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary. American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary. American Brass Founders' Association.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in England.

SOCIETIES AND COLLEGES

Iron & Steel Institute, G. C. Lloyd, secretary, London, England, announces that Mr. Andrew Carnegie, past president of the association, has presented the institute with $100,000 for research scholarships. The object of this scheme of scholarships is to enable students who have passed through college or who have been trained in industrial establishments to conduct research experiments in iron and steel and related subjects. The appointment for scholarship is for one year, but the council may at its discretion renew the scholarship for a further period. Further information may be obtained from the secretary.

Massachusetts Institute of Technology, Boston, Mass., during the past year has made the requirements for the degree of Doctor of Engineering more definite, and has placed it in the hands of the board which also administers the regulations for the degree of Doctor of Philosophy. The requirements for the degree of Doctor of Engineering and Doctor of Philosophy have now been made substantially equivalent. The executive committee has voted two Austin research scholarships carrying a sum of $500 each and remission of tuition fees. These are now open to candidates for degrees of Doctor of Engineering and Doctor of Philosophy.

Museum of Safety and Sanitation, 29 West 39th St., New York, through its secretary, Dr. William H. Tolman, is giving stereopticon lectures on safety devices. A description of the work of the safety committee of the United States Steel Corporation made in Rochester so impressed the superintendent of the Rochester Railway and Lighting Co. that he organized a committee of safety in his company which employs 2,500 people. The practical results of Dr. Tolman's work are made clear by events like this which promote methods, rules and regulations for the preservation of life and limb in industrial works, railroads and other activities of life.

University of Illinois, Urbana, Ill., has recently issued a circular descriptive of its course in mining engineering lately established. The bill establishing the department of mining engineering in the state university was passed by the last state legislature. The mining and metallurgical products of the state of Illinois, for 1907, represent an output value of over $150,000,000. Although Illinois is generally regarded as an agricultural state, it has for many years occupied second place among coal producing states and the rapid development of the iron industry about Chicago has already placed the state well up among the iron and steel producing states.

CATALOGUES AND CIRCULARS

Robbins Machine Co., Worcester, Mass. Circular of Robbins 14-inch engine lathe with compound and elevating rest.

Boicourt Co., Fort Worth, Texas. Circular of Boicourt steam power pumps, deep well pumps and deep well working head.

B. C. Ames Co., Waltham, Mass. Catalogue of bench lathes and fixtures, bench milling machines and dial gages. The company builds small machinery to order.

S. A. Woods Machine Co., Boston, Mass. Circular of inside molders, a new wood-working tool in which the advantages of a molder, shaper and matcher are comprised in one machine.

Massachusetts Institute of Technology, Boston, Mass. Catalogue of the Institute giving roster of officers and instructors, courses of study, roll of students and graduates, etc.

Chicago Pneumatic Tool Co., Chicago, Ill., and New York. Circular descriptive of Franklin tandem gasoline engine driven air compressors adapted for isolated compressed power units.

Northern Engineering Works, Detroit, Mich. Booklet 24-B of Northern electric traveling cranes, hand power cranes, jib cranes, overhead trolleys, electric hoists, steel derricks, etc.

General Electric Co., Schenectady, New York. Bulletin No. 4708 on Thompson direct current test meter type CB-3, designed as part of the equipment of central power stations for periodical meter testing.

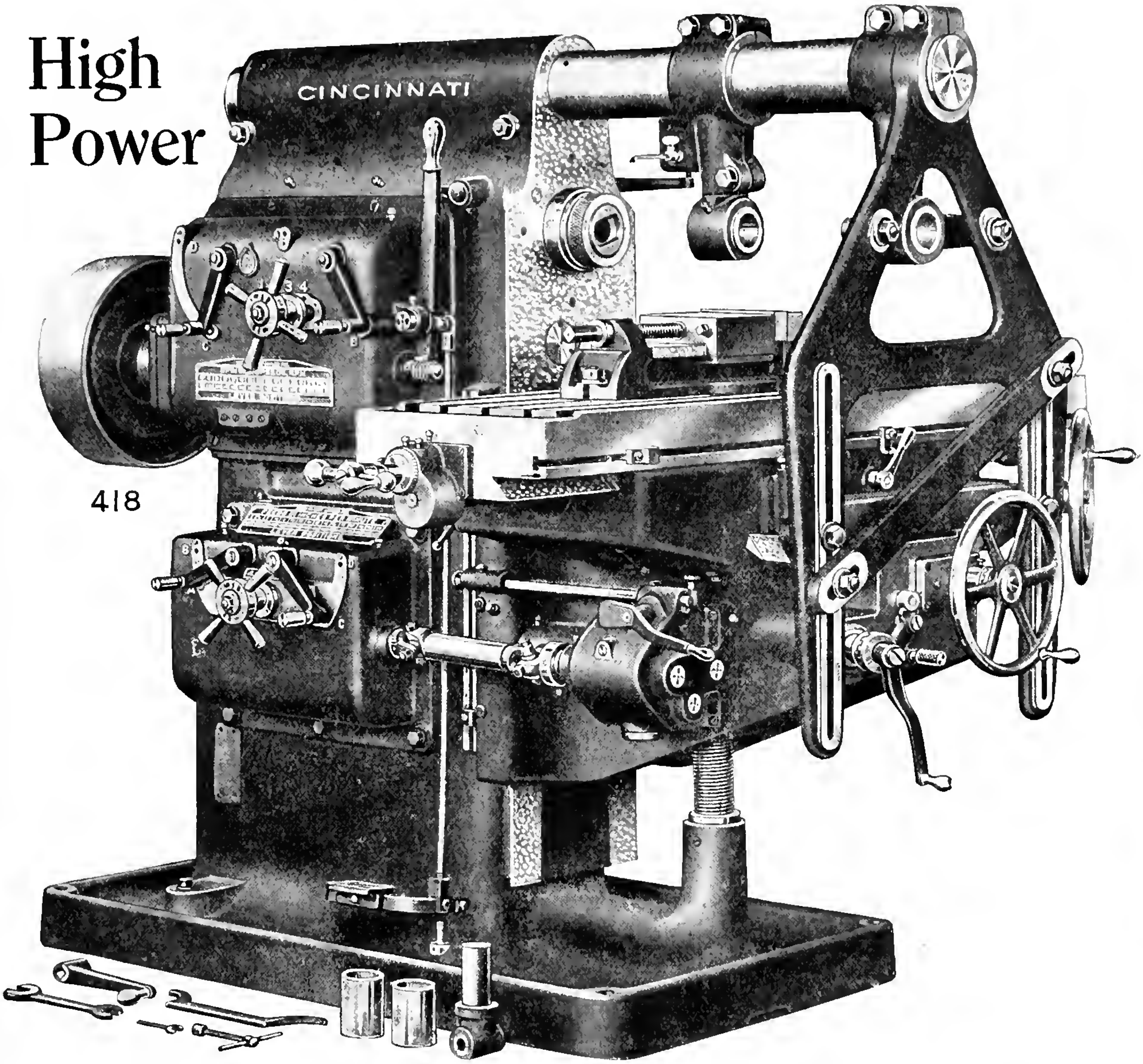
M. Rumely Co., La Porte, Ind. Pamphlet entitled "Toiling and Tilling the Soil," beautifully illustrated, advertising the Rumely "Oil Pull" tractor, a gasoline traction engine designed for plowing and hauling on farms.

Gisholt Machine Co., Madison, Wis. Leaf illustrating and describing Gisholt lathe equipment for finishing valve bodies and work of a similar nature. Also leaf illustrating Gisholt lathes used in automobile shops.

Mesta Machine Co., Pittsburg, Pa. Circular of Corliss-engine driven compressors for large capacities and pressures up to 1,000 pounds per square inch, and hoisting engines for heavy duty service and large capacities.

CINCINNATI MILLERS

High Power



THE NEWEST MILLER ON THE MARKET

All driving gears of steel with teeth of standard length and 20° pressure angle.
The drive is always through the face gear which is keyed to the spindle close against the front box.
Single plunger trip, can reverse all feeds at all times from tripped position, without interference with dogs.
Direct reading, simple, feed and speed index.
Table feed levers reverse, and also indicate direction of table travel.
Sight feed oilers on all important bearings.
Six different interchangeable drives. Change from the one in use to any other can be quickly made at any time by user in his own shop.

Ask for our 1909 catalog

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhag[illegible] Budapest. Alfred H. Sch[illegible], Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcas[illegible]-on-Tyne and Glasgow.
CANADIAN AGENT H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS Thos. McPherson & Son' Melbourne.

CONTENTS FOR JANUARY

AMERICAN BLOWER CO., Detroit, Mich. Copy of recent decision of Judge Hough of the United States Circuit Court sustaining its suit against the B. F. Sturtevant Co., Boston, Mass., for infringement of patent covering Sirocco fans and blowers.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 116 on motor generator sets for air pumps; bulletin No. 117, "Motor Drive in the Laundry;" and bulletin No. 118 on form L direct current motors 1/20 to 7½ H. P. and generators 0.6 to 3½ K. W.

AAGUTO OILLESS BEARING CO., Waynesboro, Pa. Folder advertising Arguto oilless bearings for lineshafts and countershafts in cotton mills and other locations where it is desirable to avoid the use of oil because of danger of contaminating the product.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1506 entitled "Recent Types of Arc Lamps and their Operation," by C. E. Stevens. The paper briefly discusses arc lamps in general, and describes the metallic flame arc lamp and its mechanism.

E. G. SMITH, Columbia, Pa. Catalogue of Columbia calipers, "which-way" pocket level, Columbia spherometer, steel rules, etc. The Columbia caliper is made in various styles, one of which is provided with a vernier that makes the reading of 64ths or 128ths as easy as 16ths with the ordinary plain graduation.

AMERICAN OXYHYDRIC CO., Milwaukee, Wis. Pamphlet on the oxyhydric process for cutting and welding metals. The apparatus and interesting examples of work done are illustrated, including clearing away the tangled steel debris resulting from a boiler explosion in the Pabst brewery, cutting 9-inch nickel-chrome armor plate, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4705 on the Curtiss steam turbines for low pressure and mixed pressure. Various installations are illustrated, including a 5,000 K. W. low pressure Curtiss turbine generator at the 59th St. station of the Interborough Rapid Transit Co., New York.

GOULD & EBERHARDT, Newark, N. J. Folder entitled "The Building of a Reputation," giving a brief history of the concern and advertising the Eberhardt automatic gear-cutting machine for spur and bevel gears, automatic generating machinery for hobbing spur, worm and spiral gears, rack cutters and shapers.

COLBURN MACHINE TOOL CO., Franklin, Pa. Circular describing the Colburn floating reamer holder for use in boring mills with turret heads. (See MACHINERY, December, 1909.) These holders are made in two sizes, No. 1 having a No. 4 Morse taper socket and No. 2 a No. 5 socket, the maximum capacity being holes 3 and 4 inches diameter respectively.

ROCKWELL FURNACE CO., New York. Bulletin G on annealing, hardening, and tempering furnaces fired with oil or gas fuel. These furnaces are adapted for treating, hardening, tempering, case-hardening, and annealing tools, dies, taps, punches, cutters, screws, springs; nickel, chrome, vanadium, high-speed and carbon steel; brass, copper, silver, aluminum, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y., has issued an attractive pamphlet, "The Dawn of a New Era in Lighting," which treats of the history of lighting from the tallow dip to the latest development in artificial lighting, *i. e.*, the tungsten lamp. The pamphlet describes the tungsten lamp and gives figures on its efficiency, cost of operation, and describes various applications of the lamp in interior lighting. The pamphlet is No. 3885 in the series of advertising material published by the company.

SCHUCHARDT & SCHUTTE, 90 West St., New York. Catalogue of automatic gear hobbing machines, hob grinding machines, hob milling machinery, profile milling machines and profile grinding machines. The catalogue will be found of general interest by gear makers. It contains an illustration of the Schuchardt & Schutte factory interiors, showing the erection of hobbing machines; also views of the Melville-Macalpine spiral reducing gear built for transmitting 6,000 horsepower from steam turbines to marine propellers.

BRISTOL CO., Waterbury, Conn. Bulletin No. 114, illustrating and describing Bristol's recording gages for pressure and vacuum; also Bristol's recording water level gages. The practice of recording data of pressures, vacuum, water level, etc., in power plants and other places is becoming more and more prevalent as the advantages of such records are recognized. The Bristol Co. has had twenty years' practical experience in the development and manufacture of recording instruments, and offers its experience to all interested in recording such data.

JOSEPH T. RYERSON & SON, Chicago, Ill. Ryerson Reference Book for 1910, being a complete list of the most comprehensive stock of iron, steel, machinery, and allied specialties in the world, to which are added useful tables and information for engineers, architects, contractors, structural iron workers, etc. The reference book contains 380 pages with index, and lists beams, angles, channels, T's, Z-bars, steel separators, flanges, and tank steel parts and other steel and iron specialties, boilermakers' machinery, including the Ryerson line of internal combustion machinery (see MACHINERY, July, 1909). The tables and other data will be found generally valuable by users of structural shapes, plates, etc.

CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio. Catalogue of horizontal milling machines (cone and single-pulley types), vertical milling machines, accessories, attachments, etc. The catalogue contains 160 pages filled with illustrated and descriptive matter. Some important improvements on the Cincinnati Nos. 1, 1½, 2 and 3 cone-driven machines are shown, especially in the column and feed mechanism. The column now used is similar to that used on the Cincinnati high-power machines, being a complete box form, containing the entire feed mechanism. The catalogue also illustrates the Cincinnati universal cutter and tool grinder which is a necessary accessory of milling machine equipment. Mechanics will find it of interest and value, if for no other reason than because of the detail illustrations throughout, and the directions contained in the chapter "Erection and Care of Millers." A full index adds to the value by making reference to descriptions of machines, accessories, etc., easy, and obviates the necessity of thumbing over the pages until the desired matter is found.

NILES-BEMENT-POND CO., 111 Broadway, New York. Pamphlet entitled "Grinding—Not Milling—the Way to Machine Flat Surfaces," being an illustrated description of the Pratt & Whitney vertical surface grinder and some products. It is claimed that the Pratt & Whitney surface grinder with vertical spindle will grind from twelve to twenty times faster than ordinary surface grinders. The efficiency of the machine is partly due to the cup-shaped wheel, which covers the full width of the work while it reduces it to perfect flatness. The horizontal table facilitates chucking all ordinary work, and the magnetic chuck makes the chucking of small work very simple and rapid. Illustrations of work done comprise flat-irons aluminum castings, carbon segments, cast-iron flanges, circular saws, repeating rifle hammers and ejector levers, automatic pistol frames, knife blades, hardened steel planer knives, carpenters' planes, aluminum and iron automobile manifolds, automobile steering gear housings, automobile transmission gear cases, gear blanks, automobile cam shafts, typewriter parts, lathe chuck bodies, cast iron frames, etc. The pamphlet is a fine example of typographical work and will be found very interesting by all concerned in the economical and rapid production of surface ground work, whether they be shop managers, superintendents, foremen or machinists.

TRADE NOTES

WHITE CO., Philadelphia, Pa., is putting a gasoline-motor driven truck of 1½ ton nominal capacity on the market.

CHICAGO BELTING CO., Chicago, Ill., has opened a branch store at 71 Dey St., New York, with Mr. E. T. Toogood manager.

HUTHER BROS. SAW MANUFACTURING CO., Inc., Rochester, N. Y., announces that it also manufactures sheet steel specialties.

EXPORT CORPORATION, LTD., 29 Broadway, New York, wants estimates and plans of a complete plant for refining and briquetting salt.

RAE ELECTRIC VEHICLE CO., Springfield, Vt., is a new enterprise which will be ready for business in January. It is erecting a new factory.

THE SUPERIOR TAP CO., Springfield, Vt., has been reorganized, and will move to Charlestown, N. H., where a factory is being constructed for its use.

BAILEY AUTOMOBILE CO., Springfield, Mass., is making important changes in its factory and will bring out a new two-cycle motor for its 1910 cars. New machinery will be installed.

SPITZLE MFG. CO., Utica, N. Y., was recently made the sales agent of the Fulton Machine & Vise Co., Lowville, N. Y. The company will market the entire product of the Fulton Machine & Vise Co.

STANDARD WELDING CO., Cleveland, Ohio, has recently added to its large factory a two-story building giving 50,000 square feet additional space which will be utilized by the tube welding department.

WELLS BROS. CO., Greenfield, Mass., held its annual meeting of stockholders December 1 and elected the following officers: Frank O. Wells, president and treasurer; F. E. Snow, vice-president, and Messrs. Wells, Snow, White, Blake and Pratt, directors.

AIR BRAKE MAGAZINE, Meadville, Pa., is a new journal published by the Air Brake Magazine Co., and edited by Frank H. Dukesmith. As the name indicates, the journal is devoted to the principles, construction, action and use of steam and electric railway air brakes.

Q. M. S. CO. (Quincy-Manchester-Sargent Co.), Plainfield, N. J., has moved its Western office in Chicago from 1775 Old Colony Building to 738 First National Bank Building. The company's interests in the West will hereafter be taken care of by Mr. J. C. Hoof.

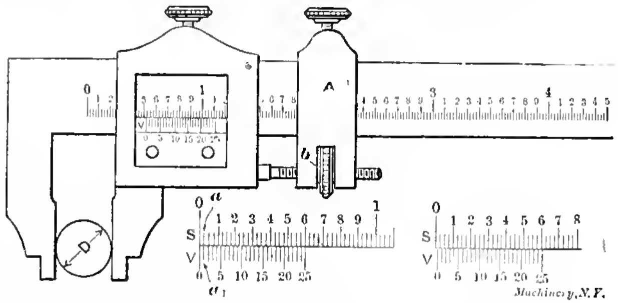
TOLEDO-MASSILLON BRIDGE CO., Toledo, Ohio, has recently added a new department to its business, having gone into the extensive manufacture of all kinds of cranes, hoists, coal and ore-handling machinery, etc. C. H. Tucker, recently of the Case Crane Co., is in charge of the new department.

Supplement to MACHINERY, February, 1910

Operations for the Article in this number entitled "Machine Shop Practice—The Vernier: Its Principle and Method of Reading"

SHOP OPERATION SHEET NO. 124

Franklin D. Jones — MACHINERY, February, 1910



Reading a Vernier

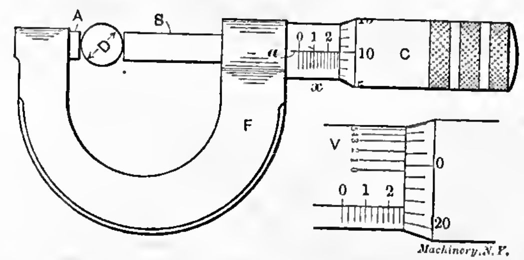
NOTE.—The vernier is an auxiliary scale that is attached to caliper squares, protractors, etc., for obtaining fractional parts of the sub-divisions of the true scale of the instrument. The above illustration shows a caliper square with a vernier scale V, reading to 0.001 inch.

1. A section of the true scale, together with the vernier scale, are shown in the enlarged detail views at S and V, respectively. On this particular instrument, the inch divisions of the regular scale are divided into tenths and each tenth into four parts, so that the finer divisions are fortieths of an inch. The vernier scale V has twenty-five divisions, and its total length is equal to twenty-four divisions on the regular scale or twenty-four fortieths of an inch. Therefore each division on the vernier equals 1/25 of 24/40 or 24/1000 inch (0.024). As 1/40 equals 25/1000 it will be seen that the vernier divisions are 1/1000 (0.001) inch shorter than those on the regular scale; so that when the zero marks of both scales coincide, the two first lines a and a_1 to the right, differ by 1/1000 inch; the next two by 2/1000, etc. Now if the zero line on the vernier is moved (as shown in the detail to the right), obviously the distance in thousandths of an inch will be indicated by the number of that line on the vernier that exactly coincides with a graduation line on the scale. In the illustration, it is the tenth line on the vernier that exactly coincides with one on the scale; therefore the distance between the two zero lines is 10/1000 (0.010) inch. If the vernier zero were moved to the right just twice this amount or 20/1000 (0.020) inch, the twentieth division would be exactly in line with one on the regular scale.

2. To measure the exact diameter D with a caliper square, adjust the sliding jaw until it is close to the work and then lock the slide A by the screw shown. With the nut b, which is used for making fine adjustments, move the jaw until it just touches the work. The distance that the vernier scale zero has moved to the right of the zero mark on the true scale (which equals diameter D) is then read directly in thousandths of an inch, by calling each tenth on the true scale that has been passed by the vernier zero, one hundred thousandths, and each fortieth twenty-five thousandths, and adding to this number as many thousandths as are indicated by the vernier. The vernier zero in the illustration is slightly beyond the five-tenths division; hence the reading is 0.500 plus the number of thousandths indicated by that line on the vernier that exactly coincides with one on the scale which, in this case, is 15, making the reading $0.500 + 0.015 = 0.515$ inch.

SHOP OPERATION SHEET NO. 125

Franklin D. Jones — MACHINERY, February, 1910



Reading a Micrometer

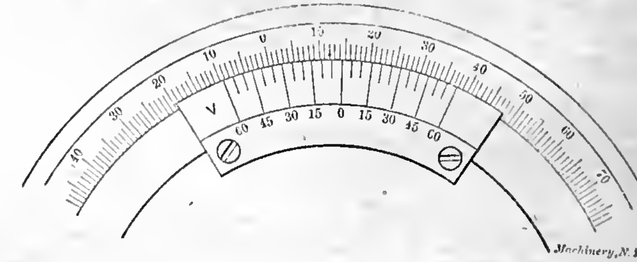
NOTE.—The micrometer caliper is used for taking very accurate measurements. The instrument consists principally of a main frame F, a measuring screw or spindle B which is threaded into a fixed nut in the frame F, and a thimble C, which turns with spindle B. The pitch of the thread on spindle B, and on practically all micrometer screws, is 1/40 of an inch, there being 40 threads on the screw for each inch of its length. Along the frame, as at x, there are graduations which are 1/40 inch apart; therefore when thimble C and spindle B are turned one complete revolution, they move in or out, a distance equal to one of the graduations or 1/40 inch, which equals 25/1000 inch. It is evident then that if instead of turning the thimble one complete revolution, it is turned say 1/25 of a revolution, that the distance between the anvil A and the end of spindle B will be increased or diminished 1/25 of 25/1000 of an inch. As the beveled edge of thimble C is graduated into twenty-five parts, measurements to within one thousandth of an inch are easily taken.

1. To measure the diameter D of a piece of work, adjust the spindle B until the work will pass between it and the anvil A, and then turn thimble C until the end of B just comes into contact with the work. Next count the number of whole divisions that are visible on the scale x of the frame, multiply this number by twenty-five (the number of thousandths of an inch that each division is equal to), and add to the product the number of that division on the thimble that coincides with the line a. The result will be the diameter expressed in thousandths of an inch. For example, the diameter indicated by the micrometer when set as shown in the illustration would be determined by multiplying the eleven divisions visible on the frame by twenty-five, and adding ten to the result, that being the graduation number on the thimble that coincides with the line a. Then D equals $11 \times 25 + 10 = 285/1000$ inch. As the numbers 1, 2, etc., on every fourth graduation, indicate hundreds of thousandths, the reading can be easily taken mentally.

2. By the addition of a vernier scale V on the frame (see enlarged detail view), measurements within one ten-thousandth part of an inch can be taken. Micrometers thus equipped are read as follows: First determine the number of thousandths, as with an ordinary micrometer. Next find a line on the vernier scale that exactly coincides with one on the thimble; the number of this line represents the number of ten-thousandths to be added to the number of thousandths obtained by the regular graduations. The reading shown in the illustration is $271/1000 + 3/10000 = 2713/10000$ inch.

SHOP OPERATION SHEET NO. 126

Franklin D. Jones — MACHINERY, February, 1910



Reading a Protractor Vernier

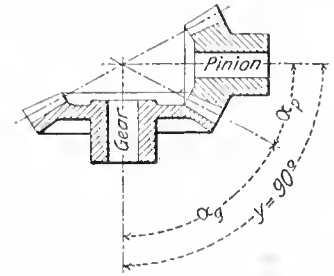
NOTE.—A protractor is an instrument that is used for the measurement of angles. The graduations on the protractors commonly used by machinists are ordinarily not finer than whole degrees, so that the instrument cannot be set to, nor measurements taken of, fractional parts of a degree with accuracy. By the addition of a vernier scale, the principle of which was explained on sheet No. 124, subdivisions of a degree are easily read.

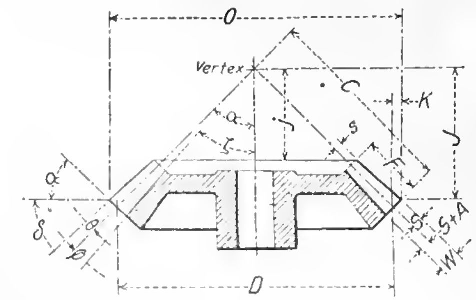
1. The vernier scale V of a Brown & Sharpe universal bevel protractor is shown in the illustration above. This particular vernier makes it possible to determine the angle to which the instrument is set within five minutes (5′) or one-twelfth of a degree. The degree, which is the unit of angular measurement—the same as the inch is a unit in linear measurement—is divided into sixty minutes, so that a division of a degree is expressed as so many minutes; thus 5½ degrees equals 5 degrees, 30 minutes (5° 30′). It will be noted that there are practically two scales of twelve divisions each, on either side of the vernier zero mark. The left-hand scale is used when the vernier zero is moved to the left of the zero of the true scale, while the right-hand scale is used when the movement is to the right. The total length of each of these vernier scales is equal to twenty-three degrees on the true scale, and as there are twelve divisions, each division equals 1/12 of 23 or 1 11/12 degree. One degree equals 60 minutes (60′), and 11/12 degree equals 11/12 of 60 or 55 minutes; hence each division on the vernier expressed in minutes equals $60' + 55' = 115$ minutes. Now as there are 120 minutes in 2 degrees, we see that each space on the vernier is 5 minutes shorter than 2 degrees; therefore, when the zero marks on the true and vernier scales are exactly in line, the first two graduations to the right or left are 5 minutes apart; the next two, 10 minutes; and the next two 15 minutes, etc. It is evident then that if the vernier zero is moved, say to the right, until the third line from it (also to the right) is exactly in line with one on the true scale, the movement will be equal to 15 minutes, as indicated by the number opposite this line on the vernier.

2. To read the protractor, first note the number of whole degrees passed by the vernier zero, and then count in the same direction the number of spaces between the vernier zero and that line which exactly coincides with one on the regular scale; this number of spaces multiplied by 5 will give the number of minutes to be added to the whole number of degrees. The reading of a protractor set as illustrated, would be 14 whole degrees plus 30 minutes (14° 30′).

I—BEVEL GEAR FORMULAS

Bevel Gears with Shafts at Right Angles.





Note: α_p = Pitch Cone Angle of Pinion
α_g = Pitch Cone Angle of Gear
N_p = Number of Teeth in Pinion, etc.

Use Rules and Formulas 1-21 in the order given.

No.	To Find	Rule	Formula
1	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the number of teeth in the pinion by the number of teeth in the gear to get the tangent	$\tan \alpha_p = \frac{N_p}{N_g}$
2	Pitch Cone Angle (or Edge Angle) of Gear	Divide the number of teeth in the gear by the number of teeth in the pinion to get the tangent	$\tan \alpha_g = \frac{N_g}{N_p}$
3	Proof of Calculations for Pitch Cone Angles	The sum of the pitch cone angles of the pinion and gear equals 90 degrees	$\alpha_p + \alpha_g = 90°$
4	Pitch Diameter	Divide the number of teeth by the diametral pitch; or multiply the number of teeth by the circular pitch and divide by 3.1416	$D = \frac{N}{P} = \frac{NP'}{\pi}$
5	Addendum	Divide 1.0 by the diametral pitch; or multiply the circular pitch by 0.318	$S = \frac{1.0}{P} = 0.318P'$
6	Dedendum	Divide 1.157 by the diametral pitch; or multiply the circular pitch by 0.368	$S+A = \frac{1.157}{P} = 0.368P'$
7	Whole Depth of Tooth Space	Divide 2.157 by the diametral pitch; or multiply the circular pitch by 0.687	$W = \frac{2.157}{P} = 0.687P'$
8	Thickness of Tooth of Pitch Line	Divide 1.571 by the diametral pitch; or divide the circular pitch by 2.	$T = \frac{1.571}{P} = \frac{P'}{2}$
9	Pitch Cone Radius	Divide the pitch diameter by twice the sine of the pitch cone angle	$C = \frac{D}{2 \times \sin \alpha}$
10	Addendum at Small End of Tooth	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the addendum	$s = S \times \frac{C-F}{C}$
11	Thickness of Tooth at Pitch Line at Small End	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the thickness of the tooth at the pitch line	$t = T \times \frac{C-F}{C}$
12	Addendum Angle	Divide the addendum by the pitch cone radius to get the tangent	$\tan \theta = \frac{S}{C}$
13	Dedendum Angle	Divide the dedendum by the pitch cone radius to get the tangent	$\tan \varphi = \frac{S+A}{C}$

These dimensions are the same for both gear and pinion (Nos. 5–13).

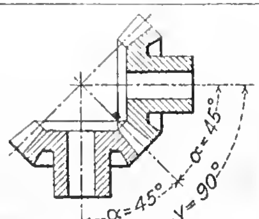
Contributed by Ralph E. Flanders

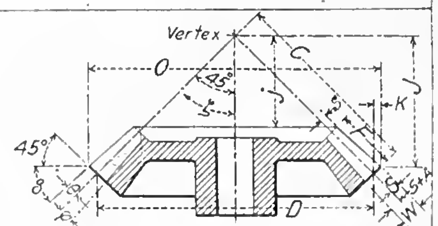
II—BEVEL GEAR FORMULAS

Bevel Gears with Shafts at Right Angles. (Continued).

No.	To Find	Rule	Formula
14	Face Angle	Subtract the sum of the pitch cone and addendum angles from 90 degrees	$\delta = 90° - (\alpha + \theta)$
15	Cutting Angle	Subtract the dedendum angle from the pitch cone angle	$\zeta = \alpha - \varphi$
16	Angular Addendum	Multiply the addendum by the cosine of the pitch cone angle	$K = S \times \cos \alpha$
17	Outside Diameter	Add twice the angular addendum to the pitch diameter	$O = D + 2K$
18	Apex Distance	Multiply one-half the outside diameter by the tangent of the face angle	$J = \frac{O}{2} \times \tan \delta$
19	Apex Distance at Small End of Tooth	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the apex distance	$j = J \times \frac{C-F}{C}$
20	Number of Teeth in Equivalent Spur Gear	Divide the number of teeth by the cosine of the pitch cone angle	$N' = \frac{N}{\cos \alpha}$
21	Proof of Calculations by Rules Nos. 9, 12, 14, 16 and 17	The outside diameter equals twice the pitch cone radius multiplied by the cosine of the face angle and divided by the cosine of the dedendum angle	$O = \frac{2C \times \cos \delta}{\cos \theta}$

Mitre Bevel Gearing.





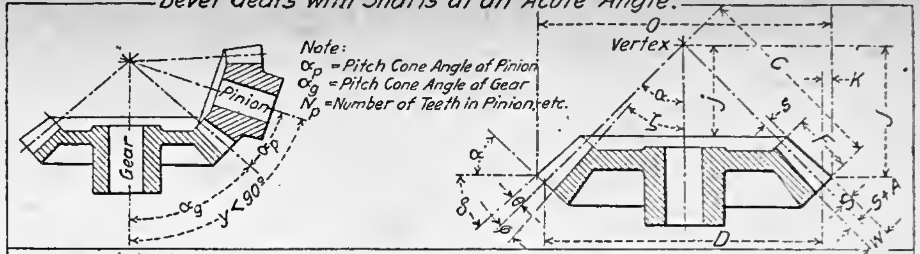
Use Rules and Formulas 22, 4-8, 23, 10-13, 24-26, 17-19, 27 and 21 in the order given. All dimensions thus obtained are the same for both gears of a pair

No.	To Find	Rule	Formula
22	Pitch Cone Angle	Pitch cone angle equals 45 degrees	$\alpha = 45°$
23	Pitch Cone Radius	Multiply the pitch diameter by 0.707	$C = 0.707D$
24	Face Angle	Subtract the addendum angle from 45°	$\delta = 45° - \theta$
25	Cutting Angle	Subtract the dedendum angle from 45 degrees	$\zeta = 45° - \varphi$
26	Angular Addendum	Multiply the addendum by 0.707	$K = 0.707S$
27	Number of Teeth in Equivalent Spur Gear	Multiply the number of teeth by 1.41	$N' = 1.41N$

Contributed by Ralph E. Flanders

III—BEVEL GEAR FORMULAS

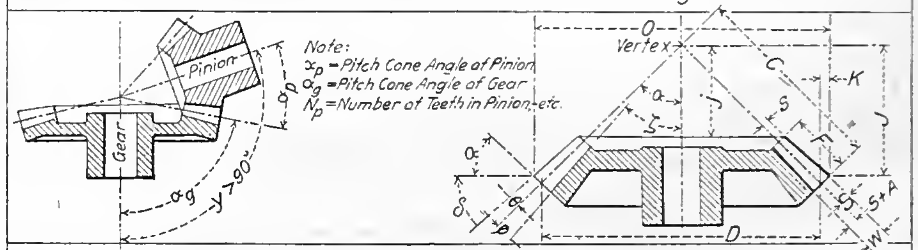
Bevel Gears with Shafts at an Acute Angle.



Use Rules and Formulas 28-30, and 4-21 in the order given.

No.	To Find	Rule	Formula
28	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the sine of the center angle by the sum of the cosine of the center angle and the quotient of number of teeth in the gear divided by the number of teeth in the pinion; this gives the tangent	$\operatorname{Tan} \alpha_p = \dfrac{\operatorname{Sin} y}{\dfrac{N_g}{N_p} + \operatorname{Cos} y}$
29	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of the center angle by the sum of the cosine of the center angle and the quotient of the number of teeth in the pinion divided by the number of teeth in the gear; this gives the tangent	$\operatorname{Tan} \alpha_g = \dfrac{\operatorname{Sin} y}{\dfrac{N_p}{N_g} + \operatorname{Cos} y}$
30	Proof of Calculations for Pitch Cone Angles	The sum of the pitch cone angles of the pinion and gear equals the center angle	$\alpha_p + \alpha_g = y$

Bevel Gears with Shafts at an Obtuse Angle.



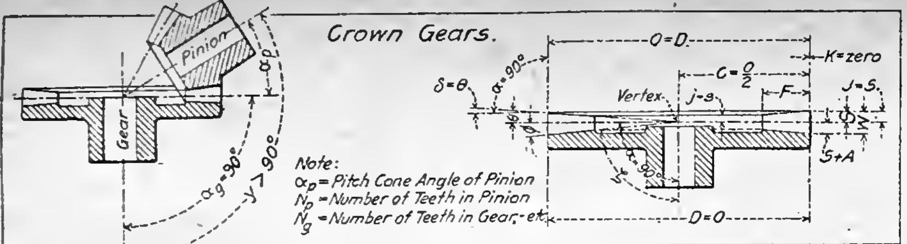
Use Rules and Formulas 31 and 32 as directed below.

No.	To Find	Rule	Formula
31	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the sine of 180 degrees minus the center angle by the difference between the quotient of the number of teeth in the gear divided by the number of teeth in the pinion and the cosine of 180 degrees minus the center angle; this gives the tangent	$\operatorname{Tan} \alpha_p = \dfrac{\operatorname{Sin}(180^\circ - y)}{\dfrac{N_g}{N_p} - \operatorname{Cos}(180^\circ - y)}$
32	Whether Gear is a Regular Bevel Gear, a Crown Gear, or an Internal Bevel Gear	Add 90 degrees to the pitch cone angle of the pinion. If the sum is greater than the center angle use rules and formulas 33, 30 and 4-21 in the order given. If the sum equals the center angle see rules and formulas for crown gear. If the sum is less than the center angle see rules and formulas for internal bevel gear.	
33	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of 180 degrees minus the center angle by the difference between the quotient of the number of teeth in the pinion divided by the number of teeth in the gear and the cosine of 180 degrees minus the center angle; this gives the tangent	$\operatorname{Tan} \alpha_g = \dfrac{\operatorname{Sin}(180^\circ - y)}{\dfrac{N_p}{N_g} - \operatorname{Cos}(180^\circ - y)}$

Contributed by Ralph E. Flanders

IV—BEVEL GEAR FORMULAS

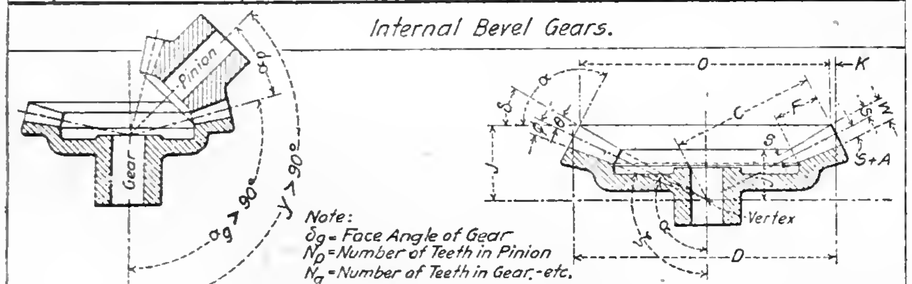
Crown Gears.



Use Rules 31 and 4-21 in the order given, for the pinion; use Rules 30, 4-8, 36, 10-13, 37, 15 and 38 in the order given for the crown gear; if dimensions for crown gear are known, to find center angle and dimensions of pinion, use rules and formulas 34, 35 and 4-21 in the order given

No.	To Find	Rule	Formula
34	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the number of teeth in the pinion by the number of teeth in the gear, to get the sine	$\operatorname{Sin} \alpha_p = \dfrac{N_p}{N_g}$
35	Center Angle	Add 90 degrees to the pitch cone angle of the pinion	$y = 90^\circ + \alpha_p$
36	Pitch Cone Radius	Divide the pitch diameter by 2	$C = \dfrac{D}{2}$
37	Face Angle of Gear	The face cone angle of the gear equals the addendum angle	$\delta_g = \theta$
38	Number of Teeth in Equivalent Spur Gear	The teeth are equivalent in form to rack teeth	N'_g = infinity

Internal Bevel Gears.



Use Rules and Formulas 31 and 4-21 inclusive for the pinion; use Rules and Formulas 39, 30, 40, 41, 15, 42, 43, 18, 19, 44 and 21 in the order given for the gear

No.	To Find	Rule	Formula
39	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of 180 degrees minus the center angle, by the difference between the cosine of 180 degrees minus the center angle and the quotient of the number of teeth in the pinion divided by the number of teeth in the gear; subtract the angle whose tangent is thus found from 180 degrees	$\operatorname{Tan} \alpha_a = \dfrac{\operatorname{Sin}(180-y)}{\operatorname{Cos}(180-y) - \dfrac{N_p}{N_g}}$ $\alpha_g = 180 - \alpha_a$
40	Pitch Cone Radius	Divide the pitch diameter by twice the sine of 180 degrees minus the pitch cone angle	$C = \dfrac{D_g}{2 \operatorname{Sin}(180-\alpha_g)}$
41	Face Angle of Gear	Subtract 90 degrees from the sum of the pitch cone angle and the addendum angle	$\delta_g = \alpha_g + \theta - 90^\circ$
42	Angular Addendum of Gear	Multiply the addendum by the cosine of 180 degrees minus the pitch cone angle	$K_g = S \times \operatorname{Cos}(180-\alpha_g)$
43	Outside (or Edge) Diameter of Gear	Subtract twice the angular addendum from the pitch diameter	$O_g = D_g - 2K_g$
44	Number of Teeth in Equivalent Internal Spur Gear	Divide the number of teeth by the cosine of 180 degrees minus the pitch cone angle	$N'_g = \dfrac{N_g}{\operatorname{Cos}(180-\alpha_g)}$

Contributed by Ralph E. Flanders

MACHINERY

February, 1910

THE MELVILLE AND MACALPINE REDUCTION GEAR FOR MARINE STEAM TURBINES

RALPH E. FLANDERS*

IT has been evident to the general public for some time past that the steam turbine has not been entirely satisfactory in its application to ship propulsion. There have been many direct evidences of this, such as the papers on the subject read before various technical societies in this country and Europe, and authoritative articles of the same character in various scientific journals. There have been even more ominous indications in the vicissitudes of actual installations. It has been very difficult, for instance, to get figures on the coal and steam consumption of the most important of the turbine-driven steamships. The figures would surely have been given out if they made even a satisfactory showing. There have, furthermore, been one or two actual failures, necessitating a return to reciprocating engines, though doubtless these failures were due to designing with insufficient knowledge or experience in this line.

The Nature of the Problem

The difficulty is that the turbine, to be efficient and compact, must have a high velocity of rotation, while the propeller, working in a dense medium and imparting a comparatively slow velocity to the ship which it propels, should work at a far less rotative speed. Up to the present time this discrepancy has been met by modifying the design of both the turbine and the propeller, running one at a slower speed and the other at a higher speed than would be indicated by a design for economy in either alone. As a result the combination has an efficiency which, while high enough to make its use commercially possible, is, nevertheless, very far below what ought to be obtained.

Among the various compromises that have been suggested are, the use of electrical transmission between a turbine-driven dynamo and a motor driving the screw; a hydraulic transmission set involving a turbine pump and motor; and the use of gearing. The problem has also in a way been attacked from another angle by using a combination of reciprocating and low-pressure turbine engines.

Of the various direct solutions of the problem proposed, but one has ever been tried on a large scale—the use of gearing to reduce the speed of an efficient turbine to that required for an efficient propeller. An experimental apparatus of this kind in a full size, high-power application has been designed by Rear Admiral Melville and his engineering associate, Mr. John H. Macalpine. This apparatus was built for them, through the good offices of Mr. George Westinghouse, at the Westinghouse Machine Co., of Pittsburg, Pa. Mr. Westinghouse invited MACHINERY to send an editorial representative to examine this reducing gearing, and investigate its design and construction.

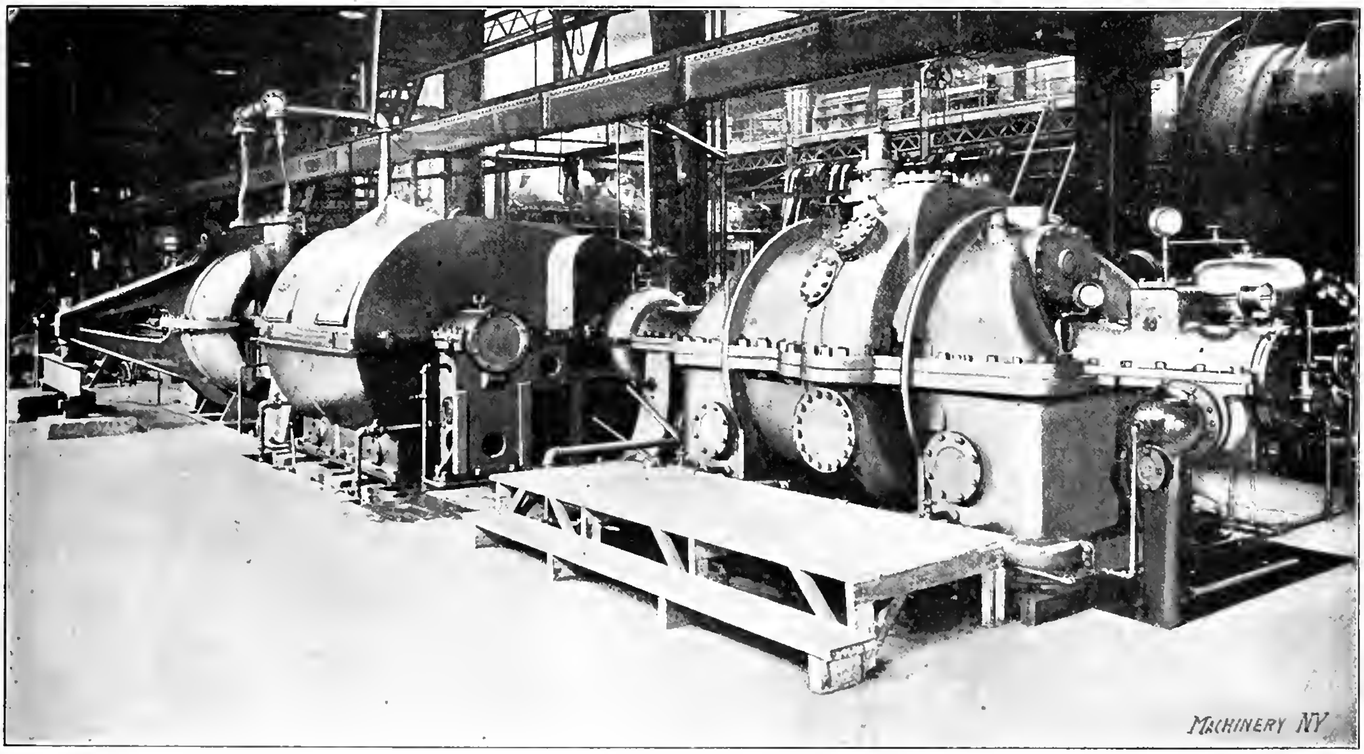


Fig. 1. 6,000-horsepower Steam Turbine, Melville-Macalpine Reducing Gearing, and Hydraulic Dynamometer, set up on Floor of Testing Department

General Description of the Gear

Mr. John H. Macalpine, one of the joint inventors of the gear, and Mr. H. T. Herr, general manager of the Westinghouse Machine Co., very courteously gave their time to explaining to the writer the principles of the construction and operation of the device. It is installed on the testing floor of the plant, as shown in Fig. 1. The steam turbine for driving the gearing in the test is shown at the right. This turbine, running at a normal speed of 1,500 revolutions per minute, is easily capable of giving 6,000 H. P. The gearing itself is mounted in the casing in the center of the line of mechanism. The third member is a water brake or dynamometer of unusually ingenious construction, which will be described later.

The construction of the gears and their supporting mechanism is clearly shown in Figs. 2, 3 and 4. A small pitch was deemed essential if a reasonable absence of noise was to be secured. This necessarily meant broad teeth, in view of the fact that the 6,000 horsepower had to be transmitted at a

* Associate Editor of MACHINERY.

pitch line velocity of nearly 100 feet per second, if the tooth pressure was to be kept within the limits desired. The gearing is of the herringbone type, as shown. The pinions have 35 teeth each, and the gears 176, a hunting tooth being introduced to equalize the wear. The pitch is 1¼ inch and the helix angle is 30 degrees. The thickness of the pinion teeth at the pitch line was made ⅛ inch greater than that of the gear, with the idea of compensating for the more rapid wear to which the pinion would be subjected. Detailed dimensions of the gear teeth are given in Fig. 6. The forgings for the gears were made of an ordinary grade of mild steel, obtained from Messrs. Krupp, and the cutting of the teeth was done by Messrs. Schuchardt and Schütte, of Chemnitz, on the Pfauter gear-hobbing machine. This machine and the hobbing process have been previously described in MACHINERY.*

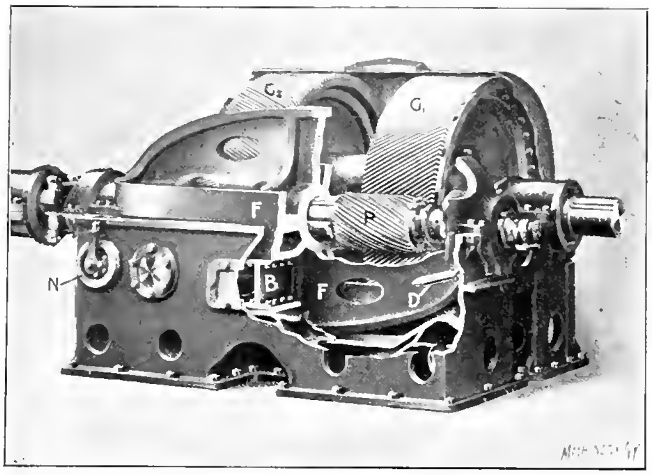


Fig. 2. Sectional View of the Reducing Gearing, showing the Floating Frame

The Floating Frame and Its Action

Two difficult problems had to be solved by the designers in the mounting and use of these gears. One problem is that of the application of a lubricant to teeth running at the high peripheral speed employed. The other problem is the maintenance of a working contact over the full length of face of gears as broad as those here used. In considering the magnitude of this last problem, the great size and power of the gears and the strain to which they are subjected should be remembered; and it should also be stated that, in the opinion of the designers, a separation of even 0.001 inch of the surfaces which should be in contact, would be considered beyond allowable limits. These difficulties have limited the use of herringbone gears in the DeLaval turbine to comparatively small powers; but by the invention of a new method of mounting, they have been here overcome.

In the first place, the sleeve on which the pinion teeth are cut is carried by three liberal bearings in the exceedingly rigid frame F, as shown in Figs. 2 and 4. In Fig. 3 the top of this frame is shown removed. The stiff frame supports the pinion so that its deflection under the load it transmits is negligible. The gear itself is stiff enough without added support, being of a hollow drum construction, somewhat different from that shown in Fig. 2.

It is not merely necessary, however, to give assurance that the pinion shall maintain its rigidity. It must further be so mounted as to accommodate itself to imperfections in its own teeth and those of the gear it runs with, if assurance is to be given that the contact and the distribution of pressure will extend over the whole face of these wide gears. This assurance is given by the mounting of frame F on a flexible support. This support is formed by two sections of an I-beam B, whose elastic web permits frame F to be rocked in a vertical plane parallel with the gear axes, under the influence of forces imposed by the tooth action. These forces will be best understood by reference to Fig. 5.

The pinion sleeve, it should be understood, is free to take its own position longitudinally within a limited range. Neglecting the very slight friction of the well-lubricated teeth, the total forces of the tooth contacts, as indicated by $B\,E$ and $B'\,E'$ in Fig. 5, will be nearly at right angles to the teeth at B and B'—that is to say, they will be at 30 degrees to the vertical; hence the two parallelograms of forces will be similar. Now the horizontal forces at $B\,D$ and $B'\,D'$ are the only axial forces acting on the pinion, owing to the method of driving, which will be explained later. If these forces are not equal, the pinion will at once shift longitudinally, which it is free to do until they are equal. The two parallelograms of forces then become equal to one another in every respect and the vertical force $B\,F$ is equal to the vertical force $B'\,F'$. But besides this longitudinal movement of the pinion, the frame in which it is mounted is free to rotate about the center point O by the flexing of the web of I-beam B (see Fig. 4); hence it follows that the moment of the vertical force $B\,F$ about O must be equal to that of $B'\,F'$ about the same point; as $B\,F$ equals $B'\,F'$, the arms of these levers $O\,B$ and $O\,B'$ must be equal. Thus it is claimed that not only will the total forces on the teeth of P_1 and P_2 be equal, but that the distribution will be made similar by the rocking of the floating frame and the longitudinal self-adjustment of the pinion sleeve, so that the centers of pressure B and B' will be similarly placed.

This equal distribution of the pressure, it will be seen, besides requiring the rocking of the frame, requires absolute freedom in the slight endwise movement of the pinion sleeve. This is secured by an ingenious driving device and universal coupling shown at the farther end of the pinion shaft at the left of Fig. 3, and indicated diagrammatically in Fig. 5. The coupling consists of two flanges C_1 and C_2 mounted on the turbine shaft T and the pinion shaft S. These two couplings are connected together by two transverse links $L_1\,L_2$ and by a center pintle, care being taken not to make this restraint redundant. The shaft T can, therefore, only rotate the shaft S through links L_1 and L_2, and no longitudinal force can be transmitted through these. Even when shaft S is moved longitudinally a considerable distance from its central position, the longitudinal forces are so small as to be negligible. The pinion, therefore, has perfect freedom of axial movement in its bearings. To permit the free rocking movement of the frame, the pinion is driven by shaft S, which passes completely through it to the end distant from the coupling, where it is keyed and bolted. This shaft has clearance in the central hole of the pinion sleeve, and is so flexible that it imposes practically no constraint on the pinion and floating frame.

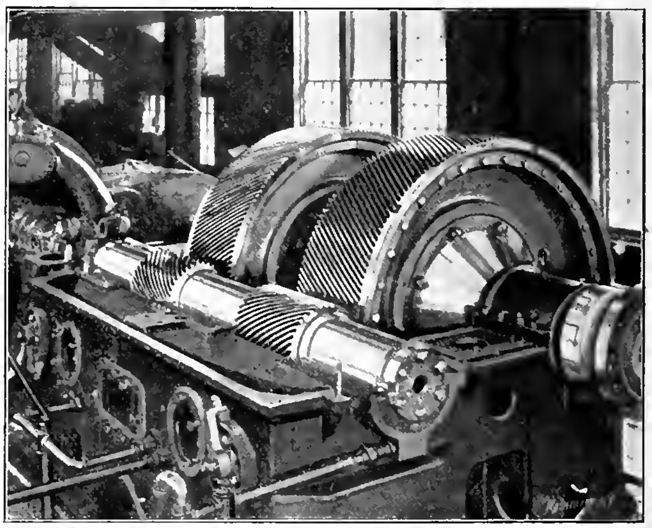


Fig. 3. The Gearing with the Cover and the Top Half of the Floating Frame Removed

Elaborate calculations were made by the designers to find out how much the teeth would come out of contact with each other in varying from normal alignment in the way permitted by the floating frame and its connections. The rigidity of the floating frame, it has been found, is so great, that under full load the end bearings will be lowered relatively to the center by not more than 0.0005 inch.

The effect of the floating frame, as has been described, is

* See article entitled "Gear Cutting Machinery" in MACHINERY, Engineering Edition, May, 1908.

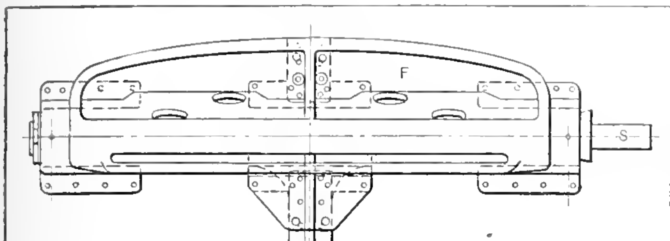
to prevent any opening of contact from errors in alignment in a vertical plane. Without this frame, such errors would be serious. The opening of contact due to a warping of the I-beam supports, and a consequent lack of parallelism in the horizontal plane, has also been investigated; it was found to be negligible for the involute form of tooth, but not so favorable for the cycloidal. The latter also has the disadvantage as compared with the involute that it will not run properly except at the exact center distance, so its use was not considered for this work. The involute form, on careful investigation, showed a number of other advantages which space forbids taking up here.

It was found that the warping of the I-beam supports of the floating frame, while it did not affect seriously the contact of the teeth, was nevertheless unstable. That is to say, there is no tendency to return to a normal position. It was therefore necessary to confine the movement of the frame in this direction. For this purpose struts D and D' are provided (see Figs. 2 and 4) which leave the frame free to rock, but hold it against horizontal movement. They bear in seats of the frame in one end and on the points of screws at the other, which are adjusted and locked by the mechanism shown at N in Fig. 2. This arrangement greatly facilitates the true setting up of the floating frame without interfering to the slightest degree with the freedom of movement in the vertical plane.

Oiling the Teeth and Bearings

It was mentioned that the oiling provisions had something to do with the success of the apparatus. Oil is supplied to the bearings under a pressure of about 10 pounds, and runs through them with a constant flow under conditions common to such machinery. Special provisions had to be made, however, to get the oil into the working surfaces of the teeth, where it must be used to reduce the friction or lost work to a minimum, and to give assurance of long life to these working surfaces. Owing to the high peripheral velocity (6,000 feet per minute) oil simply sprayed on the teeth would be immediately thrown off by centrifugal force.

The plan devised for employing the oil effectively consisted in providing a supply pipe with a series of jets directing the lubricant under a considerable head right at the point where the teeth of the pinion are rolling into mesh with the gear teeth. Even when thrown off of the pinion, under these conditions it is thrown back onto the gear, and *vice versa*; there is absolutely no escape for the oil except by running through the meshing teeth and out on the further side. This oil pipe has, of course, to be held securely, as it is in a position where it would wreck the gearing if it got loose. An examination of the precautions taken for holding it, however, gives the observer perfect confidence on this score. Piping is provided both above and below the gearing to permit the latter to be reversed, as is necessary for marine work. In connection with the amount of opening possible for the teeth, it should also be remembered that the presence of oil in the bearings and on the gear teeth tends to lessen this factor below the calculated amount.



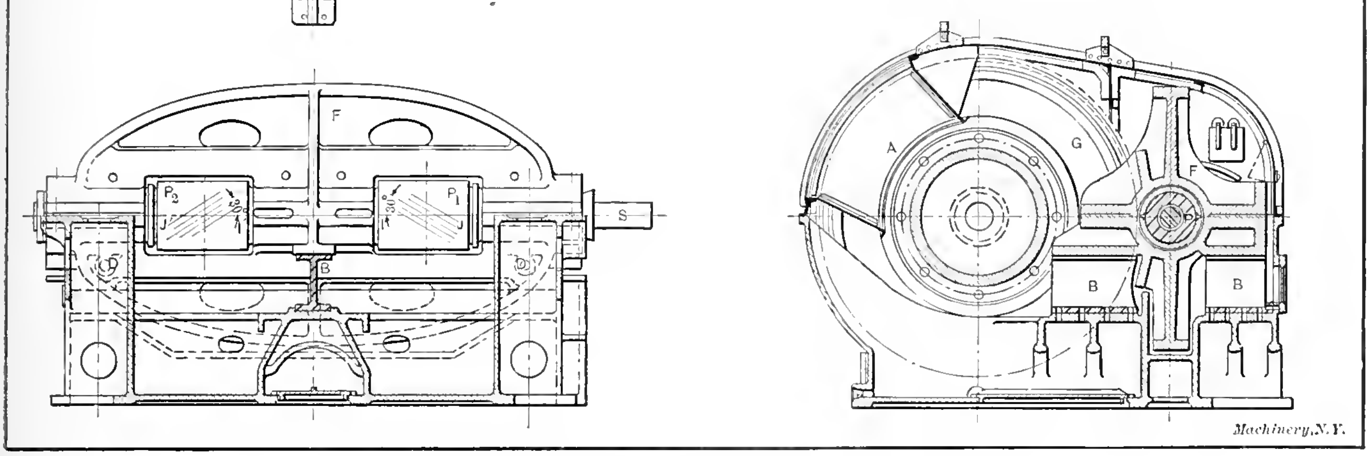


Fig. 4. Details of the Construction of the Gear, showing the Floating Frame, etc.

While it has not been possible to do more than touch lightly on the immense amount of calculation and investigation undertaken by the designers of this mechanism, the writer has said sufficient, he is sure, to show that the highest degree of technical skill has been brought to bear on the subject, and that the proposition is one of engineering pure and simple, there being no evidence of "cut-and-try" or guesswork methods in the design. It may be said in this connection that the gearing has been carefully calculated to have a large margin of strength over the shafting, which transmits the power to it from the turbine and connects it with the propeller. It is, therefore, confidently believed to be the strongest link in the chain between the turbine and the propeller; and the latter, or the shaft which drives it, will be the first to fail in the event of dangerous racing, the striking of wreckage, or other similar accident.

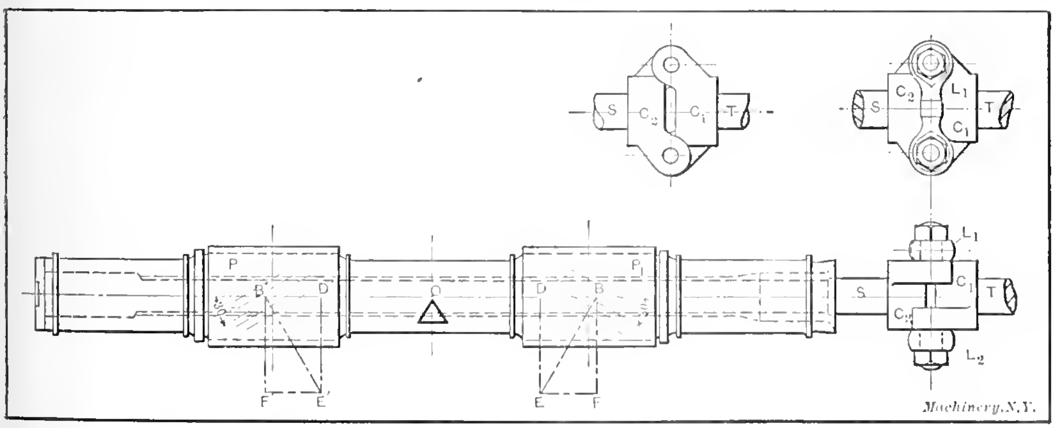


Fig. 5. Action of the Forces on the Gear Teeth in Distributing the Pressure over the Full Width of the Face

Testing the Effect of the Floating Frame

The two points in testing the apparatus were, of course, to determine, first, the character of the bearing obtained; and second, the efficiency of the mechanism. To be sure that the gears have the carrying capacity desired, it must be made certain that the floating frame and other precautions taken

distribute the bearing over the whole length of the teeth. The efficiency was important first from the standpoint of power consumption, and second from the standpoint of durability. The amount of power wasted in a mechanism bears naturally a close relation to its length of life. If it consumes a large amount of power in friction, it may be assumed that it will eat itself away in a short space of time.

Before starting up the machine under power, the teeth of the pinion were red leaded, and it was turned by hand until the large gear had revolved once. At this time the top part

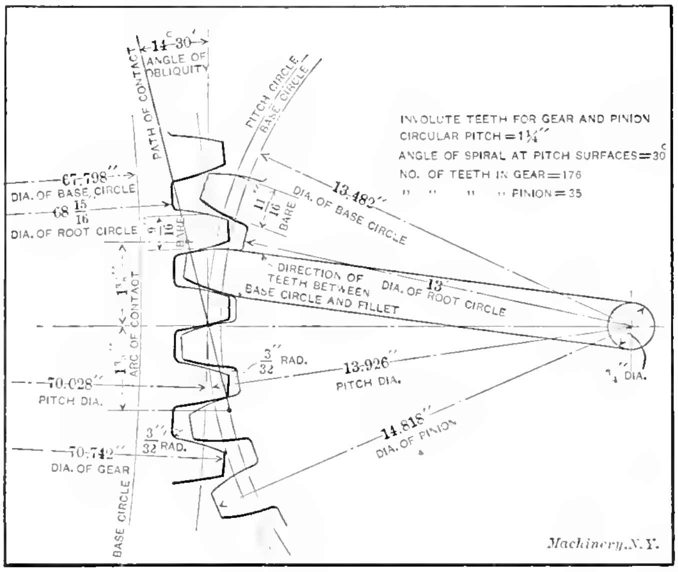


Fig. 6. View of Gear Teeth on Plane at Right Angles to their Axes, showing Dimensions for both Gear and Pinion

of the floating frame was not in place, so that both pinion and gear were fully exposed. It was found that the teeth bore a little hard from one to two inches at both ends of both the right- and left-hand spirals of both the pinion and the gear, and hardly at all in between these points. This was doubtless due to the slight spring in the hob in getting down in to the work and in leaving the cut.

The gear was then run by the turbine at three or four hundred revolutions per minute and with practically no load, without putting the top part of the frame in place. This, of

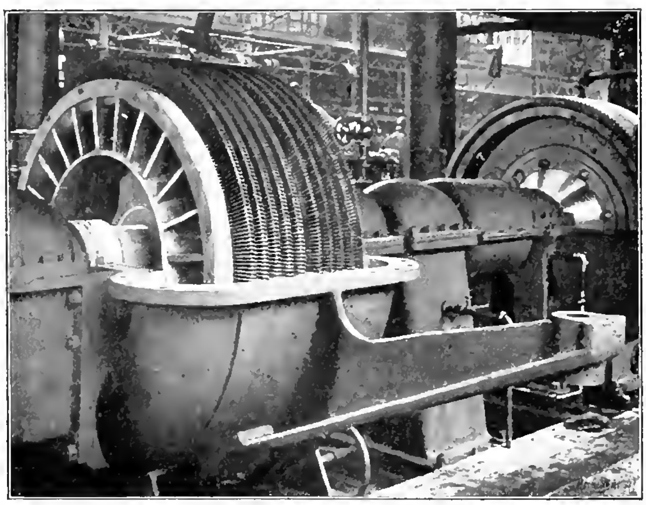


Fig. 7. The 6,000-horsepower Hydraulic Absorption Brake with Upper Half of the Casing Removed

course, brightened the hard bearings at the end of the teeth. These were scraped and then the erection of the gear was completed. After running a second time under light load the bearings came up in spots along the whole length. After a second scraping a load of 6,700 horsepower at 1,500 revolutions per minute was put on. From this time on the markings came up very satisfactorily. It is not probable that these marks are marks of real wear. They are more likely the effect of the application of pressure to the loosened surface left by the cutting and scraping tools.

The accurancy demanded in the cutting, and further refined by the simple scraping operations just described, was of a far higher degree than that met with in any other job of gear cutting within the writer's knowledge. First, the width of face in proportion to the pitch is very great (the total width of face being forty inches); and, second, the stiffness and rigidity of the gears and their mountings are such as to show plainly any inaccuracy of a kind that could not be compensated for by the floating frame.

The Hydraulic Brake

For the efficiency tests, to find a form of brake or dynamometer that would continuously absorb the 6,000 horsepower which it was desired to transmit through this gearing, was no easy matter. When it is considered that the heat generated per hour by the absorption of one horsepower is 2,545 British thermal units, and that for 6,000 horsepower it would be the equivalent of the combustion of 1,200 pounds of coal per hour, the magnitude of the problem is easily comprehended.

An ordinary Prony friction brake would certainly be out of the question. The use of a generator and water rheostat offered other difficulties, particularly in the matter of obtaining the degree of accuracy desired. It was, therefore, determined to build a modification of a hydraulic brake which had been in use in the plant of the Westinghouse Machine Company for many years for the testing of all steam turbines manufactured by it. This brake had to be redesigned for much lower speeds than the origiual construction, and consequently was of greatly increased size. It is shown set up on the testing floor at the extreme left in Fig. 1, while details of its construction are illustrated in Figs. 7 to 10 inclusive.

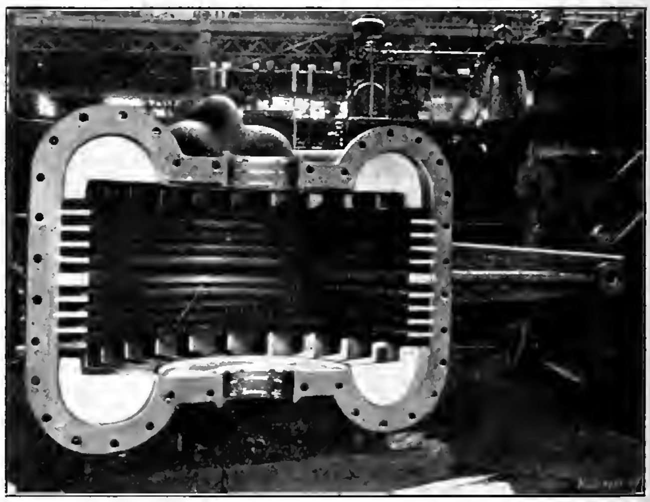


Fig. 8. Interior View of Upper Half of Casing, showing Blades

The dynamometer consists, briefly, of a rotor connected to the source of power and provided with regular turbine blades; a casing containing baffling blades ranged in alternate rows with the turbine blades of the rotor; provision for keeping the casing supplied with a greater or less amount of water which, by the action of the blades, furnishes the resistance; and a mounting for the casing so that it is pivoted about the axis of the rotor, and is restrained from revolving only by a weighing arm extending from the side, which bears on a lever connected to the scale.

Figs. 7 and 8 show the blading very well. This is mounted in the casing and the rotor in the same way as for regular turbine work. Fig. 9 shows the arrangement. The curved blades revolve, while the straight, cross-hatched ones are stationary. Water entering at *A* moves axially to the right and left, where it is picked up by the curved blades and started to whirling. As it passes through these it is dashed against the stationary blades and constrained to stop its peripheral movement, being forced again axially to the next row of revolving blades, which, in turn, start it to whirling again—and so on. This alternate picking up of the water by the rotor and checking of it by the stationary blades furnishes the resistance to the movement.

The path of the water after it leaves the blades is more plainly seen in Fig. 10. It passes through the curved side passages *F* in the direction shown, guided by baffle plates.

Here it is again thrown to the interior of the rotor, where it returns to the center opening, marked *A* in Fig. 9. The water is thus passed through the blades over and over again.

The amount of resistance which this dynamometer offers at a given speed is dependent on the amount of water in the casing, so that the load is increased by letting in more water. This is done through passages *C* and *C'*. The immense amount of heat generated may be allowed to pass off in the form of steam through openings *D* and *D'*. Instead of allowing the power to be dissipated entirely in steam, however, it is more practicable to keep a constant flow of water through the brake. The cool water comes in at *C* and *C'*, and goes out heated at *E* and *E'*. By proper manipulation of the valves the amount

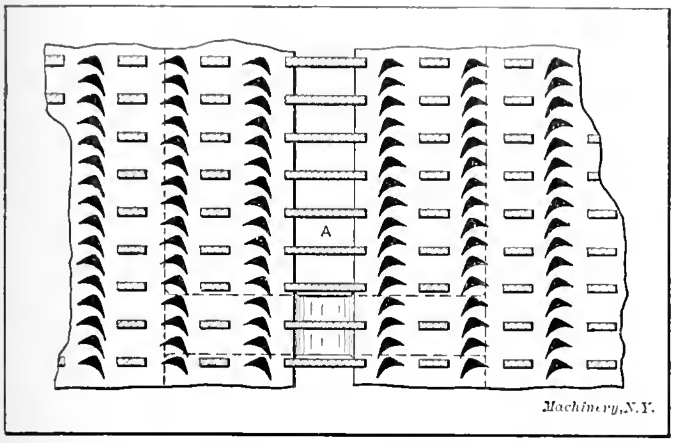


Fig. 9. Arrangement of Rotating and Stationary Bladee whose Action on the Contained Water furnishes the Reeistance

of water, and the consequent amount of power absorbed, can be very delicately regulated. In Fig. 1 the inlet openings are shown connected to the supply pipe by flexible hose.

Measuring the Power Furnished to the Gearing

The apparatus just described satisfactorily solved the problem of measuring the power delivered by the gearing, which, with the power furnished to the gearing, had to be known in order to ascertain the efficiency. At the beginning of these tests it was found that the ordinary means of measuring the power input, owing to the very high efficiency of the gearing, sometimes gave resulting efficiencies of over 100 per cent. Evidently then, most refined means must be taken for this work.

While the indicator method of calculating power cannot be used on the turbine, it is possible to calibrate any particular machine of this type so that its power is accurately obtained by using the absolute inlet pressure of commercially dry steam as a measure. To do this it was only necessary to keep the speed and the exhaust pressure constant. By substituting for the reduction gearing a dynamometer, connected directly to the turbine shaft, it was then possible to lay out a diagram in which the horsepower output was given for various inlet pressures. This line was practically straight, so that values interpolated between points obtained by actual observation are quite dependable. Tests of the apparatus made with this method of calculating the horsepower input gave efficiencies ranging from 98.5 to 99 per cent with the horsepower varying from 3,771 to 6,057.

The results obtained were so surprisingly good that it was thought advisable to check the tests by using some other method of determining the amount of power lost. For this the simple and very satisfactory method was followed of determining the amount of heat carried away by the lubricating oil coming from the bearings and the teeth of the gears. Practically all the transmission loss in the gear would appear as heat in the oil. In one of the tests checked by this method, when the brake horsepower read 5,088, it was concluded that 64.17 horsepower was accounted for by the heat of the oil, with a resulting efficiency of 98.75 per cent, which agreed with the results obtained in the previous tests. This figure is probably a little too high, as there is an indeterminate small quantity of heat radiated from the gear casing and the oil piping that has not been accounted for. Even if this were 20 per cent of that accounted for, which is not probable, the efficiency indicated would still be 98.5 per cent.

A Forty-hour Test

Besides many shorter trials an extended forty-hour endurance test was given the apparatus. This began at 3:15 P. M., Saturday, October 16, 1909, and continued until 7:15 A. M. on the following Monday morning. This test was witnessed by officials especially delegated for the purpose from the Bureau of Steam Engineering of the United States Navy. During this trial an average load of 6,048 horsepower was carried at a speed for the gear of 300.6 revolutions per minute. There was nothing in the operation of the gear to indicate that this load might not be carried indefinitely.

It will be readily understood that a constant draft of 6,000 to 7,000 horsepower on the boiler plant could not be long maintained without interfering with the regular operations of the company. As a consequence, the duration of the test was necessarily limited to the period between noon on Saturday and the early morning of the following Monday. A continuous test of five or six days, representing the time of an average transatlantic voyage, would doubtless be of more popular interest, but it would be of no more real scientific value. When the parts of the apparatus have once attained a maximum temperature, which remains constant for a reasonable period, and providing that temperature is within the limits generally recognized as conservative, a condition has been established which is capable of being maintained indefinitely. In the present instance the trial continued over thirty-four hours after the temperature conditions had become constant.

Personal Observations

It is, perhaps, as a job of gear cutting that this apparatus will be most interesting to the readers of MACHINERY. For that reason it may not be inappropriate to record some of the personal observations of the writer on the running of the gears. Exceptional opportunities were furnished for observation, as Mr. Herr kindly arranged for the running of the apparatus under a load of 3,000 horsepower which was the

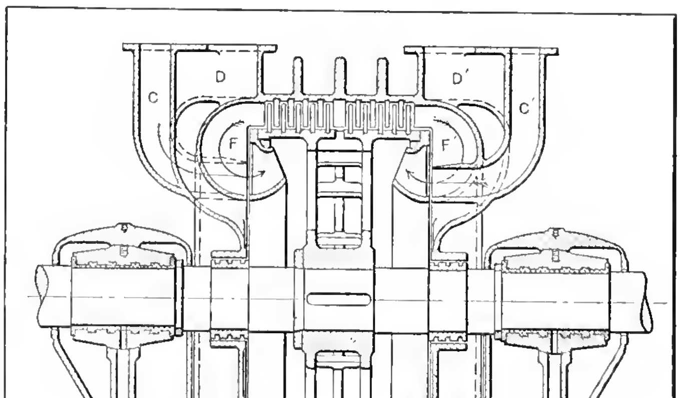


Fig. 10. Section through Hydraulic Brake, showing the Various Water and Steam Passages

full boiler capacity available for testing work without shutting down the machine shop.

Transmitting this 3,000 horsepower and reducing the speed from 1,500 to 300 revolutions per minute, the gearing ran in a way to inspire a high degree of confidence. What noise there was was not objectionable, and some of it was doubtless accounted for by air waves set up by the revolving teeth. There was little or no trace of sounds synchronous with the revolutions of the large gear. The metallic sounds emanating from the casing were of a resonant character, with no indication of grinding or rubbing. This was true even when the sound was transmitted by a pencil resting on the machine

frame and pressed against the lobe of the ear, or by a knife held between the teeth and resting on the frame.

The wide and satisfactory bearing across the whole working surface of the teeth, mentioned in an earlier paragraph, was plainly seen. The action of the floating frame could also be easily observed, owing to the fact that a little inaccuracy had been committed somewhere, perhaps in the mounting of the gears, which caused the pinion and frame to vibrate vertically at each revolution of the large gear. The full bearing just described was maintained by the floating frame under these conditions. The writer was unable to detect with assurance any sound or vibration synchronous with the rate of revolution of the large gear and the rocking of the floating frame, so that the action appeared to be as easy and regular as if conditions had been perfect. In setting up the apparatus the shafts of the two gears were set some 0.020 inch nearer together at one end than at the other, so that this inaccuracy also was taken care of without any harmful effects.

The writer noted scraper marks along the pitch lines of the pinion. On inquiry it was learned that scraping was done to relieve the bearing at the pitch line, where there is no rubbing and consequently little wear. Doing this, it was thought, would tend to make the gears wear more evenly over the whole area. The further away from the pitch line we get in an involute gear tooth the more rapid is the wear. Diagrams showing this have previously been published in MACHINERY.* It has been proposed that this scraping be done occasionally on the pinions while they are in service.

It appears that there is but one probable source of inaccuracy which the floating frame will not take care of. This is inaccuracy in the helix angle. The included angle between the teeth of the gears must be the same as the included angle between the teeth of the pinion. To insure this, so far as the original construction is concerned, it is only necessary to have the gearing ratios in the hobbing machine when cutting the gear and pinion in exactly the same proportion as the ratios between the numbers of teeth in the gear and pinion. It will not do to obtain approximate helix angles. Inaccurate mounting of the large gears might tilt them so that the helix angle would be variable about the circumference. Running with red lead, as described, is a safe test of accuracy in this respect.

At first the writer was inclined to criticise the use of as steep a helix angle as 30 degrees. So far as running smoothly is concerned, the full requirements appear to be met when the gears are given merely enough slant so as to gain a tooth or slightly more in the width of the face of the gear. A very much less angle than 30 degrees would be sufficient under the conditions of lubrication provided for securing the desired sensitiveness to the end movement with varying pressure. There is one other consideration which enters here, however, which inclines one to believe that the larger angle is the better. As explained, the natural tendency of the gears is to wear out of shape and bear only at the pitch line. This would result in a series of point bearings. Now, with a 30-degree angle, such as is shown in Fig. 5, there would be bearing wherever each of the tooth faces, as shown by the diagonal lines, crosses the center line of the engraving. If the angle were smaller there would be fewer points of contact, and if there were a gain of only one tooth in the width of face the tendency would be to wear down to a single point bearing at a time on a single tooth. This, however, would be a tendency only, and would never actually occur, but it is proper to avoid that tendency by increasing the pressure angle. The only disadvantage of a large pressure angle lies in the fact that it makes it more difficult to get a good job of gear hobbing; but as a good job was obtained with the 30-degree angle there was no chance for criticism here.

In the operation of this device it is evident that the temperature of the oil will play an important part in giving warning of possible trouble, in the same way that it determined the efficiency of the apparatus. So long as the oil runs cool, within certain temperatures determined by experiment and experience, so long may the engineer rest assured that the apparatus is working efficiently and without rapid deterioration. The heating of the oil will give him notice to look for trouble. As for errors from accidents, as already explained, the gear teeth are the strongest link in the chain between the turbine and the propeller, so that trouble will be expected elsewhere first.

In regard to the matter of oil temperature it may be stated that in the forty-hour test previously described, absorbing 6,000 horsepower, the average running conditions gave a temperature rise of about 30 degrees Fahrenheit with a flow of about 591 pounds of oil per minute. These temperatures are so low and the consequent efficiency so high that the designers feel confident that the normal capacity of the gear may safely be set much higher than 6,000 horsepower—perhaps as high as 10,000 horsepower.

It will be noted that a rather low grade of material was used. This allows room for a considerable increase in strength and durability without change of proportions. It is possible also to nearly equalize the life of the pinion and the gear by making the former of a considerably higher grade of material. It would be advisable, however, to permit the pinion to wear out the faster, as it is more easily and cheaply renewed than the gear. In view of the high efficiency and consequent small wear of the teeth it would not seem to be necessary to make the pinion teeth thicker than the gear teeth as they are shown in Fig. 6, so the expense of making two hobs for this work can be saved.

Expected Results in Practice

It may, perhaps, be interesting to note some of the advantages that will follow a successful application of this device to marine propulsion. In the case of the *Mauretania* or the *Lusitania*, for instance, it is probable that the steam consumption is at least 14.5 pounds per shaft horsepower per hour, while turbines of similar capacity running at normal speeds, operating with the reducing gear, should not exceed 11 pounds per shaft horsepower per hour. This means that the boiler capacity (taking into account also the improved efficiency of a low speed propeller) could be reduced from 70,000 shaft horsepower to about 45,000 horsepower, making a reduction of over 35 per cent in the coal consumption. Reckoning on unofficial figures, this would make a saving in coal of $5,300 per voyage, with a corresponding decrease in the cost of wages and maintenance. An increased cargo capacity would also result, not only from the reduction of over 1,600 tons in coal, but also in the great reduction in weight of machinery and the space necessary to accommodate it.

Still further advantages are claimed for war vessels, particularly in the matter of economy at the regular cruising speeds. With the smaller dimensions also of the high-speed turbines thus made possible the engineer will be able to start them cold instead of having to pass through the long and (in war time) dangerous warming-up process that now appears to be necessary. Further improvements contemplated for these turbines will entirely obviate any danger in quick starting. The inquiries sent in and the tentative plans under way for both naval and merchant vessel installations for this reducing gear indicate the interest that is felt in it by naval engineers.

Too much cannot be said for the firmness of Messrs. Melville and Macalpine and the courage of Mr. Westinghouse, in determining to make the trial of this construction on a full size model. Anything less than this would have been unsatisfactory. The questionable point was the ability of the apparatus to transmit high powers at high velocities with high efficiency, and this question could only be settled by actually transmitting high powers at high velocities with high efficiency. As an example of engineering and invention this reducing gearing is admirable; as a piece of gear cutting, it is remarkable. Its practical application will be awaited with great interest, and with great confidence as well, on the part of those who have had an opportunity to investigate it.

* * *

One of the most essential details of the aeroplane flying machine is a light-weight motor, which combines reliability and high power with small weight. It is stated by an English journal that Sir Hiram Maxim has designed an all-steel motor of 87 H. P. which weighs only 210 pounds.

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* See page 364 of the January, 1909, number of MACHINERY, Engineering Edition.

HEATING AND VENTILATING OFFICES IN SHOPS AND FACTORIES*

CHARLES L. HUBBARD†

The writer's articles in past issues of MACHINERY on shop heating and ventilation have been confined to the machine and erecting rooms, without any special mention of the conditions to be met with in the proper ventilation of the offices and drafting-rooms. As a matter of fact, the requirements are more exacting here than in the shop proper where the cubic space is usually large compared with the number of occupants, and where, under average conditions, the workmen are more actively engaged than those employed in office work. If clear and alert minds are required anywhere about a manufacturing establishment, it is in the offices and drafting-rooms, and such a condition can be brought about only by providing the rooms with an abundance of pure, fresh air at the proper temperature and without drafts.

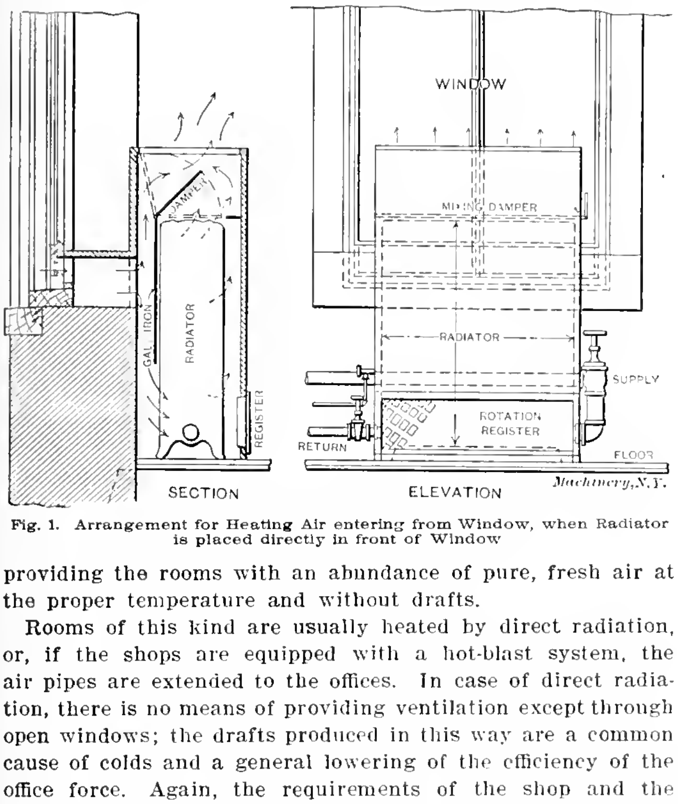

Fig. 1. Arrangement for Heating Air entering from Window, when Radiator is placed directly in front of Window

Rooms of this kind are usually heated by direct radiation, or, if the shops are equipped with a hot-blast system, the air pipes are extended to the offices. In case of direct radiation, there is no means of providing ventilation except through open windows; the drafts produced in this way are a common cause of colds and a general lowering of the efficiency of the office force. Again, the requirements of the shop and the office are not the same, and a hot-blast system which gives satisfactory results in the former may be far from suitable for office ventilation. When the air is rotated within the building it is hardly suitable for the offices on account of odors which it may contain and also because its purity is hardly up to the standard required for this purpose. Again, if the entire air supply for the hot-blast apparatus is taken from out-of-doors, and is therefore of the required purity, the temperature requirements may not be the same for the office as for the shop, and the chances are that the former will become overheated unless the registers or dampers are partly closed which, of course, results in a corresponding reduction in the air supply.

Simple Means for Heating and Ventilating Without Using a Fan

It is the object of this article to point out several different ways, more or less efficient according to their cost, by means of which the ventilation of the offices may be improved. Let us first take the case of an office heated by direct radiators and where the finish of the room is such that the matter of appearance is not of great importance. The arrangements shown in Figs. 1, 2, 3, and 4 can be made without great expense by the shop carpenter, with a little assistance from a galvanized iron worker. The idea in each of these cases is to bring fresh air in through the window by raising the lower sash slightly, and to pass the air over and between the sections of the radiator before delivering it into the room. Arrangements of this kind cannot be depended upon to always deliver a fixed quantity of air like a fan, because the amount will vary somewhat with the strength and direction of the wind and also with the outside temperature, but fair results may be obtained in this way at a very reasonable cost.

The objection is sometimes raised that the radiator being proportioned for direct work only, cannot be depended upon to warm outside air for ventilation also. In a considerable number of cases coming to the attention of the writer, no trouble has ever been experienced from this cause. Direct radiators are commonly proportioned for zero weather and therefore, much of the time, are larger than are necessary, and also, as the air passes over them at a higher velocity and lower temperature, their efficiency is much increased. In extreme weather the amount of fresh air can be reduced temporarily, or the window can be closed entirely and the air rotated over the radiator by openings provided for that purpose.

Fig. 1 shows the method of enclosing a radiator which stands directly in front of a window and projects above the sill. The casing is made of ⅞-inch sheathing with galvanized iron damper and inner casings as shown. When the mixing damper is thrown to its extreme upper position, as shown by dotted lines, all of the entering air passes downward back of the radiator, and then upward between the sections, where it becomes heated and is discharged into the room through the open top of the casing. When it is desired to reduce the temperature of the room, the mixing damper can be thrown to the right, thus admitting a mixture of hot and cold air without reducing to any great extent the volume of air supplied. By closing down the damper on top of the radiator, practically all heat will be shut off. A register placed in the front of the casing, near the bottom, serves to take air from the room when it is desired to use the radiator for heating only, as at night time.

Fig. 3 shows a plan, elevation and section of the casing and damper when the radiator stands at the side of a window instead of in front, as in Fig. 1. In this instance the whole casing is made of galvanized iron, although wood may be used if desired. The general principle is the same here as in Fig. 1, the only difference being its adaptation to another position of the radiator. The register for the rotation of air in this case is replaced by a door in the front of the casing, which may be opened at night or when ventilation is not required.

In Fig. 2 the radiator occupies a position across the end of the room at right angles to the window. Here the arrangement of casing and damper is somewhat different from those already described. In this case the air is delivered into the room through a register face or grille at the end of the boxing, instead of at the top, as before. This arrangement is only adapted to pipe radiators or a deep sectional radiator of very open pattern, as the air passes through it lengthwise instead of upward between the sections. The mixing damper here extends across the end of the radiator and deflects the entering air either through the radiator or over it, according to the temperature desired. The radiator is enclosed in a galvanized iron casing open at each end, while the passages for the cold air are of wooden sheathing, as shown. Air is admitted for rotation through a door or register in the wooden boxing.

Sometimes, in buildings of mill construction with heavy brick walls, the radiators are set in recesses in front of the windows. A very satisfactory way of encasing them and admitting fresh air is shown in Fig. 4. With this arrangement no extra space is required, as the front of the casing is in line with the inner face of the wall and does not project into the room. A thorough mixture of the warm and cold air currents is obtained by carrying up a shield above the mixing damper, as shown, and delivering the air near the sash.

Using Fans for Impelling the Air for Heating and Ventilation

Having taken up some of the simpler methods of improving the ventilation in offices and drafting-rooms, let us now consider various ways in which the air supply may be made more reliable under all conditions. The only practical way of doing this is by the use of a fan, and to get the most satisfac-

* For additional information on heating and ventilation, see "Sizes of Pipe Mains for Hot Water Heating," and articles there referred to, in the September, 1909, issue of MACHINERY; also Reference Series No. 39, "Fans, Ventilation and Heating."

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tory results it is best to provide a separate apparatus for these rooms, unless special means are used for regulating the temperature of the air supplied when the regular shop system is made use of. There are two ways of ventilating by means of a fan; one is to exhaust the vitiated air and depend upon inward leakage around doors and windows for a fresh supply, and the other is to force in fresh air and allow the foul air to find its way out either by leakage or through specially provided flues or transoms. Both supply and vent fans are made use of in special cases, but this is not usually necessary under

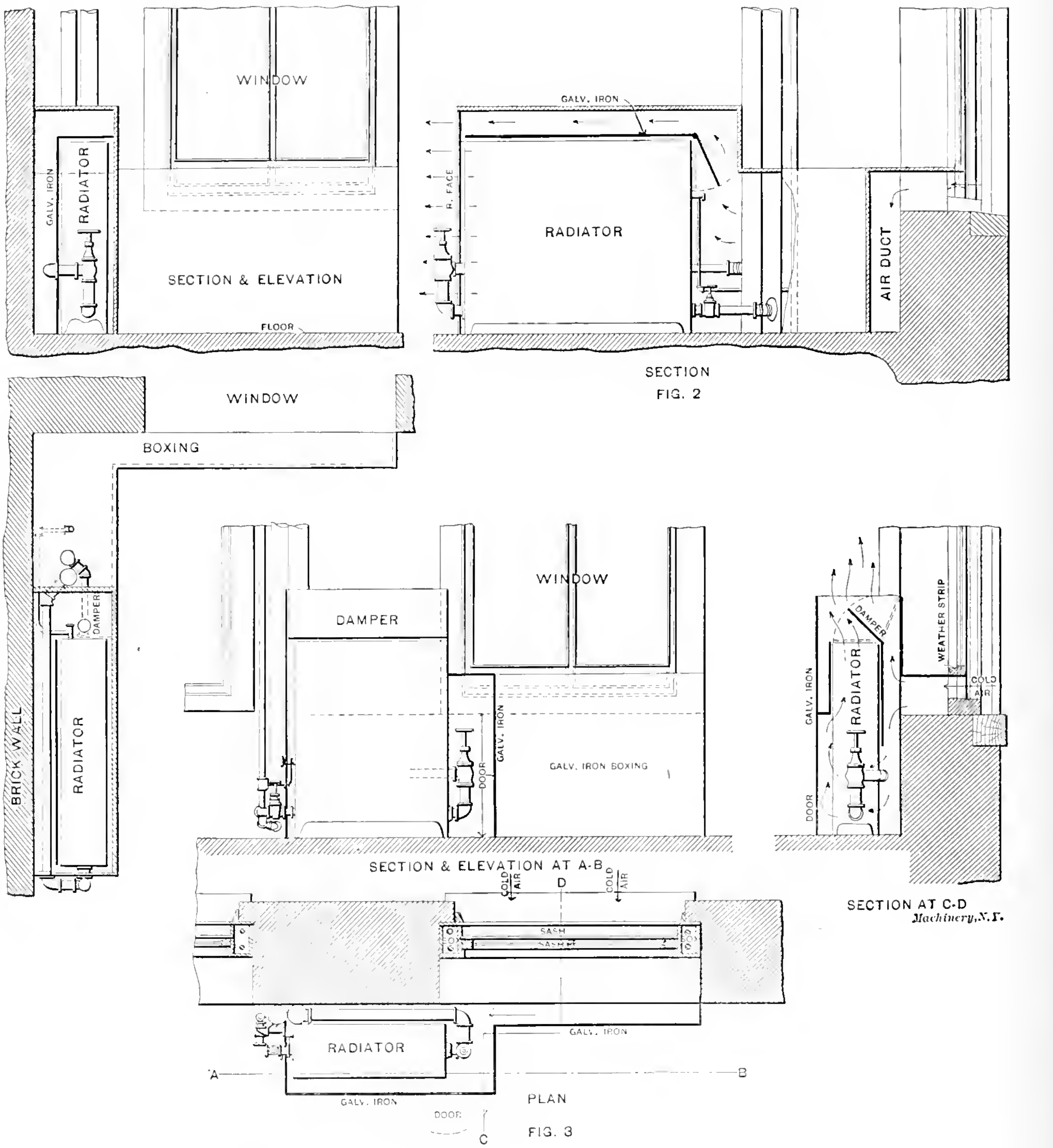


Fig. 2. Arrangement used when the Radiator is placed along a Wall at Right Angles to the Window
Fig. 3. Arrangement used when the Radiator is not placed in front of the Window

ordinary conditions. The method of supplying fresh air under pressure is more satisfactory for general ventilation, as it gives an opportunity of warming it and also permits of better distribution. When the exhaust system is used the fresh air at outside temperature leaks in, and in so doing is very liable to produce uncomfortable drafts near doors and windows.

The device shown in Fig. 5 is the simplest form of fan supply. This, in a sense, is a makeshift, but for single rooms where it is desired to improve the ventilation without very much expense it may be made to give very good results when properly installed and operated. This is adapted to rooms with sufficient direct radiation to warm them comfortably in zero weather. Such rooms, as already stated, will be overheated a greater part of the time, unless part of the radiators are shut off. The upper part of rooms heated in this way contain a considerable body of pure air at a temperature ten to fifteen degrees higher than that of the air near the floor; hence, if a certain amount of outside air can be mixed with this to bring the temperature down to 68 or 70 degrees, it will gradually fall to the breathing level, and thus, by proportioning the outside air supply to the surplus heat given off by the radiators, a very marked improvement in the purity of the air may be obtained.

The apparatus consists of an ordinary desk fan placed in a wooden boxing so arranged as to draw outside air from the top of a window, the upper sash being dropped slightly, and to discharge it in a thin fan-like sheet near the ceiling. The object of this is to thoroughly mix it with the warm air of the room before it has a chance to fall in the form of a cold draft. Narrow registers, with cords for opening and closing from the floor, are placed in each side of the boxing around the fan, as shown. When the cold air supply is too great,

and drafts are felt, the sash may be partially closed and the side registers opened slightly, as may be required. In this way the cold air is reduced and part of the supply is drawn from the room and recirculated. This, of course, reduces the ventilation, but the volume of fresh air must be sacrificed rather than to allow the presence of cool drafts. A 12-inch desk fan run on the medium speed will answer very well for

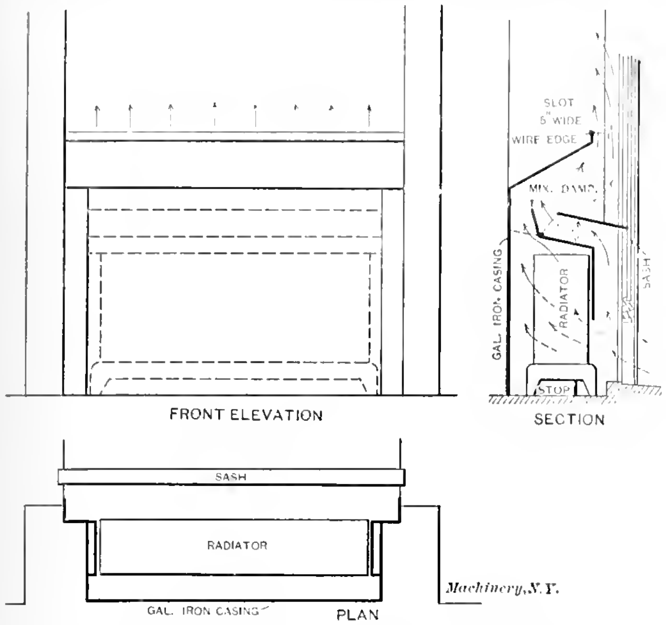


Fig. 4. Radiator placed in front of the Window, in a Niche in Thick Brick Wall

a room containing from 6 to 8 people. The diffuser opening may be about 4 inches in depth by 4 feet in length, the object being to secure a thorough mixing of the air.

A better arrangement, though more expensive, is shown in Fig. 6. This is adapted to the ventilation of several rooms by extending the distributing duct from the fans by means of suitable branches. The apparatus is hung from the ceiling

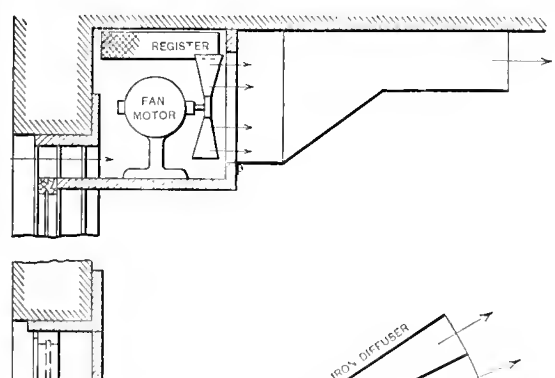


Fig. 5. Simple Arrangement for Desk Fan Ventilation

at some convenient point in the shop, as shown in Fig. 7, and takes its air from the upper part of a near-by window. The air is warmed by means of a special heater made up of pin radiators, and divided into three or four separately-valved sections for regulating the quantity of heat as required at different seasons of the year. Close regulation for varying the temperature of the air during different parts of the day is secured by the use of a mixing damper which "by-passes" a part of the air through a separate passage under the heater, where it mixes with the hot air just before it enters the fan.

An important point in an arrangement of this kind is to keep the cold air by-pass entirely separate, as shown in the section in Fig. 6, so that the air will not be warmed to any extent while being drawn past the heater. Otherwise it will be difficult to secure a sufficiently low temperature in mild weather. The mixing damper may be operated by hand, being adjustable, so that it can be set in any desired position. A better arrangement is to use one of the systems of automatic control, with a "graduated" mixing damper, as by this means the apparatus requires no particular attention after the thermostat is once set.

This type of apparatus is more especially adapted to cases where the rooms are heated by direct radiation, and the air supplied at a temperature of 68 or 70 degrees, for ventilation only. The heater can be made of sufficient size to both ventilate and warm the rooms if desired, although if the space to be warmed is of considerable extent, it is more common to use the outfit shown in Fig. 8, simply because it is more compact. If the heater in Fig. 6 is used for ventilation only, a "hot-air" thermostat should be placed in the duct and set to maintain an air temperature of 68 or 70 degrees. If the heater is proportioned to warm the rooms as well, a "room" thermostat should be used instead, this being placed upon an

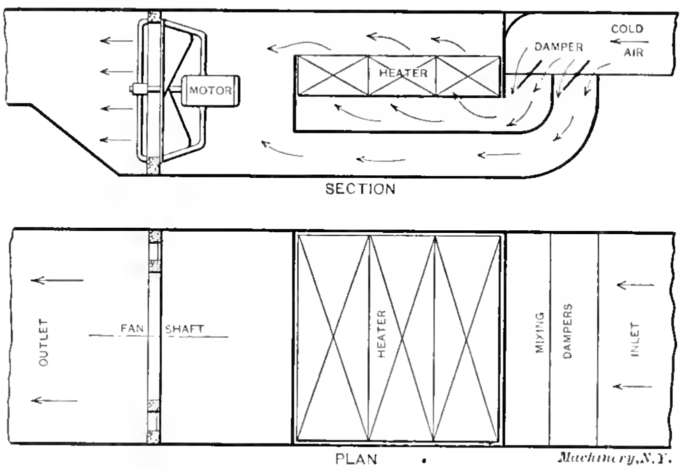


Fig. 6. Arrangement for Ventilating with Heated Air, or for both Heating and Ventilation

inner wall of the room. In case the air is to be delivered at a fixed temperature for ventilation only, a dial thermometer should be placed in the side of the air duct at some convenient point beyond the fan. This is necessary for setting and adjusting the thermostat if automatic control is used, and for operating the hand mixing damper in other cases. When the apparatus is used for heating also, all adjustments of thermostat and damper are done by means of an ordinary wall thermometer, which indicates the temperature of the room. The fan shown in this case is of the disk type, driven by a direct-connected motor. If more convenient, a belted high-speed motor may be used, or the fan may be driven from a convenient countershaft. High-speed motors are not usually objectionable about a shop, as quietness of operation is not of great importance in locations of this kind.

The computations for determining the size of fan and heater are simple. The air supply should be based on 2,400 to 3,000 cubic feet per occupant per hour, which allows a small margin for overcrowding at times without inconvenience. The square feet of surface in the heater for ventilation may be computed by the equation

$$S = \frac{O \times C \times 1.3}{1,500} \qquad (1)$$

in which

S = square feet of radiating surface

O = number of occupants,

C = cubic feet of air per hour per occupant = 2,400 to 3,000.

When the heater is used for warming the rooms in addition to ventilation, the following may be used:

$$S = \frac{(O \times C \times 1.3) + T}{1{,}000} \qquad (2)$$

in which S, O, and C are the same as in (1), and T = the total heat loss from the rooms in heat units per hour. The value of T in average cases may be found by multiplying the glass surface by 90, the net wall surface by 20, adding the results, and multiplying by the following factors, according to exposure:

TABLE I

Exposure	Factor	Exposure	Factor
North	1.32	Northwest	1.26
East	1.12	Southwest	1.10
South	1.0	Northeast	1.22
West	1.20	Southeast	1.06

The size and speed for the average disk fan and the horsepower of motor is given below.

TABLE II

Diam. of Fan, Inches	Revolutions per Minute	Cubic Feet of Air per Minute	Horsepower of Motor
18	530	1,000	0.08
21	450	1,400	0.09
24	400	1,800	0.12
30	320	2,900	0.18
36	270	4,200	0.25

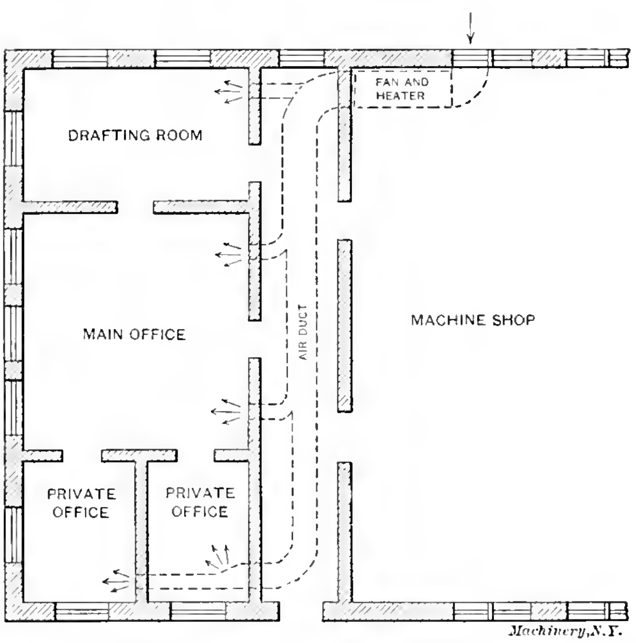


Fig. 7. Plan of Offices with Apparatus shown in Detail in Fig. 6 installed

Example: The offices and drafting-room in a shop contain an average of 36 people; there are 300 square feet of window surface and 600 square feet of wall surface. The exposure is west. What will be the size and speed of disk fan, and horsepower of motor to drive it? Also, how many square feet of pin radiation will be required.

We have 36 × 3,000 ÷ 60 = 1,800 cubic feet of air required per minute, which from Table II calls for a 24-inch fan running at 400 revolutions per minute and requires 0.12 horsepower to drive it. The square feet of surface in the heater is found by substituting the known quantities in equation (2); the first step is to find the value of T.

(glass) 300 × 90 = 27,000
(wall) 600 × 20 = 12,000

39,000 × 1.20 = 46,800.

Substituting in the equation, we have

$$S = \frac{(36 \times 3{,}000 \times 1.3) + 46{,}800}{1{,}000} = 187.$$

Fig. 8 shows an outfit which may be used in the same way as the one just described, when it is desired to have the apparatus as compact as possible. In this case a blower of the steel plate type is used instead of a disk fan, and a pipe heater of the regular hot-blast type takes the place of the pin radiators. This apparatus may be supported upon a platform or upon I-beams suspended from the ceiling or roof of the shop. The same idea regarding air-ways and mixing damper as in the arrangement shown in Fig. 6, is carried out here. The deflector in front of the heater prevents the air from being drawn directly across the hot pipes when the mixing damper is set for all, or nearly all, cool air. The mixing damper shown is for hand manipulation. In case the automatic arrangement is employed, the double damper shown in Fig. 6 should be used.

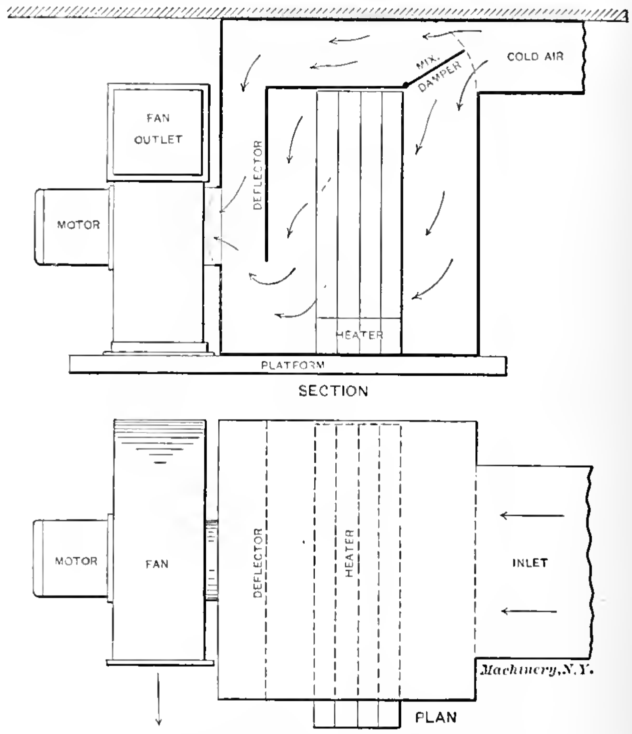


Fig. 8. A Compact Apparatus for both Heating and Ventilation

Pipe heaters for ventilation only should be 6 or 8 pipes deep, and the square feet of heating surface may be computed by equation (1) by substituting 1,800 for 1,500 in the denominator of the second member. When used for heating as well as ventilating, the heater should be from 12 to 14 pipes deep, and the surface computed by equation (2), substituting 1,200 for 1,000 in the denominator. In all of the computations for heaters it has been assumed that steam at a pressure of about 5 pounds would be used.

The piping for a heater of the hot-blast type is shown in Fig. 9. The special point brought out here is the method of making the return connections from the different sections with the main return. Each separate return in this case is sealed against the others by a siphon loop to prevent the condensation from backing from one into the other, which is apt to occur if this precaution is not taken to prevent it. As the coldest air strikes the outer sections, condensation is more rapid and the pressure is slightly less than in the inner ones; hence the necessity of sealing the returns. As the pressure in the return main is always slightly higher than in the heater, owing to the drip connection with the supply main, it is necessary to make the legs connecting with the heater longer than the others, as the highest column of water is always in this side of the loop.

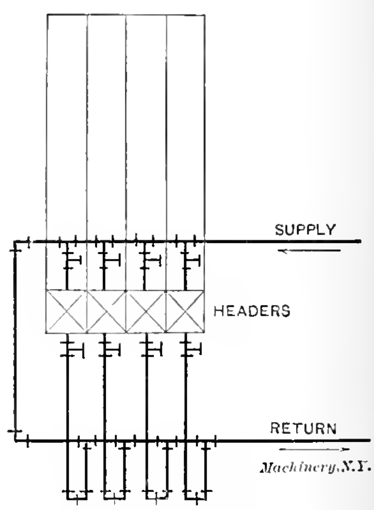


Fig. 9. Piping for a Heater of the Hot Blast Type

Of equal importance with the fan and heater is the method of distributing and discharging the air to get the best results without perceptible drafts. Fig. 10 shows an outlet for delivering air from the side of a duct where diffuser blades are

used for spreading the air as it enters the room. An adjustable deflector is provided to catch the desired amount of air it is desired to deliver at each outlet. Fig. 11 shows a diffuser outlet and adjusting damper for use when the air is discharged at the end of a branch instead of from the side of a duct as in Fig. 10.

When the main shop is heated by a hot-blast system taking all, or a considerable portion of its air from out-of-doors, an

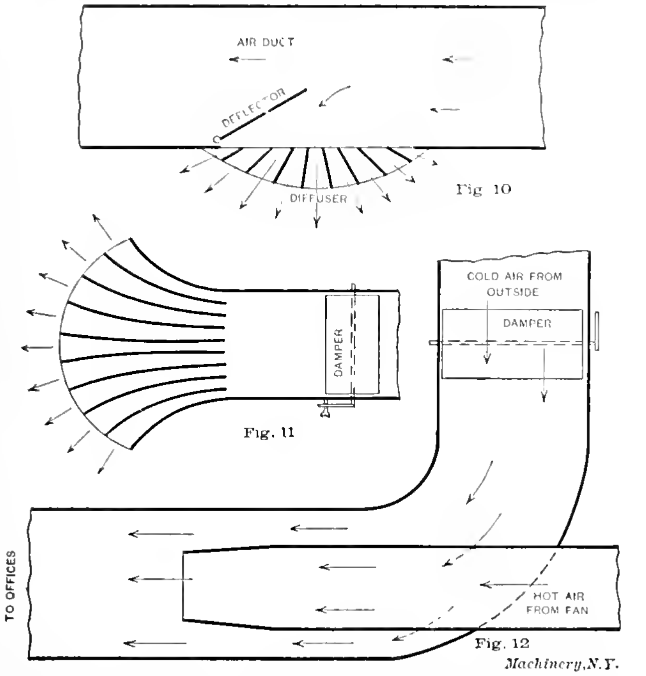


Fig. 10. Outlet for Hot Air from Side of Duct. Fig. 11. Diffuser Outlet and Adjusting Damper for End of Branch Duct. Fig. 12. Injector Arrangement for Mixing Hot and Cold Air

"injector" arrangement like that shown in Fig. 12 may be used for mixing a certain amount of cold outside air with the hot air from the fan, when the temperature of the rooms becomes too high. In this way the temperature may be lowered without reducing the air supply; instead, it will be increased, because the amount of hot air will remain the same while a certain amount of outside air has been added for cooling it. Fig. 13 shows the way of connecting the outside air supply to the "injector." It is well to make this connection some distance back from the outlets to the rooms, in order to give an opportunity for a thorough mixture of the air before reaching the rooms. The amount of cool air required can be regulated by means of a damper.

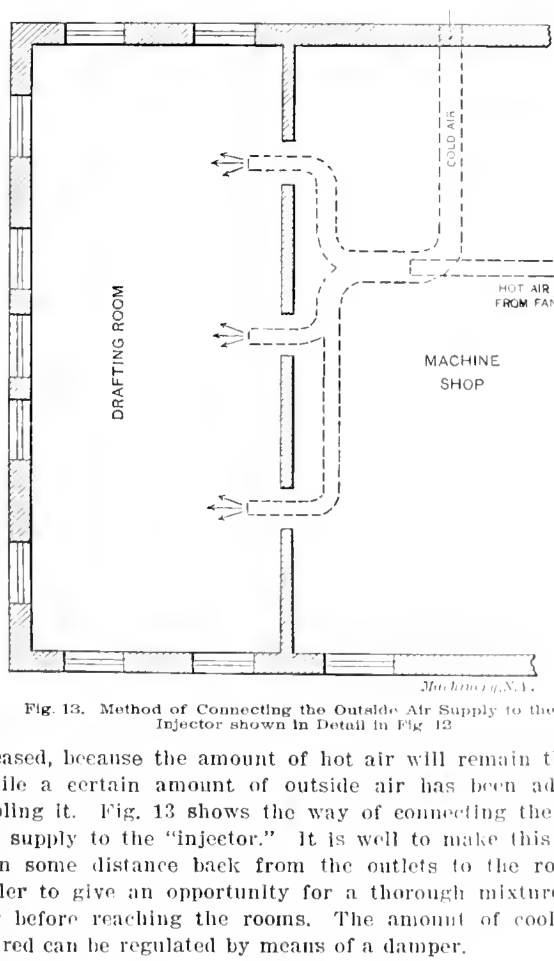


Fig. 13. Method of Connecting the Outside Air Supply to the Injector shown in Detail in Fig. 12

The size and speed of the blower type fan and the horsepower of motor, can be obtained from Table III, which has been computed for this class of work.

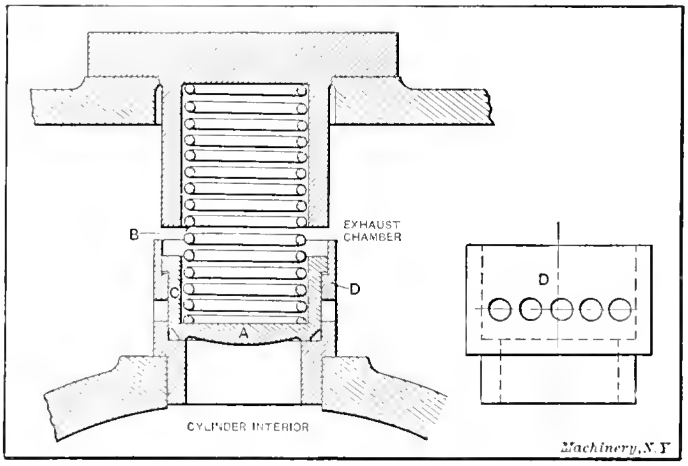
TABLE III

Diam. of Fan Wheel, Inches	Revolutions per Minute	Cubic Feet of Air per Minute	Horsepower of Motor
30	540	3,600	1.6
36	450	5,000	2.0
42	380	7,000	3.0
48	330	8,600	3.7
54	300	11,000	4.5
60	270	13,500	5.5
72	240	16,500	6.8

* * *

RELIEF VALVE FOR STEAM ENGINE CYLINDERS

The pop safety valve now almost universally used on American locomotive and marine boilers and largely on stationary boilers rapidly reduces the boiler pressure when it "blows off." The construction of the valve is such that the area effectively exposed to steam pressure is considerably increased when the valve lifts, the steam having to escape past the lip of the valve through an opening technically known as a "stricture." This increase of effective pressure overcomes the spring pressure, sufficiently to open the valve wide and permit the steam to escape freely. When the pressure has reduced a few pounds, the valve closes as suddenly as it opened, the effective pressure being as quickly reduced as it was



Bollinckx Improved Relief Valve for Cylinders

increased. The quick and positive action rapidly lowers the boiler pressure and also reduces the deterioration of the valve seats to a minimum because of reducing the time of blowing off and the cutting action of steam blowing through a partially opened valve. The pop valve is either open or closed whereas the ordinary safety valve sputters, blows, again sputters and slowly closes leaving perhaps a slight leak to cut away the valve bearing.

An analogous construction is employed in an improved form of steam cylinder relief valve devised by H. Bollinckx, steam engine builder, Brussels, Belgium, to prevent hammering of the valve on the seat. Ordinary relief valves give trouble by hammering on their seats if adjusted closely to the maximum compression allowed. In the Bollinckx design it will be observed that the valve is made in the form of a piston *C* closely fitting the cage *D*. Through the sides of the cage are holes communicating with the exhaust chamber. The valve *A* has a flat seat of the ordinary form outside of which it is beveled off, thus forming an annular cavity. In order to relieve the pressure, the valve must lift from its seat sufficiently to permit the steam or water to escape through the ports in the side of the cage *D*. If the valve lifts and falls rapidly, it cannot pound the seat because the steam trapped in the annular cavity cushions it, deadening the shock.

* * *

Five miles of the Panama Canal have been opened to navigation. This includes the channel from the point in the Bay of Panama where the water is 45 feet deep at mean tide to the wharf at Balboa. Steamships are using this part of the canal daily.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—3

THE G. A. GRAY CO.

ETHAN VIALL*

Of the many interesting shops of Cincinnati, not one is more interesting than that of the G. A. Gray Co.; and yet there is none more difficult to adequately describe, for it is not so much the machines and devices one sees there as it is the methods and workmanship, which are above the ordinary. Huge planer parts weighing thousands of pounds are machine finished, and with absolutely no hand work are made as interchangeable as the parts of a watch. This seems almost impossible, and only a personal visit to this shop can really convince one. Of course the absolute interchangeability of parts is a very desirable feature for any class of machines, for as a rule, the average shop whether large or small, pays out more money in the erecting or assembling department than in any other single department just because of the immense amount of hand fitting, scraping and filing that must be done in order to make the alleged interchangeable parts go together. On very small or medium-sized parts the problem is not so difficult as it is on large work, yet that large parts weighing hundreds or thousands of pounds each can be made interchangeable, is an absolute fact and this too without any scraping or other hand work whatever. In other words, parts may be so finished in a machine that one or a hundred will fit into its appointed place with perfect accuracy.

Fig 1. Blocks placed in Clapper-boxes in Different Positions to show Accuracy of Fitting

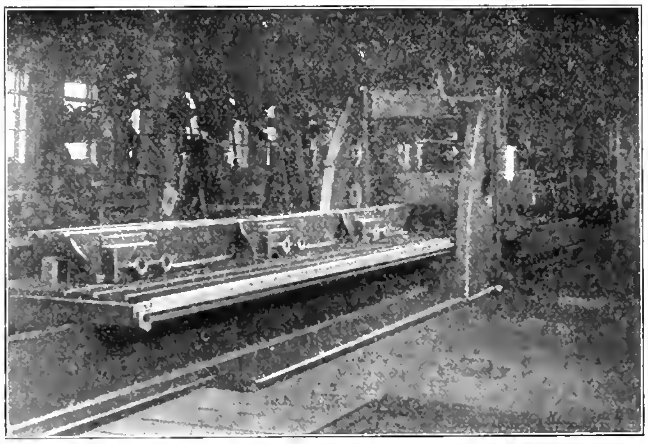


Fig. 2. Planing Four Small Planer Beds on a 34-foot Planer

Naturally, judging from the foregoing, anyone can see that the G. A. Gray Co. does not rush the work through the shop at the rate of sixty miles an hour and then put on an extra force of men in order to get it through the assembling department before the Panama Canal is finished.

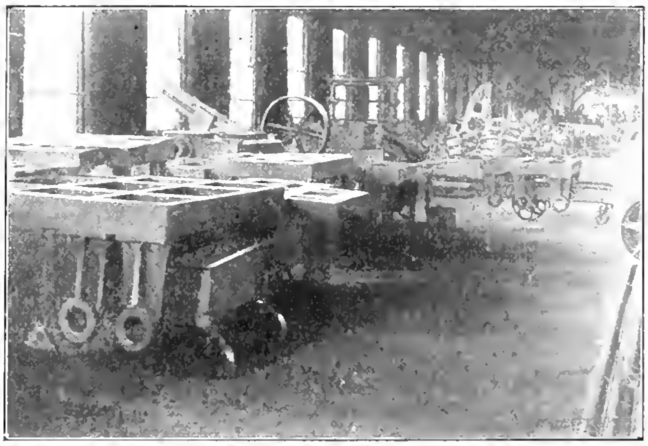


Fig 3 Planer Bed Boring Jigs and Trucks on which they are stored

Fig 4 Crossrail Assembling Room

In the shop, twenty-three planers are in constant use, which gives the firm a chance to test the machines which are built, under every conceivable condition. As the company owns its own foundry, the proper metal for each part is secured—hard, close-grained iron for parts subject to wear and tough iron for those under strain and liable to fracture—and so it is evident that the importance of the foundry, as well as the machine shop, is appreciated.

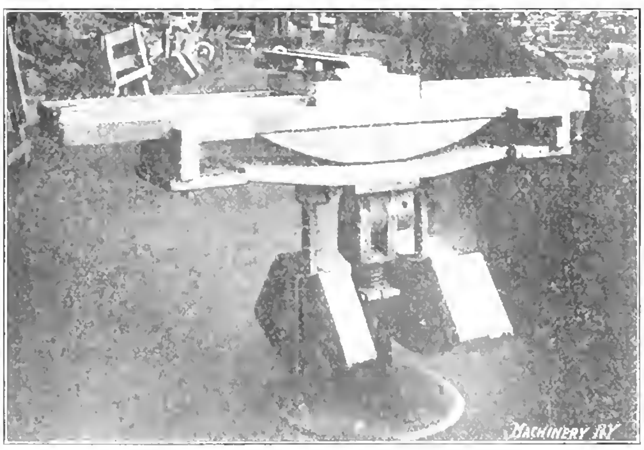


Fig 5 Universal Stand to hold Crossrails when fitting the Slides

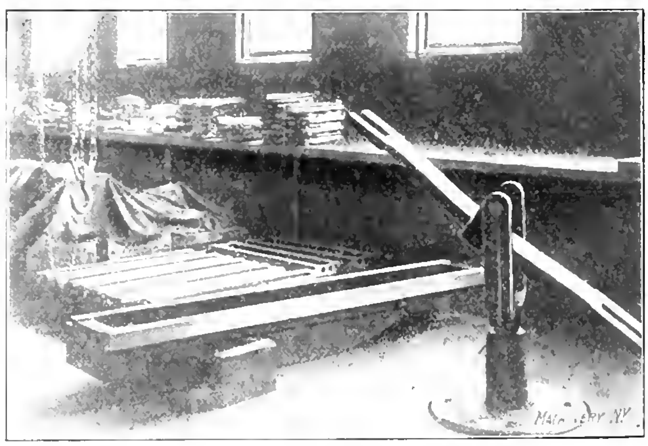


Fig 6. Stand for Holding Rails while Scraping the Ends

* Associate Editor of MACHINERY.

Briefly glancing at a few of the points in the Gray planer construction, we find that the driving gears and racks are made of a special semi-steel mixture, which tests 41 per cent more than cast iron. All rail and feed screws are of 50 point, and shafts of 55 to 60 point carbon, hammered crucible steel. Driving shafts run in solid cast iron bushings accurately ground, and set into holes correctly located and bored directly into the bed of the planer, and the holes in bushings, gears and pulleys, as well as all holes for feed rods and the like are reamed to plug gages. Any parts which are reamed too large are scrapped, and not fitted with a special bushing or part. Keys are milled to snap gage sizes, instead of using cold rolled stock filed to approximate fits. Keyways are milled to standard sizes in an automatic machine, built for this purpose. All cylindrical parts are ground. The housings are made absolutely square with no provision whatever for shims to make a "Dutch fit."

Fig. 7. Special Countershaft Brackets fitted to Planer Housings

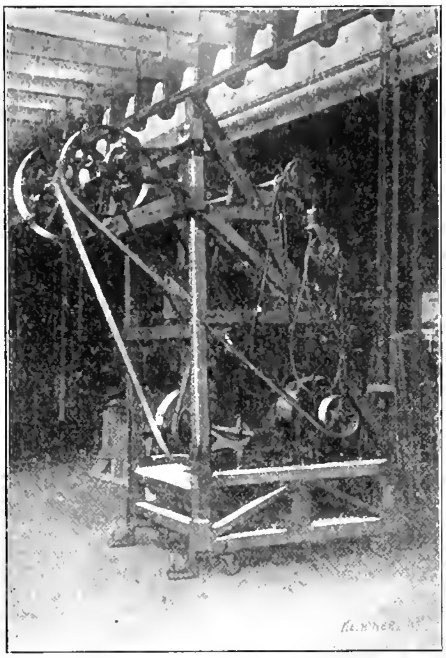


Fig. 8. Portable Motor-driven Countershaft for Testing

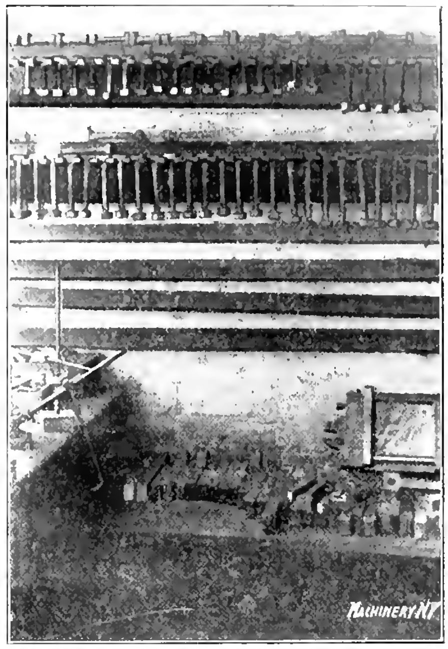


Fig. 9. Planer Operator's Corner showing Bolt-racks and Tools

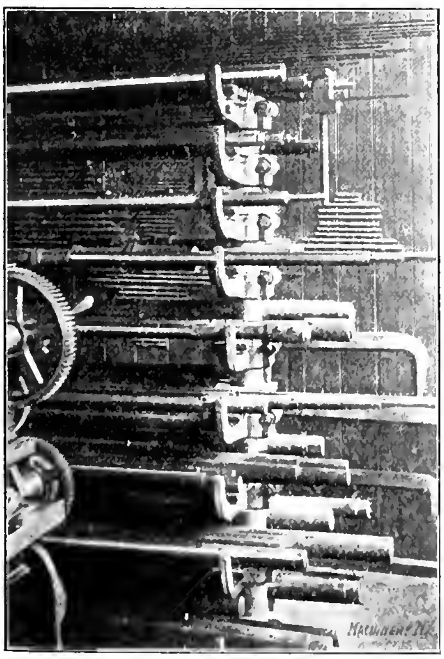


Fig. 10 Boring-bar Racks and Cages

I could go on indefinitely enumerating the points picked up during my visit, but the above must suffice for the present; there is one very important thing, however, that is often overlooked by users which is that besides being made right, a planer must be leveled up properly where it is to be run, and kept so. In order to make this leveling or testing as simple as possible, the four top surfaces of the V's are planed perfectly true at the same setting in which the V's themselves are planed, so that a level may be applied directly on top of them; therefore it isn't necessary to hunt for round bars of the same size to lay in the V's before using a level.

Nothing that I saw in the shop impressed me more, as regards accurate workmanship, than an inspection of a pile of clapper boxes and tool-blocks. Out of perhaps a hundred, I selected four at random and placed the blocks in a different position in each one. The parts had not been touched by a scraper—or anything but a planer tool—and were just as they came from the machine; yet absolutely no difference could be detected in the fit, no matter in what position the block was placed in the box. The fit was close enough to hold the blocks suspended at any point, yet a push of the fingers easily carried them to the bottom, and the fit of any one block was as good in one apron as in another. The four clapper boxes with the blocks in four different positions are shown in Fig. 1. At *A* the block is shown high in the box; *B* shows it turned end for end; *C* shows it bottom side up with the ends in the right direction, while *D* shows it bottom side up but turned in the opposite direction.

In Fig. 2 are shown four small planer beds being planed at once on a 34-foot planer with a 62-foot bed. When a planer bed is finished, no mark of any kind is put on it to indicate which end is to be toward the front of the machine, as it will fit just as perfectly one way as the other on any machine of its size, and this, too, with no scraping except the broad cross scraping, which is done to harden the surface and to remove the "loose metal" left by the planer tools, which, if it were not removed, would soon cut out the bearing.

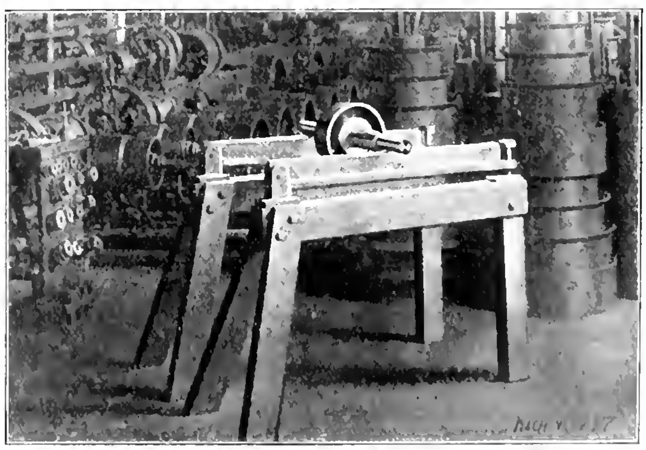


Fig. 11. Iron Ways on which Pulleys are balanced

The various jigs used for accurately locating the different holes in planer beds, and the special trucks on which they are kept, are shown in Fig. 3. This method of storing makes the handling of these heavy jigs a very easy matter.

A view of the department in which the crossrails and their fittings are put onto the housings is shown in Fig. 4, and in Fig. 5 is shown a balanced, universal scraping stand for cross

rails and slides, these being among the parts that have to be drilled and tapped after planing and, consequently, are liable to be sprung by these subsequent operations, and so must be corrected by scraping. In mounting the cross rails on the stands, they are held in practically the same way as when

Fig. 8 is a portable motor-driven countershaft used for trying out planers on the testing floor. By using this countershaft, a planer may be tested anywhere it may be placed.

A planer man's corner with its tools and neat bolt rack is shown in Fig. 9, and in Fig. 10 is shown the racks used in

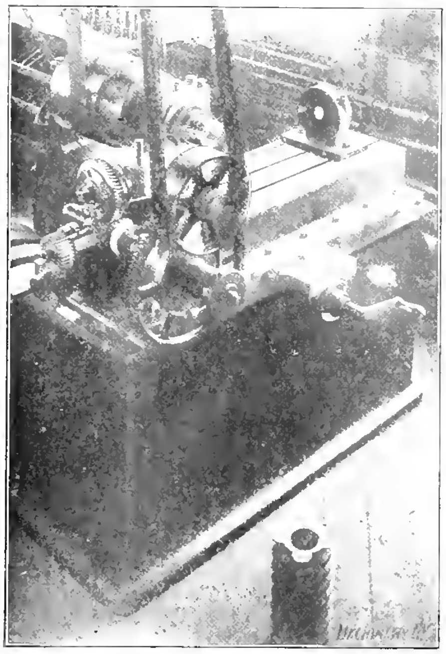


Fig. 12 Special Machine for Milling Spirals

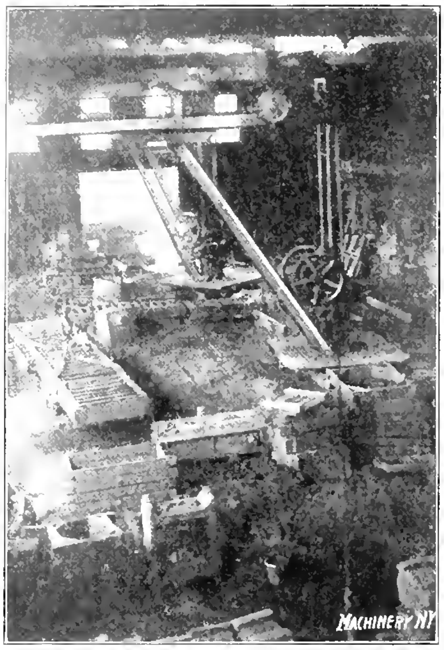


Fig. 13. View of Foundry Showing Crane Arrangement

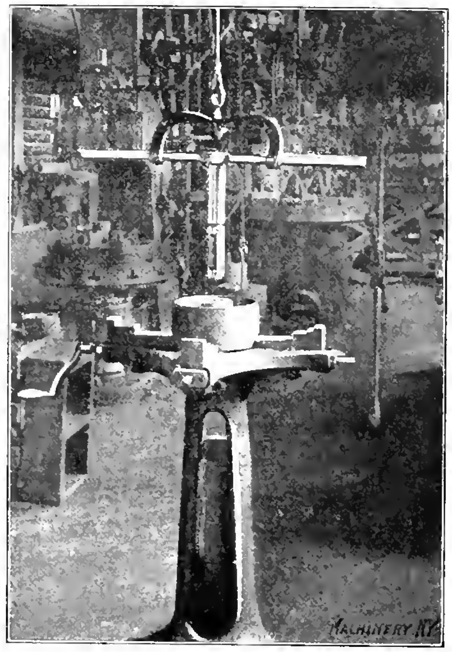


Fig. 14. Pulley Chucking Machine and Reaming Device

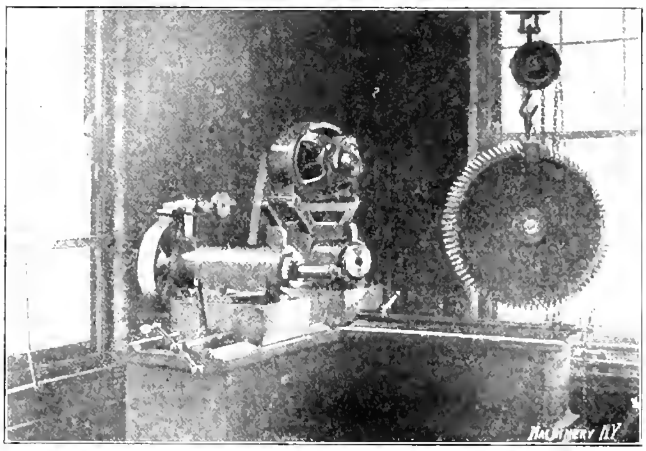


Fig. 15. Universal Motor-driven Gear-testing Machine

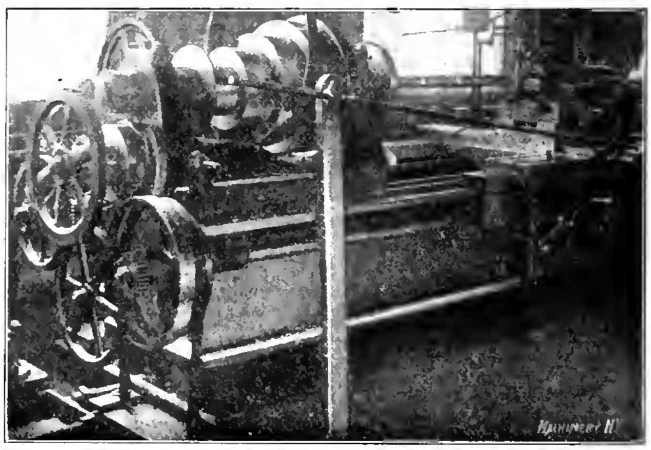


Fig. 16 Lathe driven by Pulley on Lead-screw when Cutting Spiral Grooves

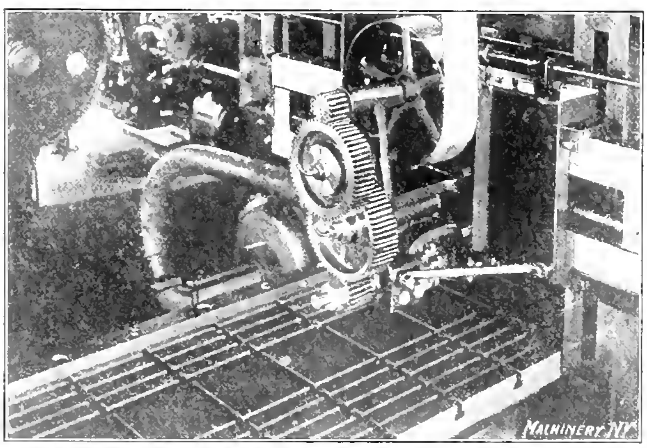


Fig. 17. Rack Milling Machine with Individual Chip Exhaust Fan

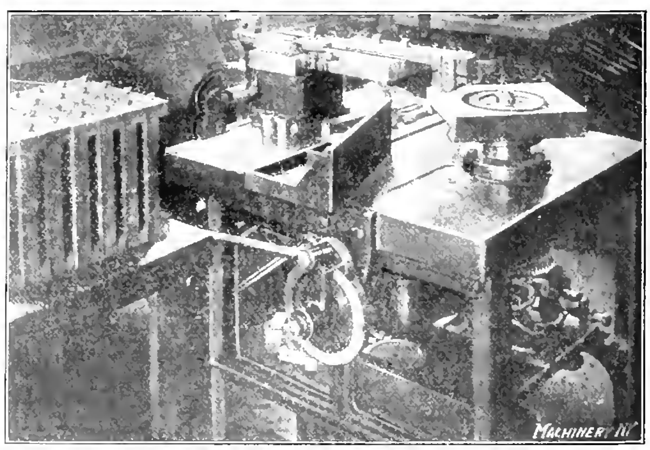


Fig. 18. Automatic Graduating Machine

bolted to the housings, in order to eliminate the error which might result were they clamped to the stand one way and bolted to the planer in another.

Fig. 6 is a stand used for finishing the ends of rails.

Fig. 7 shows the way a planer has been fitted with a special countershaft mounted on brackets bolted to the housings, in order to belt to the lineshaft without interfering with some low steam pipes.

the toolroom to hold the big boring-bars, reamers and other heavy bar tools, while on the wall are some of the large inside and outside gages.

The spirals used for spiral geared planers are milled on a special extra-heavy milling machine (Fig. 12) built for this purpose only. The gears are cut from the solid with a formed end mill, first being roughed out and then allowed to "season" before finishing.

Fig. 13 is a view of the foundry taken just after an unusually busy period, and shows the convenient crane system used.

Pulleys are held in the chucking stand (Fig. 11), and the holes carefully reamed to size with an adjustable reamer suspended from a counterbalanced bracket as shown. All pulleys are carefully balanced on the three-legged balancing ways (Fig. 11) which are made, legs and all, of iron, the V's being adjustable so as to be easily leveled.

Fig. 19. Nut Grinding Fixture and Arbors used

Spur gears are cut on Brown & Sharpe automatic gear cutters, and bevel gears are planed on a special gear planer. To insure the perfect running of all these gears, they are tested

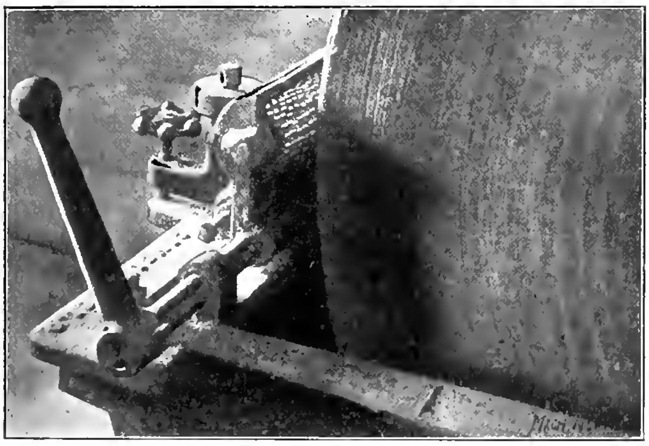


Fig. 20. Tool for Truing the Grindstone

on the special machine shown in Fig. 15, which is operated by a variable speed motor which permits the gears being run at any speed desired. The machine is equipped with dou-

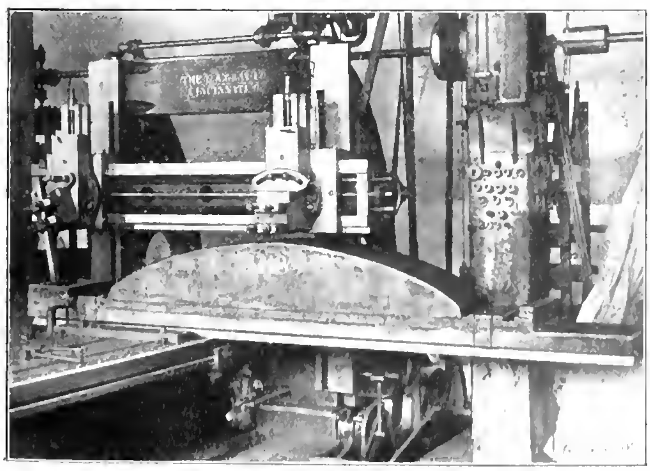


Fig. 21. Planing the End of a Large Crossrail

ble brakes, so that the gears can be run under resistance in either direction. The spindles carrying the gears to be tested can be set at any angle with each other. When tested in this way, it is definitely known that gears will run properly, not only on machines being erected, but also on any which may need repairs.

All driving shafts are chased with spiral oil grooves in the lathe shown in Fig. 16, which, owing to the great lead of the spiral, is not driven from the cone pulley on the spindle, as usual, but from a pulley placed on the lead-screw as shown, thus doing away with the abnormal strain that the gears would otherwise be under. For convenience, the machine, when used for cutting oil grooves, is driven from below by a belt running through the floor, the shifter being arranged as shown. The oil holes for these shafts are not drilled at random as is generally the case, but are all jigged.

Some of the small racks are milled, and this is done on a machine which is fitted with an individual exhaust fan, as shown in Fig. 17.

Mistakes in graduating on a milling machine are so frequent where a considerable amount of this work has to be done, that some sort of an automatic machine is almost a necessity, so the one shown in Fig. 18 has been built for this work. The piece to be graduated is first set at the proper angle so that the marking may begin at the right place, by means of a sliding angle-plate, after which it is tightened on the indexing spindle and the angle-plate is drawn back out of the way. The long and short lines are automatically spaced by means of a cam-wheel with one long and four short

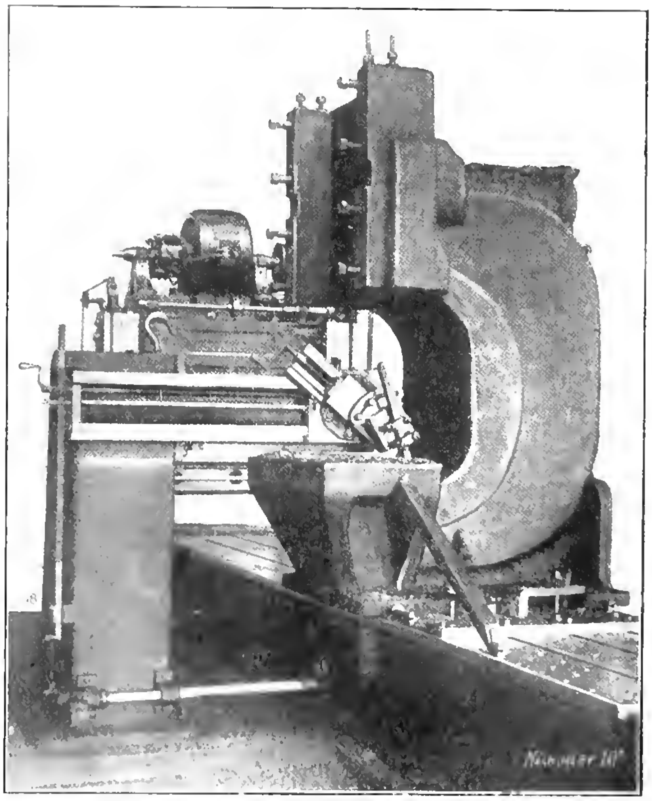


Fig. 22 Planing the Lower Jaw of a 16,000 pound Shear Casting

rises, and the marks are *rolled* in instead of cut, which forces the material into the pores of the metal and insures perfectly sharp, true dividing lines of equal depth, without tearing.

Nuts are ground on the bottom true with the tapped hole, so that they will bear evenly and not be under a side strain, by placing them top first on compensating arbors like *A* or *B*, Fig. 19, which are held in the spindle of the grinding fixture *C*, which is made to fit the regular grinder table.

The big grindstones in the shop are kept true by using the patented truing device which is plainly shown in Fig. 20.

Several jobs of more than passing interest have been done at the Gray shop at different times, one of the jobs being the planing of the lower jaw of a huge shear weighing 16,000 pounds. The independent housing shown in Fig. 22 was used. Fig. 21 illustrates the difficult feat of planing the end of a big 3,118-pound crossrail in which the great overhang and short stroke made the job one to test the capabilities of any planer, both in the rigidity of the table and the reliability of the reversing mechanism.

* * *

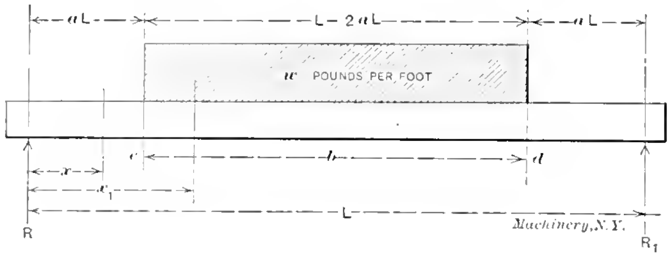
Don't try to make a motor pick up its load too quickly, or before it gets up to its speed.

DEFLECTION OF BEAM UNIFORMLY LOADED FOR PART OF ITS LENGTH

GEO. E. BARRETT*

A recent problem in design involved the calculation of the deflection of a simple beam uniformly loaded for part of its length, as illustrated, and a careful search was made of all the hand-books, American as well as foreign, and of the text-books available that could throw any light on the subject, but no formula was found from which the maximum deflection could be computed, so the next step was to deduce one. At first, it was thought that the result would be too complicated and too long for practical consideration, but, as a matter of fact, the formula is not difficult to handle, especially with a table of logarithms, and then the fact that accurate results can be found without resorting to an approximate method ought to commend its use.

Referring to the engraving, the load is symmetrical and uniformly distributed for a distance b with an intensity of w pounds per foot. Let the distance from each reaction R and R_1 to the load be aL, where a is less than unity.



Beam Uniformly Loaded for Part of its Length

$$R = R_1 = \frac{w\,(L - 2\,aL)}{2} = \frac{wL\,(1 - 2a)}{2} \qquad (1)$$

For any distance x between the left reaction and c the bending moment will be

$$Rx. \qquad (2)$$

For any distance x_1 between c and d, the bending moment will be

$$R x_1 - \frac{w\,(x_1 - a\,L)^2}{2} = R\,x_1 - \frac{1}{2}\,w\,x_1^2 + w\,a\,L\,x_1 - \frac{1}{2}\,w\,a^2\,L^2 \qquad (3)$$

The well-known equation for the elastic curve $EI\dfrac{d^2y}{dx^2} = M$, where E equals the modulus of elasticity of the material used, I, the moment of inertia of the section, and M, the bending moment at any distance x or x_1, can be now used to deduce an expression for the deflection.

Between R and c

$$E\,I\frac{d^2y}{dx^2} = R\,x. \quad \text{See formula (2)} \qquad (4)$$

$$E\,I\frac{dy}{dx} = \frac{1}{2}\,R\,x^2 + C \qquad (5)$$

$$E\,I\,y = \frac{1}{6}\,R\,x^3 + C\,x + C_1 \qquad (6)$$

Between c and d

$$E\,I\frac{d^2y}{dx^2} = R\,x_1 - \frac{1}{2}\,w\,x_1^2 + w\,a\,L\,x_1 - \frac{1}{2}\,w\,a^2\,L^2 \qquad (7)$$

See formula (3)

$$E\,I\frac{dy}{dx} = \frac{1}{2}\,R\,x_1^2 - \frac{1}{6}\,w\,x_1^3 + \frac{1}{2}\,w\,a\,L\,x_1^2 - \frac{1}{2}\,w\,a^2\,L^2\,x_1 + C_2 \qquad (8)$$

$$E\,I\,y = \frac{1}{6}\,R\,x_1^3 - \frac{1}{24}\,w\,x_1^4 + \frac{1}{6}\,w\,a\,L\,x_1^3 - \frac{1}{4}\,w\,a^2\,L^2\,x_1^2 + C_2\,x_1 + C_3 \qquad (9)$$

y in (6) $= o$ when $x = o$; then $C_1 = o$.

$\dfrac{dy}{dx}$ in (8) $= o$ when $x_1 = \dfrac{L}{2}$; then $C_2 = \dfrac{1}{48}\,w\,L^3 - \dfrac{1}{8}\,R\,L^2 - \dfrac{1}{8}\,w\,a\,L^3 + \dfrac{1}{4}\,w\,a^2\,L^3$

Formula (5) $=$ (8) when $x = x_1 = aL$; this will give a value of

$$C = -\frac{1}{6}\,w\,a^3\,L^3 + \frac{1}{48}\,w\,L^3 - \frac{1}{8}\,R\,L^2 - \frac{1}{8}\,w\,a\,L^3 + \frac{1}{4}\,w\,a^2\,L^3$$

Substituting this value of C in (6) gives the following expression for the deflection of the beam for any position between R and c.

$$E\,I\,y = \frac{1}{6}\,R\,x^3 - \frac{1}{6}\,w\,a^3\,L^3\,x + \frac{1}{48}\,w\,L^3\,x - \frac{1}{8}\,R\,L^2\,x - \frac{1}{8}\,w\,a\,L^3\,x + \frac{1}{4}\,w\,a^2\,L^3\,x.$$

Formula (6) $=$ (9) when $x = x_1 = aL$; substituting this value for x and x_1 in (6) and (9) and placing them equal to each other gives a value for C_3 of $-\dfrac{1}{24}\,wa^4L^4$. The maximum value for y will occur when $x_1 = \dfrac{L}{2}$. Substituting this value for x_1 and the value obtained for C_2, in (9) give

$$E\,I\,f = \frac{w\,L^4}{384}\,(-5 + 24\,a^2 - 16\,a^4)$$

where f is the maximum deflection. Substituting for w, the expression for total weight W is

$$E\,I\,f = \frac{W\,L^3}{384\,(1 - 2\,a)}\,(5 - 24\,a^2 + 16\,a^4)$$

$$f = \frac{W\,L^3}{E\,I\,384\,(1 - 2\,a)}\,(5 - 24\,a^2 + 16\,a^4) \qquad (10)$$

The expression for maximum bending moment is

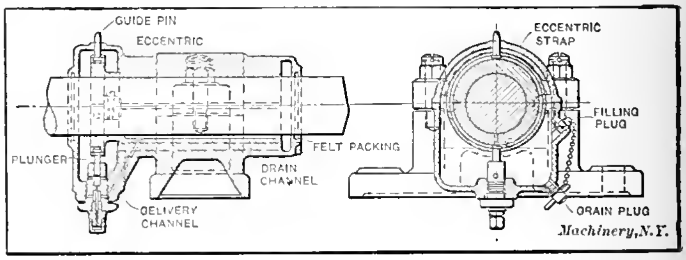
$$M_{max} = \frac{1}{8}\,W\,L\,(1 + 2\,a) \qquad (11)$$

* * *

BEARING WITH SELF-CONTAINED OIL PUMP

JOSEPH G. HORNER*

A new automatic forced lubrication system is being introduced for bearings of various kinds by Messrs. Vickers, Sons & Maxim, Ltd., who have several works in England devoted to various manufactures. The novelty is that the pump



Bearing with Automatic Oil Pump for Forced Lubrication

is enclosed in the bearing in an oil chamber at one end, and is driven by the rotation of the shaft so that the volume of lubricant varies with the demands made upon it. An eccentric (see the illustration) mounted on the shaft within the chamber drives the pump plunger which delivers the oil up through a sloping channel to the under side of the shaft where it is mostly required. The waste oil collects in a drain channel and returns to the chamber. The pump plunger has a stroke of about 5/16 inch, with a diameter of about 3/8 inch. In general the eccentric is surrounded with a strap the action of which is positive on both strokes, but in some cases the strap is dispensed with and the plunger is forced downward by the eccentric and returned by a coiled spring. In another modification for axle-boxes, a tube is carried from the pump to the top of the bearing to lubricate the pad there. In others a row of pumps actuated by one shaft supplies oil to multiple sight-feed lubricators for engine parts.

[The principle of the automatic oil pump arrangement is the same as that illustrated and described in MACHINERY, Dec., 1906, in an item entitled: "A Shafting Hanger With Forced Lubrication."—Editor.]

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MAKING HEAVY CHAIN AND ANCHORS FOR UNCLE SAM

CHESTER L. LUCAS*

"In time of peace prepare for war" is an old adage that seems to be especially heeded by the great naval powers of the world. Forward strides have been made in methods of naval warfare, and the achievements in building battleships and their equipments have been little short of marvelous. One of the primary requisites of a battleship is speed, and while we hear much of the results along this line, little has been said of the modern methods that are employed for anchoring and holding in check these valuable warships; for it must be remembered that a battleship can go to destruction as quickly on a reef as under the enemy's fire. Realizing the importance of this factor, the United States government has a well-equipped department at the Charlestown Navy Yard wherein every link of chain and every anchor used in the navy is made. Through the courtesy of Commander H. E. Parmenter, MACHINERY's representative was allowed to photograph and record the various processes and machinery used in chain and anchor making.

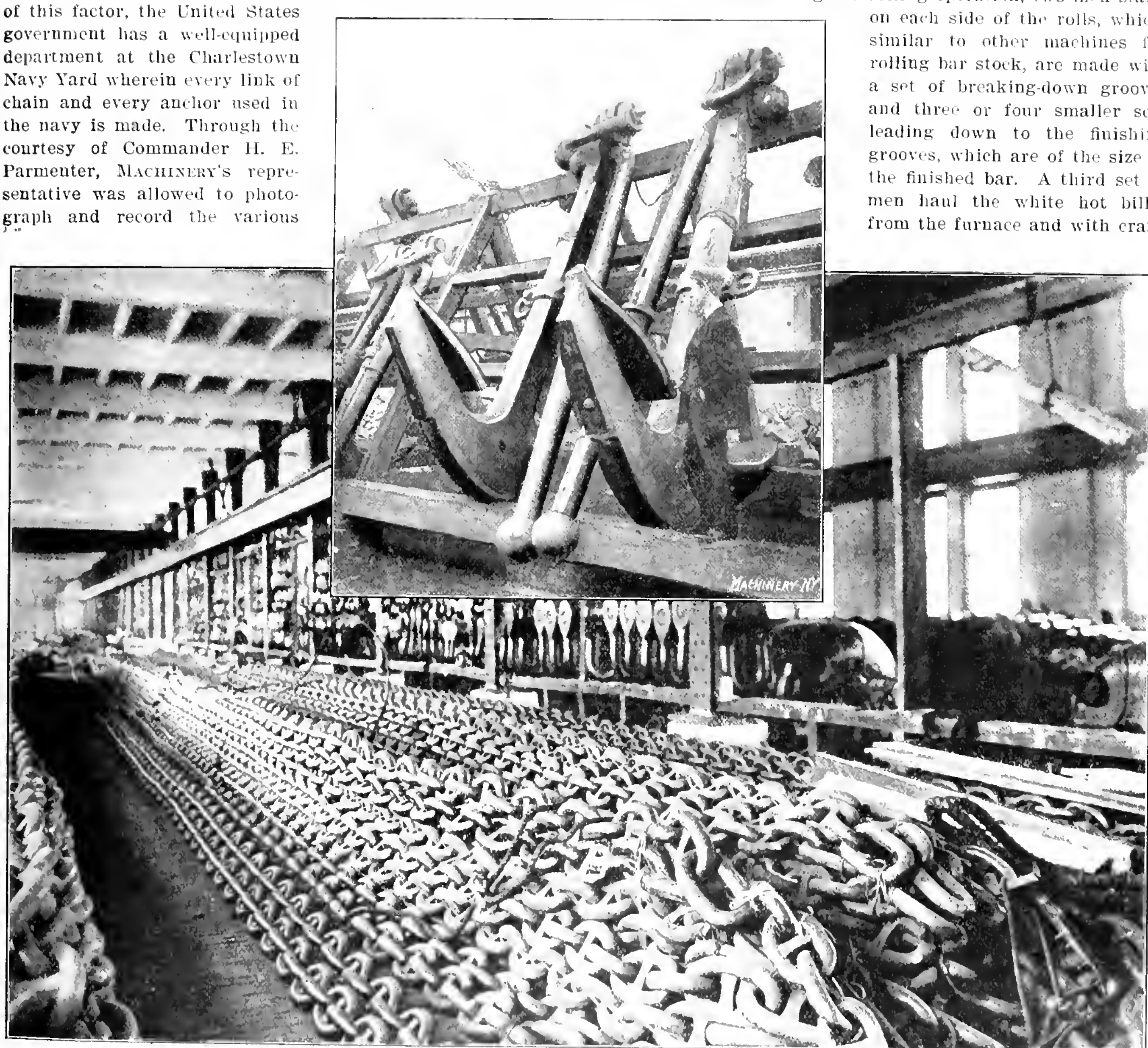

Fig. 1. Anchor Chain Storage, and 17,500 pound Anchors

The Iron

But one make and one quality of iron is used for the heavy chains in the navy, and by heavy chains are meant those with links made of bars from $2\frac{1}{2}$ inches to $3\frac{1}{4}$ inches in diameter. This iron comes from one of the best makers in Pennsylvania, and is received in square muck-bars $1\frac{3}{8}$ inch in diameter. It is accepted only after passing the rigid physical and chemical tests imposed by the government. One requirement of the chemical test is that the percentages of sulphur and phosphorus be very low. By getting the iron in the muck-bar, it is assured that the metal has received the lowest number of heats possible before the chain-smiths of the navy yard begin to work it.

Rolling the Bars

The first step in making the heavy chain, taking for example the $2\frac{1}{2}$-inch size, is to cut the muck-bars to lengths of about 2 feet, the cutting being done cold by means of large alligator shears. These short lengths are then wired into bundles of about 25 each. As these bundles weigh from 250 to 300 pounds, they are handled with crane-tongs and in this manner slid into the huge furnaces. From the furnaces these white hot billets are passed to the rolls and converted into bars of the required diameter—in this case $2\frac{1}{2}$ inches. Fig. 2 shows a view of the rolling department of the chain shop with the furnaces on the left and the rolls on the right. The chain shop is in charge of Mr. William Kelley. In front of the furnaces may be seen piles of cut muck-bars ready to be bundled for the furnace. During the rolling operation, two men stand on each side of the rolls, which, similar to other machines for rolling bar stock, are made with a set of breaking-down grooves and three or four smaller sets leading down to the finishing grooves, which are of the size of the finished bar. A third set of men haul the white hot billet from the furnace and with crane tongs rush it to the breaking-down rolls. To successfully start the billet through the first set of grooves is the hardest part of the rolling, but as this set of grooves is made with short, cleat-like teeth, the metal is sent through without much trouble. Fig. 3 shows the starting of a white hot billet. If the iron starts to slip, a handful of sand is thrown in and the slipping tendency overcome. After the iron has gone through the breaking-down grooves it is passed back over the rolls and entered in the next set. As the metal is passed through the smaller grooves in the rolls it is, of course, stretched to a greater length, and after the last set has been passed the bar is ten feet long, and the rolling time has been so short that the iron is still at a bright red heat.

Cutting and Bending

From the rolls it is but a few steps to the hot-saw which cuts the bars to the proper lengths for the links. The hot

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saw itself is about 4 feet in diameter and travels with a peripheral speed of 20,000 feet. At a 30-degree angle to the saw is set the table, which is provided with a vise to grip the bar while cutting. The table is set level with the floor, so there is no unnecessary handling of the hot bars. The purpose of cutting the iron bars at a 30-degree angle is to provide for the scarf, so essential to welding. Some idea of the capacity of this saw may be obtained when it is realized that a 30-degree cut through a 2½-inch bar (a cut 5 inches long) is made in 4 seconds.

The two machines shown in Fig. 6 are for bending the links. They are very simple but ingenious machines, and they form the links much better and in a fraction of the time that it would take to do it by hand. Both of these machines were designed by Commander Parmenter and made in the machine shops of the Charlestown Navy Yard under his supervision. The smaller machine is for chain made from 2½-inch stock, while the larger one takes stock from 2¾ inches to 3¼ inches. The action of the machine, which is in reality a press, is very simple and easily understood. The forming

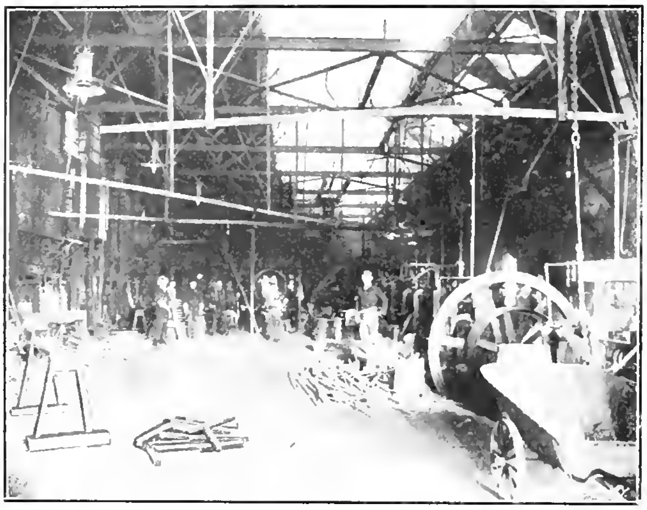


Fig. 2. General View of the Chain Shop

arbor, shaped like the inside of the link, is located just inside of the oval opening at the front of the machine. The groove around this arbor is spiral, so that as the iron is bent to the shape of the link, the ends will be separated enough to allow the links to be connected before welding. On either side of the central opening may be seen the two cam grooves that guide the forming rolls that bend the link. The bar from which the link is to be made is inserted at the left-hand side of the press; the ram descends, carrying the forming rolls (which are mounted in slides to provide for lateral movement)

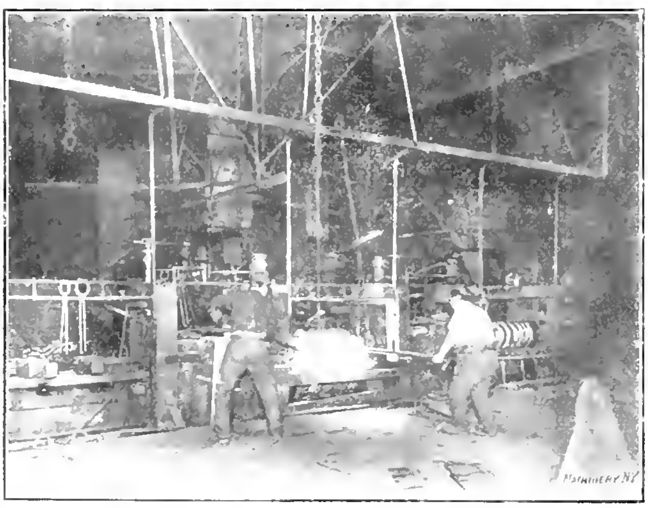


Fig. 3. Starting a White-hot Billet through the Rolls

down the grooves, thus giving the link-shaped motion that does the forming. After the link is bent, the arbor recedes, allowing the link to drop to the opening at the base of the machine. All of these operations of rolling, sawing and bending, from the time the billet leaves the furnace for the first time, are performed in one heat and when the link drops from the bending machine it is still at a good red heat.

Welding and Testing

In the welding department there are about a dozen fires with their "chain-gangs" for welding the links. These fires

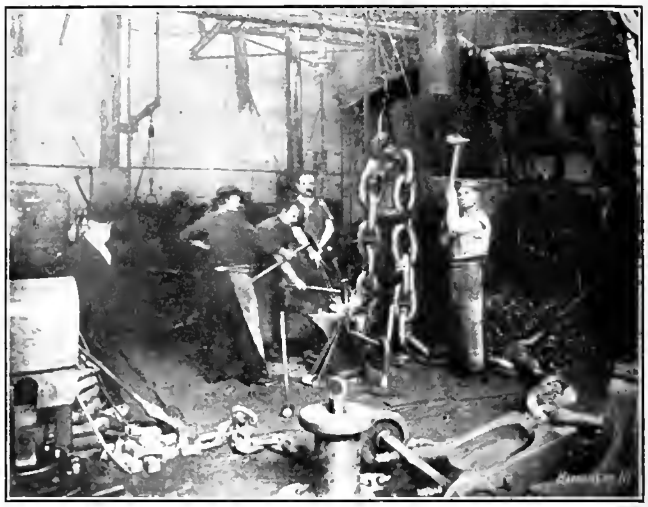


Fig. 4. The Chain Gang at Work Welding a Link

use coke for fuel, and at the side of each one is a constantly growing chain of completed links. Fig. 4 shows one of these fires with its crew at work welding a link. For some of the chain a welding machine is employed, but most of the work is done as shown in the illustration. After connecting the uncompleted link to the rest of the chain, the slack of the finished chain is pulled up out of the way by the hoist shown and the link to be welded is bent together. Next, the joint is placed in the fire and heated without heating the rest of the chain any more than can be helped. When the welding heat

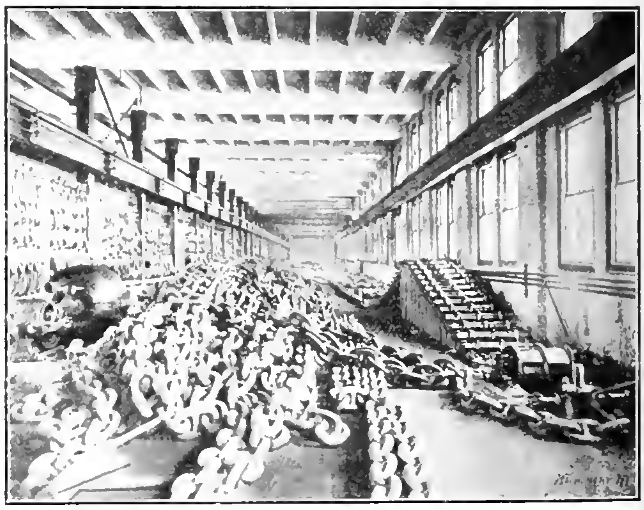


Fig. 5. Chain Painting Apparatus and Chain Ready for Painting

is reached, the link is quickly transferred to the anvil and the strikers send in the blows, under the direction of the smith, who handles the link. The rapidity with which this welding is done is surprising, considering the fact that the chain has "a string tied to it" that makes it awkward to handle. After welding, a drop-forged block is placed in the center of the link and the sides of the link closed in upon it, holding it firmly in place. Each block has the letters "U. S. N." raised upon each of its sides, and while this block does not add to the strength of the chain,* it has a purpose, which is to prevent the chain from kinking and catching while stored away in the hold of the battleship.

* According to Unwin the British Admiralty rule for the proof test of studded cable chain is: Test load in tons (2,240 pounds) = 18 d^2, corresponding to a load of about 11½ tons per square inch of section. For close-link crane chain without studs it is: Test load in tons = 12 d^2. The stud chain thus is subjected to a proof load 50 per cent greater than close-link chain. However, tests made both abroad and by the Boston Navy Yard have shown that the stud does not add to the ultimate strength but rather detracts from it. The function of the stud is essentially to insure the chain running freely from the chain lockers and prevent it becoming rigid under heavy strains. EDITOR.

Testing and Finishing

The testing apparatus used to prove the quality of the chain is very powerful and the result is conclusive. Owing to the location, it was impossible to obtain a good photograph of the apparatus. The chain is placed in a steel-lined pit, 100 feet long, 3 feet wide and 3 feet deep while under test. A length of chain 90 feet long is made fast at one end of the pit and the other end attached to the testing machine. With this machine it is possible to subject the chain to a strain of 80,000 pounds, this being accomplished by using hydraulic pressure. From each length of chain three links (called a triplet) are taken and tested to destruction. This test proves the chain beyond all doubt, and no poor or weak link can possibly "get by."

At the end of the testing pit there is a steel subway that leads to the storehouse on the other side of the street. A thirty horsepower winch furnishes the power for pulling the chain through the subway. Fig. 5 shows a view of one side of the storehouse, with a pile of chain waiting to be painted. At the right-hand side of the engraving may be seen the device that is employed for painting the chain. Just under the drum in the foreground is the paint tank. The paint, which is black asphaltum, is kept hot by the steam pipes running through the tank. The chain is passed through the tank and

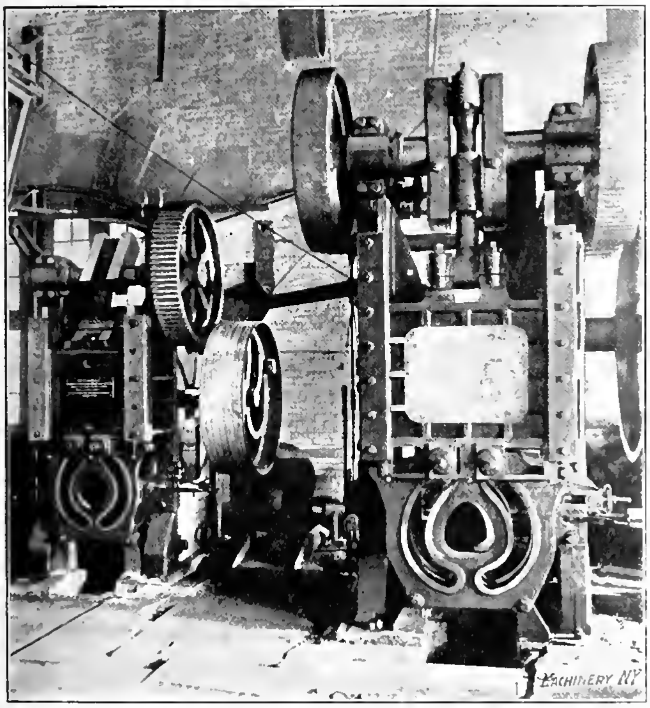


Fig. 6. The Link Forging Machines

under the steel drum and then over the inclined rollers. Another thirty horsepower winch at the farther end of the building is used to draw the chain through the tank and over the rollers. As the paint is applied hot and the chain is drawn over the rollers very slowly, the paint is dry by the time the chain leaves the apparatus. The other side of the chain storehouse is shown in Fig. 1. This view shows more clearly the blocks in the links. Here again the floor is literally lined with chain, and one would think that there was chain enough made to last the navy for years, but when it is remembered that the life of a chain is limited, being scrapped as soon as re-testing proves it to have lost its elasticity or to be otherwise defective, it can be easily seen that Uncle Sam's chain-making industry is an important one.

Anchor Making

The anchor shop of the United States Navy is located in the same large building as the chain shop, and while it is not as large a department, it is fully as important. The work is in charge of Mr. William Paul, whose experience in this line is without a doubt unequaled in this country.

Material and Equipment

In this shop are forged all the anchors for the navy. They vary in size from 400 pounds to 17,500 pounds. The material from which anchors are made is simply the scrap from the process of chain-making—imperfect links, short ends, etc. Fig. 7 shows a pile of this waste chain iron ready to be made into anchors. At the anchor shop it is made into billets of sufficient size to make the various anchor parts. These rough masses of iron are held and worked on huge porter bars, which for the large anchors are 6 inches in diameter and about 12 feet long. The furnaces are of the same type as those

Fig. 7. A Pile of Scrap Chain from which Anchors are made

used in the chain shop, burning soft coal for fuel. Oil furnaces have been tried, but were discontinued for reasons of economy. The steam hammers—and there are six or eight of them—range up to twenty horsepower on the large work.

The Anchor and its Parts

As has been intimated, anchors are built up of several parts, each of which is forged at different fires, according to the size of the work. The parts of an anchor are the two palms, the crown, the shank, the stock and the shackle. The stock and the shackle are not parts of the main anchor forging, though they are very essential to the proper working of the anchor. The stock is to insure the anchor falling in such a position as to grip firmly, and the shackle is the connecting link for attaching the chain. Referring to Fig. 8, *A* is the shank, *B* the crown, *C* the stock, *D* the shackle, and *E E* are the palms. The palms, however, are only called by that name before they are welded to the crown. In the completed anchor, the ends of the crown with the attached palms are known as the flukes.

The System of Forging

In everything that Uncle Sam does there is a common underlying factor that enters into every detail. That factor is system, and it is right at home in the anchor shop as well as in the chain shop. A small model anchor with correct proportions has been made and from that model the weights and measurements for the various sizes of anchors have been computed. Each anchor, then, has its standard size and weight, which is a great aid to the blacksmith. The

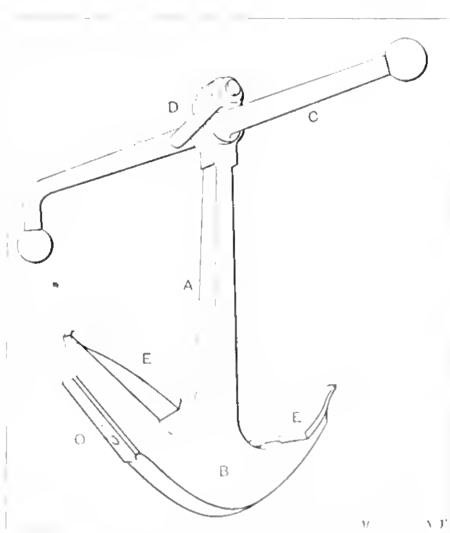


Fig. 8. The Anchor and its Parts

palms, as forged, are merely flat pieces, triangular in shape and quite thin. The shank is forged with a flat end to be welded to the crown, and holes are forged in the top end for the stock and shackle. The crown is forged with a recess to receive the end of the shank when making the box weld. Through the ends of

the crown are two holes which are used to hold it to the porter-bar while it is being shaped and welded to the shank. After the anchor is finished, the holes are extended through the palms and a large rivet put through and headed over. This rivet serves no purpose other than to improve the looks, unless it be to keep the elements from the interior of the iron. A glance at the anchors shown in Fig. 9 illustrates this point. At first thought it is natural to think that the rivet helps to hold the palm to the crown, but as these two parts are united by a weld it is plain that the rivets cannot add to the strength. After the forging of the crown and shank is

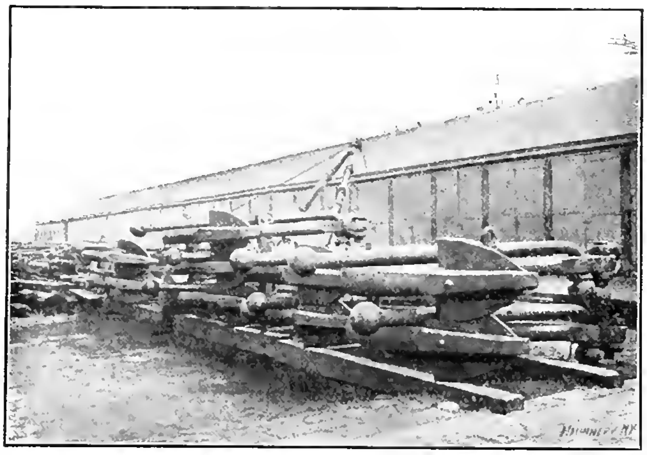


Fig. 9. A Pile of 3- and 5-ton Anchors

finished, they are heated in separate fires and box welded together. The anchor is now complete except for the stock and shackle. These parts are not added until the last thing. The stock is a plain forging and needs no comment. In putting the balls on the ends of the stock, it is, of course, necessary to leave one of the balls off until the stock is put through the anchor, after which the ball may be headed over. The shackles for the small and medium-sized anchors are forged in quantity. These shackles are made from round bars of the size of the body of the shackle, the ends being upset to form the eye. The holes in the eyes and the shaft that enters the

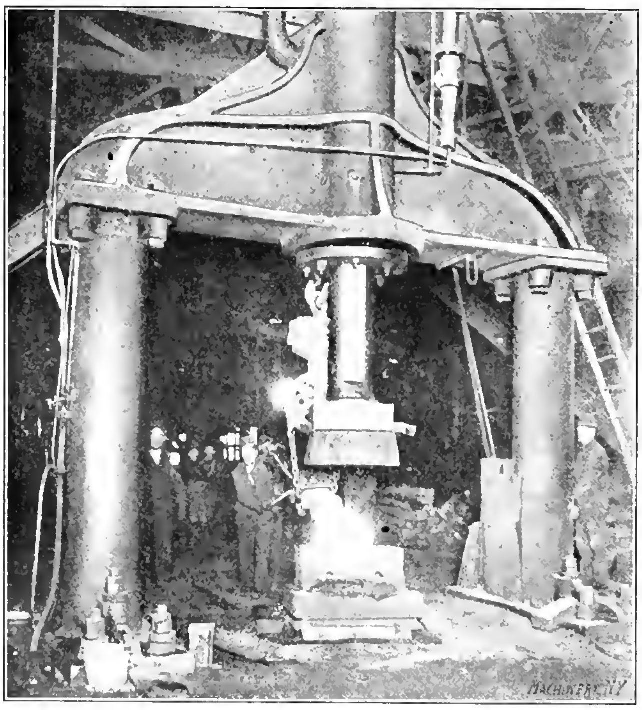


Fig. 10. Forging an Anchor Crown under a 20-ton Steam Hammer

holes are slightly oval so that they may be easily assembled correctly. The shaft is held in place by a taper key, called the fore-lock pin. To bend these shackles and still keep the iron up to its full size, was a problem that Commander Parmenter solved very neatly. The tendency is for the iron to stretch and so flatten out around the bend, thus materially weakening the shackle. He designed a simple and powerful bender that presses the ends of the piece hard up towards the bending point while the shackle is being bent at the same time, thus supplying the extra stock necessary to make a full bend. Fig. 10 shows the 20-ton steam hammer at work putting the finishing touches on one of the flukes of a medium-sized anchor. In this case, as the anchor is not a very heavy one, the crown is being held by the crane and guided by using large tongs instead of the porter-bar used on the larger work.

Costs and Accuracy of Anchor Forging

While the description of anchor forging is not a lengthy one, the work of making a 17,500 pound anchor takes a number of men 27 working days. As the material in the shape of crude iron costs in the neighborhood of eighty dollars a ton and the men receive from three to five dollars a day, it is not hard to realize that the cost of one of these large anchors runs up into four figures.

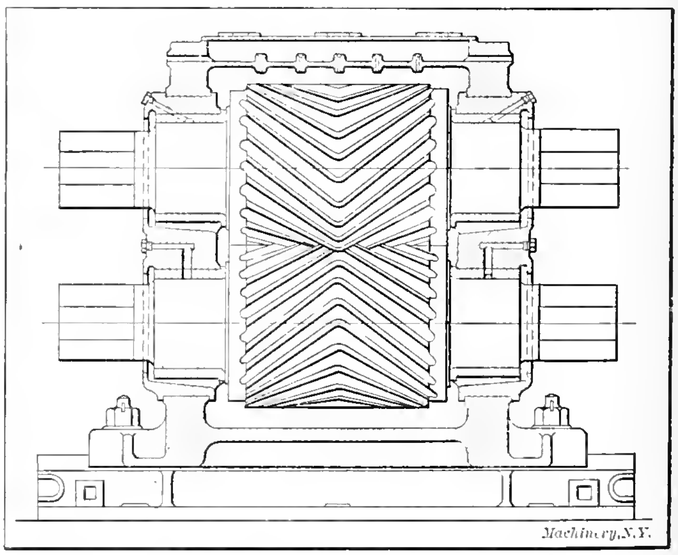
Fig. 9 shows some finished anchors weighing from 6,000 to 10,000 pounds. The two anchors shown in the upper part of Fig. 1 weigh 17,500 pounds each. As the battleships are constantly increasing in size with every new model, the anchors and chain must keep pace (a 20,000-pound anchor is under consideration at the present time), so it is hard to say when the limit will be reached. Upon each anchor the actual weight is stamped in large figures. A few of these figures were copied off as follows: 17,550, 10,030, 9,080, 10,040, 6,004, 5,975. As these anchors were made for 17,500, 10,000, 10,000, 10,000, 6,000, 6,000 pound anchors, respectively, the figures show how closely the work is done, a fact due to the system of proportional sizes that is so closely adhered to by Uncle Sam's experienced anchorsmiths.

* * *

DOUBLE HELICAL CUT PINIONS FOR ROLLING MILLS

JOSEPH G. HORNER*

The steel pinions which drive the rolls of rolling mills have hitherto usually been cast in molds made by tooth-blocks in a gear wheel molding machine. Messrs. P. R. Jackson & Co., Ltd., of Salford, Manchester, England, who are probably the largest manufacturers of cast gears in England, have now constructed a plant for cutting the teeth of rolling mill pinions of double-helical forms, or straight when required. It follows that such gears must be en-



Machine-cut Double Helical Rolling Mill Pinion in Enclosing Housing

closed in an oil box in order to secure the fullest efficiency and durability. They are, therefore, fitted in enclosed housings with oil supply tank above as shown in the accompanying illustration. The advantages of smooth running, reduced blacklash, and greater durability, should more than compensate for the higher first cost of these gears over ordinary cast pinions.

* * *

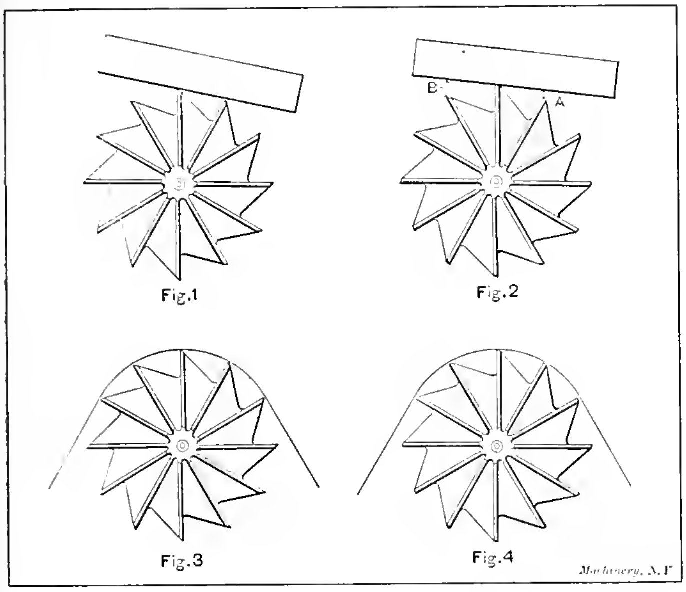
Blue ink lines on tracings seldom show up clearly on blue-prints, but if a quantity of orange ink is mixed with the blue the line is made opaque.

*Address: 45, Sydney Buildings, Bath, England.

EXPERIENCES OF A YOUNG TOOLMAKER*

T. COVEY

On reporting to his foreman that the surfacing mills were ready to be hardened, Jim was told that his next job would be to grind up the end mills that he had made. Mr. Corbin took him to the grinding room and showed him the machine that he was to use to grind the shanks, and sent him to get the same gage that he used in turning the shanks. On his return Mr. Corbin said, "Whenever you are setting up a grinder for a job like this, you should keep the wheel well away from the work until you are sure that the stops that trip and reverse the traverse feed of the wheel are properly set, as otherwise the wheel is liable to run into a shoulder on the work or the footstock of the machine and either break the wheel, or damage the work or the center; and, *never run a large wheel that has no guard over it.* Now to grind tapers on this machine, loosen the clamps at the end of the table and swing the table around in the proper direction by means of this adjusting screw. This end is graduated to indicate inches per foot, and you will notice that I have set it at ½ inch per foot, which is proper for a Brown & Sharpe taper. You cannot depend on these graduations, however, for more than an approximate setting. The shank should be ground enough so that it is nearly cleaned up and then tested with the gage, first wiping it clean and dry and putting a light chalk mark lengthwise of the shank; then when you try it into the gage and twist it around, if the chalk mark is rubbed off evenly and it seems to stick in the gage, it fits all right. If one end of the chalk line is rubbed off and the other is not it shows that the table should be adjusted to make the end on which the chalk was rubbed off a little smaller. You will note that the gage is marked "Tang to project ⅜ inch"; and when you have ground the shank small enough to let the end project ⅜ inch you have it the right size. You should watch when you are first starting to grind a mill to see if it runs out badly from being sprung in hardening, which frequently happens. When the work is not too badly sprung you can scrape the center in the shank over enough to get the mill to clean up all right, but if it is sprung too much for this, bring the part to me and I will have it hardened over again. When you have the shanks all ground you can grind the teeth on that little universal cutter grinder." And with that he left Jim to himself. He got along all right until he had the first one down nearly to size. As the wheel had not been dressed off, the work was rather rough. Jim noticed it but did not know what was the matter, though he could readily see that the finish was not as good as it was on lots of work he had seen. John Cary was working on a surface grinder nearby, and he asked him if there was not some way to make that machine grind smoother.



Figs. 1 to 4. Testing the Teeth of End Mills for Clearance

"Why! I should say that if the wheel were trued off it would do a better job," said John.

"How do you true it off?" asked Jim.

"Get a diamond from the tool-room and fasten it in the holder; then with the wheel running move it slowly past the diamond—you get the diamond and I'll show you how."

When Jim came back with the diamond John went over to the machine and looked the work over; then as he dressed the wheel off, he said, "I'll tell you how I manage when I have a lot of pieces that are alike, as you have here: I true the wheel off once when I begin the job; then I rough grind all of my work down nearly to size, leaving about 0.0015 stock for finishing. After that I true the wheel off again and finish one piece and note the reading on the dial of the feed handle. By bringing the handle to the same place for each shank you can get them all the same size without taking each one out to try it two or three times. You can also do this when you are roughing them out, only the wheel will wear off more in taking off so much stock and you will have to feed it in a little further each time. When you are roughing off work, it is almost impossible to do a job in reasonable time and have the wheel stay true, and you would have to dress the wheel on each piece to do a good job; but in roughing out, the wheel will stand some crowding and still be true enough to get the stock off rapidly. If you rough all the pieces first, when you come to finish them they will be round and clean, and as you have only one or two thousandths to take off each piece the wheel will easily stay in good shape to finish a dozen shanks. Use plenty of water at all times as it keeps the work cool and helps to keep the wheel clean."

"Thank you," said Jim, "I'll do it that way."

Jim got the shanks ground in reasonably good time, and in the meantime he watched a man that was sharpening some end mills in a machine like the one that Mr. Corbin had told him to use for that purpose, and he saw him take a mill out of the machine after he had ground two or three teeth and hold the mill up to the light with a scale across the teeth. Going over to him he asked him why he did that.

"I do that to see if I have the right clearance," said he.

Jim picked up a mill that he had not ground yet and held it up to the light, using his scale as a straightedge, as he had seen him do. "Oh," said Jim, "you grind the teeth at an angle with the face that will show clearance when the scale rests on the tooth following it." (See Fig. 1.)

"No! I don't! That gives too much clearance. Here try this one," he said, handing him one that he had just ground.

Jim held the scale on that and saw that it looked altogether different; in fact, it did not look to him as if it had any clearance at all.

"Why, on this one the scale does not even touch the following tooth. Surely, that is not clearance enough."

"Yes it is," said he. "As long as the distance from the cutting edge of the following tooth (*A*, Fig. 2) to the scale is less than the distance from the scale to the tooth in front (*B*, Fig. 2), you have clearance."

"But why was this mill ground like this?" said Jim, pointing to the mill he had first picked up.

"Some fellows have a wrong idea as to the amount of clearance needed, and that mill was not inspected after it was ground. It has altogether too much clearance; there is no support to the cutting edge, and the result is that it will get dull before it will do half the work it should. Let me take that flexible scale of yours and I will show you. There!" said he, now you can see the actual clearance it has when at work." (See Fig. 3.)

"Yes," said Jim, "that does look like too much."

"Now try the one here that I have just ground. See the difference? And there is plenty of clearance, too." (See Fig. 4.)

"I see that there is now, but at first I was inclined to think that you were joking with me. I have been sent for left-hand monkey wrenches, and to the blacksmith to get file teeth drawn out, and on other fools' errands, until now when I see or hear something that does not look just right at first, I am like the man from Missouri—I 'have to be shown.' Well, I have got these shanks about ground, and the next thing is to grind the teeth. I suppose that I will have to set that ma-

* Previous installments of this series of articles appeared in the numbers for August and December, 1909.

chine up as you have this one."

"No, I'll be through here in a few minutes and you can have this one. That one is all set up for grinding the teeth on the ends and I will finish my job in that. It will save us both work."

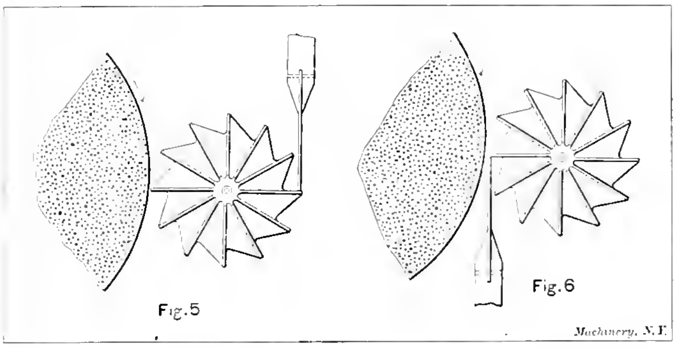
Jim wiped off the grinder and returned the gage and diamond to the tool-room and then started in to grind the teeth. As the machine was all set up he had no trouble at first, and he remarked to his friend on the other machine that "it was not such a very difficult job to grind cutters."

"No, the most important part is to get the clearance right and keep them straight. If they are not straight it is difficult to do accurate work with them."

"What is the best way to tell if they are straight?"

"Oh, just measure each end with your micrometer and keep them within a half a thousandth or so of the same size." Then as his job was finished he gathered up his work and tools and went away.

Jim got a two-inch micrometer and went over the mills he had ground and found that they were pretty straight. He



Figs. 5 and 6. Incorrect and Correct Methods of setting Tooth-rest

had only two more to grind the side teeth on, and one of them was the one that he had made the mistake on when he was milling it up. He put it in and started to grind it when he noticed that on one of the teeth the wheel did not cut at all, while it took a good cut off the others. He saw at once that something was wrong, and as John was still working on the surface grinder he took the mill to him and asked him what was the trouble. John looked at the mill and said, "Your machine is not properly set up."

"Why, it is just as that man who left a few minutes ago was using it, and he seemed to think it was all right."

"Well, I suppose it is all right for mills on which the teeth are evenly spaced, still I would rather have it set differently if I were using it, and not take any chances."

"What is wrong about it?"

"The finger which you use to index with should bear against the same tooth that you are grinding (See Fig. 6) and not on the opposite side, as it is now. (See Fig. 5.) With the finger, or stop, resting against the tooth you are grinding, all the teeth stand in the same position in relation to the wheel while they are being ground; while if it rests against any other tooth any inaccuracy in the spacing of the teeth makes an error in grinding. Of course, ordinarily the teeth of mills are properly indexed and it would make little difference, but you will occasionally find a case like the mill you have here, and also cases where the face of the teeth have been ground free hand, especially saws, etc., where it becomes necessary to grind new teeth because the old ones were worn too short to work good, and in such cases it is impossible to grind the mills or saws so that they will work good unless the tooth that is being ground is the one that rests on the index finger."

"I wonder why that man did not say something about that? He seemed to be a pretty good fellow."

"Probably he did not think that any of your mills had irregular spacing; or it may be that he never took notice of that feature. No one man knows all about this business, you know. We all have our failings and are never too old to learn something new to us and old to the other fellow. I have seen grinding machines put on the market by some of our most reputable machine builders, so designed that it was impossible to get the index finger underneath a cutter in the proper position. Still it is easy to demonstrate that it must be there to do good work."

Jim changed the machine by putting the arm that holds the finger into the binding socket from the bottom, then on re-grinding the mill be found that it acted differently. But on measuring the mill up with his micrometer he found that the tooth that was off in the indexing was apparently small, and he asked John the reason for that.

"That is all right," said John. "It is small because the two teeth you are measuring are not exactly opposite each other. If you had means of measuring the radius of each tooth, you would very likely find them all the same. If you doubt it, put the mill on the lathe centers, clamp an indicator in the tool-post and revolve the mill slowly by hand with the indicator just registering zero as the cutting edge of the tooth passes it and you will probably find that all of the teeth are of the same height."

"I think I understand what you mean," said Jim, and he went back to his machine and finished up his other mill, after which he called John over and asked him if the other machine was properly set up to grind the teeth on the ends. John looked it over and said, "I think it is, but we can tell better by putting a mill in and grinding it. There are two things to look after in grinding the teeth on the end of a mill. One is to get the proper clearance and the other is to be sure that the center of the mill is not higher than the outside. If the center is high it will not leave an even surface when at work; that is, if you were milling a plain surface on which it was necessary to take several cuts side by side you would find that the center of each cut would be low, leaving furrows on your work; while if the center was low this would not occur, so you see it would be better to have the center of a mill a little low, if anything."

"How do you tell when it is low?"

"By holding a straightedge across the two teeth that are opposite each other and noting that there is light underneath

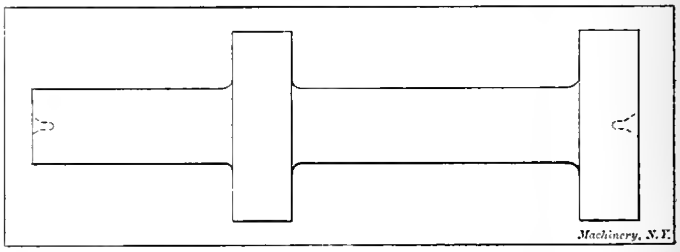


Fig. 7. Test Piece used to set Grinder Table Straight, prior to Internal Grinding

the straightedge in the center of the mill. Or, in case of an odd number of teeth, by rubbing the end of the mill on a plain surface on which you have rubbed a thin coat of prussian blue, then if the mill is properly ground the blue should show on the outer edges of the teeth and very little, if any, in the center. You very seldom find mills with an odd number of teeth, however, as it is difficult to measure the diameter of such mills, and unless it is necessary for some special purpose, they are not made. This machine seems to be all right, but a coarser wheel would be better, as this one is so fine that you are liable to burn the teeth if you are not careful."

"What do you mean by burning the teeth?"

"Why, drawing the temper from them. I don't suppose that it would be possible to burn steel in the way that it could be burned, or overheated, in a blacksmith's fire, by grinding. It is just an expression that machinists and toolmakers have coined for their own use and means heating the steel by grinding until its temper has been drawn. You will be able to notice it by the outer edge of the teeth turning blue."

"It seems queer to me," said Jim, "that this high-speed steel, which will remove chips of a blue color, could be injured by drawing the temper to a blue color."

"Well, to tell the truth, it does to me also, and I am unable to explain why it is so, but I do know that a great many brands of steel will not stand it. There are some brands of high-speed steel that the makers claim cannot be injured by heating on a grindstone or emery wheel, but I never saw any

that was improved by it, and I would much rather be on the safe side because steel on which the temper would not be affected will generally crack and check until the cutting edge would crumble away ,under a cut."

"But why is a coarse wheel less liable to heat a tool or cutter than a fine one?"

"A wheel for grinding metals is built up of numerous particles of abrasive material held together by a bond, or cement, and in a way could be likened to a milling cutter, as it actually cuts chips off, though, of course, they are very small and cannot be recognized as chips except under a strong magnifying glass. Now if you were to use a milling cutter with very fine teeth and force it to take all the cut it could, each tooth would cut until the space in front of it was full of metal when it could cut no more; then if it were not yet free to discharge this metal, or had not passed over its cut, it would have to carry the metal along rubbing hard against the work until it could get rid of it. By this time perhaps the metal is jammed in so hard that it sticks fast, and when the tooth comes around again it is already full and can only rub past the work, causing much more heat than it would if it could cut. On the other hand, take a coarse cutter and there is plenty of room for the chips, and each tooth can cut all the time that it is in contact with the work without crowding the space full of chips. It is the same way with emery, or abrasive, wheels; the coarse ones are adapted to remove metal fast without generating much heat, while the fine ones are more for putting a smooth finish on work, but they must not be crowded or the teeth will become full and the wheel will rub along instead of cutting freely."

Jim finished all the grinding on the mills and took them to Mr. Corbin, who looked them over and pronounced it a good job. "Now," said Mr. Corbin, "your surfacing mills are ready to be ground, and that will finish them. Take them over to the same machine that you used to grind the shanks on the end mills. You will find a chuck over there that will fit on the spindle of the head-stock; put that on instead of the driver, unlock the spindle so that it can turn, and shift the belt onto the pulley that is fixed to the spindle; then you can chuck the mills and grind the inside the same as you would bore them out in a lathe. There is an internal grinding attachment for the machine and you can get some one of the men that is working over there to show you how it is set up, as I have not the time now. I'll be over after a while and see how you are getting on."

Jim carried his work to the machine, put on the chuck and chucked one of the mills; then he asked John about the internal grinding attachment. John pointed it out to him, and told him that to put it on the machine he would have to remove the wheel from the main spindle and mount a pulley, which he showed him, in its stead; then turn the spindle head around and mount the attachment on the support provided for it and connect the spindle of the attachment to the main spindle by a belt. "Did you set the machine straight before you chucked your mill?" asked John

"No," said Jim.

"Well, you will find it a rather difficult job to get it straight unless you do it first."

"I don't know how to get it straight other than to set the graduations at zero."

"Here in this cupboard is a piece of steel that we use for that purpose. (See Fig. 7.) Take your mill out of the chuck and put this in instead, catching it by the small straight end; set it as true as you can and then take a cut off the two disks. When you have the table set so that your cut leaves both disks the same size, using a micrometer to measure with, the machine will be set to grind a straight hole. If you chuck the piece pretty true, you can get it nearly straight by noticing on which disk the wheel throws off the most sparks, and changing the table accordingly. Leave the big wheel on the spindle until you get the table set straight, as it will cut faster than the small one. When you are ready to put on the attachment, let me know and I will help you to get things right."

Jim got the machine straight in a short time and then removed the wheel and made the other changes that John had mentioned; then he called him over and asked him if he had things right.

"Yes, I think so," said John, "but you will have to get a new wheel, as that one is about worn out. Tell the stock-keeper that you want a wheel for internal work, if Mr. Corbin does not specify it on the order. You will probably have to turn it down with a diamond until it is small enough to go in the hole, as the wheels to fit this fixture do not come less than $1\frac{1}{2}$ inch in diameter."

"How would you chuck the mills?" asked Jim; "true with the outside or inside?"

"True with the outside first; then watch when you start grinding and if the hole runs out so that there is danger of it not cleaning up, chuck it so that it will, leaving the outside as true as you can."

"But how can you tell that it is going to clean up before it is finished?"

"Well, until you get enough ground out so that you can measure the diameter of the hole, or until the cut covers more than half of the circumference in some one place, it is simply a matter of judgment; but after that it is a simple matter that is familiar to most lathe hands. Measure the diameter of the hole as the cut leaves it and subtract this size from the finished diameter; the difference is the amount of stock on both sides of the hole. Divide the difference by two and add the result to the size of the hole as it measures; set a pair of common inside calipers to this size, using an outside micrometer to set them to; then if there is no place in the hole that the inside calipers will not touch, the hole will clean up. For instance, suppose you grind out one of the holes so that you can measure the diameter of your cut, and then set a pair of inside calipers so that you can just feel a touch with both legs resting against a ground surface; then set an outside micrometer to the inside caliper so that you can get the same touch as you did in the hole, read the micrometer and find that you have ground the hole to, say, 1.242 inch diameter. The hole is to be 1.250 inch when finished; then $1.250 - 1.242 = 0.008$ inch stock still to be removed. $0.008 \div 2 = 0.004$; $1.242 + 0.004 = 1.246$. Set your outside micrometer to this size and set your inside calipers so that you get a light touch on the micrometer; then with the inside calipers measure the hole, and if you find no spot where the calipers are free, the hole will finish all right. You want to be careful though that the wheel is cutting full size when you take the cut that you measure from, for if it should spring away from its cut for a thousandth or so your measurements would be off. It is best to have apparently a couple of thousandths to come off the lowest spot; then you are sure. You will find that internal grinding is different from outside work, especially in small holes. It is necessarily a much slower job and cannot be crowded if you expect to do good work."

"Do you use water?" asked Jim.

"No. On outside work water washes the grindings away and helps to keep the wheel clean while the reverse is the case with inside work. However, it is a good idea to cool the work with water before trying in a plug or hardened and ground sizer; for if the work was warm and you inserted a cold sizer that would just go in, unless you were pretty quick in pulling it out again, it would be very likely to stick, as the hole would close in and the sizer expand, on coming in contact with each other."

Jim got on pretty well with his work and had a couple of the holes ground when Mr. Corbin came to see how he was getting on. "You seem to be going at it all right," said Mr. Corbin.

"The credit for that is due to Mr. Cary, there, who showed me how to go about it. Where will I grind the ends?" asked Jim.

"On this same machine. There is an expanding arbor that fits the spindle in the place of the center; put that in and loosen the nuts that clamp the headstock and swing it around so that the graduations read 90 degrees, and clamp it fast again. Then slip one of your mills on the arbor and secure it by tightening the screw in the end of the arbor; take off the internal attachment and put the big wheel back on the spindle, then you can back the wheel away until it will clear the mill, set the stops so that one reverses the travel of the

wheel at the center and the other at the outside. Let your cut come on the side of the mill that is traveling upward. The mills should be ground so that they are square across the ends, or if anything a very little concave. When you get the ends ground you can grind the teeth on the cutter grinder that you used to grind the end mills on." With that Mr. Corbin left Jim to himself again.

Jim got the holes all ground out and the machine set up to grind the ends. As he started in to grind, however, he found that the head was not set quite right to get the ends square, and he made several efforts at re-setting it without much better results. John noticed him and coming up said, "Leave the head clamped as it is and make any other adjustment you wish by changing the whole table the same as you would if you were grinding a taper. The screw adjustment on the table is much more sensitive and it is no trouble to move it as little as you like. You want to be sure and keep your wheel clean at all times so that it cuts and does not glaze the work by rubbing. Glazing seems to set up a strain in the metal; sometimes enough to burst the mill lengthwise. I broke two mills myself in this manner before I found out the cause; the tool hardener got the blame for it, and at the time I thought he was to blame, but I have learned since, from experience and observation, that it was my fault. I have seen several mills that broke during the grinding operation or shortly after, and all that I ever saw had a smooth glazed surface and under close examination would show numerous small checks all over the glazed part. I never like to see a smooth glassy surface on hardened and ground work unless it is obtained by lapping, and if such surfaces are afterward lapped they will generally show up more irregular than one obtained with a sharp wheel. In thin work such as saws, templets, etc., if the wheel is allowed to glaze, or even approach that condition, the work is sure to buckle."

"Is it much of a job to grind the spiral teeth on these mills?" asked Jim.

"No," said John, "it is an easy matter. The only difference in grinding straight and spiral teeth is that for spiral teeth the index finger is secured in a fixed position in front of the wheel; then when the mill is pushed by the wheel, the face of the tooth resting on the finger, which does not move, causes the mill to turn just the same as it did when the teeth were cut. The top of the finger should be rounded slightly so that the face of the tooth bears on the center of it. The wheel should be trued off so that that there is only a narrow cutting surface, and the finger should be wide enough to allow the tooth to rest on it before the wheel begins to cut, which should be when the end of the mill approaching the wheel reaches the highest portion of the rounded end of the finger.

"How do you hold the cutter?"

"You can either put in on a solid arbor between centers, or there is a hollow arbor for that machine with stepped collars to fit the standard sized holes in cutters; this arbor slides on a round bar that may be mounted in a fixed position in front of the wheel. This latter method is the best as there is no possibility of getting one end of the mill you are grinding smaller than the other, in fact, nothing but straight mills can be ground in this way. Well; I have got my job over here finished and I'll have to pick up and leave. If you run into anything you can't master, let me know and I'll do my best to help you out."

"Thanks," said Jim. "I think I ought to be able to finish up this job without bothering anyone any more."

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As photographs are becoming more and more commonly used as evidence in legal cases, the *Engineering Record* calls attention to the necessity of having photographs thoroughly identified. Engineers and contractors who make a practice of taking photographs as matters of record would do well to have some independent representative present at the time each photograph is taken, so that he could go on the witness stand and testify that the views were taken in his presence and correctly represent the conditions on the dates when they were taken. Unless some such plan is followed the court may refuse to accept photographs as evidence on the ground that they are not properly authenticated.

TOOLS FOR DRAWING SEAMLESS AUTOMOBILE LAMP HOODS

WILLIAM A. PAINTER*

The drawing dies and punches for drawing a rectangular hood for automobile lamps, in one piece, are illustrated herewith. The advantage of a one-piece hood over the regulation built-up and riveted one is the convenience in cleaning, there being no seams or rivet heads to catch the rouge, cleaning compound or polishing cloth; in addition, the hood has more pleasing lines and greater accuracy can be obtained.

A rectangular shell or drawing is more difficult to produce than a circular one, especially where the corners or angles

Fig. 1. Punches and Dies for Rectangular Lamp-hoods and the Stock Before and After the Drawing Operations

have to be sharp, as the rapid flow of metal to the corners, when reducing from the flat, being out of proportion to the rest of the area, has a tendency to clog and tear the metal. This hood is made of brass, and measures 1 7/8 inch deep and 4¼ inches by 4½ inches across the sides; it is made from a round blank *A* (Fig. 1), the quantity not warranting a special blanking die attached to the drawing die.

The shell is drawn in two operations. Two dies of the same size are used, except that the drawing edges of the first die are rounded, while the second one is sharp. The cast iron shoes or holders are duplicates, and are made for a double-action press. The first drawing operation is made in die *D*, which is set in the holder in place of die *C*, which is the finishing die. The sleeve *B* is used in both operations. The

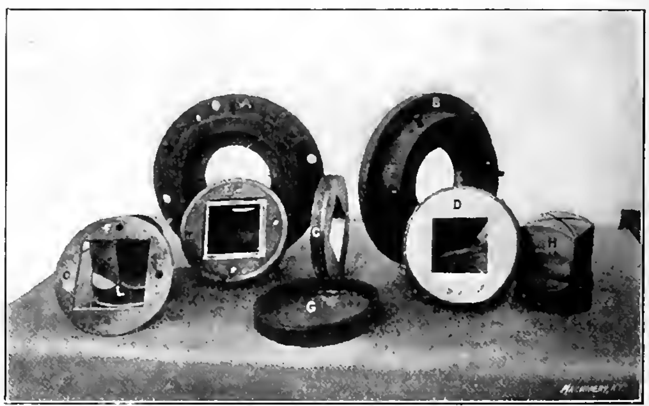

Fig. 2. Protective Shields used for Local Hardening and Dies with Shields in Place

blank *A* is held in place on die *D* by spring gage-pins, different holes being used for different depths of hoods. After the first operation, the flange on the shell is nearly rectangular in form, as shown at *G*. The flow of metal to the corners is also shown, proving that a circular blank is the correct shape, and not a rectangular one, as this shape would not draw at all.

The rounded punch *F* for the first operation and also the one shown at *E* for the second operation are both vented by holes and cross channels; the object of this is to prevent the punch from drawing the finished shell upward by suction on the return stroke of the press. The holes alone would not be of any advantage, as the sheet metal would cling to them and stop the passage of air, but with the channels this is overcome.

The first operation draws the shell to within 3/16 inch of

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full depth. The shells are then annealed, and the sharp draw-punch *E* and the die *C* are put in the press. The shell enters the die and rests on its flange, and is held by a sleeve while the punch enters. This operation sharpens the edges only, as the drawing of the metal has been accomplished in the first drawing die. The partly completed hood is shown at *H*, while different views of the finished hood are shown at *J* and *K*.

The dies and the sleeve are held in place by six half-inch square-head screws. The cast iron holders are bored straight to fit the dies, which are beveled five degrees in the center of the rim, leaving about 5/16 inch of straight surface at the top and bottom as shown at *C*, Fig. 2. This straight surface is an easy fit in holders *A* and *B* so that the dies can be revolved when the screws are loosened; the object of this is to permit first tightening the punch on the thread of the plunger when setting up tools, without regard to the relative positions of the die and sleeve. When a shell is put in the die and the bed is set to match the screws in the bolster, if the die is free it can be revolved until it matches the punch; the punch is then entered into it and all screws are tightened. This operation is repeated on the sleeve or pad, and it eliminates packing the punch with washers to make it line with the die, as well as the risk of the punch jarring loose and breaking the die or sleeve.

These dies were hardened by my local hardening process, as the shape and angles of the disks would make it a hazardous operation to harden them in the regular way. [For a description of this hardening process see Mr. Painter's article on Local Hardening and Tempering, August, 1908.—Editor.] The dies are 9½ inches in diameter, 1¼ inch thick, and only 1½ inch from the corners of the rectangular hole to the outside, so that the strain in hardening would be at these sharp corners.

The face of the die with one of the steel covers used in the local hardening process in place is shown at *D*. The back of another die when covered to within ½ inch of the square hole is shown at *E*. There are four ½-inch holes in this cover to equalize the cooling. The covers for die *C* are shown at *F* and *G*. These are the same as those shown in place at *D* and *E*. The thickness of the stock from which these covers are made is 0.025 inch. The band *G* is slit with shears and held together with rivets.

These dies were heated in a gas oven and then dipped in clear water. They did not shrink or warp, and have been used for drawing thousands of hoods. The punches *H* and *L* have machine steel bodies and tool steel working ends. The ends are hardened on the outside only, sheet steel being applied to the back of them when hardening. All these covers were put on before heating the parts and were dipped with them. The temper was drawn to a light straw color after the covers were removed.

* * *

At a recent exhibit of gas appliances in New York, certain power-driven machinery was shown, having exposed bevel and sprocket wheels in operation. To prevent accidents to visitors, they were protected with wooden shields, sufficiently to keep the inquisitive sightseer out of harm's way. In regular manufacturing use, however, we infer that these potential instruments of accident are absolutely unguarded, so far as the maker has provided. The extra cost of providing efficient gear guards would perhaps be two or three dollars at the most. What is the use of saving a few cents where the saving may mean the loss of a finger, hand or arm? Even if the humanitarian aspect is ignored, it is poor business policy of the user to let such man-traps exist, and he has a right to expect the manufacturer to supply his machines guarded in all respects where possible. Damage suits are ugly affairs; the defendant is beaten even if he wins because the ill-will and hatred engendered will cost him much in the end.

* * *

The value of the imports of machine tools to Hungary, according to recently published statistics, amounted in 1907 to about $900,000. Machines to a value of about $500,000 were imported from Austria, $325,000 from Germany, and only $58,000 from the United States. Recent developments show that Hungary offers a fair field for the machine tool trade.

YOUNG BRAINS AND OLD

A. S. ATKINSON*

It goes without saying that the young man has a better chance to-day than the old chap who has passed fifty, and when you get past the latter age, woe be unto you if you lose your job. It doesn't seem to matter very much that our grandfathers took more stock in age than in youth and looked upon the man under thirty as of little real account in the business and manufacturing world. Age meant maturity of judgment, and one couldn't be sure of himself much under fifty. So they put out their sign of "Slow and Sure."

Now we have reversed conditions, and every shop and business concern is picking up the young man and dropping the old. Of course some old codgers can't be shelved. They simply bob up smilingly and get there just the same. Nevertheless, the old sign has been reversed, and we read the warning, "Young men wanted; no old men need apply."

Well, of course, that's all right if everybody believes that a man of fifty has lost his usefulness and is chiefly good for holding down cheap jobs that an office boy fresh from school could do as well; but sometimes the "Oslerizing" process may be carried a bit too far. I suppose I am particularly interested in it because of the story about "Old Si Smith," which I related in a recent number of MACHINERY, and of another little experience of "Pop" Lester's, who took his medicine like a man and then got cured of the "old age delusion."

"Pop" was superintendent of the big machine shop whose sooty black smoke can be seen any day clouding the atmosphere up on the Hudson, just far enough beyond the city line to escape the Health Board's edict that nobody shall burn soft coal in the metropolis. This shop is one of the oldest in the country, and it had the reputation of doing some of the finest work on this side of the Atlantic. The old man who built it up had made Pop superintendent way back in the eighties, and under his wise management the profits had been large enough to please anybody except a modern millionaire's son anxious to get the record for fast spending.

Anyhow, when the old man died and the young chap inherited the fortune and the big machine shops, there was bound to be some sort of a change. The youngster came down to look the shops over, and brought an expert with him. They went through the shops, under the guidance of Pop Lester, the superintendent, and the way they commented on the machinery and equipment was enough to drive a good machinist crazy. "Antiquated," "Out of date," "Fit only for the scrap-heap." These were a few of the epithets they used, and Pop winced and bit his lips. He tried to explain that some of the machinery was almost as good as new, and that all of it was doing first class work.

They didn't listen much to these apologies for the machines; they had a reason for their inspection. It didn't come out right away, but after a while it leaked. The young heir wanted to increase his profits, so he could spend a few more dollars on Delmonico dinners and chorus girls, and the machine expert was looking for a good fat job as superintendent and incidentally for some liberal commissions on machinery. They both had their way in time. Pop was kindly and thoughtfully relieved of his position, the young owner explaining plausibly that he wanted the shops run on modern methods, and he thought a young superintendent could do the trick better than an old man. His father had been all right in his day and time, but things had changed a good deal since he was a young man. The shops were in a bad way, and were not making half what they should. He had figures and facts to show it. Here they were, if Pop wished to examine them.

The old superintendent was too surprised and dumbfounded to protest or even to examine the paper shoved toward him. You see he had been the head of the shops so long that he had got into the habit of considering it a life job. It would have been, too, had the old man lived.

Pop wasn't exactly turned loose to shift for himself. That youngster condescendingly said that the deposed superintendent could take a position in the drafting-room, where he

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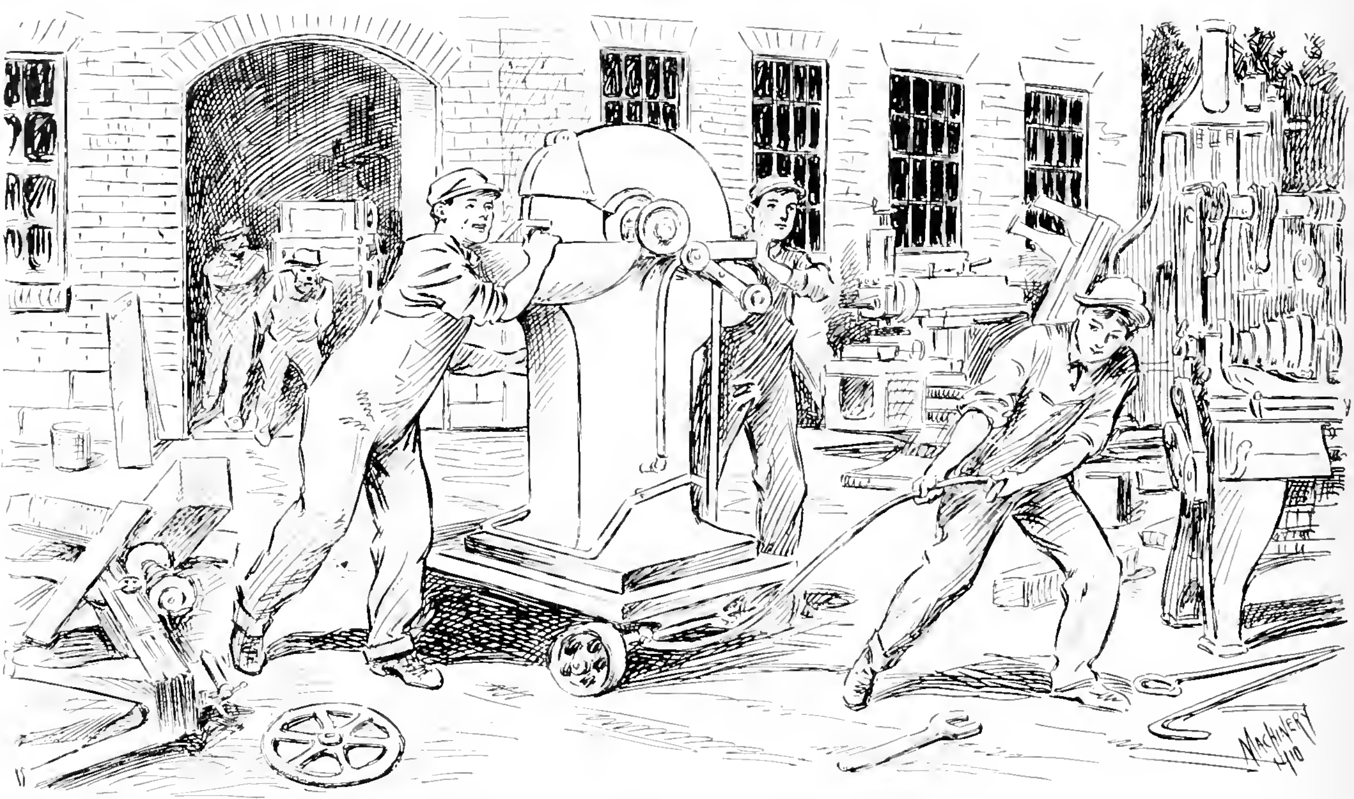
could make himself useful at twenty per week! Think of it!—when his salary had been running into figures that would pay for a first-class automobile once a year!

We felt sorry for the old man, every one of us, but we had too much to think about in holding down our own jobs without openly rebelling for the sake of another. Pop had been kind and considerate to every one of the boys, and we didn't forget it now. We went round in a delegation and asked him what we could do for him. Go on strike? "Good Lord, boys, no!" he said. "We never had a strike in these shops—not since I've been here—and I'm not going to be the cause of one. Go back to your work and hold your own jobs. I'm mighty thankful, however, for your expression of confidence in me—mighty thankful."

The new superintendent was about as boyish-looking as the young owner of the shops, but a little bit shrewder and more experienced. He knew more about machinery than his employer, and possibly more about men and business. At any rate it had all been framed up before he took hold, and the first thing they did was to rip out the old machines. Say, it was a waste of good material, and it gave you a real heartache to see the machines smashed up and carted away. Why, orders ahead had to be cancelled, and others we lost through delay, so the contracting parties threatened to sue the young owner. There was a lot of legal quarreling, and a good deal of trouble all around. The young superintendent, I guess, hadn't figured on the loss of time the big change would make, and neither had the owner.

Well, things finally got started. We had a few new orders, and we started on them. But all that machinery was new to many of the men, and they had to go slow. The young superintendent told the foreman of the shops that he had to make up for lost time, and he tried to push us, but you can't be pushed when you're riding a new horse, and we had a lot of breakdowns and ruined much work. The more the foreman drove us, and the more the superintendent fumed and threatened, the worse we seemed to get, and the new machines showed they were nervous, too, or something like it.

Then pretty soon another trouble followed. Some of the work the shops turned out wasn't satisfactory and didn't come up to specifications, and the buyers refused to pay or threatened to sue the shops for swindling them. Now the old man had earned the reputation for superior work in the past, and his name stood for more than most people's bond. When



"Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in"

some of them weren't more than a year or two old, and some had done good service for five years and were good for five more. Some of Pop's old pet machines, a big jig-saw and a boring mill he'd had for ten years, were a little out of date and had been patched up some, but they hadn't lost five days for repairs or breakdown in all that time.

Pop had been a little economical in a way; he always hated to turn down an old machine for a new one until he was pretty well satisfied its days of usefulness were gone. I suppose he looked at 'em most as he looked at himself. A machine must wear out in time, and if you keep it long enough it will get out of date. But it isn't good policy to hurry it along to the scrap-heap too fast. Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in. But he had nothing to say and the machines were sold for scrap and for second-hand machines, just as bidders chose. The new machines came in and were put up by experts. They looked all right, and were all right, and they had many new improvements. Some of 'em could do double the work, and I guess it was only a question of time before the young owner would find his profits increased. But we lost a lot of time making the change. Some of the an article came out of his shops and bore the name of the firm, it was accepted without question everywhere. This reputation meant a lot more to the shops than the young owner realized. At first he told the kickers to go to some hot place, and the others he defied in court and got all he wanted of such proceedings. I suppose he had to have the experience to cool him down and make him understand that even a millionaire isn't the only toad in the big business puddle.

Things went from bad to worse in this way, and by the time we got used to the new machines the shops had a dozen lawsuits on hand and a lot of rejected junk that buyers had shipped back to us. But worse than all this, we'd tarnished the reputation of the old man's shops for first-class work. I guess instead of increasing his income, the new superintendent had cut a pretty big hole in his employer's bank account.

We heard something about this from their talk around the shops, and they put their heads together to find some remedy. The first thing we knew about it was they'd decided to cut wages. That was something that had occurred only twice in the history of the works. Once when hard times hit the business world, the old owner had appealed to us, and said he'd have to cut wages for a time to prevent losses, but he'd restore them within six months or a year. This same thing

happened ten years later, and each time we met the cut with a smile and assured the old man it was all right. He'd stood by us, and we'd stand by him. But now nothing was said about restoring the wages later. Indeed, when our committee spoke about it, they were pretty nearly kicked out of the office, and told to mind their business or they'd be "chucked" out body and soul. Pleasant, wasn't it? Just the sort of "dope" to make self-respecting workmen love their employer. We did, of course, and stood ready to grovel on the ground before him. We talked it over, and decided that for the present no strike would be called. We felt proud of the reputation of the shops, and didn't want to disgrace them. We stood it quietly for six months, and then we asked again if wages would be restored to their old standard pretty soon. We got our reply all right, and it was right in the face. It came in the form of another cut, and a pretty deep one. We couldn't stand for that, and we struck—every mother's son of us. We walked out and let the machines stand idle, and then the most distressed man around the diggings at that time was Pop Lester. He was genuinely sorry and worked up. He went around among us and begged us to refrain from any violence. He tried to excuse and apologize for the young owner and the new superintendent. But there wasn't much to say in their behalf, and Pop had some pretty weak arguments to present.

A big strike in a machine shop isn't an easy proposition for any employer to face, and that kid and his kid superintendent found before they were through they had to do some hustling. You can't pick up five hundred skilled workmen every day in the year, especially when the wages offered were small. So the strike drifted on for several months, and then to six months. The plant was losing orders right along, and it was costing the owner a pile. I guess he had to cut out some of his expensive dinners and chorus girls.

It was the most peaceful strike I ever saw. Pop was around night and day, and we listened to his advice and kept from doing any harm. They managed to get a dozen or two men in the shops, but they ruined more work and machines than anything else. Then one day Pop Lester came around with a more serious look on his face than ever, and when he got enough of us together, he said: "Boys, I want you to go back to work to-morrow—for my sake."

"Too much to ask, Pop," somebody yells out. Then another says: "If you'll be superintendent of the shops, we'll go back at the old wages."

The old man smiled and answered: "That's just what I came to tell you. I've got back my old job, and I want every man here to get his, too."

There were plenty of wild cheers then, and some of them were so noisy that we had to wait a long time for the old superintendent to finish. "You will have to go back at the lower wages," he continued, "for the plant has lost lots of money, but as soon as we get some of it back, we'll restore wages."

Did we go back? You bet! The next morning every man was in his place, and things began to hum. Pop was kept as superintendent after that until he died; and as for that youngster, he learned his lesson, and now before making a big change he always consults with his old reliable guards.

* * *

The use of lava for gas burner tips dates from 1854 when J. von Schwarz discovered its advantages for the purpose. The lava is found in Bavaria at the southeastern point of the Fichtel Mountains, near Bayreuth. It has been used for hundreds of years for musket balls, marbles, fireproof utensils, carved ornaments, etc., being readily turned, sawed and polished. It does not disintegrate with long-continued and repeated heatings, and its smooth non-porous surface prevents carbonization and deposits from the gas.

* * *

The value of the yearly import of machine tools to Spain amounts to about $600,000, and Germany supplies more than one-third of the machine tools imported. Apparently Spain offers an opportunity for the increase of the foreign trade of the United States in machine tools.

JIGS IN A REPAIR SHOP*

A. H. LAVERS†

That jigs are an indispensable factor in economical quantity manufacturing is undisputed. As a necessary element in repair machine shops that are a part of any manufacturing establishment, where the shop is used merely in repairing and building additional equipment, the use of jigs has apparently been neglected to a greater or less extent. This applies particularly to plants in which repairs must be interchangeable and effected at short notice.

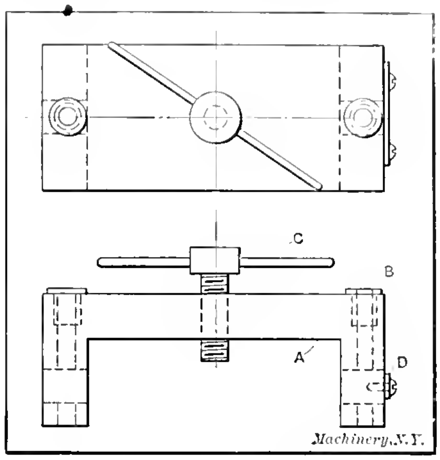


Fig. 1. Simple Form of Jig for Drilling Two Holes in Shaft Ends

In the case of pipe flanges and fittings, or standard parts, it pays to make up fairly expensive jigs, as a standard once established can rarely be altered without causing confusion. The cost of jigs for parts of machinery constantly undergoing changes and improvements, is usually the most important feature, although the time element in duplicating parts must not be lost sight of. Another point that undoubtedly has a bearing on the question is to make the jigs as simple and fool-proof as possible, thereby permitting the employment of unskilled labor in drilling operations and minor lathe jobs.

As a usual thing, repair shops of this character are supplied with drawings of a machine and an order to build one, which, if satisfactory, would necessitate the building of several more. At once the question presents itself: If the machine is satisfactory, what parts will wear out, call for replacement and the use of jigs in repair? This must be decided and then the simplest possible design of a satisfactory jig should be made.

It is good practice to leave the judgment of matters of this kind to some one man who is familiar with the particular shop's practice, but entirely independent, and who, also, has an opportunity to study the machines in operation in both the machine shop and the factory.

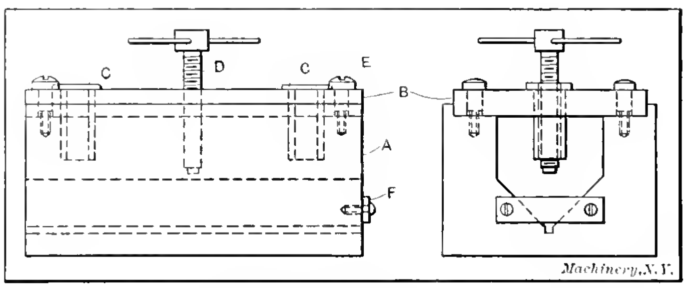


Fig. 2. Jig with Removable Top and V-shaped Locating Surfaces, for Drilling Shaft Ends

A great help in production of work of this kind is to have an equipment of reference gages for press, running fits, etc., standard reamers and tram-rods for bores or parts of large diameters. It sometimes helps to economize by combining several operations on different machines in one jig, and further on some illustrations of this will be presented. Once in a while a job will present itself in which the first number of duplicate parts required will run up in the hundreds, and then a dozen pieces that are duplicates are required at frequent intervals. This, of course, allows the expenditure of a little more money to decrease the first cost of

* For additional information on this subject, see the series of articles on Jigs and Fixtures which began in April, 1908, and other articles referred to in connection with the first installment of this series.

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production, thereby giving a little better price to succeeding pieces.

The writer will, in the following illustrations, endeavor to present a number of simple jigs covering various operations. It is not claimed that there is anything strikingly original about these jigs, but simply the adaptation of simple means

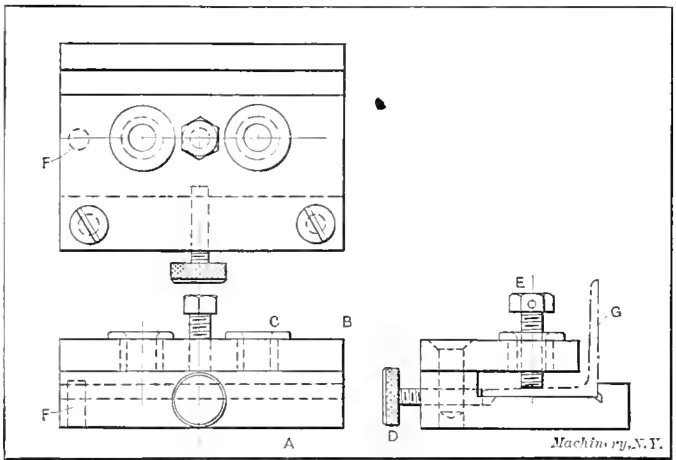
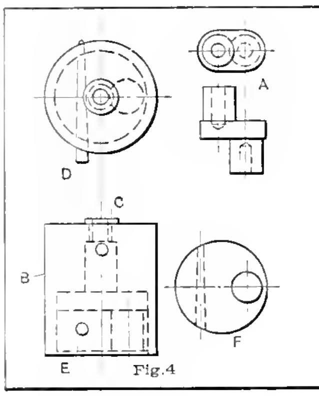


Fig. 3. Simple Jig for Drilling Accurately-spaced Holes in Angle-iron

to produce interchangeable work. It is also intended to include in this article some examples of simple lathe and boring mill chucks, which, while they are not, properly



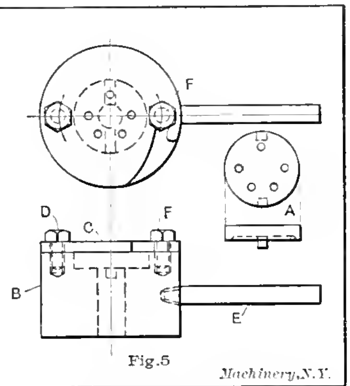


Fig. 4. Ingenious Form of Jig for Drilling Crank A

Fig. 5. Jig with Hardened Plate which guides the Drill and clamps the Work

speaking, jigs, are an important aid to the production of interchangeable parts.

The jig illustrated in Fig. 1 is for drilling two holes at the ends of a piece of shaft, and, as may be seen from the illustration, it is of the simplest construction. The body *A* is of U-section and in it holes are drilled to receive the work. Two holes are drilled at right angles to the shaft openings, and are counterbored to receive the bushings *B*. The shaft is clamped by screw *C*, and located by stop *D*. It may be worth mentioning that the body was made of an old casting which happened to be available, and the same thing is true of several of the other jigs illustrated. It is a distinct advantage to use patterns of machine parts to make jigs of, if possible, and in a fairly large plant with a variety of machines, the number of patterns that are available for such purposes is surprising.

Fig. 2 is a sketch of a jig that was made to accomplish a purpose similar to that of Fig. 1, but it has an advantage that will be noted. The surface against which the work is clamped is V-shaped, and the body *A* is provided with a removable top plate *B* in which the drill bushings *C* are located. This plate may be taken off and another one substituted with a different size and spacing of drill bushings, thus making the jig available for one or more jobs. In this particular case, it was possible, by this method, to use this jig for over twenty-five similar pieces of work. The fitted screws *E*, locate the various plates *B*, while *F* serves as a stop for the work.

The writer is aware that there are various simple adjustable center distance jigs that could be devised, but his experience has been that it is rarely possible to produce duplicate work economically with unskilled labor when using such jigs. It is almost impossible, without the use of precision measuring tools, to adjust a jig twice alike, whereas by the use of the plate *B* in Fig 2, an error made in the plate is not increased in the work, measuring is avoided and there is not the possibility of having the errors one way one time and another way the next.

In Fig. 3, we have another extremely simple jig that serves its purpose excellently. It is used to drill an angle iron in which the holes must be accurately spaced. *A* is the body, *B* is the cover containing the drill bushing *C* and the clamping screw *E*, and *D* is also a clamping screw with a knurled head. The angle iron *G* is placed against stop-pin *F* preparatory to clamping.

In Fig. 4, the extreme simplicity of this jig is its principal charm. It is used to drill a hole in each end of the lubricator crank *A*. The drill bushing *C* is centrally located at the top of body *B*. Beneath this bushing there is an enlarged hole to accommodate one leg of the crank. The other leg is placed in the piece *E*, which is shown in plan at *F*. This piece *E* is held in place by the dowel-pin *D* and it is a neat sliding fit in body *B*. The hole drilled in the body just under the bushing *C* is to allow the chips to escape. Incidentally, it should be noted that this jig represents about three hours' time for its construction; it paid for itself on its first job.

A jig is shown in Fig. 5 that is built on a different principle. It was designed to drill the pneumatic valve shown at *A*, which is a disk having five 1/8 inch eccentric holes and two lugs. It is finished on one face, on the side, and on the small surface shown on the other face. To drill the disk, it is placed in body *B* which is counterbored to fit it and which has corresponding recesses to receive the lugs. The cover *C*, which is hardened, acts both as a series of bushings and as a clamp. This cover is rotated on the screw *D* to permit the removal and replacement of work. The opposite screw *F* clamps the cover securely in position after the work is in place. A half-inch pipe handle *E* is provided simply for the operator's convenience.

As noted in the first part of the article, some jobs call for a considerable number of duplicate parts and permit the construction of a more complicated jig. This is illustrated by Fig. 6. The requirements call for four holes of different sizes to be accurately drilled in a machine steel link. This is a fixture with an eccentric clamping device of original

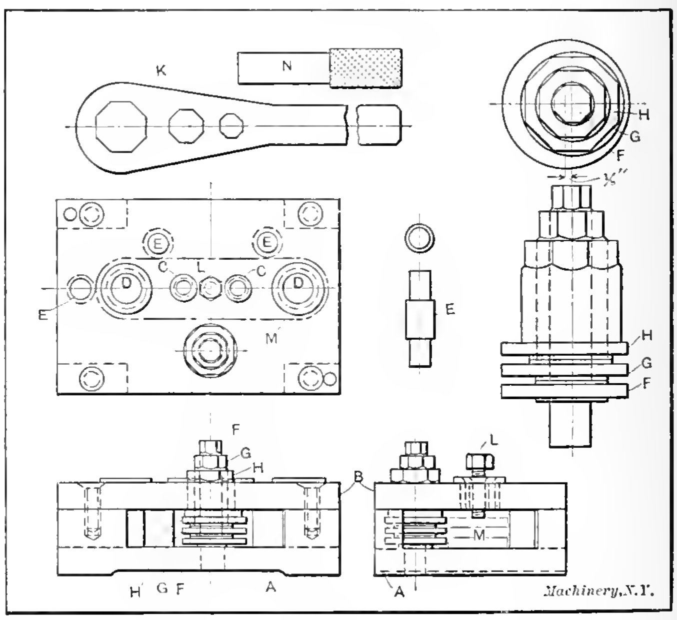


Fig. 6. Jig equipped with Unique Type of Eccentric Clamping Device

features. *A* is the body; *B* the cover; *C* are the smaller drill bushings, and *D* the larger ones. There are three stop-pins *E*, which are light press fits in both cover and body. There are three eccentric clamping disks *F*, *G*, and *H* (see also enlarged detail). Disk *F* rotates on *G*, and *G* on *H*. An extension on *F* rotates in the body *A*, and the larger extension

of H in the cover B. There is an octagon on the end of each disk spindle, and a wrench K with corresponding holes to fit each. The links M to be drilled are shown in position, three being drilled at one time. This arrangement of eccentrics gives an independent side clamp for each link, thus allowing for any irregularity in width. The clamping screw L has an octagon head to fit the smallest hole in wrench K. A plug N is placed in the first of the larger holes drilled, to prevent the pieces from working when drilling the other holes, although the work has been satisfactorily done without it.

In Fig. 7 there is shown a casing for a reversing mechanism and in Figs. 8 and 9 two jigs, the former being a boring mill jig, and the latter a drill jig for drilling the flange holes in line with the bearings. The casing is composed of three parts: A, B, and C. As will be noted, this casing has four bearings in it, two of different sizes in A, one in B of the same size and in line with the smaller bearing in A, and one in C, in line with, and the same diameter as, the larger bearing in A. The holes at X and Y are for fitted bolts, used instead of dowel pins, and the other ten holes shown are clearance holes for through bolts. As will be shown later, the fitted holes serve a double purpose. The casings are made male and female at the joints, and these are turned to close limits, A and C being alike, and B fitting into them.

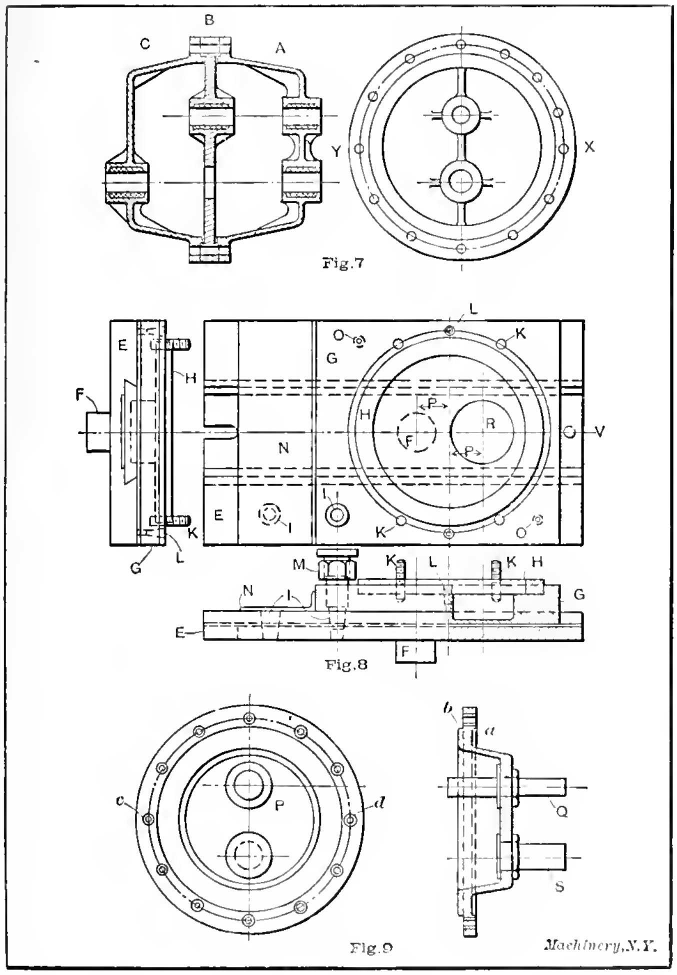


Fig. 7. Casing with Drilled Flanges and Bored Bearings. Fig. 8. Jig in which Bearings are bored. Fig. 9. Jig in which Flanges are drilled

In order to properly set forth the features embodied in these designs, it will be necessary to describe the boring mill jig, then the drill jig, and afterward give a short description of the operations. In Fig. 8 E represents the body of the boring mill jig, in which there is a tapered slide on the top side, and a pin F on the other side to fit the hole in the table of the boring mill, thereby centering the body E. The slide G works in and is closely fitted to E. This slide is counterbored to fit the male part of the joint in casings A and C on the longitudinal center line and midway between the bearings in the casings. The removable ring H is closely fitted to G and projects just enough above G to fit the female joint on part B. By removing H, G becomes the opposite of the joint on A and C.

Two tapered holes I have a center-to-center distance equal to that of the bearings in the casings. Four removal studs K are made somewhat smaller than the bolt holes in the flanges of the casings to hold the latter in position after they are located in the jig. There is a tapered hole L on each side of G, and these serve to center the casings and always bring the bearings in the same relative position. The pins are parallel and closely fitted where they go through the casings, and

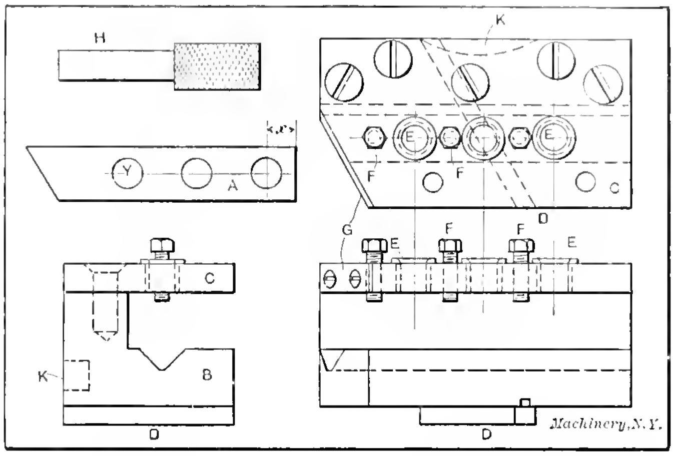


Fig. 10. Combined Drilling and Milling Jig for Part A

tapered below that to fit the holes L. A tapered pin M fits holes I, and is parallel where it goes through G. The nut shown is for the purpose of releasing it; the head is simply a projection to allow M to be securely driven into G. The locating pin that fits the tapered hole L, and also the reamed holes X and Y (see Fig. 7) in the casings, is similar in construction to M, but smaller. A protection strip N prevents chips from getting into hole I, and the working part of the slide E. R is simply a clearance hole in G for the bearings.

In the drill jig shown in Fig. 9, the casing P is the principal part. This casing is recessed at a to correspond to the male part of the joint on casing A and C and at b to fit B. The pin Q on the inside of the jig fits the bearing in B, and on the outside the small bearing in A, while S fits the large bearing in A or C. When drilling C, pin Q is removed. There are twelve holes with bushings shown; the two at c and d are removable to allow smaller bushings to be inserted, in order to first drill and then ream these two holes for the fitted

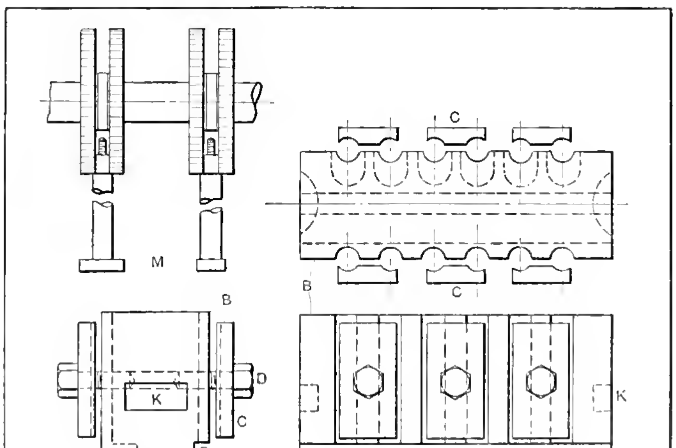


Fig. 11. Fixture for Milling Square X on Bolts A in Correct Relation with Rectangular Heads

bolts previously referred to. A brief description of the boring and drilling operations will make clear some of the uses of various parts of these two jigs.

When machining a new set of casings, the studs K are removed from the boring mill jig, and placed in the tapped

holes O, and the ring H is also removed. The casings A and C are first finished on the faces of the flange and tongue, and the bearings rough babbitted. Either casing A or C, as the case may be, is then placed in the boring jig, and the bearings approximately lined up with the center line V. The casing is then clamped on the jig by means of U-clamps placed over the studs K in the tapped holes O. The bearings are then bored; first the one in line with F, and then the other, after the slide is shifted to the next location by inserting pin M in the other hole I. The drilling jig is now placed on the casing and pins Q and S are inserted in the bearings, thus locating the holes in the flange with reference to the bearings. All the flanged holes are drilled and holes X and Y are reamed. In case of repair to the bearings, the casing A or C is located on the boring jig by the pins that fit into the reamed holes X and Y, and in the tapered holes L in the slide G; the casing is then clamped by means of studs and nuts K in position in the boring mill jig. Thus one jig

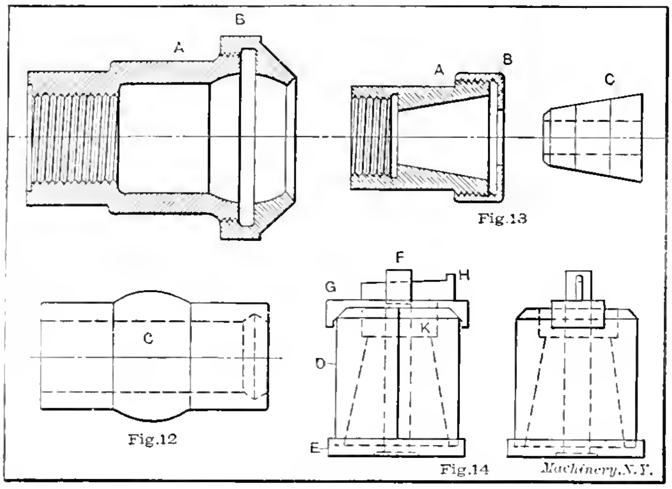


Fig. 12. Simple Chuck in which Bearing C is bored. Fig. 13. Chuck for Boring Part C. Fig. 14. Babbitting Jig in which Part C is cast

is dependent on the other. When casing B is to be bored, the ring H is placed in the position shown in Fig. 8, and then the operation is the same as described for A and C. By the use of these jigs, it is possible to produce new work or repair the bearings in the old casings at any time, and they will be interchangeable. The bearings are, of course, bored to gage.

In Fig. 10 we have an example of a combined milling and drilling jig. The work A consists of a round piece of tool steel, one end of which is to be milled at an angle and accurately spaced from the center lines of three holes to be drilled; the distance x on the work is immaterial within 1/8 inch. B is the body of the jig, having a V-slot cut in it to center the work, and a recess K in the back to clamp it to the table of the machine. A clamp on the other side rests on the jig near the V-groove. In the top-plate C the drill bushings E, and the clamping screws F are located. A removable piece D is recessed into B and made to fit the table slots in the milling machine, thus setting the work at the proper angle; during the drilling operation this piece is removed. The milling cutters are set against a hardened strip G to secure the proper distance from the center line of the first hole and the angle of the cut. After the stock is cut off with a power hack-saw it is clamped in the jig a certain distance from the last hole in the end; this distance is equal to X with an allowable variation of one-eighth inch. The hole Y is first drilled, and then the plug H is inserted to prevent the work from moving. The other holes are then drilled. After the required number of pieces are drilled, the piece D is fastened to the fixture, which is clamped to the milling machine table. The end of A is then milled, plug H locating the holes with reference to the cut.

Fig. 11 shows a milling fixture in which the work A is milled square at X, and at a certain relation to the rectangular head. The body of the fixture is recessed on its sides to a depth equal to half the diameter of the bolt. It is also recessed on the bottom at H to correspond to the longer side of the rectangular head, and at G to fit the shorter side. This is shown plainly at E. The bolts are held by clamps C and clamping screws D. A projection F fits the table of the milling machine. Recesses K on each end of B are used to clamp the fixture to the table. The first and second settings of the bolts are clearly shown by the diagrammatical view at M, making further explanation unnecessary.

A simple chuck is illustrated in Fig. 12 for boring the bearing C. This bearing is first turned all over on the outside by a forming tool and then mounted in the chuck. The body of the chuck A is threaded on one end to fit the spindle of a 16-inch lathe, and it is bored out on the other end to fit the parallel end of C. B is a cap screwed onto A and bored to fit the spherical part of C. Thus when C is placed in chuck A and cap B screwed home, it clamps the work on the spherical part; the parallel part is also effective in centering the work. This chuck is extremely simple, yet very efficient.

The chuck shown in Fig. 13 is similar to that in Fig. 12, except that the work is tapered, C being the work, A the body of the chuck threaded to fit a 16-inch lathe, and B the clamping cap. As the work, in this instance, is of composition, the babbitting jig used will be of interest and is illustrated in Fig. 14. The base E is counterbored on the under side to receive the head of pin F, and on the top to fit shell D. This shell is split through the center and tapered at the top to correspond to the taper on G. Pin F, which acts as a core, is slightly tapered, and has a slot in the top so that by driving the key H in, G, D and E are securely clamped together, making a solid box. By removing H, the box falls apart and F is easily driven out of the work A. The parallel part K of the top is to allow chucking in the lathe for forming.

In summing up, the important points to be observed in repair shop jig design, are: (1) Simplicity; (2) minimum cost; (3) ease of operation consistent with cost; (4) use of machine parts or patterns already made, in designing fixtures, when only slight modifications are necessary; (5) the co-operation of the machine designer to secure simplicity in parts; that is, a number of simple pieces in preference to one complicated piece of mechanism, thus helping the shop side of the question; (6) the combination of a number of different machine operations in one fixture, if this can be done at a minimum cost, as a small loss of time on the machines, due to changing, is not noticeable in comparison to a high fixture cost for a few pieces of work; (7) comparative interchangeability; that is, good enough for the intended work but no more, as going to extremes in this line of work is particularly objectionable.

* * *

It appears that Australia intends to take a prominent place in the development of aerial navigation. A consular report states that Messrs. Walter Thompson and F. A. Boyd of Perth, West Australia, have developed certain designs and models for aerial navigation machines, including, among other inventions, a novel steering apparatus, a "fulcrum" by which an aeroplane floating and soaring in the air will maintain a condition of perfect equilibrium, and a simple and safe design, making it possible to attain speeds with aeroplanes higher than those hitherto attempted. A company has been formed in Australia, and a member of this company has left for England in order to exploit the inventions there. With no other details than those above at hand, it is, of course, impossible to say whether or not the inventions are of practical value and importance.

* * *

Perhaps there is no other feature of marine architecture about which there is so much doubt as the propeller, nor any feature more important to-day in the matter of efficient propulsion. An excellent illustration is the recent improvement made in the Cunard steamship *Mauretania*, by the change in her low-pressure propellers from three blades to four blades. They were made with other changes in design in accordance with a formula deduced by one who made a special study of the subject. The increase in speed is remarkable considering that the *Mauretania* had already exceeded the limit imposed by the contract of the Cunard Co. with the British government.

NEW SPUR GEAR GENERATING MACHINE

JOSEPH G. HORNER

A new spur gear generating machine (the Sunderland patent) is being manufactured by Messrs. J. Parkinson & Sons, of Shipley, Yorkshire, England. There are several bevel gear generators in the field, but few as yet for spur gears, the reason being that the objections to the use of single rotary cutters are not so great when spur gears are cut as when they are applied to bevel gears. Still, the growing demands for teeth of ideal accuracy for high-speed gears includes spur teeth, and the use of the single rotary cutter introduces elements of slight inaccuracy which are inconsistent with the ideal. The Fellows' machine has been familiar for many years, but the greatest impetus to generated spur gear teeth was given about three years ago when German designs of machines for generating these gears by hobbing were introduced. This lead has been followed extensively in England and the United States. The Sunderland spur gear generating machine is designed to avoid the difficulties which have arisen in the operation of the hobbing machines. These were principally the cost of hobs, which is high, due to the difficulties in hardening and grinding them, and to the heat generated in heavy cutting, which results in inaccurate gears. In the Sunderland machine a rack-shaped cutter is employed, containing six teeth hardened and ground. Its cost is only about one-fifth that of a hob, it is easily re-sharpened, and less heat is generated in cutting, while increased output is claimed.

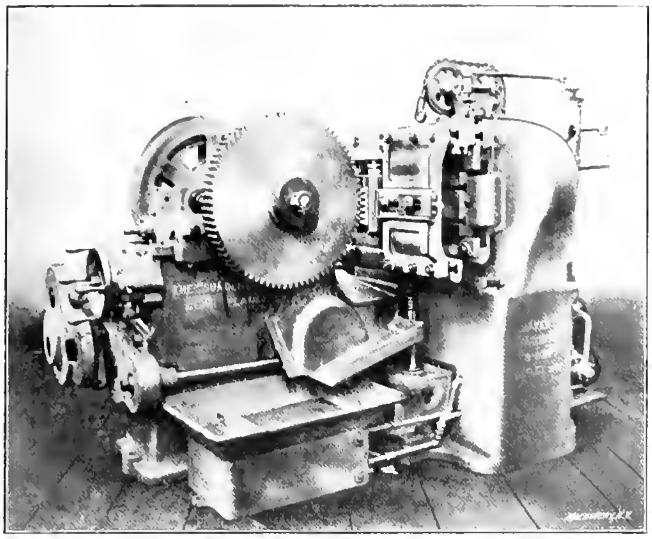


Fig. 1. The Sunderland Patent Spur Gear Generating Machine

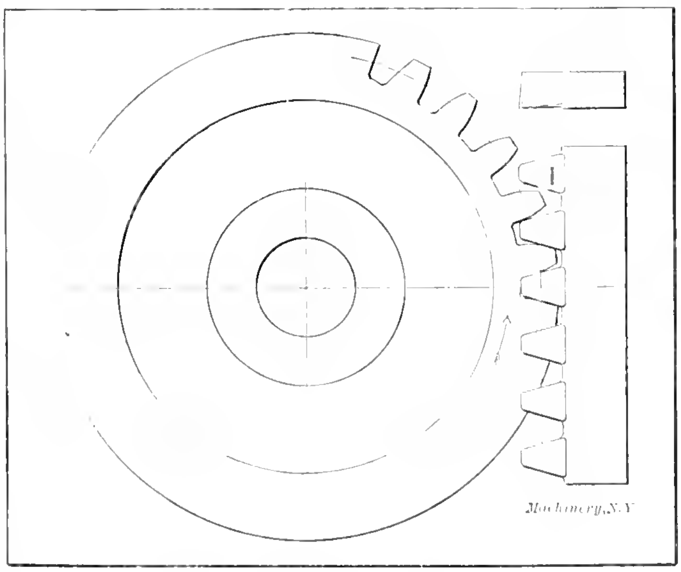


Fig 2. Diagram Showing Action of Rack-cutter in the Sunderland Gear-cutting Machine

* Address: 45 Sydney Buildings, Bath, England

The rack cutter, of involute type cuts, of course, all gears of the same pitch, all meshing accurately with each other and with a rack; and the results are more accurate than those obtained by single rotary cutters, or by planers controlled by a former, while one cutter only is required for one pitch instead of a series of rotary cutters, or a series of formers. The rack cutter is mounted on a slide which imparts a reciprocating motion to it, while the wheel blank, mounted on a horizontal arbor fitted in the spindle of the dividing wheel, rotates in relation to it, in unison with an upward movement of the cutter slide, as in the actual engagement of gears. The rolling movements impart the tooth curves while the reciprocating movements of the rack tool cut the teeth to the correct depth. Several of these operations repeated are required to complete the teeth of the wheel. In the first position the cutter touches the edge of the blank. In the second the blank is fed in to the proper depth, while the spaces are cut by the reciprocating cutter. The heaviest work is done by the leading teeth of the cutter, and as the wheel blank rotates in unison with the upward movement of the cutter the remaining teeth are gradually relieved from strain, and thus retain their keen cutting edges longer for finishing. After as many teeth are cut as can make full contact with the rack cutter through a distance equal to one pitch, the wheel blank is withdrawn clear of the cutter, its rotary motion arrested, and the cutter-slide returns vertically to its original position, that is, to a distance equal to the pitch being cut. The blank is then returned forward to the position for cutting, the rotary motion is re-started simultaneously with the upward movement of the cutter slide, and another cutting cycle repeated. These movements are automatic until the wheel is completed. Only two sets of change-gears have been set up, one for the number of teeth to be cut, and the other for the pitch. Cutting speeds can be varied from about 20 feet to 40 feet per minute. The various speeds are obtained in the machine itself, so that the machine is driven by a constant-speed belt from a line-shaft; or it can be arranged for a motor drive. A pump and circulating pipes are fitted to the machine.

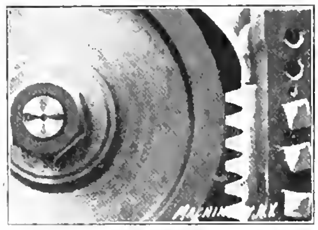


Fig 3. First Position: Cutter just Touching Blank

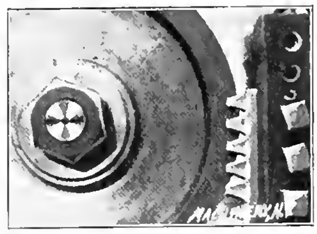


Fig. 4. Second Position: Blank Fed to Proper Depth for Teeth

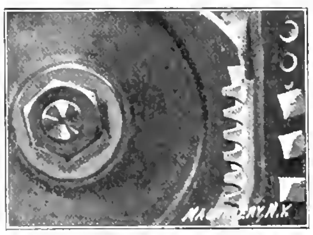


Fig. 5. Third Position: Blank and Cutter having Advanced a Distance equal to the Circular Pitch

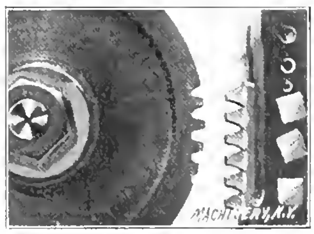


Fig. 6. Fourth Position: Blank withdrawn from the Cutter

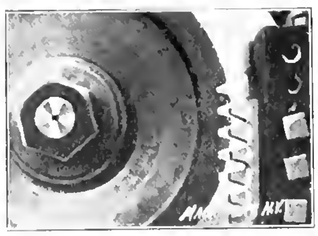


Fig 7. Fifth Position: Cutter returned to Starting Point

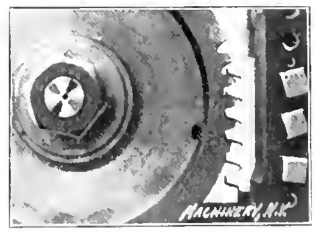


Fig. 8. Sixth Position Blank returned to Cutting Position; beginning of Second Cycle

The machine cuts gears from 3 inches to 24 inches in diameter, and pitches from 8 to 2½ diametral pitch, and widths of faces up to 8½ inches. It weighs 3½ tons.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

GROWTH FROM SMALL BEGINNINGS

The machine tool industry is remarkable in the fact that it is a growth from small beginnings. In mentally reviewing the history of the firms which have been successful in that line, we do not call to mind one which made a flying start with large capital and highly developed organization behind it. These phases have come later. The original start was made from humble beginnings, often by men working at the lathe and the bench.

This hopeful condition is due, possibly, to the high plane of development which machine tool design has reached in this country. The plane is so high that the product which is to meet competition successfully must have behind it a *personality*, brimming with enthusiasm and original ideas. Such personalities are self-selective. They rise to the top like the cream in the milk pitcher. They are not usually attracted by complex organization and powerful resources.

* * *

A DEFECT IN THE SALES DEPARTMENT

Almost every enquiry a manufacturer receives has some value—the actual value depending largely on the way the enquiry is handled. Comparatively few advertisers so handle their enquiries as to get the greatest possible return from them. Some are content with sending a catalogue or circular, and possibly a form letter, which they never follow up, although in many cases a purchase is not made for months after the enquiry is sent in. Other manufacturers, particularly of automobile supplies and office appliances, it is positively dangerous to write to, because the name of the enquirer is immediately placed in a species of mill which proceeds to grind out long follow-up letters, the intent of which is apparently to make life a burden for the unfortunate enquirer, and in time to force him to buy. There must be a reasonable mean between these two methods, and it can be found in the intelligent handling of enquiries by a trained office man who thoroughly understands his business, and not by a typewriter who is handed a list of names to send form letters to.

If the manufacturer considers the amount of money which is often spent in trying to effect a sale, he can quickly figure out that it will pay to handle enquiries intelligently. An instance of the lack of this quality is mentioned by a well-known machine tool dealer who writes us:

A manufacturer will send us prices and quote us discounts, and we take an order and send it in. In the meantime he has made some exclusive agency arrangements with another house covering this territory, and we are politely informed on receipt of the order that they can't fill it on account of these arrangements. Our salesman has lost his time and we have lost ours and we have talked up a deal for the benefit of one of our competitors, as we have to notify our customer that we can't fill the order. There are not so many machine tool dealers in the country but what manufacturers could, without overexertion on their part, keep them posted as to their sales arrangements, and also on their new designs by sending out up-to-date printed matter. The majority of the new catalogues that we receive we have to ask for, although when a manufacturer gets out anything new one day's work in his office would suffice to supply all the machine tool dealers in the country with this information. The greatest assistance we get is through the medium of the trade journals, and this gives us the opportunity of thanking you very much for keeping us posted in the manner you do.

* * *

TECHNICAL LITERATURE

It does not seem to be an exaggerated statement that at least fifty per cent of the technical books brought out to-day in America have been written merely to satisfy the ambition of an author who wants to see his name on the title page of a book, and published simply because the publisher expects to make a profit on the book, and for no other reason. A great many technical books are practically nothing but abstracts and compilations of other books previously published, containing hardly anything that is new and original, not even in the treatment or arrangement of the matter; and in some cases these new books are even inferior to works that have been previously published. Such books have, therefore, no excuse for their existence except the ambition of the author and their money-making possibilities.

Technical books of real merit are few and far between. In this respect a decided difference has been noted by many book reviewers between German and American books. German technical books and English as well, are noted for their thoroughness, logic and originality. The "padding" so common in many American works, is almost always absent from German technical publications. The German mind especially appears to be particularly adapted for arranging the material properly, systematizing it in such a way as to lead the reader or student from subject to subject by easy stages, and provide him, at the end of the journey through the book, with a clear, comprehensive conception of the subject treated.

There have been many reasons advanced for this difference between German and American books. The most plausible is that the "hustling" of American life shows itself in its technical literature. It is produced in haste, and too little attention is given to detail. Perhaps this is because many of our books are not the works of authors with ample time for investigation and study, but of actual workers in the industries who cannot give a large portion of their time to book writing. This last feature is one of the redeeming characteristics of some American technical books. Written by men actually engaged in practical work, with all their faults of illogical arrangement, unbalanced contents and lack of comprehensiveness, they are more practical, more thoroughly in touch with the industrial conditions, and better adapted to the use of the every-day man, than the more thorough-going and comprehensive German works.

The demand for books written in the popular style is perhaps accounted for by the limited educational advantages of a large number of technical book buyers, represented by the workers in every trade; but even this feature presents no excuse for the production of books which are simply "hashed over" from the writings of other authors, because a popularly written book is capable of just as logical arrangement and even more original treatment of the subject than a more scientific treatise.

WHEN TO SAFEGUARD MACHINERY

Machine designers, manufacturers, and others concerned with the production of machinery are slowly awaking to the fact that it is not good design or business policy to put machines on the market having unprotected gears and other danger points. The movement for greater safety in industrial pursuits has already had a marked effect on machine design, but there is still great need of improvement in this respect, in the construction of many classes of machinery. In an editorial in May, 1907, we made a point of the fact that the time to safeguard danger points in machinery is when the design is on the drawing-board. The designer can cheaply and effectively provide guards in the original design of the machine, whereas they might be cumbersome or entirely out of the question after the machine had been built in the ordinary way. We suggested that "safety of operation should be placed on a par with mechanical efficiency, and that our schools of mechanical engineering could do no greater service for the manufacturing interests of the country than to instil this principle in the minds of their students."

Mr. R. C. Bolling, of the United States Steel Corporation, at the recent annual meeting of the Museum of Safety and Sanitation, New York, spoke of the difficulty of providing effective safety devices on machinery that had not been designed for them. He said that the United States Steel Corporation, which is spending about $1,000,000 annually for accident prevention and compensation to injured workmen, has experienced great difficulty in protecting danger points on machines, cranes and other appliances that had been unprovided with these desirable accessories when built. In fact, it was practically impossible in some places to provide railings for runways and protection for gears, because of lack of clearance, etc. Such provision would have made necessary the re-construction of roofs, changes in foundations and in the whole lay-out of the mill, amounting practically to a reconstruction of the plant. Mr. Bolling said that almost all the machines, cranes and other apparatus could have been adequately protected in the original construction with little or no additional cost; but when provided afterward the expense was very heavy.

We reiterate that the time to safeguard machinery is when it is on the drawing-board; and designers should awaken fully to a sense of their responsibility in this respect. They should consider safety as of equal importance with operating efficiency, for if the machines, unprotected, are not safe to work, they are failures, no matter how efficient they may be as producers. Finally, manufacturers and all users of machinery should fully comprehend the significance of the Museum's motto: "Prevention is a benefaction—compensation an apology."

* * *

THE AUTOMATIC MACHINE AS A CIVILIZING AGENT

It is the fashion among certain critics of the present social order to cast aspersions on the automatic machine as compared with the hand processes which it has displaced. The old idea that it throws workmen permanently out of employment has been pretty thoroughly exploded; but there still remains a vestige of the ancient superstition that ingenious inventions tend to degrade labor. It is claimed that the workman becomes a part of the machine, performing in unison with it the few movements of feeding or adjustment which it is impracticable for the machine to perform by itself.

With this unfriendly view of the automatic machine we boldly take issue. There are without doubt many instances in which the criticism holds good, but this condition is only a passing phase of development. The application of automatic feeds, for instance, has relieved and will continue to relieve the operator of tiresome routine work. We shall eventually change our belief that the only mechanisms which can successfully be made self-acting are those which may be operated by unskilled labor. The time is approaching when mechanisms will be found profitable which require the attention of mechanics of the very greatest skill and experience. As the field thus broadens, mechanics of all grades of ability will become more and more engaged in the work of supervision, instead of being bound to the monotonous repetition of manual movements required for hand work or machine feeding.

The continued development of the automatic machine holds out hope to the workman for relief from much that constitutes the drudgery of labor.

* * *

SALARIES VS. PROFITS

A STUDY IN SHOP AND OFFICE MANAGEMENT

POLYCON

The draftsman, usually, has an excellent opportunity to study methods of shop management and general business systems. Except in some of the largest establishments, he has free access to the shop, and usually avails himself with more or less freedom of the opportunity to study shop methods and, incidentally, to break up the monotony of close confinement to the drawing-board. His work, too, brings him more or less into contact with foremen and workmen, and he is thus in a position to learn the shop view of matters with some degree of accuracy. In addition to this, the drafting-room being a sort of neutral ground between shop and office, he is often able to get something of an insight into office methods, more particularly as regards the ordering and cost-keeping departments. It has been the writer's fortune, good or bad, to have wandered considerably, and to have been employed in establishments doing a wide variety of business, from pure manufacturing to pure engineering, including various admixtures of these two extremes. Although making no pretensions to speak authoritatively on the subject, I have always been rather a close observer of shop management, and a comparative description of some of the systems I have seen might be of interest.

Cost Systems

Shop *A* was engaged in the manufacture of gas and steam engines and boilers for use in the oil fields, besides making general oil-well supplies and attending to repair work. The shops were modern and employed about four hundred men, and the output was limited to a few standard sizes. The cost system was handled by one clerk, and there was one foreman to each of the usual departments, machine, forge, foundry, pattern, and boiler shops. The stock was kept by a young man, and was delivered to the workmen as required, on an order from the foreman.

Shop *B*, where I was employed immediately after leaving *A*, was engaged in exactly the same line of work, with the addition of a general line of plate work, such as tanks and pen-stocks, and the development of a line of larger sizes of gas engines. On account of these latter branches a large force of draftsmen was maintained, while in the previous position I was alone in my glory. The number of men employed was but inconsiderably greater than in the case of *A*, but the cost department included three or four clerks, all of whom appeared to have enough to do, and each foreman had a clerk. In order to get a piece of drill steel or a machine screw from the stock-room, it was necessary for the workman to get an order from the foreman, take it upstairs to the cost department to have it signed, and then get the material from the stock-keeper, who, by the way, also had an assistant.

Now it is significant that while the *A* company was paying a good dividend to the stockholders and was also able to give its employes, as a Christmas present, a substantial bonus based on their wages, the *B* company not only was not paying dividends on the stock, but was in actual financial difficulties. I do not say that the elaborate cost system was the sole cause of the trouble with *B*, but I do believe that a simpler system would have been sufficiently accurate for the purpose, and would have saved thousands of dollars yearly.

Office Systems

The first establishment under this heading, *C*, was engaged principally in the manufacture of mining and ore-handling machinery, and had modern and well equipped shops employing five or six hundred men. Having a well-established business, the selling was done chiefly by correspondence and by one or two supply houses in the mining districts, beside which the general manager and engineers

took occasional trips when something "big" was in the air. The business of this company was handled by the president, general manager, treasurer, and purchasing agent, with a staff of clerks and stenographers not exceeding five. All of the above officials, as well as the superintendent and some of the engineers, were stockholders in the company, were receiving satisfactory salaries, and there was a spirit of hearty cooperation evident among them.

Company D was also engaged in manufacturing, mining and ore-handling machinery. The office building was a handsome four-story structure, and the shops, employing about the same number of men as C, were well built and equipped with the most modern tools and appliances. This company had a president, general manager, works manager, secretary, treasurer, purchasing agent, auditor, sales manager, two vice-presidents and a chairman of the board of directors, most of whom were relatives of the original members of the firm and drew large salaries, their assistants, in some cases, doing the work.

It is not difficult to understand that while C was paying dividends, D was not, and further, was in serious financial difficulties. Both companies maintained large and efficient engineering staffs, had well-equipped shops and an established reputation in their lines of business, and it could not but be patent to the most casual observer that the profits in the case of D went to pay large salaries to supernumeraries.

Shop Systems

The next shop to be considered, designated as E, was one which had grown from a jobbing shop and, at the time that I worked there, employed about four hundred men, building steam engines, boilers, mining machinery, saw-mill and pulp-mill machinery, and general plate work. The buildings were frame structures, inadequate for the work, and the tools were—some of them—fit only for the scrap heap. However, there were some good, heavy machines, and, with good management, the plant should have been capable of producing a fair output. As stated, the shops had grown from small beginnings at a time when business was plentiful and prices good, and the company had always been able to pay good dividends. Being a close corporation, practically owned by three men actively engaged in the management, one of whom was the general manager, a sharp eye was kept on the balance sheet. This being so, it seems strange that the shops were not maintained in a more efficient state, but, on the contrary, the manager's sole idea of economy seemed to lie in the reduction of expenditures. In order to get the work out cheaply, all sorts of patchwork was done on the patterns, metal was skimped to the limit, an excess of scrap and a low grade of pig was used, and the machinery was often shipped out only half finished. All through the shops an excessive number of apprentices was employed, and laborers were doing work which should have been done by skilled mechanics; in the office, the highest salaried man outside of the general manager and the treasurer received $150 a month. At the same time, the cost system was only used to obtain the total cost of a new size or design of machine; it gave no idea of where the loss or profit occurred, and was not followed up for duplicate machines. The natural result of these methods was that this concern was losing more in bad castings and mistakes than was saved by the false economies, and continually the few good workmen employed would leave because the firm was not willing to pay them as much as someone else would pay.

In sharp contrast to this was plant F. Here the spirit was to do the kind of work best suited to the requirements, to improve the equipment as fast as financial conditions would warrant, to pay such wages as would attract and keep the best men, and to keep down costs by finding out exactly where losses occurred and then rectifying the conditions causing the loss. Each month an accurate and complete statement was made up, showing the number of men employed and their wages, the cost of material consumed and the output, with a comparison with previous months. The foundry had to make a daily report of all castings, giving the names of the molders whose castings were spoiled and the cause thereof, and every foreman was made to feel that he was there to improve the output in quality and reduce the cost.

Conclusions

And now to point the moral! Not that it is necessary to do so, for it seems as if the conclusions were self-evident. However, the officers of any corporation owe it to the stockholders to so conduct the business as to pay a reasonable profit in the form of dividends. Too many corporations are like D: they pay large salaries to the officers and provide remunerative and not-too-laborious employment for sons and sons-in-law. Others, with perfectly honest intentions, are overburdened with systems or are swamped by an overweening vanity on the part of the officers, manifesting itself in elaborately-fitted offices and lavish but ineffective advertising. Still others are being wrecked by incompetent or too daring engineers, who undertake unusual contracts without sufficient investigation of the conditions and requirements, with the result that the work as finally designed over-runs the estimate excessively.

The best results, however, would be obtained if the order and cost systems were kept in the simplest possible form consistent with obtaining accurate and reliable results; the same rule should apply to the business management. In the shop it is good economy to pay fair wages and to insist on a fair return of work therefor. System is a good thing, but, like most good things, it is possible to have too much of it and, therefore, "be temperate in all things" is good advice in the business world, as elsewhere.

* * *

THE POWER OF LARGE GUNS

A gun may properly be considered as a prime mover, and its output may be expressed in terms of horsepower. As, however, the period of time during which energy is exerted is very short, the horsepower expressed in figures becomes rather startling. A calculation involving the horsepower of the large 16-inch gun mounted at Sandy Hook, for instance, will reveal more than anything else the enormous size and power of this gun. The projectile weighs 2,370 pounds and has a muzzle velocity of 2,300 feet per second. The energy developed at the muzzle is about 88,000 foot-tons. If we assume that the projectile moves through a distance of 33 feet within the gun while acquiring the given velocity, and that the acceleration of the projectile is uniform until the muzzle is reached, the mean velocity of the projectile while within the bore would be $\frac{2,300}{2} = 1,150$ feet per second, and the period of time during which the energy of 88,000 foot-tons is developed would be $\frac{33}{1,150} = \frac{1}{35}$ of a second. This corresponds to a total of $88,000 \times 35 \times 60 = 184,800,000$ foot-tons per minute. Since the horsepower = 33,000 foot-pounds, or 14.7 foot-tons per minute, we have $\frac{184,800,000}{14.7} = 12,600,000$ horsepower, as the power developed by the gun during the period and conditions mentioned.

* * *

In accordance with the factory and work-shop act of Great Britain, the British Government has issued regulations relating to safety arrangements to be used in dry grinding and finishing processes. According to these rules all grinding wheels must be provided with a hood or other appliance so constructed and arranged as to take care of practically all dust created. A duct of adequate size arranged to carry away the dust must be provided, and a fan or other effective means for extracting the dust must be installed. Suitable respirators must also be provided for all persons employed in grinding, whether working in a room or in the open air. No person is permitted to do any work other than grinding in a room where grinding is carried on, except work required for cleaning purposes. Provisions are also made for effective cleaning of rooms in which grinding is carried on, at least once a week. The employer is required to furnish all safety apparatus, respirators, etc., and every person employed is required to make full and proper use of the appliances provided.

LAYING-OUT AND ALIGNING OPERATIONS ON MACHINE TOOLS—1*

ALFRED SPANGENBERG†

In general, laying out is the process of placing such lines on castings, forgings, or partially finished surfaces, as will designate the exact location and nature of the operations specified on the drawing; an aligning operation, as its name implies, consists in lining-up a shaft bearing, bracket, or other similar machine element, in its proper place relative to other members. The first-named operation usually is associated with the process of machining, while the last-mentioned is generally included in the work of assembling. Laying-out and aligning operations may be divided into two parts: the preliminary and the final. The preliminary operation consists in approximately locating a machine element in place for the purpose of marking the clamping bolt holes on its supporting member; in the final alignment, the exact location is ascertained for the purpose of drilling the dowel pin holes, the work being held by its clamping bolts. Clearance in the bolt holes permits of this adjustment.

As the ultimate results obtained in assembling are controlled to a large extent by the accuracy of these operations, it is of the utmost importance that means be provided for insuring the refinement that the nature of the case demands. Jigs and fixtures have, of course, been a dominant factor in dispensing with much of the ingenuity and skill required in this work, but owing to special considerations a preclusion of these valuable adjuncts to manufacturing work may be advisable. In this case a simple gage or templet, or even a wooden jig provided with steel bushings, will greatly facilitate the operation of laying out or aligning, and, in fact, when proper care is exercised in using these comparatively crude devices, work may be produced on an interchangeable basis as good as with more expensive tools; although it is to be expected that more skilled labor will be required.

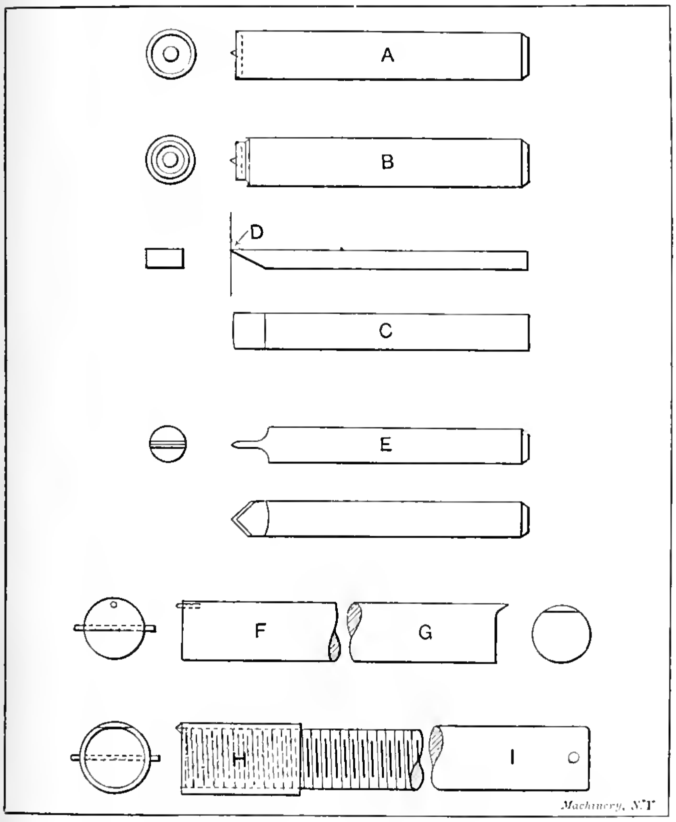

Fig. 1. Special Tools used in Laying-out Operations

As regards the different methods of laying out and aligning, no definite rules can be given. The machinist must consider the means at hand and the nature of the job; he must then use his ingenuity and be guided by his practical experience. A few special cases are illustrated in the accompanying line-engravings; the methods and processes shown and the remarks made in regard to them are intended only as suggestions of how the work may be accomplished without the employment of drill jigs. It is not to be inferred that the way shown is, in each instance, the best method possible and the only one applicable. Circumstances alter cases; while the methods shown may be eminently suitable for one set of conditions, they may either be too refined or not refined enough for other conditions and requirements.

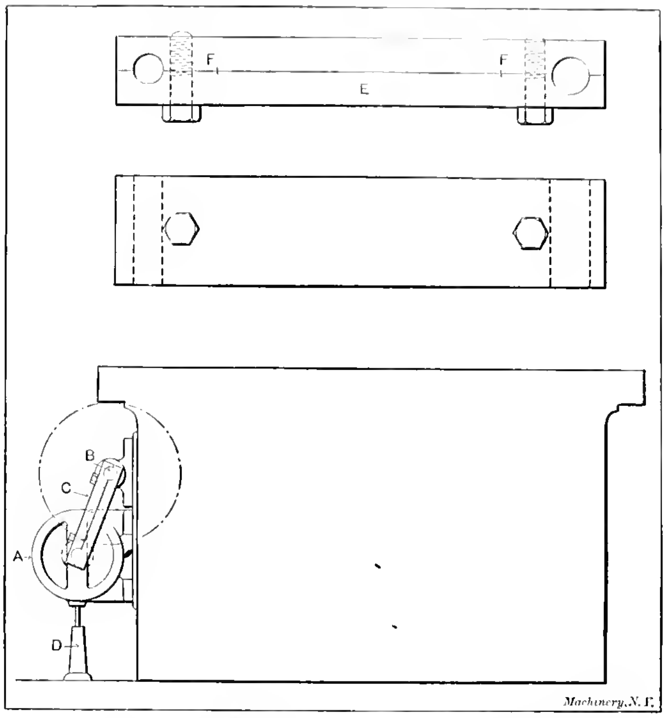

Fig. 2. Locating a Small Motor by the Use of a Link

Special Tools and Appliances

Aside from the more common laying-out tools such as the dividers, surface gage, steel scale, etc., there are a number of tools of a special form used for laying-out operations, some of which are shown in Fig. 1. The form of center punch shown at *A* will greatly facilitate marking off holes through brack-

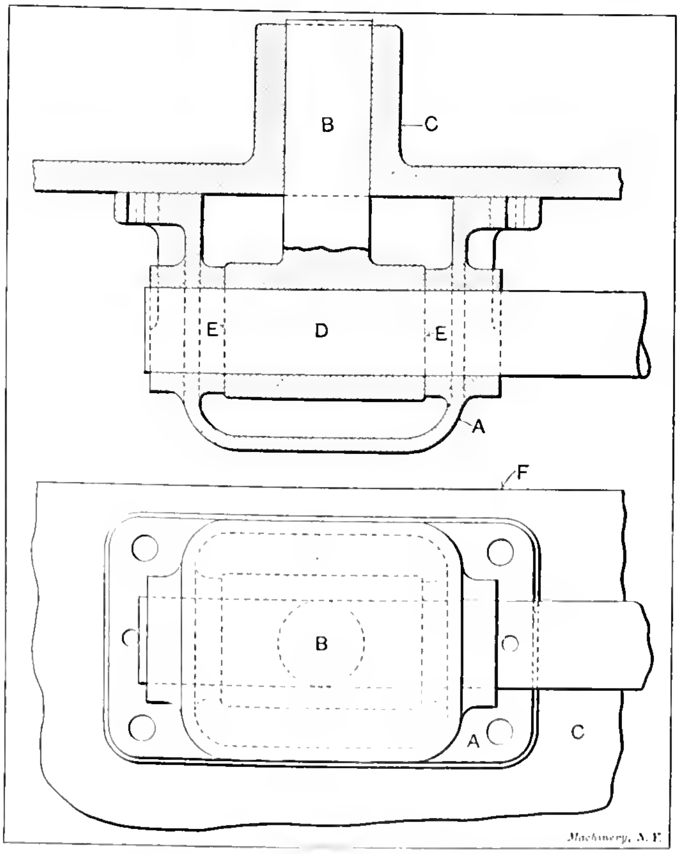

Fig. 3. T-jig for Locating a Bevel Gear Bracket

* For additional information on this and kindred subjects see "Assembling a 48-Inch Motor-Driven Planer," in the December, 1909, issue of MACHINERY, and other articles there referred to.

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ets and templets, or in laying off pin holes for cams. It is necessary to provide a number of different sized center punches of this type, as the body of the punch must fit the clearance hole in the work. For obtaining a circle, the diameter of the tap drill, the punch or marker may take the form shown at *B*, while a combination of the two will provide a guard circle.

A flat scriber *C* is very useful for marking a line on a plane surface at right angles to another plane surface when the corner is rounded as shown at *D*. The form of marker illustrated at *E* is for giving permanence to lines intersecting on surfaces at right angles, as for instance, in marking the relative position of a gear on a shaft. At *F* is shown a special marker for laying out a circle, the center of which must coincide with a hole already bored. The body of the marker fits the bored hole and a circle is scribed in the piece to be marked off by rotating the marker when the point is in contact with the work. Two methods of making the scribing point are clearly indicated in the engraving, the one shown at end *G* producing a circle the diameter of the body. In marking off a hole in alignment with a threaded hole, a bushing *H* having a scribing point is made to fit the threaded arbor *I*. This arbor fits the threaded hole, and the bushing is rotated to mark the circle.

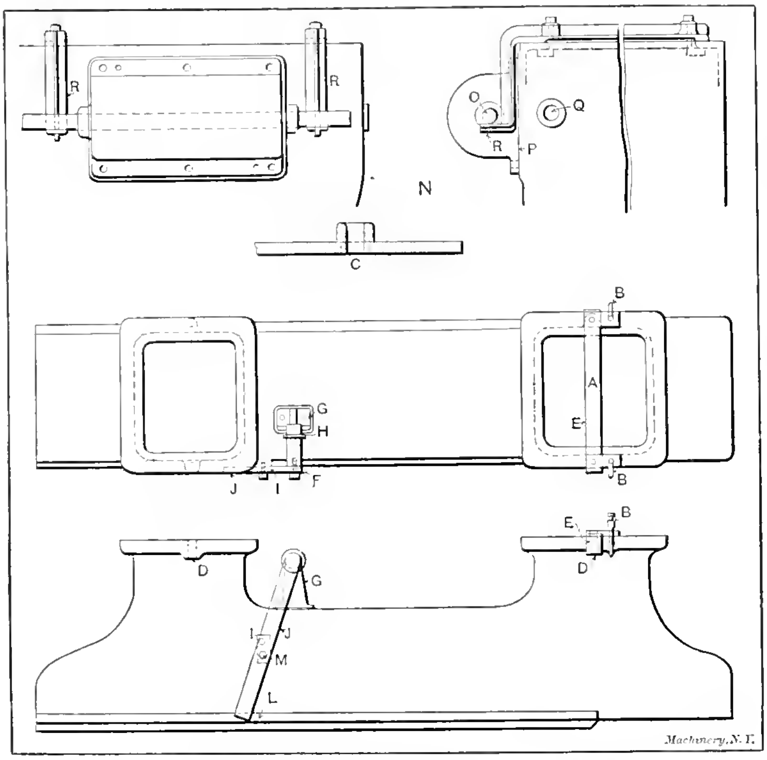


Fig. 4. Special Gages and Templets for Laying-out and Aligning Operations on a Turret Lathe Bed

One of the most convenient and accurate methods of locating gear centers is by the use of links. For drilling or boring operations the link may take the form of a casting provided with hardened steel bushings to guide the cutting tools. Again, a link may be used for cases similar to the one shown in Fig. 2, which illustrates the method of accurately setting a small motor *A* so that its pinion will mesh properly with a gear on shaft *B*. The work is accomplished as follows: With the link *C* and the motor in position as shown, the jack-screw *D* is adjusted until the motor frame just touches the finished seat on the bed. This adjustment is determined by means of tissue paper placed between the motor and bed, after which the bolt holes are marked off on the bed; the special marker *B*, Fig. 1, is used for the purpose. The construction of the link is clearly shown at *E*, Fig. 2; this form, being made of two pieces bolted together, permits of ready application to a shaft supported between bearings, without removing the shaft. Such a case is frequently met with in applying a geared pump to a machine already built. For ordinary cases, however, the link may be made in one casting or forging, as the circumstances require, and provision for clamping may be made by sawing through the ends as far as indicated at *F*.

In Fig. 3 is shown a T-jig for locating a bearing bracket *A* relative to the hole *B* in the main casting *C*. The requirements are that the axes of hole *B* and shaft *D* must intersect, and the faces of hubs *E* must be equidistant from the axis of *B*. It is evident, however, that the T-jig will not take care of the alignment of the shaft *D* with reference to its being parallel with the surface *F*. This may be accomplished by measuring down from surface *F* with either a combination square or surface gage or, in case the adjacent bearing for shaft *D* is already located, bracket *A* will find its own alignment by using this bearing to support the shaft.

The Use of Templets

When a number of pieces are to be made interchangeable without the use of jigs or fixtures, this can be accomplished by the employment of templets for laying out the work. While these devices greatly simplify laying-out and aligning operations, they are not intended for guiding the cutting tools. Templets are particularly well adapted for work where the holes to be laid out lie in the same horizontal plane, and, owing to this condition, the templet usually takes the form of a flat plate of sheet iron, or a wooden piece, having the same general outline as the work to be laid out. Again, many irregular forms are drawn on work from accurately filed templets, after which permanence is given the lines by dotting them with prick-punch marks placed directly on the line.

In making a templet for the first-mentioned class of work, holes are drilled in the templet to conform to the drawing of the piece to be laid out. In use, the templet is laid on the work and is then clamped to it by suitable and convenient means, so that its outline coincides with that of the work. The layout may be transferred to the work by means of a marker as already explained, or, in the case of comparatively large holes, an ordinary scriber is used to mark the circles, and after the templet is removed from the work, the center of each circle is laid out with dividers, permanence being given the lines by a prick punch. Witness circles are often placed on the work to make sure that the original lines were closely followed in drilling, *i. e.*, a circle is drawn in each case 1/32 inch larger in diameter than the one worked to; then, if the hole is correctly drilled, it will be concentric with this circle.

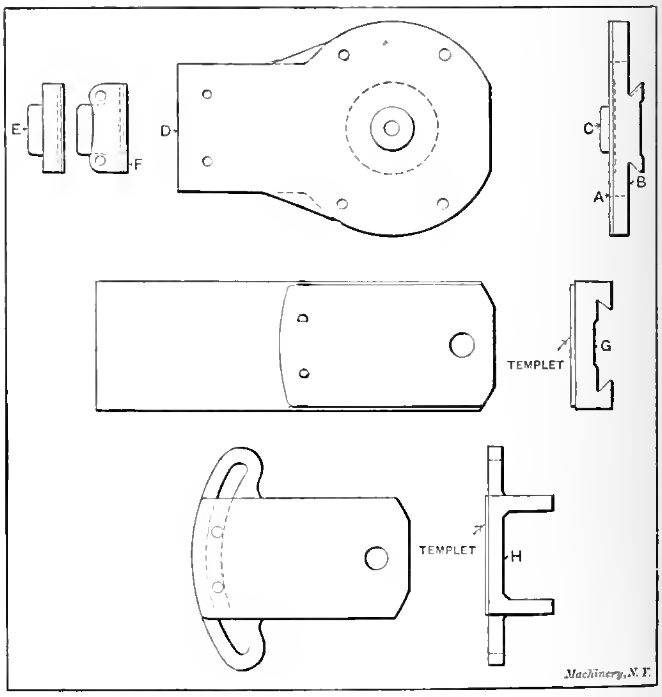


Fig. 5. Sheet Iron Templets for Laying out Planer Crossrail Members

For a certain class of work where great accuracy is not required, templets may be made provided with hardened steel

bushings for guiding the cutting tools independently of the skill of the operator, in which case, however, the templet takes the form of a jig. Owing to the lack of rigidity due to the thin material of which such jigs or templets are constructed, no attempt is made to provide clamping arrangements. The templet may be clamped to the work by means of ordinary C-clamps, or with machinists' clamps. Very frequently, however, it is desirable to provide locating points which may consist of pins extending from one or both sides of the templet, as the case may require, or the locating points may be formed by bending the edges of the metal to a right angle.

The application of a jig such as just described is illustrated in Fig. 4, which shows the method of drilling foundation bolt holes in a turret lathe bed, the holes being drilled from the bottom. As will be seen, the jig or templet *A* consists of three pieces of flat iron riveted together and clamped to the bed by means of clamps *B*. The method of inserting the drill bushings is shown in detail at *C*. To facilitate setting the jig with reference to the bosses *D* on the under side of the bed casting drilling the tap holes in the lathe bed, not shown. Steel lining bushings *E* are provided for the drill bushings. The jig and work are clamped to the drill press table by straps and bolts. The frame consists of four pieces of ash fastened at the corners with blue and wood-screws, the joints being made as shown. Ash is the best wood for the purpose, since, if well seasoned, it is less likely to warp than any other, but where this wood is not available, maple is a good substitute.

A slightly more expensive, but more durable jig, for the same purpose is shown at *F* in the same engraving. This jig is made of flat bar steel riveted together, and is of the same general construction as the wooden one.

Gages for Aligning Operations

A gage may briefly be defined as any standard of comparison; as here used, the term gage will have reference to special devices for aligning work without the employment of ordinary tools such as a combination square, surface gage, etc. Besides greatly facilitating aligning operations, the particular

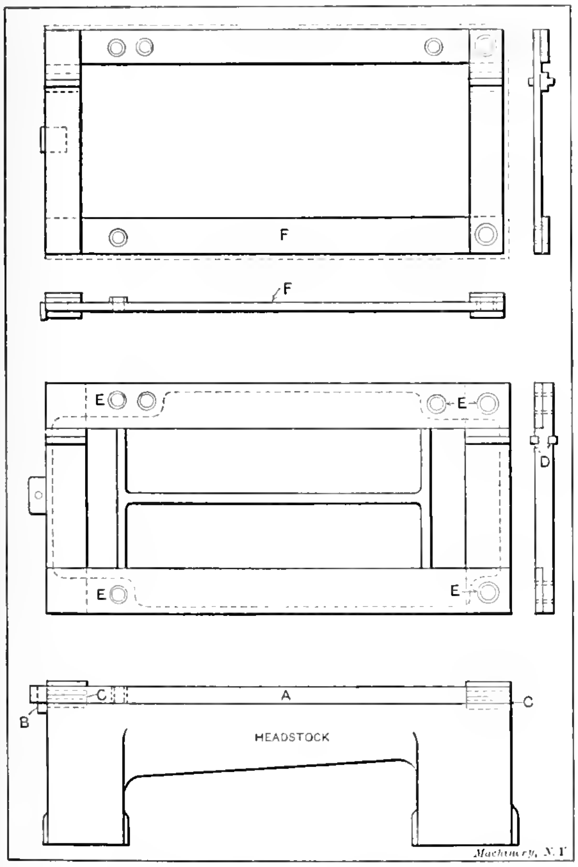


Fig. 6. Application of a Wooden Jig for Drilling a Lathe Headstock. At F is shown a Similar Jig constructed of Flat Bar Steel

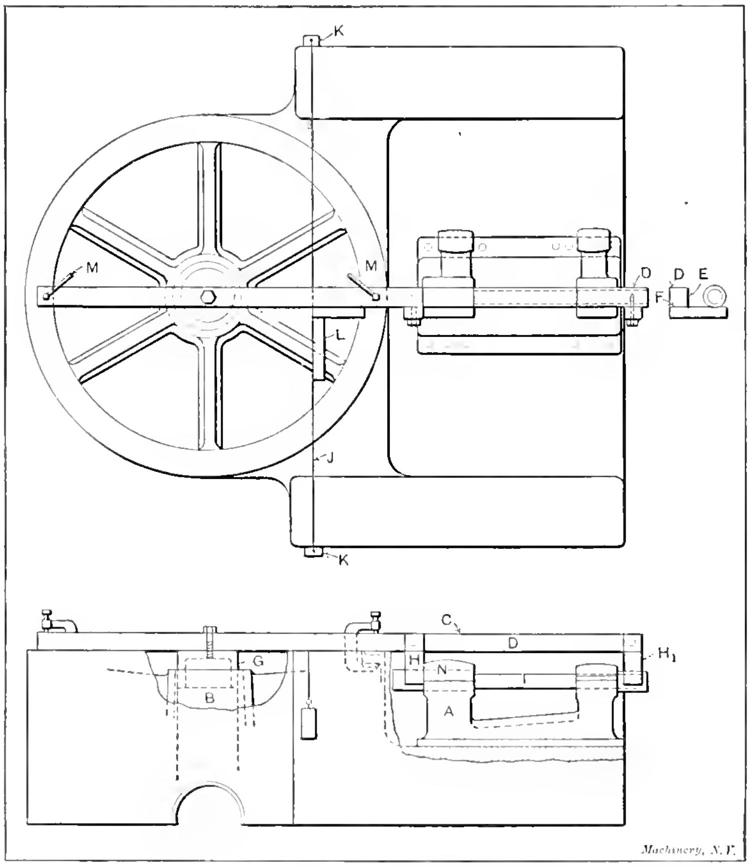


Fig 7. Gage for Aligning the Driving Shaft Bracket on a Vertical Boring Mill of the Bevel Gear Driven Type

so that the holes when drilled will be concentric with these bosses, jig member *E* is bent to a right angle at each end so as to extend down the casting; the location is determined by matching these ears with the bosses on the bed.

In Fig. 5 is shown the application of sheet iron templets for laying out cross-rail members for large planers. Templet *A* for swivel member *B* is located by the hub *C*, and is lined up to match the end *D*. A separate templet is provided for laying out the swivel clamp *E*; edge *F* of the templet is bent over to form a locating point. But one templet is required for laying out slide *G* and its clapper-box *H*. This is lined up on each member as shown. It is obvious that these templets are more advantageous than cast iron jigs for this class of work, since very large and heavy jigs would be required, and furthermore, no great accuracy is necessary, as the bolt holes have 1/16 inch clearance.

As already stated, a very cheap and serviceable jig for certain classes of work can be constructed of wood. At *A*, Fig. 6, is shown a jig of this character for drilling the clamping bolt holes in an engine lathe headstock—in this case for a 30-inch lathe. The jig is located by pin *B* and keys *C*, the latter fitting a keyway in the headstock; having these keys on both sides of the jig as shown at *D*, it is also used for

advantage of using gages is that the possibility of error due to carelessness in transferring scale measurements is avoided. It is assumed, however, that the gages here shown are intended only for duplicate work; it would not be economy to make gages for aligning only a few pieces.

Turning back to Fig. 4, *F* represents a simple gage for aligning bracket *G* on the bottom of a turret lathe bed. The requirements are that face *H* of the bracket must be a certain definite distance from seat *I* on the bed, but the alignment in a longitudinal direction is non-essential. The gage merely consists of two pieces: a straightedge *J*, planed only on one side and one end, and a gage which is fastened to the end of the straightedge as shown. As surface *L* on the bed lies in the same plane with seat *I*, the straightedge is made long enough to reach this surface, thereby obtaining greater accuracy in the alignment. Bolt hole *M*, already tapped, is utilized for clamping the gage. In aligning the bracket, its face is brought into contact with the gage, and the bracket is then set longitudinally to match its seat on the bed.

Another gage, or more properly speaking, a pair of gages, for aligning a feed box on the turret lathe bed shown in the lower part of the same engraving, is shown at *N*. The requirement of the present case is simply that the feed-box shaft

hole O be located a certain definite distance from the top of the bed; seat P on the bed takes care of the center distance from hole Q. It is obvious then, that the gage castings R should only provide a positive locating surface with reference to the top of the bed; this is accomplished in the manner shown. The location endwise is determined by scale measurement from the end of the bed.

An aligning operation on a vertical boring mill bed, and the gage used, is illustrated in Fig. 7. This boring mill is of the bevel gear driven type, in which the pinion meshing into the table bevel gear is carried on the driving shaft in bracket A. The problem of aligning this driving shaft bracket with reference to the spindle hole B in the bed, is easily solved by using gage C. As will be seen, this gage consists of a bar D planed on two sides, E and F; a bushing G fitting the spindle hole; and two gage pieces H and H_1. A special arbor I, having both its ends ground to the same diameter, fits bracket A.

When in use, a line wire J is stretched across the bed by means of weights K. This wire lies in a small groove or mark planed in the bed for the double purpose of squaring the gage and setting the housings. Square L is used in setting the gage before it is clamped by means of clamps M, so that when the bed members are assembled, the driving shaft will be approximately square with the housing faces. With the gage in this position, bracket A is set so that its arbor just touches the gage blocks H and H_1. The location with reference to the distance from spindle hole B in the bed is determined by simply bringing the hub face N on bracket A into contact with the side of gage block H. After the operation of marking off the tap holes in the bed is accomplished, and the holes are drilled and tapped, bracket A is reset in the same manner and clamped by its bolts, for drilling and reaming the dowel pin holes.

* * *

A few years ago mahogany was regarded as a very precious wood and was employed only for the interior finish of the finest houses and in the manufacture of high-priced furniture. During the past few years, however, there has been a wonderful development in mahogany importation and use. The total quantity of mahogany imported in 1908 was nearly forty-two million board feet. It is one of the most valuable woods known for other than decorative purposes. As a pattern material it is unsurpassed, being strong, light and not as much affected by rough usage as pine. It takes glue remarkably well and is also superior to pine in that it is not affected as much by dampness.

DERIVATION OF BEVEL GEAR FORMULAS*†

RALPH E. FLANDERS‡

In the present article are given the derivations of the formulas used for calculating the dimensions of bevel gearing for all conditions of shaft angles and types of gears, including bevel gears with shafts at right angles, miter gearing, bevel gears with shafts at acute or obtuse angles, crown gears, and internal bevel gears.

In Fig. 1 is shown an axial section of a bevel gear, the pitch lines showing the location of the imaginary pitch cone. The pitch cone angle is the angle which the pitch line makes with the axis of the gear. The pitch diameter is measured across the gear drawing at the point where the pitch lines intersect the outer edge of the teeth. In speaking of the pitch of a bevel gear we always mean the pitch of the larger or outer ends of the teeth. Diametral and circular pitch have the same meaning as in the case of spur gears, the diametral pitch being the number of teeth per inch of the pitch diameter, while the circular pitch is the distance from the center of one tooth to the center of the next, measured along the pitch diameter at the back faces of the teeth. The addendum is the height of the tooth above the pitch line at the large end. The dedendum (the depth of the tooth space below the pitch line), and the whole depth of the tooth are also measured at the large end.

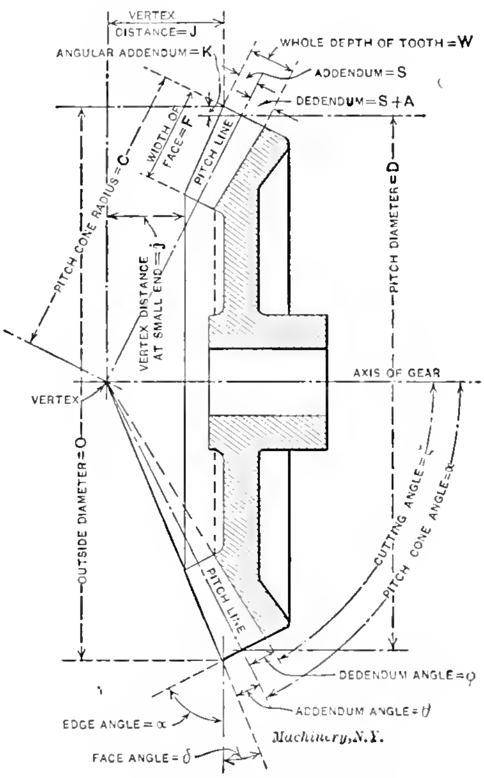


Fig. 1. Dimensions, Definitions and Reference Letters for Ordinary Bevel Gear

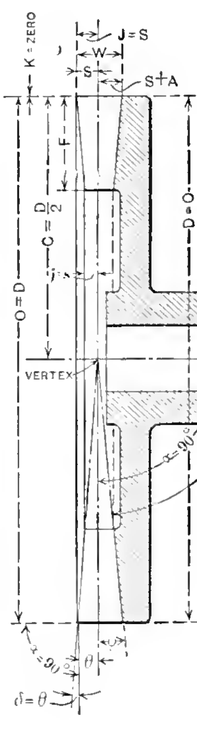


Fig. 2. Dimensions for Crown Gear

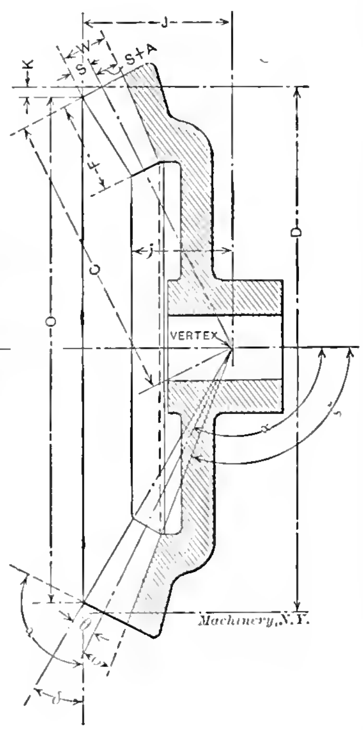


Fig. 3. Dimensions for Internal Bevel Gear

The pitch cone radius is the distance measured on the pitch line from the vertex of the pitch cone to the outer edge of the teeth. The width of the face of the teeth, as shown in Fig. 1, is measured on a line parallel to the pitch line. The addendum, whole depth and thickness of the teeth at the

* With Data Sheet Supplement.

† The following articles dealing with the subject of bevel gearing have previously been published in MACHINERY: Cutting Bevel Gears with Rotary Cutters, January, 1897; Bevel Gear Formula, January, 1898; Cutting Bevel Gears with Correct Teeth, June, 1898; Cutting Bevel Gears, June, 1898; Chamfering Bevel Gears, July, 1902; Bevel Gear Chart, September, 1905; To Calculate the Center Angles of a Pair of Bevel Gears having their Axes at other than Right Angles, June, 1906; Strength of Gears, December, 1906, engineering edition; Bevel Gear Diagrams, May, 1907, engineering edition; Bevel Gear Formulas, May, 1907, engineering edition; Cutting Bevel Gears with a Rotary Cutter, October, 1907; A Bevel Gear Gage, January, 1909; A Bevel Gear Problem, April, 1909. Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-over, December, 1909, engineering edition; Accurate Setting of the Bevel Gear Cutter, December, 1909, engineering edition. See also MACHINERY'S Data Sheet No. 36, September, 1904, Proportions of Bevel Gears; No. 37, October, 1904, Dimensions of Miter Gears; No. 64, December, 1906, Strength of Bevel Gears; No. 69, May, 1907, Bevel Gear Formulas and Diagrams; No. 102, Extra Data Sheet, October, 1908, Table for Determining the Outside Diameter of Bevel Gears; MACHINERY'S Reference Series No. 37, Bevel Gearing.

‡ Associate Editor of MACHINERY.

small or inner end may be derived from the corresponding dimensions at the outer end, by calculations depending on the ratio of width of face to the pitch cone radius. (See s, w and t in Fig. 4.)

The addendum angle is the angle between the top of the tooth and the pitch line. The dedendum angle is the angle between the bottom of the tooth space and the pitch line. The face angle is the angle between the top of the tooth and a perpendicular to the axis of the gear. The edge angle (which equals the pitch cone angle) is the angle between the outer edge and the perpendicular to the axis of the gear. The latter two angles are measured from the perpendicular instead of from the axis for the convenience of the workman in making measurements with the protractor when turning the blanks. The cutting angle is the angle between the bottom of the tooth space and the axis of the gear.

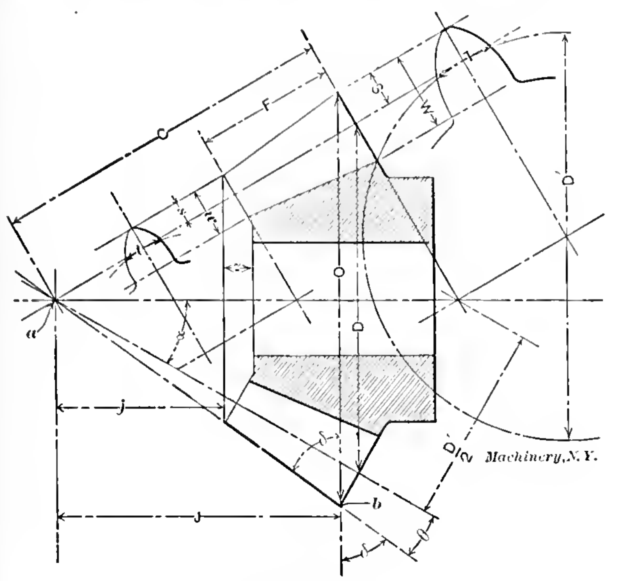


Fig. 4. Diagram Explaining Certain Calculations Relating to Bevel Gears

The angular addendum is the height of tooth at the large end above the pitch diameter, measured in a direction perpendicular to the axis of the gear. The outside diameter is measured over the corners of the teeth at the large end. The vertex distance is the distance measured in the direction of the axis of the gear from the corner of the teeth at the large end to the vertex of the pitch cone. The vertex distance at the small end of the tooth is similarly measured.

The shape of the teeth of a bevel gear may be considered as being the same as for teeth in a spur gear of the same pitch and style of tooth, having a radius equal to the distance from the pitch line at the back edge of the tooth to the axis of the gear, measured in a direction perpendicular to the pitch line.

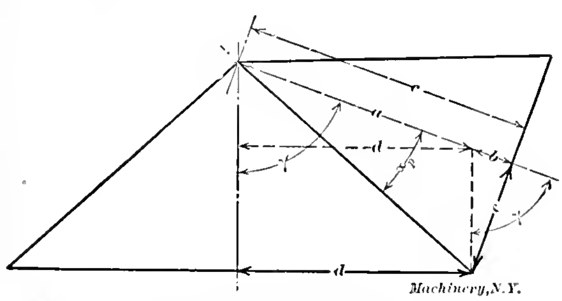


Fig. 5. Diagram for Obtaining Pitch Cone Angle of Acute Angle Gearing

This distance is dimensioned $\frac{D'}{2}$ in Fig. 4. The number of teeth which such a spur gear would have, as determined by diameter D' thus obtained, may be called the "number of teeth in equivalent spur gear," and is used in selecting the cutter for forming the teeth of bevel gears by the formed cutter process.

In two special forms of gears, the crown gear, Fig. 2, and the internal bevel gear, Fig. 3, the same dimensions and definitions apply as in regular bevel gears, though in a modified form in some cases. In the crown gear, for instance, the pitch diameter and the outside diameter are the same, and the pitch cone radius is equal to one-half the pitch diameter. The addendum angle and the face angle are also the same. The angular addendum becomes zero, and the vertex distance is equal to the addendum. The number of teeth in the equivalent spur gear becomes infinite, or in other words, the teeth are shaped like those of a rack.

When the pitch cone angle is greater than 90 degrees, so that the gear becomes an internal bevel gear, as in Fig. 3, the outside diameter (or edge diameter as it is better called in the case of internal gears) becomes less than the pitch diameter. Otherwise the conditions are the same, although many of the dimensions are reversed in direction.

Rules and formulas for calculating the dimensions of bevel gears are given in the accompanying Data Sheet Supplement. The following reference letters are used:

N = number of teeth,
P = diametral pitch,
P' = circular pitch,
π = 3.1416,
a = pitch cone angle and edge angle,
γ = center angle (angle between axes of two meshing gears),
D = pitch diameter,
S = addendum,
$S + A$ = dedendum (A = clearance),
W = whole depth of tooth space,
T = thickness of tooth at pitch line,
C = pitch cone radius,
F = width of face,
s = addendum at small end of tooth,
t = thickness of tooth at pitch line at small end,
θ = addendum angle,
ϕ = dedendum angle,
δ = face angle,
ζ = cutting angle,
K = angular addendum,

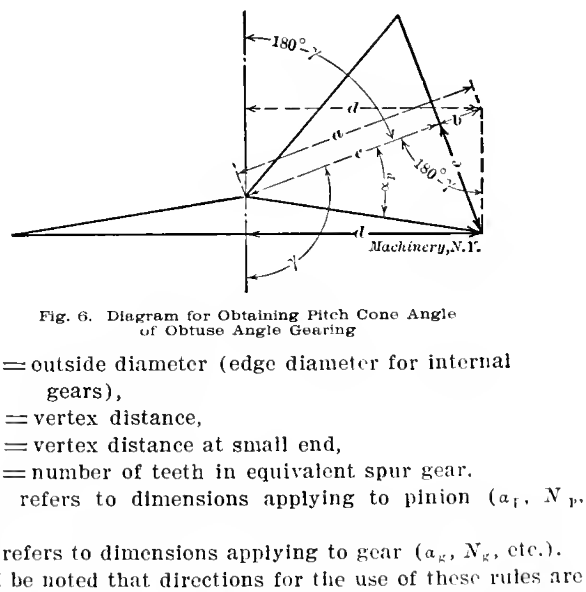


Fig. 6. Diagram for Obtaining Pitch Cone Angle of Obtuse Angle Gearing

O = outside diameter (edge diameter for internal gears),
J = vertex distance,
j = vertex distance at small end,
N' = number of teeth in equivalent spur gear.

Sub $_p$ refers to dimensions applying to pinion (a_p, N_p, etc.).

Sub $_g$ refers to dimensions applying to gear (a_g, N_g, etc.).

It will be noted that directions for the use of these rules are given for each of the six cases of right angle bevel gearing, miter bevel gearing, acute angle and obtuse angle bevel gearing, and crown and internal bevel gears.

Rules and Formulas for Bevel Gear Calculations

The derivation of most of these formulas is evident on inspection of Figs. 1 to 4, inclusive, for anyone who has a knowledge of elementary trigonometry. It is not necessary to know how they were derived to use them, however, as all that is needed is the ability to read a table of sines and tangents.

Formulas 5, 6, 7 and 8 are the same as for Brown & Sharpe standard gears. The dimensions at the small end of the tooth given by Formulas 10, 11 and 19 obviously are to the corresponding dimensions at the large end, as the distance from the small end of the tooth to the vertex of the pitch cone is to the pitch cone radius. This relation is expressed by these formulas. The derivation of Formula 20 may be understood by reference to Fig. 4:

$$D' = \frac{D}{\cos\alpha} = \frac{N}{P \times \cos\alpha}, \text{ also } D' = \frac{N'}{P}$$

$$\text{therefore } \frac{N'}{P} = \frac{N}{P \times \cos\alpha}, \text{ or } N' = \frac{N}{\cos\alpha}$$

Formula 21, for checking the calculations, will also be understood from Fig. 4, where it will be seen that

$$O = 2\,ab \times \cos\delta, \text{ also that } ab = \frac{C}{\cos\theta}$$

$$\text{therefore } O = \frac{2\,C \times \cos\delta}{\cos\theta}$$

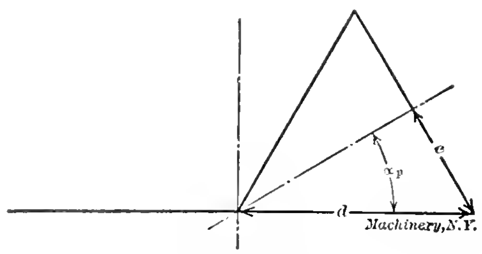


Fig. 7. Diagram for Obtaining Pitch Cone Angle of Pinion to mesh with Crown Gear

Formulas 22 to 27 inclusive are simply the corresponding Formulas 1, 9, 14, 15, 16 and 20 when $\alpha = 45$ degrees.

Formula 28 is derived as shown in Fig. 5.

$$c = \frac{e}{\tan\alpha_p}, \text{ also } c = a + b = \frac{d}{\sin\gamma} + \frac{e}{\tan\gamma}$$

$$\text{therefore, } \frac{e}{\tan\alpha_p} = \frac{d}{\sin\gamma} + \frac{e}{\tan\gamma}$$

Solving for $\tan\alpha_p$, we have: $\tan\alpha_p = \dfrac{e\,(\sin\gamma \times \tan\gamma)}{d\tan\gamma + e\sin\gamma}$

Dividing both numerator and denominator by $e\tan\gamma$, we have:

$$\tan\alpha_p = \frac{\sin\gamma}{\dfrac{d}{e} + \dfrac{\sin\gamma}{\tan\gamma}}$$

Since $d = \dfrac{N_g}{2P}$ and $e = \dfrac{N_p}{2P}$, and since $\dfrac{\sin}{\tan} = \cos$, we have:

$$\tan\alpha_p = \frac{\sin\gamma}{\dfrac{N_g}{N_p} + \cos\gamma}$$

Formula 29 is derived by the same process for the other gear. Formula 31 (and likewise 33) is derived from Fig. 6, using the following fundamental equation:

$$\frac{e}{\tan\alpha_p} = \frac{d}{\sin(180^\circ - \gamma)} - \frac{e}{\tan(180^\circ - \gamma)}$$

When solved for $\tan\alpha_p$, this gives formula 31.

Rule 32, of course, simply expresses the operation of finding out whether the pitch cone angle of the gear is less, equal to, or greater than 90 degrees. The derivation of Formula 34 is shown in Fig. 7:

$$\sin\alpha_p = \frac{e}{d} = \frac{N_p}{N_g}$$

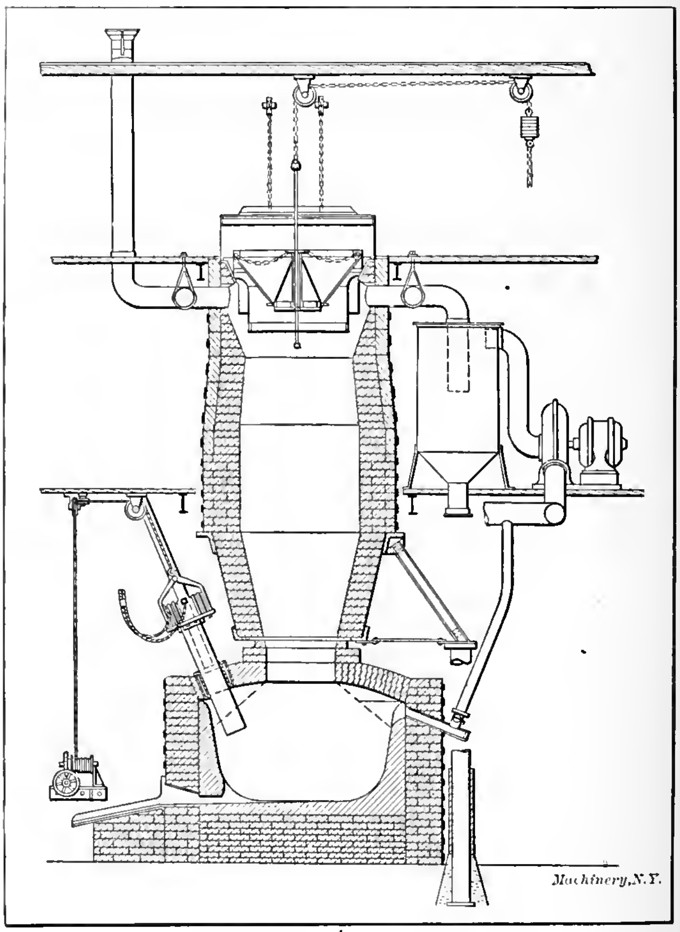
Since in a crown gear the dimension $\dfrac{D'}{2}$ in Fig. 4 is to be measured parallel to the axis, and will therefore be of infinite length, the form of the teeth will correspond to those of a spur gear having a radius of infinite length, that is to say, to a rack. This accounts for Formula 38.

Formulas 39, 40, 42 and 44 are simply the corresponding Formulas 33, 9, 16 and 20 changed to avoid the use of negative cosines, etc., which occur with angles greater than 90 degrees. These negative functions might possibly confuse readers whose knowledge of trigonometry is elementary. The other formulas for internal gears are readily comprehensible from an inspection of Fig. 3.

ELECTRIC SMELTING OF IRON AND STEEL*

At Gysinge, in Sweden, in one of the works belonging to the Stora Kopparbergs Bergslags Aktiebolag, a furnace as shown in the accompanying engraving is installed. This furnace is similar to a common blast furnace, but is provided with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles and 9,500 amperes, 674 H. P. The electrodes take the place of the tuyeres. This furnace has been running for 1,903 hours and 28 tons of iron, containing from 0.95 to 3.09 per cent of carbon has been produced. The temperature of the escaping gases from the furnaces is generally very low, and they contain on an average about 22 per cent of carbon dioxide. The gases contain practically no nitrogen, but considerable steam from the water in the ore, lime, coke or charcoal is present. No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke, and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.

The line engraving shows a vertical section through the furnace which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast furnace, and a top section or blast. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting



Electric Blast Furnace built at Gysinge, Sweden

chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace, since experiments have shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The charge is made up of ore, lime, coke and charcoal. The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way.

* Abstract of paper by Mr. E. J. Ljungberg, of Falun, Sweden, read before the Iron and Steel Institute of Great Britain.

THREAD ROLLING*

J. F. SPRINGER†

Of the several methods used for producing threads on screws, the one least understood or known by mechanics in general is the process of thread rolling. When threads are produced by means of this process, the blank, which is held in a machine made for this purpose, is rolled between two dies or blocks, provided on their faces with grooves of the right pitch, form and angle of lead, as shown in Fig. 1. The thread

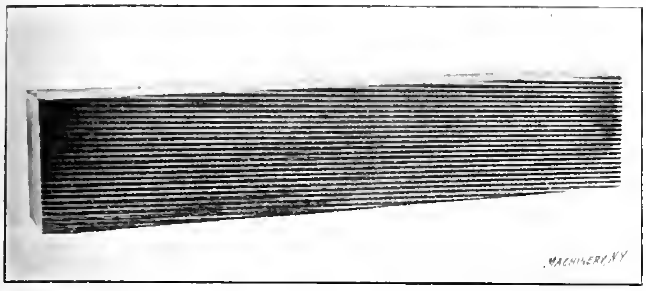


Fig. 1. A Thread Rolling Die for Rolling United States Standard Threads

is formed by the displacement of the metal, some part of which is forced up to form the top of the thread. The finished screw, therefore, is larger in diameter than the blank.

That it is possible to form or roll a perfect thread by means of straight grooves or threads cut into a flat block or die, will be understood by imagining the thread helix as unrolled upon a flat surface. In Fig. 2, for instance, the line AB indicates

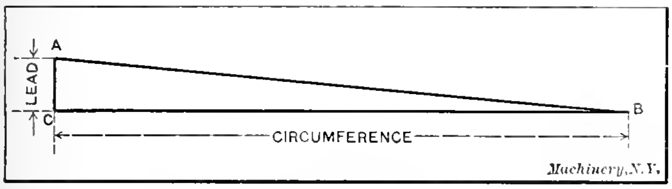


Fig. 2. Diagram for Determining Angle of Threads in Thread Rolling Dies

the helix of a thread thus developed on a flat surface; the line AC is the lead of the thread, and the line BC is the developed circumference of the screw. It is necessary, of course, that the angle of the thread cut on the flat thread rolling die be the same as the helix angle of the thread, which, in turn, is the same as the angle ABC in Fig. 2. The tangent of this angle, of course, equals

$$\frac{AC}{BC} = \frac{\text{Lead}}{\text{Circumference}} = \frac{\text{Lead}}{\text{Diameter} \times 3.1416}$$

These general remarks indicate the main principles involved in the process of thread rolling. In the following some of the elementary matters to be considered in this connection will be treated.

Methods Used for Thread Rolling

There have been a number of methods proposed for carrying out the mechanical operation of rolling threads. As far back as 1851 a machine was built for this purpose. In this machine the blank was rolled between dies or blocks with their faces vertical, one of the dies having a reciprocating motion in a direction at right angles to the axis of the blank. This fundamental idea of construction has been retained in some of the most modern thread rolling machines. Flat dies with their faces placed horizontally have also been used, but there is, as far as the writer knows, no machine of this type now on the market. In another type of thread rolling machine a cylindrical die rotating on its axis and provided with thread grooves on the outside, is set horizontally within a hollow cylindrical die provided with threads on the inside. This thread rolling machine, known as the rotary machine, is at the present time on the market. It has the merit of continuity of production; when one bolt has just been rolled, another is fed in immediately without the necessity of the reversal of the movement which in reciprocating machines causes a period of idleness. The disadvantage of the lost time in reciprocating machines, however, is partially removed by introducing a return movement which is more rapid than the advance; but the continuity of action of the rotary thread roller is, no doubt, an item of importance. A single revolution of the convex die produces, in fact, four bolts.

Automatic Feed for Screw Blanks

There are, however, other things to consider besides continuity of action. An important question is the feeding of the blanks, and the machine having flat dies of the type shown in Fig. 1, set with their faces vertical, lends itself best to automatic methods of supplying the blanks. In such feeding mechanisms the greatest problem probably is that of getting the blanks into the required position for the operation to be performed upon them. A device for this purpose is illustrated in Fig. 3. The blanks for the screws are placed in a hopper A of generous size located at the top of the machine. There is a long slot in the bottom of the hopper through which a flat plate B, called the center-board, is vertically reciprocated. This center-board has a vertical slot whose width is just a trifle in excess of the diameter of the body of the blank. When this slotted center-board rises through the slot in the bottom of the hopper—the motion being actuated by a cam and gearing as shown—one or more blanks are likely to drop, under the influence of their weight, into the slot in the plate. These blanks then hang suspended by their heads as shown. Sometimes, however, the center-board will rise through the mass of blanks in the hopper without any blank being properly located to come into the required position; but the mass of blanks will be disturbed and the next time the board rises some blanks may be caught in the manner necessary for feeding to the machine, and sooner or later one or more bolts will be suspended by their heads. To get a sufficient number to supply the machine, all that is necessary is to proportion the mechanism properly and to operate it at a suitable rate of speed.

Sometimes the blanks will be picked up crosswise or get into other unfavorable positions across the edge of the slotted center-board. An auxiliary device may then be employed to throw off such blanks. In Fig. 3 several blanks are shown

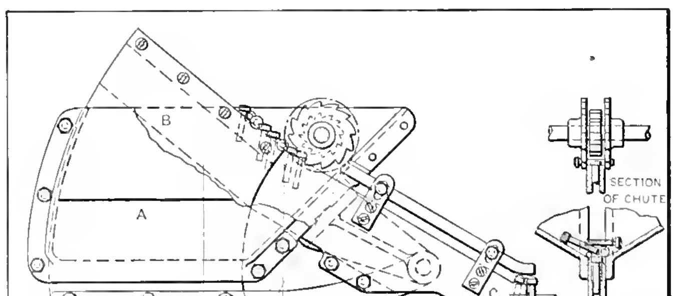


Fig. 3. Automatic Feeding or Hopper Mechanism for Screw Blanks in Thread Rolling Machines

in the proper position in the slot and two others are already delivered to the fixed portion C of the chute, while a number are in unsuitable positions for feeding. As the blanks in or on the center-board move outward to the fixed part of the chute, they pass under and between a rotating system of three toothed wheels of the ratchet-wheel type. The outside wheels pass close to the outer edges of the board, while the inner wheel passes close above the heads of the blanks which are properly caught. This is indicated in the upper sectional

* See MACHINERY, November, 1909, engineering edition: Calculating the Size of Blank for Rolling Screw Threads.

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view to the right in Fig. 3. If a blank is in the correct position in the chute it will not be disturbed by the wheels, but if not, it will be thrown off. The lower sectional view to the right shows a typical situation of the blanks when the center-plate rises through the slot at the bottom of the hopper.

It will be seen in Fig. 3 that as the blanks pass down the inclined chute they are prevented from subsequent displacement by an adjustable guide or keeper passing over their heads. At the end of the chute the direction of the blanks becomes vertical and they are then caught between the dies and the thread rolled. Of course, all thread rolling machines are not fed with automatic hoppers of this type. Conditions decide when and when not to employ devices of this kind.

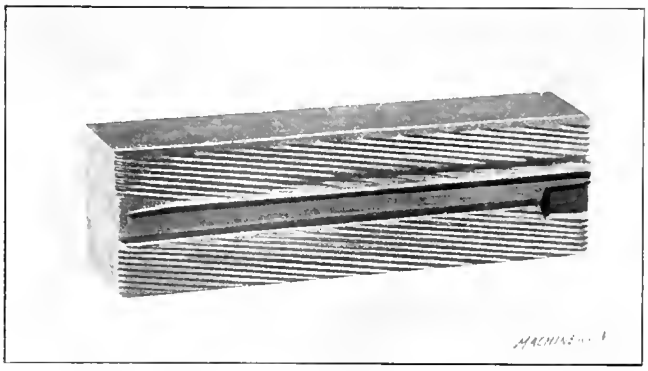


Fig. 4. A Reversible Thread Rolling Die for Wood-screws

The Thread Rolling Process

One of the thread-rolling dies is stationary while the other has a reciprocating movement. Both dies are exactly the same otherwise except for length. The thread-rolling die shown in Fig. 1 is for a right-hand thread, the grooves inclining downward toward the right. For a left-hand thread, the threads on the dies incline downward toward the left. In Fig. 4 is shown a reversible die. In this die when the upper portion is worn down the lower portion may be brought into service by reversing the die. This die is for rolling wood-screw threads. On account of the gimlet point required, the surface of the die is not flat. In rolling screw threads using one stationary and one reciprocating die, the working stroke of the moving die must be at least twice the length of the fixed die, otherwise the screw blank would not be rolled over the full face of the fixed die, but would be carried back at the return of the movable die. While a good thread might be rolled that way, it would obviously be impracticable to have the screw blank return, if for no other reason than because it would interfere with the blank just fed into the dies.

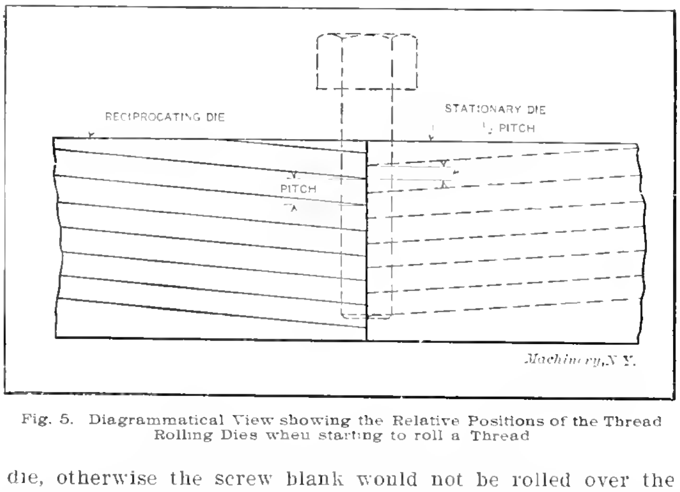


Fig. 5. Diagrammatical View showing the Relative Positions of the Thread Rolling Dies when starting to roll a Thread

When calculating the angle of the threads on the die face, the circumference of the die blank should be taken as the length of the side *BC* in Fig. 2. For example, suppose that we wish to roll an ordinary V-thread having a finished diameter of ¾ inch, and 10 threads per inch. The diameter of the blank is found by Formula (11), on page 181 of MACHINERY, engineering edition, November, 1909. This diameter is 0.689 inch, and the circumference of the blank, consequently, 2.165 inches. The screw having 10 threads per inch, the lead is 0.100 inch and hence the tangent of the angle of the thread on the die face $= \frac{0.100}{2.165} = 0.046$, giving an angle for the thread of 2 degrees 40 minutes.

A little thought will easily convince one that when starting to roll the thread it is necessary that the grooves in one die be in a given relation to the grooves in the other. The two dies work on the screw on parts separated one-half turn, and as one-half turn of the screw corresponds to one-half of the pitch, the ridges and grooves of points exactly opposite each other must be one-half of the pitch above or below the corresponding ridges and grooves in the other die. (See Fig. 5.) In rolling threads this relative adjustment must be secured, otherwise the thread rolled by one die would not coincide with that formed by the other. It is, therefore, necessary to have vertical adjustment in the slides in which the dies are mounted.

It will be understood from what has been said that not only is it important that the two die faces be adjusted exactly in relation to each other, but also that the blank be started exactly at the time when points on opposite faces of the dies are in the correct relation to each other. It is, therefore, necessary to have means of adjustment for timing the start of the operation of rolling the blank. For this purpose a starting rod is used. The blank stands with its head pointing upward at the proper level and close to the right-hand edge of the fixed die. The die is cut away at this point so that as long as the blank remains there, no work will be accomplished by the movement of the reciprocating die. The starting rod then forces the blank between the dies at the precise moment when the threads are in the proper relation to each other. The starting rod is usually referred to as the "starter." It is, of course, important that the blank pass through in a perfectly upright position. If it is started vertically there is ordinarily no difficulty in maintaining it so. At the moment of starting, the starter forces it against the vertical edge of the fixed die, which is sufficient for usual requirements. If the blank is very long, it may need support at its upper end; this support in most cases may be given by the hand of the operator.

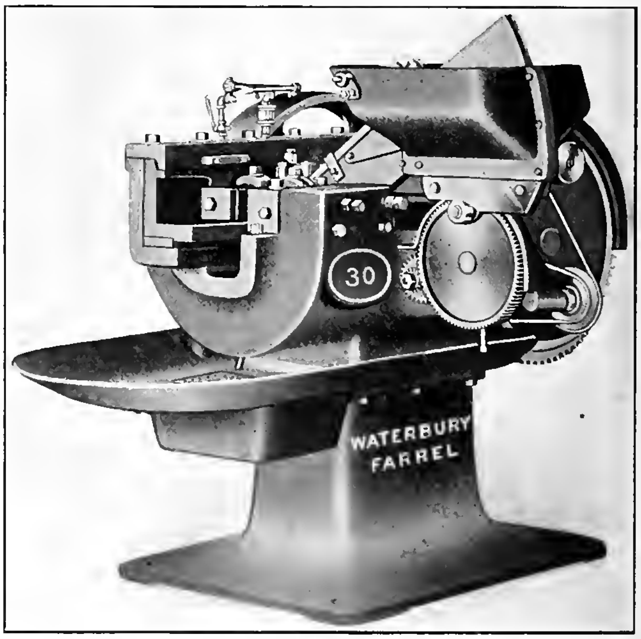


Fig. 6. A Waterbury Farrel Foundry & Machine Co.'s Thread Rolling Machine with Automatic Hopper Mechanism

At the first part of the stroke the bolt is only partially penetrated by the threads in the dies. The dies, therefore, are not mounted exactly parallel, but so that they are further apart from each other at the point where the rolling process commences. When the bolt has rolled all the way through to the left-hand edge of the fixed die the operation is complete and the movable die begins to return. It has been found desirable to provide a means of preventing the bolt from getting

caught and carried back between the dies. Gravity alone cannot be depended upon because of the possibility of the thread on the screw clinging to the moving die. One method for throwing off the work is by the use of a flat spring. One arm of a rather obtuse V protrudes over the upper edge of the movable die. When the bolt comes along its head or upper part strikes this arm of the V, forcing it back; when the work has passed, the arm returns to its normal position, so that it prevents the work from following the die back. The spring

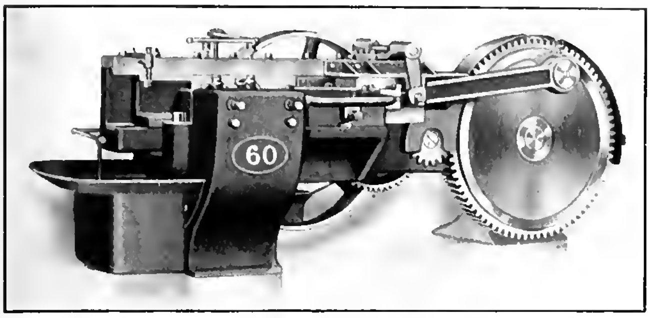


Fig 7. Large Thread Rolling Machine

will not be pressed back on the return stroke, as the work is not held very firmly to the die.

Advantages of Thread Rolling

As already mentioned, the rolling of threads increases the outside diameter; thus in the example previously given, a blank 0.689 inch in diameter produces a thread of 0.750 inch in diameter, or an increase of 0.061 inch—over 8 per cent. It will be seen, then, that if the diameter of that part of the bolt which is not threaded and the threaded portion are desired to be the same, blanks must be used having a smaller

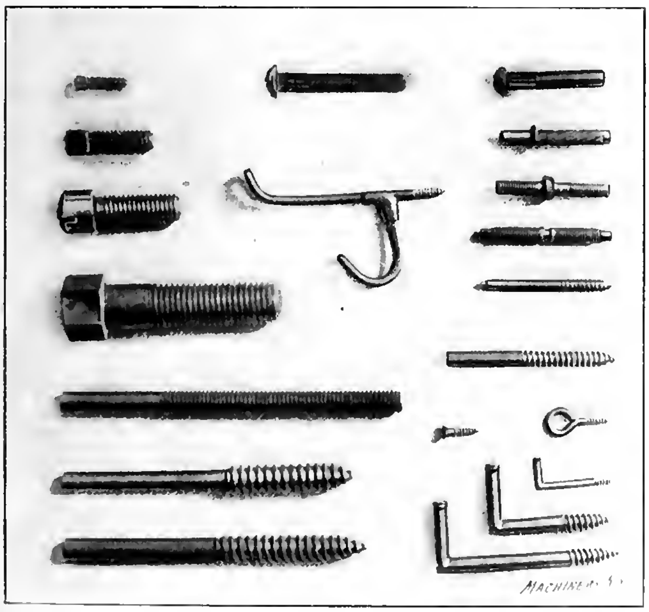


Fig. 8 Examples of Work performed in Thread Rolling Machines

diameter where the thread is to be formed.

The fact that thread rolling is accomplished without waste is perhaps a consideration worth taking into account.* Suppose that we are threading ¾-inch bolts, the threaded part being 4 inches long. When cutting the threads in a lathe or with dies we use full size stock, but when rolling them we can use stock 0.689 inch in diameter. The saving is expressed by the formula:

$$S = \frac{\pi}{4} (G^2 - g^2)\, l$$

in which G is the diameter of the finished thread, g the diameter of the blank, and l the length of the thread. For the example above, we find:

$$S = 0.7854\ (0.750^2 - 0.689^2) \times 4 = 0.276 \text{ cubic inch.}$$

For 10,000 bolts we would have a saving of 2,760 cubic inches, or about 770 pounds of steel.

* The bolts for holding together the cast iron sections of the Hudson tunnel tube are all provided with rolled thread.

Quite aside from the question of economy of material is that of the quality of the product. A bolt or screw whose threads have been rolled may not be suited to applications where microscopic accuracy of the threads is essential; no one would think of using a rolled thread for a micrometer screw. The strength of the thread, however, appears to be fully that of cut threads, although the writer is not aware of any extended comparative tests having been made between cut and rolled threads. It seems reasonable to expect even greater strength from these threads for the reason that the rolling process, executed on cold metal, may be expected to impart firmness to the thread and adjacent parts.

One of the greatest advantages of the manufacture of bolts and screws by the rolling process is the rapidity with which the work can be carried out. The smallest machine manufactured by the Waterbury Farrel Foundry & Machine Company, for instance, having a capacity of stock up to 3/16 inch in diameter, will roll screws at the rate of one every 4/5 of a second. If the thread is short, this speed, it is claimed, can be increased. The largest machine, having a maximum capacity of blanks 1½ inch in diameter, is said to be capable of rolling threads at a rate of one every three seconds. In Fig. 6 is shown a medium-sized thread rolling machine provided with the automatic feeding device illustrated in Fig. 3. As shown in the half-tone, the center-plate is at the highest point. The toothed wheel arrangement for removing blanks improperly caught by the center-plate is barely visible over the edge of the hopper. The fixed die is on the side toward the observer, the movable die being mounted in a slide having guides at top and bottom as indicated. In Fig. 7 is shown a larger machine which is not provided with an automatic feeder.

In Fig. 8 are shown a number of screws and other pieces of work having threads produced by rolling. Among these samples is a wood-screw with tapering thread and gimlet point. In other samples the thread is straight until near the end, where a gimlet form is produced. Attention may be directed to the longitudinal grooves on two of the pieces at the top of the illustration. While these are not threads in the ordinary sense, although they might be regarded as groups of multiple threads with an infinite lead, they may be readily formed by a rolling operation. Another sample shows a thread with a very steep lead. Pieces with a threaded portion at each end, one right-hand and the other left-hand, are also shown. That it is practicable to thread very close up to the head may be seen from some of the samples to the left.

* * *

THE "NEW MECHANICS"

In an address before the French Association for the Advancement of Science, Mons. Henrie Poincaré recently pointed out the contrast between the so called "new mechanics" and the old mechanics based upon Newton's laws of motion. The conceptions of the new science of motion are not easily presented in a popular form, because of their entire novelty. In a word, the modern idea is that a constant force acting upon a moving body does not impart equal increments of velocity in each successive second, but that the accelerative effect decreases as the velocity of the body becomes greater, and finally reaches a limit which it cannot pass. This limit is the velocity of light. In other words, the inertia of matter increases with its velocity of translation, and becomes infinite when the velocity is equal to that of light. Another form of statement is that the mass of a material body increases with its velocity of movement, and that there can be no motion swifter than that of light, that is, about 186,330 miles per second.—*Youth's Companion.*

* * *

CORRECTION

In the articles "Machining Cylinders and Pistons for Automobile Engines" and "Automobile Factory Practice," January number, engineering edition, it was stated that in the Nordyke & Marmon shops pistons are lapped in dummy cylinders, using oil and emery. This is an error as regards the abrasive. Powdered glass is used instead of emery on account of the well-known tendency of emery to embed in cast iron and cause destructive wear in use.

MACHINE SHOP PRACTICE*

THE VERNIER SCALE—ITS PRINCIPLE AND METHOD OF READING

Every machinist knows how confusing it is to take measurements with a scale that is graduated in hundredths or even sixty-fourths of an inch, owing to the multiplicity of lines. If it were possible to graduate a scale to thousandths, that is, so that every inch would be divided into a thousand equal parts, it would, of course, be useless, owing to the extreme fineness of the lines and the minute distances between them. Such fine divisions on a scale are not, however, necessary, for by means of a special auxiliary scale called a vernier (after its inventor), graduations which are comparatively large can be divided so that fine measurements may be taken. For example, the true or regular scale of the caliper-square shown in Fig. 1, is graduated in fortieths of an inch; but by means of the vernier scale *V*, which is attached to the sliding head of the instrument, measurements within one-thousandths of an inch may be taken. In other words, the vernier, in this case, makes it possible to divide each fortieth of an inch on the true scale into twenty-five parts. The vernier may be defined, then, as an auxiliary scale that is attached to caliper squares, protractors, etc., for obtaining fractional parts of the sub-divisions of the true scale of the instrument.

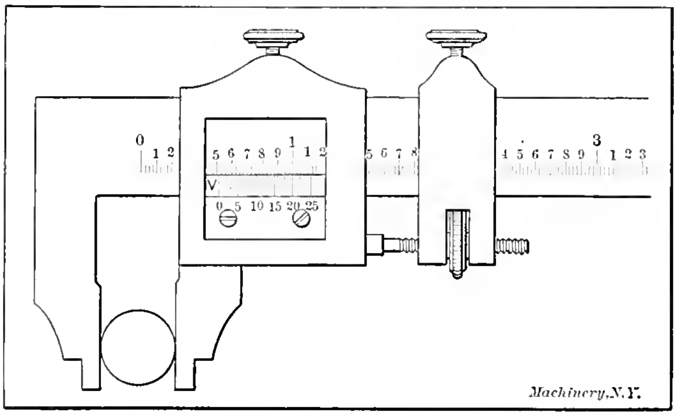
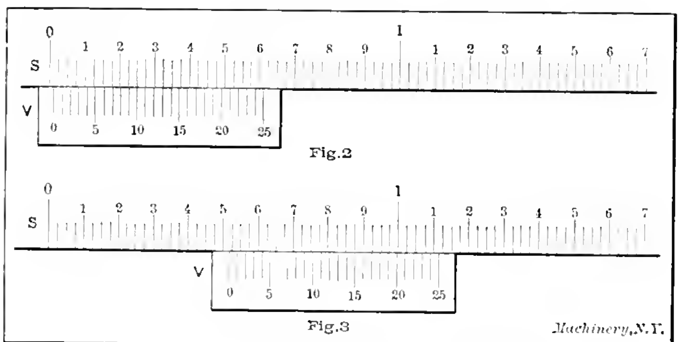


Fig. 1. Caliper Square with Vernier reading to Thousandths



Figs. 2 and 3. Scales with Verniers set to Different Positions

By referring to the enlarged scales shown in Figs. 2 and 3, the principle of the vernier can be more easily understood. Here each inch of the true scale *S* is divided into ten parts, and each tenth into four parts, so that the finest divisions are fortieths of an inch. The vernier scale *V* has twenty-five divisions, and its total length is equal to twenty-four divisions on the true scale, or 24/40 of an inch; therefore, each division on the vernier equals 1/25 of 24/40 or 24/1000 inch. Now, as 1/40 equals 25/1000, we see that the vernier divisions are 1/1000 inch shorter than those on the true scale. If, then, the zero marks of both scales were exactly in line, the two first lines to the right would be 1/1000 inch apart; the next two 2/1000; etc. It is evident then that if the vernier be moved to the right until, say, the tenth line from the zero mark exactly coincides with one on the true scale, as shown in Fig. 2, the movement will be equal to 0.010 inch, since this line was 0.010 inch to the left of the mark with which it now coincides, when the zero lines of both scales were together. Similarly, if the fifteenth line were exactly opposite a line on the true scale the movement of the vernier would be equal to 0.015, etc.; so we see that the number of thousandths that the vernier zero has moved past a graduation on the true scale, is determined simply by counting the number of spaces between the zero of the vernier, and that line on it which is exactly in line with one on the true scale. If the vernier were moved along to the position shown in Fig. 3, the true scale would indicate directly that the reading was slightly over 0.500 inch, and the coincidence of the graduation line 15 on the vernier with a line on the true scale, would show the exact reading to be $0.500 + 0.015 = 0.515$ inch; that is, the exact amount (in thousandths with this particular vernier) that the vernier zero has moved past the 0.500 division, is determined, as before stated, by counting the spaces between vernier zero line and that line of the vernier which coincides with one on the true scale.

In Fig. 4 a true scale *S* is shown that is graduated into sixteenths of an inch, and the vernier *V* has eight divisions with a total length equal to seven divisions on the true scale, or 7/16 of an inch; therefore each division on the vernier is 1/8 of 1/16, or 1/128 inch shorter than the divisions on the true scale; so we see that in this case the vernier enables readings to be taken within one-hundred and twenty-eighths of an inch instead of in thousandths as with the one described in the preceding paragraph. The divisions then that may be obtained by a vernier depend altogether on the way the true and vernier scales are graduated. In order to determine the fractional part of an inch that may be obtained by any vernier, multiply the denominator of the finest sub-division of an inch given on the true scale, by the total number of divisions on the vernier. For example, if as in Figs. 2 and 3, the true scale is divided into fortieths and the vernier into twenty-five parts, the vernier will read to thousandths, as twenty-five times forty equals one-thousand. If there are sixteen divisions to the inch on the true scale and a total of eight on the vernier (as in Fig. 4) the latter will enable readings within one-hundred twenty-eighth of an inch to be taken, as eight times sixteen equals one hundred twenty-eight. It will be seen then that each sub-division on the true scale is divided into as many parts as there are divisions on the vernier. If, for example, the vernier of a protractor has, in all, say twelve divisions, evidently each degree may be divided by it into twelve parts or one-twelfth degree. As there are sixty minutes in one degree, the protractor would indicate angles within five minutes.

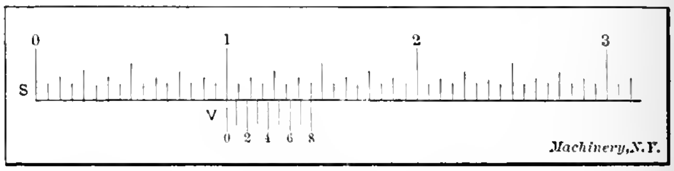


Fig. 4. Scale with Vernier Reading to One-hundred Twenty-eighths of an Inch

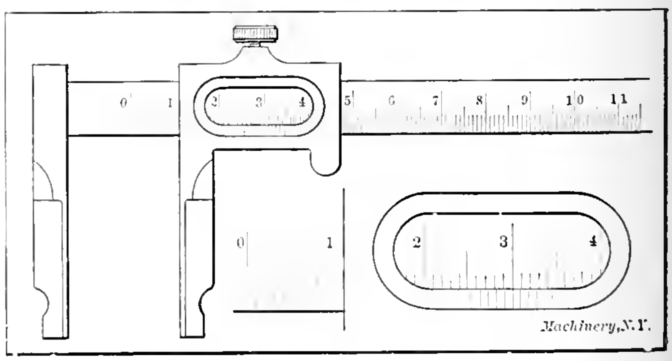


Fig. 5. Caliper Square Graduated on the Metric System

The following is a general rule for taking readings with a vernier: Note the number of inches and whole divisions of an inch that the vernier zero has moved along the true scale, and then add to this number as many thousandths, or hundredths, or whatever fractional part of an inch the vernier reads to, as there are spaces between the vernier zero and that line on it which coincides with one on the true scale.

* With Shop Operation Sheet Supplement.

For example, the zero line of the vernier shown in Fig. 1 is slightly beyond the 0.500 division, and graduation line 15 on the vernier coincides with one on the true scale; hence, the reading is 0.500 + 0.015 equals 0.515 inch. If the vernier is attached to a protractor, note the whole number of degrees passed by the vernier zero mark, and count the spaces on the vernier as before. If the vernier indicates angles within five minutes the number of spaces times 5 will, of course, give the number of minutes to be added to the whole number of degrees.

The application of the vernier to a "Columbia" caliper-square graduated on the metric system, is illustrated in Fig. 5. Here we have, instead of inches, centimeters which are sub-divided into ten parts called millimeters. By the aid of the vernier, each millimeter is again divided into ten parts so that readings can be taken to within 1/10 of a millimeter or 1/100 of a centimeter (0.0039 of an inch). The reading with the caliper set as shown in the illustration is 2 55/100 centimeters, or, as commonly expressed, 25 5/10 millimeters. This particular instrument has on the opposite side of the beam two series of inch graduations which, with the verniers, enable measurements within 1/100 and 1/128 of an inch to be taken. It will be seen that inches may be converted into metric measurement, and *vice versa*, by taking the reading first on one side of the beam and then on the other.

Further information on reading verniers when applied to a micrometer or bevel protractor is given in the Shop Operation Sheet accompanying this number, to which the reader is referred.

* * *

The education of apprentices at the United Shoe Machinery Co., Beverly, Mass., has been arranged along lines similar to those in vogue in Worcester and Fitchburg, and which have previously been mentioned in MACHINERY. The company has organized two classes of twenty-five boys each, recruited from the machine tool department. The city has a technical school supported by the town and the state board of industrial education, and the two classes of boys work alternate weeks in the shop and in the school. These boys are paid half the piece rates that the regular factory employes are paid, and earn at an average of $3 per week, although a few of them earn $5 weekly. Besides these small earnings, of course, they get a thorough knowledge of the use of machinists' tools and, in fact, learn the entire machinist's trade. The class when instructed in the school is taught such subjects as drawing, elementary machine design, mathematics and other practical subjects. They do not receive any pay while attending the school. There is no effort made to educate the students to be superintendents or foremen, but they are fitted to earn a livelihood, and, as one of the men in charge at the Beverly factory says, "If they have the right stuff in them they will get there."

* * *

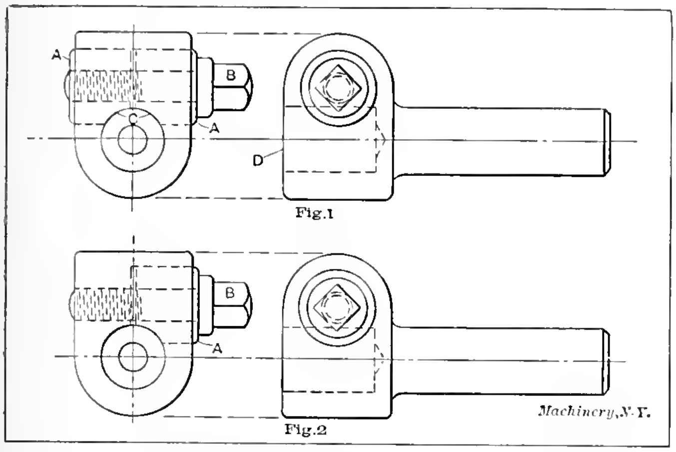
The *Mechanical World* states that aluminum may be etched by the following etching fluid: alcohol, 4 ounces; acetic acid, 6 ounces; antimony chloride, 4 ounces, and water, 40 ounces.

TOOL-HOLDER DESIGNS

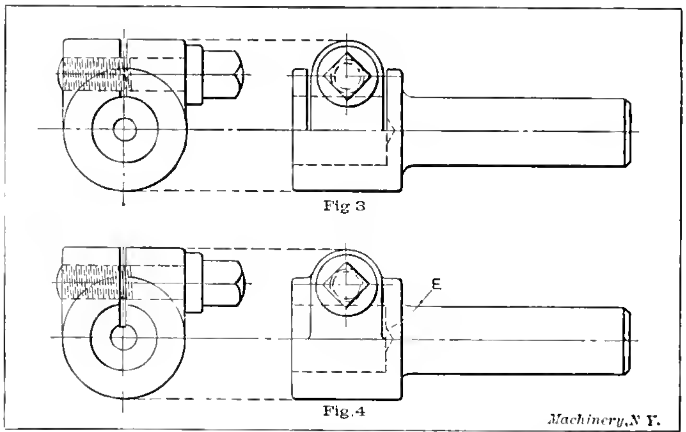
F. P. CROSBY*

A number of tool-holders of different designs for turret lathe and automatic screw machine work are shown in the accompanying illustrations. As many of the types illustrated are widely used and represent standard practice, they are presented herewith for the guidance of tool-makers, designers, or others interested in such equipment.

The binder type of turret lathe tool-holder is shown in Figs. 1 and 2. Fig. 1 illustrates a holder of the double binder type. The hardened cylindrical parts *A*, which should be fitted accurately to the body of the holder, serve to clamp the tool in place. These parts are turned away at *C* to conform to the hole in which the tool is inserted. As may be seen, one of these parts is tapped to fit the screw *B*, which has a collar head bearing against the other part. The clamping action is effected by turning screw *B*, which draws the two parts *A* together, thus binding them firmly against the cutter which is inserted in the bore *D*. The holder shown in Fig. 2 is of the single binder type. The screw *B* is tapped into the body of the holder and only one binding piece *A* is used. These holders are considered to be the best of their class and they can, of course, be made in any size that may be desired. The construction is clearly shown in the engraving.

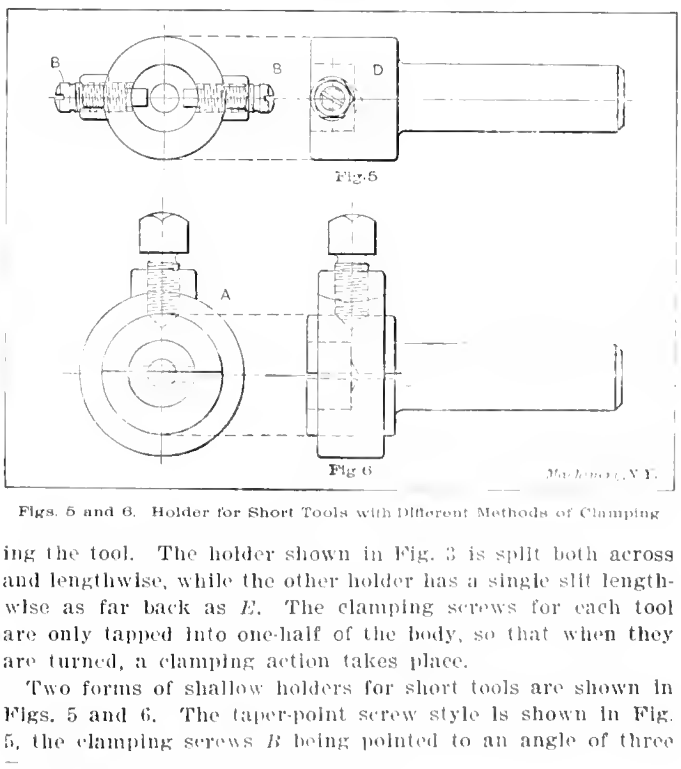


Figs. 1 and 2. Turret Lathe Tool-holders of the Double and Single Binder Type



Figs. 3 and 4. Two Tool-holders of the Compression Type

Figs. 3 and 4 show two holders of the compression type, which for some classes of work is the best. These two holders are practically the same, differing only in the way they are split to obtain the required amount of elasticity for clamping the tool. The holder shown in Fig. 3 is split both across and lengthwise, while the other holder has a single slit lengthwise as far back as *E*. The clamping screws for each tool are only tapped into one-half of the body, so that when they are turned, a clamping action takes place.



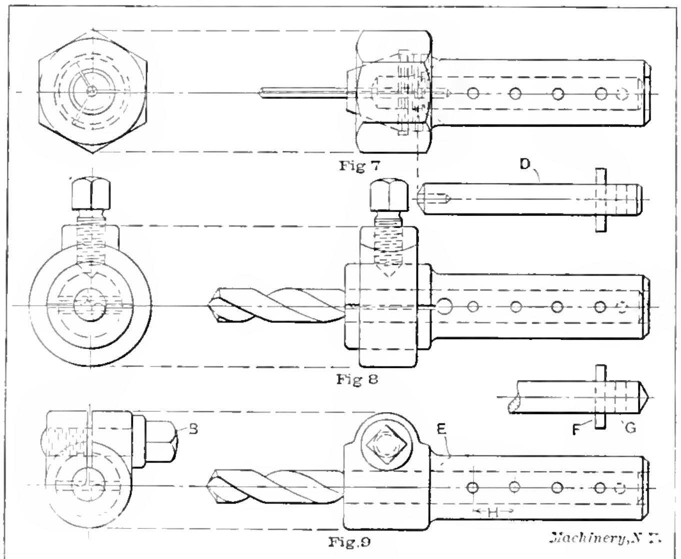
Figs. 5 and 6. Holder for Short Tools with Different Methods of Clamping

Two forms of shallow holders for short tools are shown in Figs. 5 and 6. The taper-point screw style is shown in Fig. 5, the clamping screws *B* being pointed to an angle of three

* Address, 113 North State St., Chicago, Ill.

degrees and fitting into holes drilled in the tool shank. These holes are located at the right distance from the end so that the screws bind the end of the tool shank against the holder. The holder shown in Fig. 6 is of the compression type, the split end being tightened on the tool shank by the collar *A* and pointed screw shown.

Drill holders of the compression type are shown in Figs. 7, 8 and 9. Fig. 7 shows a compression holder of the chuck type which is used for holding small drills. The shank of the drill is soldered to a larger shank, which has a retaining pin engaging the holes in the holder. This enlarged shank, that the small drill is soldered to, is shown in detail at *D*. The small hole in the end for the reception of the drill is plainly indicated by the dotted lines. The holder shown in Fig. 8 is provided with a collar and pointed screw for clamping the drill. With the exception of the method of clamping, this tool is similar in other respects to the one shown in



Figs. 7, 8 and 9. Three Types of Drill Holders

Fig. 9. The latter is slotted lengthwise as far back as *E*, and the drill is held in position by the collar-head clamping screw *B* which is tapped into one side of the holder. The shank of this holder has drilled into it a number of holes in regular order as shown. The shank of the drill is fitted with the pin *F*, which prevents the crowding back or turning of the drill in the holder. An extra hole *G* is provided for the pin,

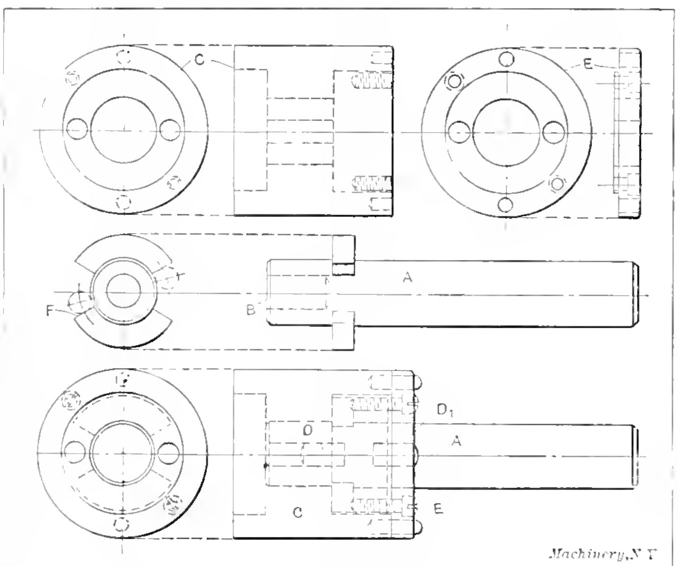


Fig 10. Assembled and Detail Views of a Die-holder

and the distance between the two pin holes is equal to one-half the dimension *H*. The clamping screw on a holder of this type needs only to be tightened enough to bring the tool in line.

Fig. 10 shows both assembled and detail views of a solid shank die-holder. The reference letters used in the detail views are the same for the corresponding parts in the assembled view. The shank and the clutch *A* is made in one piece from tool steel, and it is tempered and ground. In the end of this shank there is a clearance hole *B*, the depth and diameter of which is sufficient to give the required clearance for the work. The sleeve *C*, which is accurately fitted to the shank,

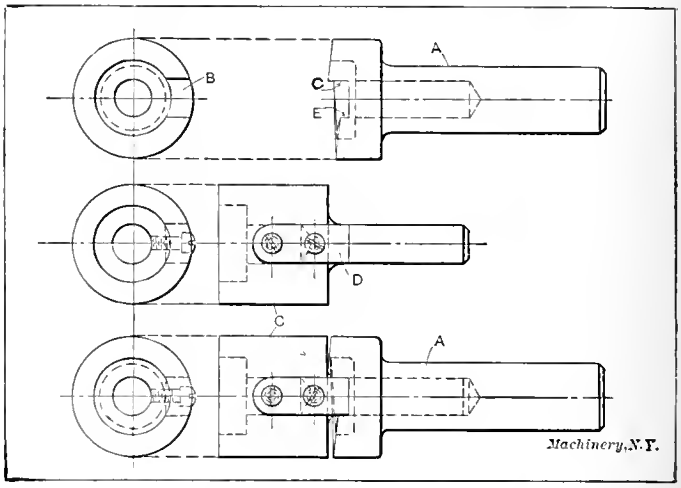


Fig. 11. Another Type of Die-holder

has attached to it the die, two of the contact pins *D* for driving the die, and the backing-off plate *E* with its contact pins D_1. The way in which the backing-off plate is held in place by screws and dowels is clearly shown in the illustration. The contact points at *F*, in case the shank should become worn, can be trued by grinding. The contact pins in case of wear can be removed and turned one-quarter way round.

A die-holder of the semi-hollow shank order is shown in Fig. 11. The shank *A* of this holder should be made of tool steel tempered and ground. On the enlarged end of the shank is shown a left-hand helix which is cut from the slot *B*. If the holder is to be used for cutting a left-hand thread, a right-hand helix has to be provided. The die is held in the

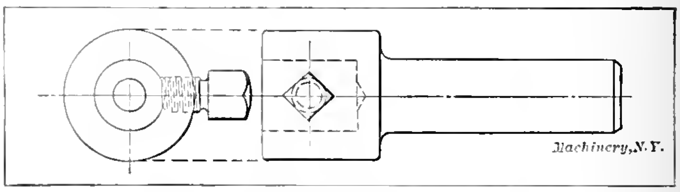


Fig. 12. Tool-holder of Objectionable Design

swiveling part, *C*, which is fitted to the shank as shown. In operation, when the turret comes to a stop, the clutch *D* disengages with the point *E*, and in backing off it is in contact with the point *C*. The clutch is made of tool steel, and is tempered and fitted to the die-holder in a manner clearly indicated in the illustration.

The tool-holder shown in Fig. 12 is one in common use, but the best place to put it is in the scrap pile, as it is simply impossible for any workman to adjust a tool in it that will be lined up properly. It is supposed that the reason for using this type of holder is to save a little on the cost. Such a tool, however, will prove to be a very poor investment.

* * *

According to the provisions of the new custom tariff of Norway, machines, motors and apparatus not manufactured in the country will be admitted free of duty. As the machine industry in Norway is comparatively undeveloped, there are a great many machines and machine parts which are thus placed on the free list, among which may be mentioned band saw blades, circular saw blades, steam hammers, pneumatic drills, steam turbines, ball bearings, link belts, etc. The complete list of the machinery admitted free of duty may be found in the November 19, 1909, issue of the *Daily Consular and Trade Reports*, published by the Department of Commerce and Labor, Washington, D. C.

* * *

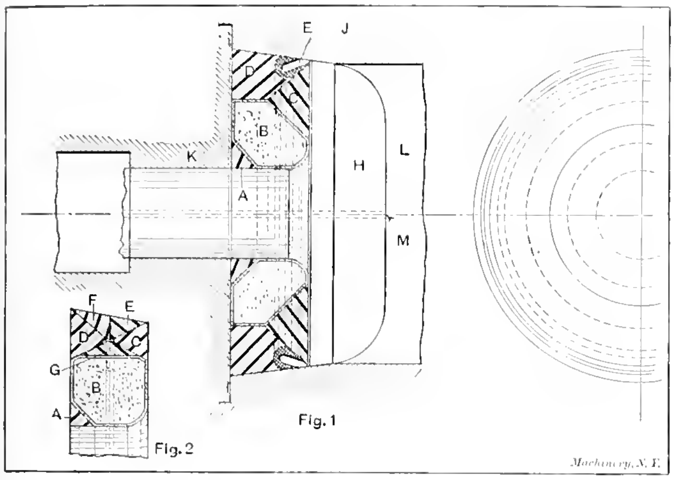
Don't forget that the top of a work-bench should slant back toward the wall.

A GAS CHECK FOR BIG GUNS

ROBERT O'NEAL*

In the large guns in use by the government, as in most other things, it is the little parts that make the great engines of war of real value. This is clearly illustrated by the fact that a fifty-thousand dollar implement of modern warfare may be temporarily put out of commission by the catching on fire of a small pad used in the construction of what is known as the gas check. This little pad which is made of canvas, hair, tallow, beeswax, etc., is worth about thirty cents, which is an insignificant sum when compared with the cost of the gun, complete; but the gun without it is about as dangerous at one end as at the other.

In Fig. 1 of the accompanying engraving is shown, in cross-section, the interior of that part of a large gun with which this little pad has to do, and in Fig. 2 the present method of



Sectional View of Gas Check for Big Guns

the construction of the rings of a gas check is illustrated. The difference between the two checks is clearly perceptible, and the advantage of that shown in Fig. 1 over that of Fig. 2 will, I think, be readily seen when the matter is fully explained.

In order to show as clearly as possible the use of the rings and the pad, it will be necessary to go into the matter somewhat in detail. In Fig. 1, *H*, *J*, *K*, and *L* represent the mushroom, the gun, the breech-plug and the powder or combustion chamber, respectively. When the charge is rammed home, the breech-plug—the face of which is shown in contact with the rear face of the rings *A*, *D*, and the pad *B*—is swung into position and turned through an arc of 40 degrees, it having entered an interrupted thread of sixty one-hundredths inch lead; this brings the mushroom *H* firmly against the wall of the gun *J*, through the contact of the rings *A*, *C*, *D*, and the pad *B*. Now, the powder charge in the chamber *L* is ignited through the vent *M*, and a pressure ranging anywhere from forty to fifty thousand pounds per square inch is generated within the chamber. Against this pressure it has been found impracticable to devise a method of holding the mushroom *H* sufficiently hard against the wall of the gun to prevent the escape of gas; therefore the gas check is necessary, as the mechanism must be free-working to allow of easy manipulation by the gun crew.

As the mushroom moves back, the pad *B* is caught between the members *A* and *C*, and as *C* is held rigid, the tendency is to reduce the thickness of the pad *B* and increase its diameter. This directly increases the diameters of the rings *C*, *D*, *E*, *F* and *G* when they are constructed as in Fig. 2, and brings them up against the wall of the gun with a pressure directly in proportion to the pressure of the gases in the combustion chamber, according to the laws of force as applied to the wedge; but this increased diameter is accompanied by a proportionate increase in the opening where the ring has been cut. The opening necessary for this expansion, though small (about 0.006 of an inch), like most little things, plays an important part, in that it allows the gas to escape through it to the pad *B*. As the temperature of this gas is that of a white heat, and acting under a pressure sufficient to throw a five-hundred-pound projectile about twelve miles in something less than half a minute, it is safe to say that this little mass of combustible substance can not long resist the onslaught of such a potential factor of destruction. Quite often only one charge is fired, when it is found necessary to renew the pad, and rarely can over three or four shots be made without renewal. While this does not require any great amount of time, nevertheless, it requires the removal of the firing lock (not shown here), the mushroom, and the dismantling of the rings; in addition the danger of fire in the turret is incurred while removing the burning pad.

It will be seen at a glance that the difference between the two gas checks illustrated lies principally in the construction of the ring *E*. In Fig. 2 this ring is of triangular cross-section and of solid metal, necessitating its being cut in order to increase its diameter when the gun is fired. In Fig. 1 ring *E* is of a U-shape in cross-section, which will allow of its being opened out to fill the space between the angular face of the ring *C*, and the wall of the gun, without cutting it, for, when the mushroom *H* recedes, the ring *C*, being solid, is carried back with it; the pad *B*, in either case, is pressed thinner and consequently larger in diameter, thus forcing the ring *D* out and hard against the wall of the gun. The gas, passing between the mushroom *H* and the wall of the gun *J*, is caught between the legs of the U-shaped ring *E*, which is being firmly supported on its inner side by the face of the ring *C* and on the outer side by the wall of the gun, while the round portion is sustained by the concave surface of the ring *D*. The pressure of the gas forces the legs outward against these three surfaces with a pressure equal to that within the chamber, and a joint is made between these surfaces through which the gas cannot possibly escape.

This design of check could be constructed to take the place of the one now in use without in any way altering the standard parts of the gun, as the set of rings shown in Fig. 1 could be made to fill the space occupied by the set shown in Fig. 2; and, if constructed with care, I see no reason why they would not last as long as the gun, or, at least, until general repairs are needed, which is usually after approximately fifty shots have been fired.

* * *

KINDLINESS AN ASSET IN MANUFACTURING

It may seem a long step from machine construction to the sentimentalism of smiles and kind words, but nevertheless these two items play an important part in many successful manufacturing plants. The object sought by a manufacturer is efficiency—efficiency on the part of the individual members of the organization as well as on the part of the machinery employed. A great deal of time and thought is expended on making the machinery efficient. Experiments are made, careful records are kept, and the best results utilized; but little thought is usually given to increasing the efficiency of the "man who works with his hands," and that often lacks system and appreciation of the final effect. Sometimes attempts are made to increase the efficiency of the men making up the organizations by methods entirely erroneous, not to say culpable, and which in the long-run prove as costly as they are ineffective.

There is, however, an inexpensive method of increasing the efficiency of the personnel in any organization. While fair compensation, and what is generally considered fair treatment are absolute essentials, a great deal can be both lost or gained by the general attitude of the employers and men in charge of the various departments. A kind word, an appreciative smile, a commendation for work well done, for instance, will often increase the efficiency, and are more effective in eliminating friction, than a so-called welfare department planned on an elaborate scale.

The efficiency of the mechanical element of the industries has been raised to a high standard, and the efficiency of the human element should be raised to an equal height by methods which will be of lasting effect both in a factory and without. If you never use smiles and kind words, try them, and you will find that the effect will be immediate, not only on those around you, but on yourself.

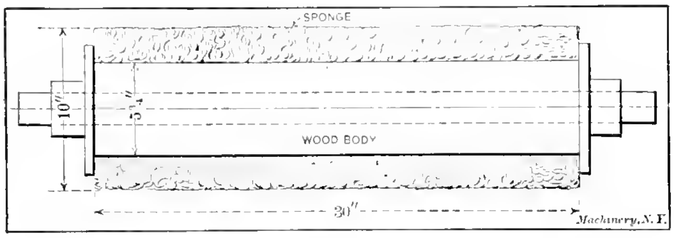
* Address: 1501 E. Monument St., Baltimore, Md.

LETTERS ON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

INGENIOUS METHOD OF TURNING A SPONGE-COVERED ROLL

A roll formed of strips of sponge and a wooden body, had to be turned true, and the writer was asked to do the job, which was wanted in a hurry. You can bet that there was



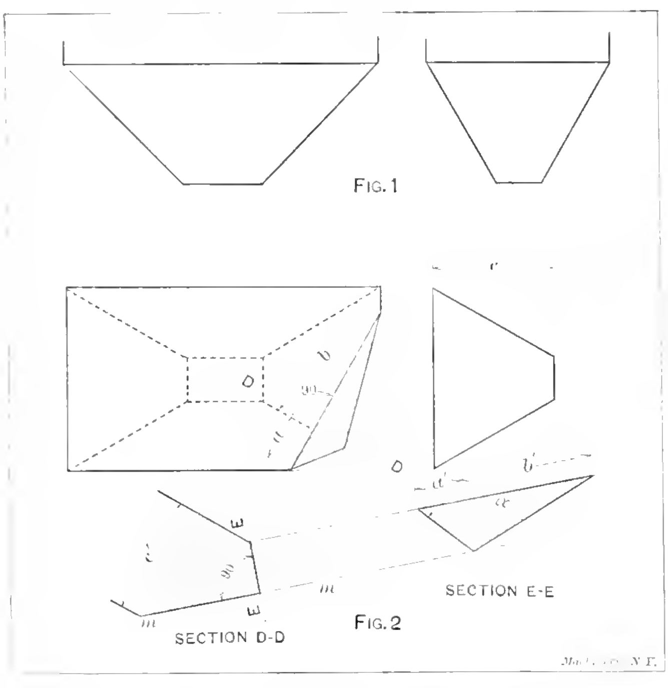
Wooden Roll with Sponge Covering which had to be turned true

some question as to how it was to be done. The sponge strips were fastened by brass tacks to the wooden body. These tacks were placed as near together as possible, there being about sixteen of them to each block of sponge. After the roll was built up in this way, the method of getting it to the required diameter proveu to be a sticker. There were enough suggestions offered to fill a book, but finally the following method was tried with considerable success. As the temperature out-of-doors was near the zero mark, the roll was placed outside on two woodeu horses with blocks arranged on either side of the shaft so that it could be turned. With the aiu of a dog on one end of the shaft, the roll was then revolved, while a fine spray of water from a hose was turned on it. In about twenty minutes the roll was frozen solid; it was then placed in the lathe and two cuts were taken over it, which completed the job. After the ice melted, the sponge covering was found true.

Lewiston, N. Y. CHARLES H. LAKE.

ANGLES OF HOPPER SIDE INTERSECTIONS

In building a steel hopper of the form shown in Fig. 1, it becomes necessary to know what angle the sides of the



Graphical Method of obtaining the Angle formed by the Tapered Sides of a Hopper

tapered portion make with each other, in order to properly bend the flange or splice plate, for the corner, as the case may be. This angle can be obtained graphically, as shown in Fig. 2. For clearness of demonstration, consider a block of the same shape as the lower portion of the hopper, with a corner cut off in a plane perpendicular to the corner *D-D*, as shown. To obtain the angle, first lay out a plan of the outline of the block as it would be before the corner was cut off; then draw section *D-D*, making c' equal to c. Draw any line *E-E*, perpendicular to *m-m*, and then projecting upward, obtain a plan view of the surface *E-E*, or a view representing the block as it would appear from above, with the corner cut off. Now draw section *E-E* making a' equal to a and b' equal to b. Then a will be the required angle. CHAS. E. EVANS.

Aurora, Ill.

[The diagrams of the Data Sheet for April, 1908, will be found very convenient for obtaining the angle formed by hopper sides.—Editor.]

MILLING A CORRECT BEVEL GEAR

In this article a method of cutting bevel gears is described which has been in use now for about two and a-half years, in a number of shops in this vicinity.

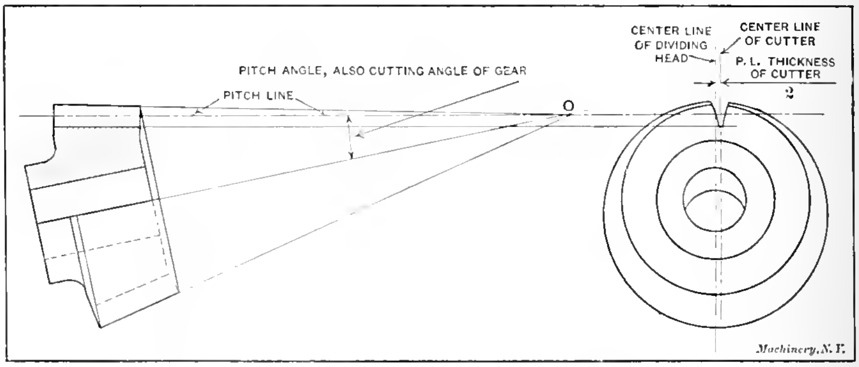


Illustration showing Method of Setting Gear Blank with Relation to Cutter

While the method is perhaps a trifle difficult to understand, as it was to work out, the results are so satisfactory as to more than make it pay. It is applicable to all cases excepting miters of very coarse pitch and few teeth and where strength is an essential feature. There is a slight excess depth at the small end of the tooth which, ordinarily, is entirely negligible and only in unusual cases is so objectionable as to make this process impracticable.

The advantages sought for and gained are these: A smooth-running bevel gear milled scientifically without "cut-and-try"; a pair of bevel gears which mesh perfectly at the pitch-line; a bevel gear which requires no filing at the small end of the tooth to make it run smoothly; and, as important

PITCH LINE THICKNESS OF B. & S. BEVEL GEAR CUTTERS

Diam. Pitch	2	3	4	5	6	7	8	10	12	14	16	20
Thickness	.513	.334	.257	.204	.169	.145	.126	.100	.082	.070	.060	.047

as anything, a method that saves a large amount of time and does away with uncertainties in bevel gear cutting.

These results are accomplished as follows: The regular bevel gear cutter is used. The gear to be cut is mounted as usual in the dividing head, but it is set up so that the working or pitch angle of the gear is the cutting angle; in other words, so that the pitch line of the tooth running to the common center *O* of the gears is parallel with the bottom of the cut, as shown in the accompanying illustration. The milling machine table is not swivelled in any case.

The cutter is set for depth, as usual, from the high point on the gear to be cut. The saddle of the machine is moved so that the vertical center of the cutter is to one side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter. A cut is then taken all around, for each tooth. This finishes, one side of the tooth. The

other side of the tooth is finished by moving the saddle in the opposite direction, so that the vertical center of the cutter is on the opposite side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter as before. Before the cut is taken the dividing head spindle is rotated so that the amount taken off this opposite side of the space is such as to leave a tooth of the correct thickness at the back, which may be easily determined by trying a spur gear cutter of the same pitch and number of teeth, or tooth gage, or spur gear tooth of the same pitch, or otherwise. This being done, the cut is taken all around, which finishes the gear.

On examination, by actual test, careful measurements or analysis of the method, it will be found that the results sought have been secured and the gears will run proudly, as self-respecting bevel gears ought to run.

Muskegon, Mich. Chas. A. Kelley.

INTERESTING WORK IN AN EXPERIMENTAL SHOP

No one class in society has a corner on inventive genius; to-day, the doctor conceives the "best thing yet," while on

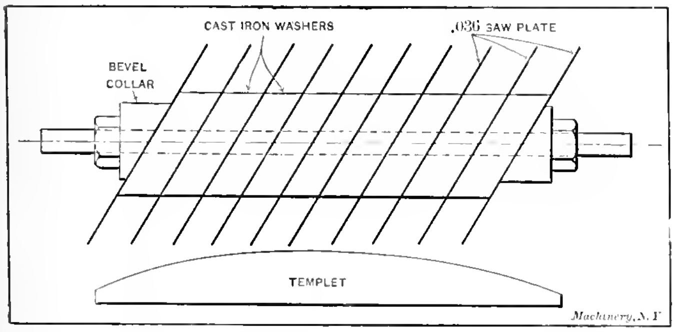


Fig. 1. Steel Disks which were turned to conform to the Templet

the morrow the chances are that it will be the laborer who is propounding something that will bring him fame and fortune. The machine shop has been and will continue to be the mecca of inventors, and a shop catering to experimental work is brought face to face with constructions and schemes as diversified as are the stations in life of their sponsors. To save the inventor from being "stung" for special tools and fixtures which he is sure will be needed when he gets to the manufacturing stage, the shop man may have to use diplomacy, and then, on his own side, resort to some homely short cuts to get the work through without these special tools.

Figs. 1 and 2 show pieces of work turned out for different

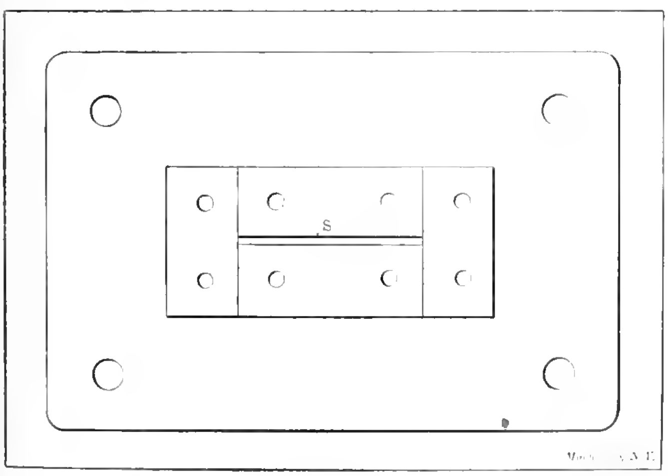


Fig. 2. Four-piece Die for Experimental Work

inventors (each with plenty of money to spend) at a fraction of the outlay that might have been put upon them. The mandrel in Fig. 1 was loaded with carbon steel disks that had to be turned to fit a templet. These disks, instead of being at right angles to the center line of the mandrel, were at an angle as shown, an effect produced by using a beveled collar on each end and loose fitting spacers between the disks. It can readily be seen that to turn these disks, projecting beyond the spacers from 3 to 5 inches, was impossible by ordinary means unless a rigging was made to follow in and out and back and forth as each one was cut separately—all of which was practically out of the question. The short way out of it was to slip on each end of the mandrel a board the size of the largest disk blank and to wrap about the whole several thicknesses of heavy manilla paper and tack it securely to the boards. After filling the disks with lead both the lead filler and the disks were turned off to the shape of the templet in quick time.

Fig. 2 shows a die and block that were substituted for the inventor's specifications for a solid tool steel die with a slot *S* 3/32 by 3 inches and absolutely to size. The four-piece die illustrated was simple to make as compared with the solid one, had ample security against spreading when set into the block, could be sharpened as often as necessary, maintained its size, and presented no risk in hardening.

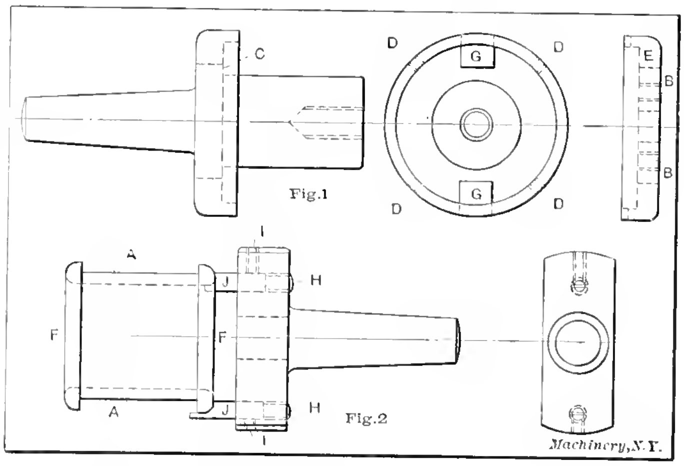
And like so many that have gone before, neither of the above pieces was ever used long enough to keep the rust off and neither produced dividends on the investment.

Middletown, N. Y. Donald A. Hampson.

MACHINING SPLIT BEARINGS

An interesting problem in the machine shop is to bore and and turn split bearings accurately. The success obtained by the use of the following methods, leads me to sumbit them to the readers of Machinery. The bearings are made of brass; when received from the foundry, they are placed in a shaper and planed on the faces *F-F* to a certain height from the back. After this operation, they are taken to the forge and sweated together. While this is not absolutely necessary, it facilitates handling the work in the next operation of chucking and boring.

The brasses are held by a pair of false jaws, which were cast



Mandrel on which Bearings are turned, and Special Tool used for Rounding Corners

for the turret lathe, and which are turned and recessed so as to clear the flange of the brass and bear on the faces *A*. The boring is done with a bar and fly-cutter, the bar being supported by a bushing in the spindle of the machine. The front face and flange are next squared and turned off before the work is removed from the chuck. It was to shorten the time required and facilitate the operation of turning the brasses that the mandrel shown in Fig. 1 was designed. The shank was made to fit in the headstock; and as the mandrel is very rigid, it is not necessary to support it by the tailcenter; consequently, high speeds can be used and there is no danger of a center becoming heated. The brasses are placed on the mandrel with the end previously finished in the turret lathe against the finished face *C*. They are locked in place by four set-screws *D*. A C-clamp is placed on the outer end of the brasses and is left there until that end and flange are finished. The cap *E* is then placed over the outer end of the brasses and the clamp is removed. This cap is fastened to the mandrel by a bolt in the center. Set-screws are provided in holes *B* to aid in removing the cap, as it is made a snug fit over the work, to prevent the latter from spreading during the process of turning. The over-all measurements are taken

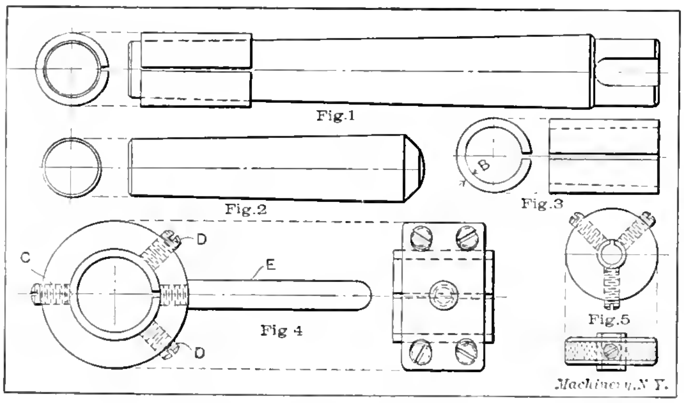
through the port-holes *G*, which are cut in the mandrel for this purpose.

After the trial lot of brasses had been completed, the radius- and fillet-turning tool, shown in Fig. 2, was designed. This tool is held by a shank in the tailstock and with it the corners of the bore and flange are rounded with a greater degree of accuracy than is ordinarily obtained when the shape of these surfaces is left to the judgment of the workman. The cutters *J* are made of drill rod, and they may be adjusted by the screw *H* and locked by the screw *I*. Direct evidence as to the time-saving qualities of the foregoing method, was given when the cost clerk made inquiry about the shortness of the time listed on the daily time cards for the lot of work which was machined by these tools.

Salem, Mass. JOHN F. WINCHESTER.

LAPS AND POINTS ON LAPPING

The laps which are shown in the accompanying illustration are excellent designs for both the outside and inside lapping of cylindrical parts Fig. 1 shows an inside lap with the arbor in place. The included angle of the taper of this arbor should be about 2 degrees; this is considered great enough for any kind of work. The lap proper, or the part that is in contact with the work, is made of bolt copper, and is shown in detail in Fig. 3. Cast iron and lead are sometimes used, but copper is the best metal for hardened work. The lap is split as shown, to allow it to expand as it becomes worn. The length of the lap should be somewhat greater than the length of the hole to be operated on, and the thickness *B* should not be more than 1/6 or less than 1/8 of the diameter of the work.



Laps for Inside and Outside Work

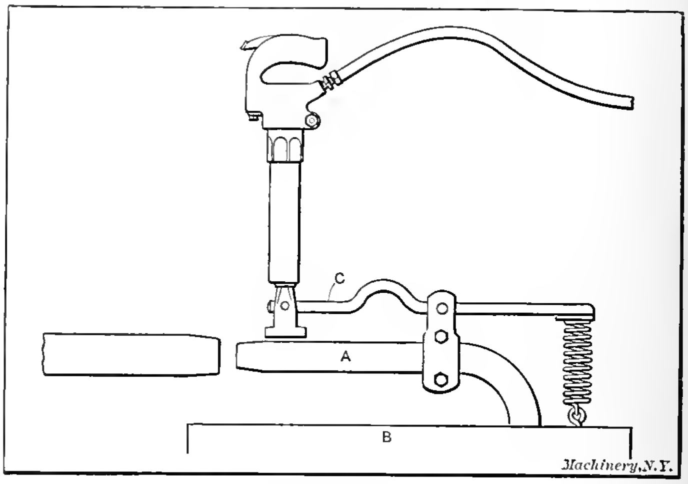
When making these laps, especially small ones, a hardened swedging plug, (Fig. 2) that is ground to the same taper as the arbor, can be used to advantage for tapering the hole through the lap before it is turned and slotted. If in the operation of lapping, the hole becomes "bell-mouthed," that is, enlarged at the ends, this is caused by the introduction of sharp emery from time to time as the hole is being lapped. To obviate this, the lap should be cleaned of all loose emery and expanded by driving the arbor farther into it. The hole is then dry lapped by using only the emery that sticks or is charged in the lap. This process must be repeated occasionally until the proper size is obtained. If the operator is careful to see that the emery used is not too coarse, and the lap is kept expanded to fit the work at all times, the result will be a perfectly straight hole. It takes considerable practice before one can use a lap and keep it from getting lumpy. If this occurs, the high spots must be removed with a file, and the lap kept a close fit to the work. The work should always be finished to size with the lap dry and well fitted to it.

Fig. 4 shows an outside lap. The proportions of the lap proper should be the same as were given for inside laps. The same method of procedure described for inside work should also be followed, *viz.*, the lap must be freed from oil and loose emery from time to time as the work progresses. The pointed screw *C* keeps the lap from slipping out of place, and the adjusting screws *D* compress it to fit the work. A handle *E* should be used on all laps of large size, as it will be found much more convenient than a lathe dog, which some workmen use for moving the lap. Fig. 5 illustrates an outside lap and holder for small work, say less than ½ inch in diameter. Laps of this size are not provided with a handle, but are knurled on the outside as shown. F. P. CROSBY.

Chicago, Ill.

PNEUMATIC FLUE WELDER

An inexpensive flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel *A*, which is attached to a cast iron block *B*, and a pneumatic hammer (equipped with a swage), which is mounted on a lever *C*. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about six inches below the level of the mandrel. This gave a taper of approximately ¼ inch to the inch. After all the long pieces were scarfed, short pieces about 8 inches long were placed in the furnace and heated on one end so that they could be drawn to a feather edge. This was also done under the pneumatic hammer. After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested, was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot so they would shrink tightly in place, thus insuring a good clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with. T. O. MARTIN.

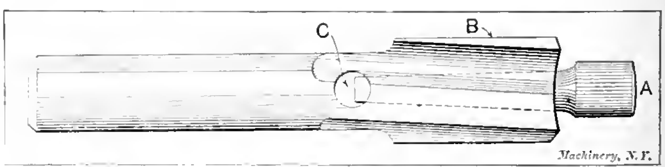


Inexpensive Tool for Flue Welding

Jackson, Tenn.

COUNTERBORES WITH REMOVABLE PILOTS

By making a counterbore with a removable taper-shank pilot the value and efficiency of the tool is increased fully 100 per cent. Once in a great while a toolmaker is found who makes them this way, but it is not the general practice. The illustration shows very plainly the design we use, excepting for very small sizes. A hole drilled at right angles to, and at the end of the taper, makes the removal of the pilot easy by inserting a drift. Standard taper pin reamers are generally used for reaming the pilot seats, thereby making the different pilots interchangeable within certain limits.



Counterbore equipped with Removable Interchangeable Pilot

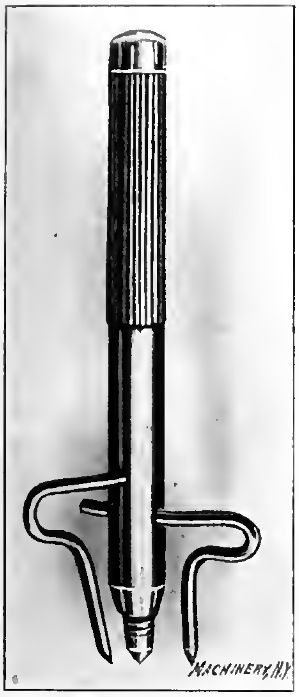
When the matter is carefully considered it is easily seen that a great combination of sizes can be made with but a few counterbores and pilots. Then again, if a pilot breaks when being used (which very often happens with the solid variety), it is but a moment's work to remove the broken part

and replace it with a new one. Last, but not least, is the convenience offered, when sharpening on a grinder, by removing the pilot. The counterbore may be held in a taper collet, if it has a taper shank, or if straight, in a simple form of chuck, fitted to the spindle of the grinder and made straight inside to fit the shank of the tool. The extra cost of the taper hole in the body and turning the pilot, is very slight when compared with the usefulness and long life of counterbores made in this way. A. DANE.

Buffalo, N. Y.

SPACING AND OUTLINING PRICK-PUNCH

By the use of the prick-punch shown in the accompanying illustration, the centers for holes to be drilled within any outline can be located, no matter what the shape, without making extra lines for guiding the point of the punch. For example, if the central part of a die is to be drilled out with, say, a 1/4-inch drill, the drill spacer on the punch is set to 1/4 inch and the guide point to 1/8 inch full; then no matter what shape is followed the centers will be 1/4 inch apart, and 1/8 inch from the line, or a distance equal to the radii of the holes to be drilled. This punch, which is 3 1/2 inches long, is made of 5/16-inch drill rod. The end is drilled and tapped for a threaded center point made from No. 12 drill rod. Care should be taken to see that the threaded end bears against the bottom of the hole so that the shock of the hammer blow will come on the end of the pin and not on the threads, as would be the case if the point were not screwed home. The thread that is exposed is flattened on opposite sides so that the point can be tightened or removed with a pair of pliers or a small wrench. Several points can be made at once by threading a piece of drill rod and pointing and cutting off pieces to the required length while holding the rod in a chuck. These points should be hardened all over and drawn to a light straw color. Both the spacing and the guide points are made of No. 42 drill rod; they are hardened in oil and given a spring temper. These points slide through the body and are adjusted to any length desired. They are held in place by a small screw which is tapped through half of the punch body. The bow or crook in the wires is to give them sufficient spring to adjust themselves. This is a laying-out tool, and is not intended for heavy work. For large drilling, it should be followed by a heavy punch to deepen the marks. WILLIAM A. PAINTER.



Prick-punch with Spacing and Guide Points

Pittsburg, Pa.

INSIDE CALIPER WITH INDICATOR ATTACHMENT

An ordinary 6-inch inside caliper that has been changed somewhat in form to adapt it to precision work, is shown in Fig. 1. One of the legs of the caliper was hammered or upset to make it thick enough to be slotted for an indicator arm, and the other side was cut off to the correct length. This indicator or registering arm is 3 1/2 inches long, and it has a travel of one inch at the point. It is 1/32 inch thick, and the graduated blade (shown more clearly in Fig. 2) is of the same thickness. The latter is recessed in the caliper leg and is fastened with two rivets. A travel of 0.025 inch on the caliper end is equivalent to 1/2 inch travel on the graduated leg, the pivot or axis multiplying twenty times. The working point *A*, Fig. 2, is made of drill rod and is hardened and rounded on the end. The smallest diameter of the point is 0.050 inch and it projects about 0.065 inch when pushed out against its shoulder. Normally this working point is held against its shoulder by a flat spring *B*. In use, the caliper is adjusted until the pointer stands at zero or at the center of the graduation. As shown, the limit of travel is 0.025 inch in either direction which is sufficient for ordinary work. The caliper is set to the required size, for close fits, with a micrometer, and allowance is then made from the indicator. This tool is especially useful when boring, to test the truth or varations of the work or in making an allowance for driving or running fits. The attachment is, so far as I know, original, as I have never seen anything like it in use, or in catalogues. WILLIAM A. PAINTER.

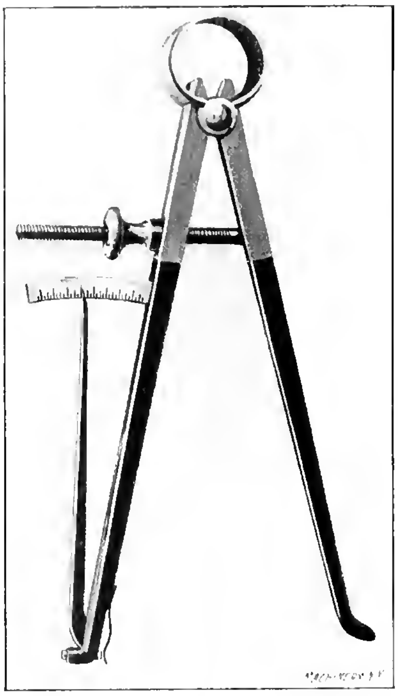


Fig. 1. Inside Caliper with Indicator

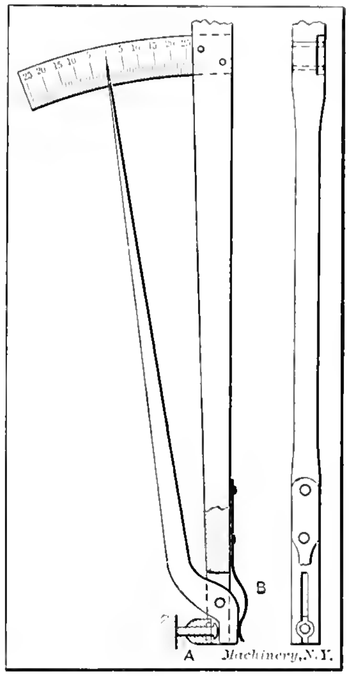
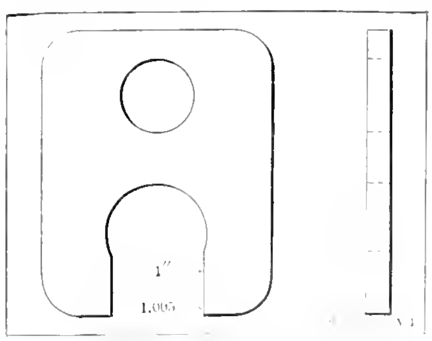


Fig. 2. Detail of the Inside Caliper Indicator Attachment

Pittsburg, Pa.

SNAP-GAGE WITH TAPER TO ALLOW FOR FINISH

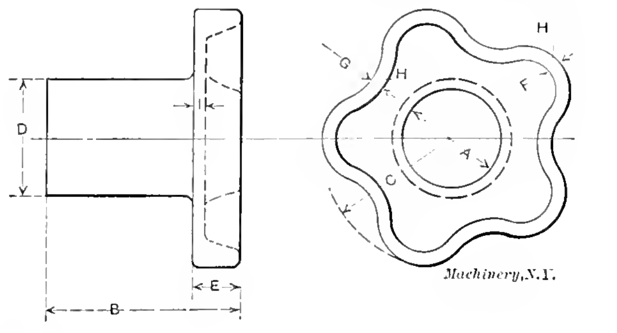
A number of armature shafts had to be finished in the lathe after being first roughed out in a screw machine, and micrometers were being used for measuring them; but there were not as many micrometers available as there were men on the job. Ring-gages were also used for the different sizes of shafts, but the men got along much better when using the micrometers, as they had to allow for finishing with emery cloth, and they could make this allowance much easier with micrometers than with the ring-gages. A lot of snap-gages were then made, which helped us a great deal. They were just like a regular snap-gage, except, instead of grinding the jaws straight all the way, they were ground straight and then re-ground 0.005 inch taper on one side, as indicated in the accompanying illustration, back within a short distance of the end. This left a short part of the gage jaw straight and the rest taper. The men using this style of gage soon became accustomed to it, and the allowances for filing and polishing were easily made. H. D. S.



Snap Gage with Tapered Jaw to allow for Finish

STAR HAND-WHEELS FOR JIGS

An excellent design of hand-wheel for use on jigs, etc., is shown in the accompanying illustration. The dimensions for five different sizes of these hand-wheels are given in the table beneath the engraving. After five years' experience, I have found that the particular style illustrated is well adapted to



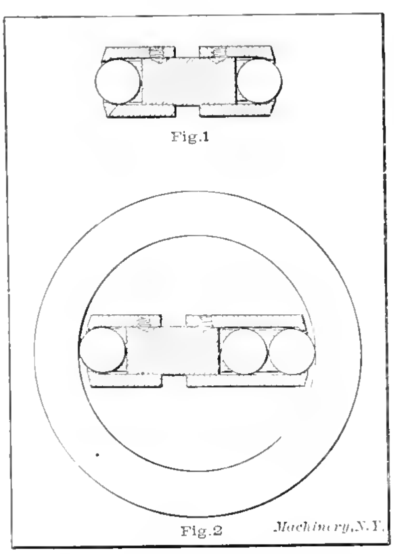
A	B	C	D	E	F	G	H	I
3/4	1 3/4	1	1	3/8	3/16	5/16	1/8	1/8
1	1 7/8	1 1/4	1 1/8	7/16	5/16	7/16	1/8	1/8
1 1/8	2	1 1/2	1 3/8	1/2	3/8	9/16	3/16	3/16
1 1/4	2 1/8	2	1 5/8	9/16	1/2	11/16	3/16	3/16
1 3/8	2 1/4	2 1/2	1 3/4	5/8	5/8	7/8	3/16	1/4

all-around jig use. By having the castings solid, they may be tapped out for any size thread and used in place of nuts, or a plain hole may be drilled and the castings pinned to round stock. The long stem gives a good length of thread for wear and brings the hand-hold far enough from the jig to prevent the fingers and knuckles from striking it. The star design gives a good grip for the fingers, and, as the top is hollowed out, the palm of the hand forms a suction, thus giving a stronger hold. This type of wheel is also easy on the operator's hands, and it is cheaper to produce in quantities, and more powerful than knurled nuts, pins, thumb-screws, etc. This wheel adds to the appearance of a jig and it can be operated very fast.

JIG AND TOOL DESIGNER.

AN INEXPENSIVE SET OF GAGES

As our manager could not be persuaded that a set of gages would be a profitable investment, I decided to make a set; but this did not appear, at first, like an easy job, as there was only a pair of one-inch micrometers to measure with. However, a highly satisfactory set of inside and outside gages, varying by 1/2 inch, was made. The inside gages have hardened ends, which may be replaced at any time at a cost of only a few cents.



Figs. 1 and 2. Inside Gages made by using Bicycle Balls at the Ends

Cast iron rings for the outside gages were first roughed out to within 1/32 inch of their finished size. To make a two-inch inside gage, a piece of half-inch round, cold rolled steel was first accurately finished to a length of exactly one inch. Two half-inch bushings, 3/4 inch long, were then turned on the screw machine and reamed part way through, a shoulder being left at one end to retain the half-inch balls which were placed in the bushings, as shown in Fig. 1.

Bicycle balls were used, and when tested they were found to be within 0.0001 inch of being accurate; therefore I was satisfied that the 2-inch gage was all right. In order to make sure that the balls came up tight against the end of the rod, set-screws were put in the bushings and the rods spotted so that the point of the screw would draw the bushing and with it the ball back against the rod. When this inside gage was finished the outside gage was bored to fit it. To make the 2 1/2-inch gage, one of the bushings from the 2-inch size was removed, and replaced with one a half inch longer, as shown in Fig. 2. In this longer bushing, two balls were placed, thus making it 2 1/2 inches in length. It was then used for turning the 2 1/2-inch outside gage. The one-ball bushing was then replaced and a drop of solder put on the set-screw to prevent its being tampered with. The 2 1/2-inch outside gage was next used as a master, and a rod was dressed down until with one ball at each end it fitted the 2 1/2-inch gage. This process was continued until a number of gages of different sizes had been made.

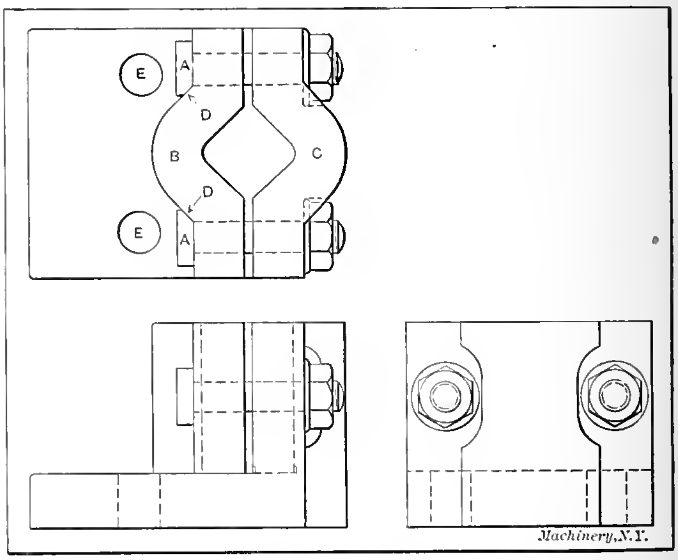
S. A. McDONALD.

Candiac, Canada.

[If gages produced by the foregoing method are to be accurate, it will, of course, be necessary to have a good fit between the ball retaining sleeves and the central plug, and also between the balls and the sleeves, so that the tightening of the set-screws will not cause the centers of the balls to be moved out of line.—EDITOR.]

FIXTURE FOR PUNCH-HOLDERS

A fixture designed for holding punch-holders on the face-plate, surface grinder, or miller, is illustrated herewith. In most shops the die-maker is compelled to use a substitute makeshift affair, which is merely a solid hub and flange with a hole bored and a set-screw in the side. The objectionable



Fixture for Holding Punch-holders of Various Sizes without marring them

features of this "job-spoiler" are legion, the worst one perhaps being the abominable set-screw (or rather the point of it) which, when tightened, not only throws the work over on an angle, but, when set up hard (as is necessary when taking heavy cuts on the miller), leaves unsightly marks in the soft shank.

The design submitted not only eliminates this annoyance, but it is preferable in every way. Obviously, it will take shanks a trifle over or under size as well as all standard sizes in use, the advantage of which should be apparent to any one caring to utilize the space that a half dozen or more of the other kind take up. As the illustration shows, the design of the fixture is very simple. The bolts *A* are a drive fit in casting *B* and a sliding fit in casting *C*. These bolts should have the under edge of the head cut away on one side, as shown at *D*, so they will lock against the side of the casting and not turn when the nuts are set up. The fixture is fastened down in the usual way by T-bolts, holes *E* being for that purpose. If the fixture is to be used for very large shanks, these holes should be placed far enough back so as to allow room for sliding jaw *B*. When so made, the fixture is excellent for grinding sub-press tools, the plunger being removed and held in the same manner as the punch shank. This fix-

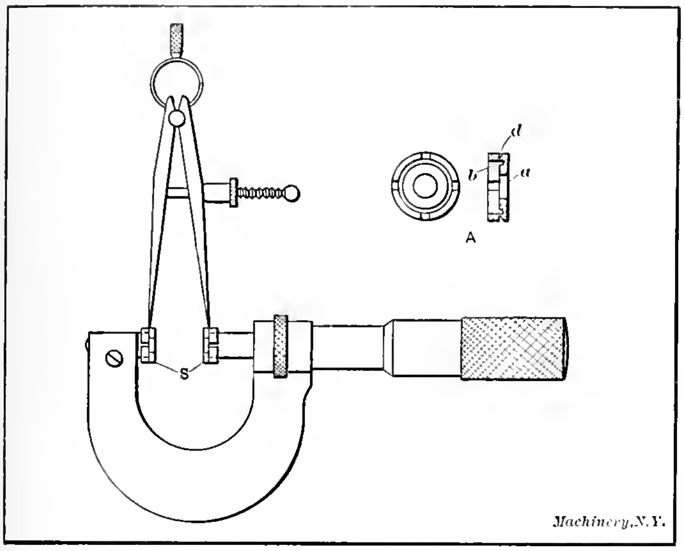
ture also makes an excellent inside angle-plate, it only being necessary to remove the sliding jaw.

The more common way, perhaps, of making tools of this class is to have the projecting base turn the other way; but the advantage in having the foot turn in under the work, as shown, is that when used on a faceplate, it does not overhang so much, thus doing away with much counterbalancing and allowing a smaller faceplate to be used.

Frankford, Pa. ROY PLAISTED.

MICROMETER ATTACHMENTS FOR SETTING DIVIDERS

One is sometimes confronted with the task of setting the dividers or trammels accurately when laying out work, such as jigs, dies, etc. If a vernier with facilities for setting the dividers is not available, the attachments shown applied to a micrometer in the accompanying engraving will be found very useful, as the dividers can be set with them quite as accurately as when the vernier is used. This is, of course, assuming that the attachments are made accurately.



The Way the Micrometer Attachments are used for Setting Dividers

As the illustration shows, these attachments consist of two sleeves *S*, one of which is fitted to the anvil of the micrometer and the other to the end of the spindle. An enlarged view of one of these sleeves is shown at *A*. A central hole *a* is drilled in the center of the sleeve so that it will be easy to see whether or not it is in contact with the anvil or spindle. Either four or six slots are sawed in the flange to insure a snug fit, and the corner is cut away, as at *b*, so that the inner surface will have a good bearing against the spindle or anvil. A groove *d* is cut in the outside, exactly in line with the inner surface, and into this groove the divider points are inserted when they are being set.

These sleeves are made in the following manner: A piece of tool steel about 1/16 inch larger in diameter than the anvil or spindle of the micrometer, is caught in the chuck and turned true on the outside, after which a central hole is drilled deep enough for the two sleeves. The end of the piece is then bored to a snug fit for the micrometer anvil or spindle, and a recess *b* is turned as shown in the sectional view at *A*. The first sleeve is then cut off, after which the second one is machined in the same way. The cutting of the V-groove *d* is the next and the most important operation. In order to cut this groove exactly in line with the inner surface of the sleeve, a piece is first turned to the same diameter as the anvil or spindle. After the end of this piece is faced square, the lathe carriage and turning tool are left undisturbed. The sleeve is then inserted over the end of the turned rod. By the use of a flat center in the tailstock, this sleeve is held firmly against the squared end of the rod while the V-groove is turned, with the tool set just as it was after the finishing cut was taken over the end of the rod. A depth of about 0.005 inch is sufficient for this groove. Slots are next cut in the sleeves in four or six places so that they may be sprung into place. The sleeves are then hardened and drawn to a blue color.

When turning the groove, and also when turning and facing the rod on which the sleeve is held, care should be taken to see that there is no lateral motion in the spindle of the lathe, as otherwise the tailstock center, when it is brought up against the work, will cause the groove to be out of alignment with the surface on the inside of the sleeve. L. E. KRAMER.

Newark, N. J.

SOLDERS FOR VARIOUS METALS

Soldering is divided into two classes, namely, hard and soft soldering. Ordinarily soldering with a heated copper bit employs "soft solders"—alloys of tin, lead, etc., which melt at comparatively low heats. The use of the blowpipe makes possible the employment of "hard solders" which are alloys of silver, copper, zinc, etc., and melt at a very much higher temperature than the soft solders. The hard soldering of copper, iron, etc., is generally known as brazing, and the solder as spelter. It must be borne in mind that both soft and hard solders deteriorate with age, if kept for a long time in a damp atmosphere. For electrical work, ingredients such as mixtures of vaseline, rosin, glycerine and chloride of zinc are used as non-corrosive fluxes. The accompanying table gives the composition of both soft and hard solders that are suitable for various metals. A. EYLES.

Manchester, Eng.

SOFT AND HARD SOLDERS FOR VARIOUS METALS

Metal to be Soldered	Flux	Soft Solder		
		Tin	Lead	Other Constituents
Aluminum.......	Stearin	70	....	Z*25 A* 3 P* 2
Brass............	Chloride of zinc, rosin, or chloride of ammonia	66	34	....
Gunmetal........	Chloride of zinc, rosin, or chloride of ammonia	63	37	....
Copper...........	Chloride of zinc, rosin, or chloride of ammonia	60	40	....
Lead............	Tallow or rosin	33	67	....
Block tin.........	Chloride of zinc	99	1	....
Tinned steel......	Chlor. of zinc or rosin	64	36	....
Galvanized steel..	Hydrochloric acid	58	42	....
Zinc..............	Hydrochloric acid	55	45	....
Pewter...........	Gallipoli oil	25	25	B*50
Iron and steel....	Chloride of ammonia	50	50	....
Gold.............	Chloride of zinc	67	33	....
Silver............	Chloride of zinc	67	33	....
Bismuth	Chloride of zinc	33	33	B 34

* Z = zinc A = aluminum P = phosphor tin B = bismuth

Metal to be Soldered	Flux	Hard Solder			
		Copper	Zinc	Silver	Gold
Brass, soft	Borax	22	78	.....	......
Brass, hard......	Borax	45	55	......	......
Copper...........	Borax	50	50	......	......
Gold	Borax	22	......	11	67
Silver............	Borax	20	10	70	......
Cast iron.........	Cuprous oxide	55	45	......	......
Iron and steel....	Borax	64	36	......	......

MACHINE CATALOGUE COVERS

A common fault with machine catalogues is that while they state just how many accessories are provided, and that this part and that are casehardened, and the other is bronze-bushed, etc., they omit to say how the machines operate and how much work of a given kind they will turn out per hour. Further, some of them do not bear on the cover the maker's name, or even that of the machine described.

How shall I index a catalogue "The Truth about Thingummies" or "The People's Verdict?" ROBERT GRIMSHAW.

Dresden, Germany.

* * *

Manufacturers interested in the International Exposition to be held at Turin, Italy, in 1911 can obtain further information relating to the exposition from the Italian Chamber of Commerce of New York, which has been appointed as the local committee for the United States.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

TINNING STEEL PANS

G. S.—I have about 1,000 steel pans 12 inches long, 8 inches wide, 2 inches high, 1/64 inch thick, to tin. What is the easiest and cheapest method of obtaining a heavy tin coating? The pans are unpolished.

A.—The question is referred to our readers for answer. It is desired that the responses refer to methods of tinning that are practicable to follow in a plant not equipped with tin dipping facilities.

PROPORTIONS OF AUTOMOBILE PISTON RINGS

H. B.—What are the proper proportions of automobile cylinder piston rings? How do they compare with the proportions of gas-engine rings used by the leading gas-engine builders? How much smaller than the bore should a gas-engine piston be turned to secure the best results? We have found that the accepted proportions for steam engine cylinder rings make rings too stiff for gas-engine use.

A.—These questions are submitted to the readers for discussion.

FINISH ON IRON CASTINGS

E. S. S.—1. I have a few castings that I wish to paint and secure a glossy enamel finish. What is the best method to obtain this finish? Could it be done without baking on? I want a finish that will not crack and lose its gloss in a few weeks. 2. Why do gray or streaked spots work through the oxidized finish on malleable iron castings? Is there any way to prevent it? The spots do not show on steel. Is it the fault of poor oxidizing?

A.—These questions are referred to our readers for answer.

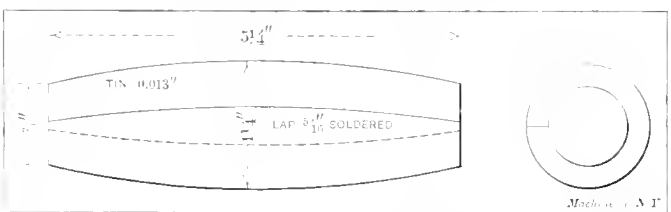
HOW TO BEND TAPERED BRASS TUBES

E. P. D.—I would like to know the best method of bending tapered tubes for automobile horns. The tubes are 9 inches long, 1¼ inch and ¾ inch diameter at the large and small ends, respectively. The tubes must be bent U-shape, the radius of the inside curve being 1½ inch. The metal is brass, 0.025 inch thick.

A.—Thin brass tubes may be bent without crushing or wrinkling by first filling them with melted rosin or melted sulphur. The bending should be done over a hardwood former shaped to the arc of the curve desired, but as a commercial process for bending tubes in large quantities this method is too slow. Descriptions of improved methods of bending tapered brass tubes are invited from our readers.

HOW ARE COFFIN HANDLES MADE?

R. S. B.—How is the coffin handle shown in the sketch made? It is of tin 0.013 inch thick, with seam lapped about



5/16, and soldered. The work shows very slight evidence of wrinkling, and if made in the press is a very good job.

A.—The question is submitted to the readers of MACHINERY for reply. A contribution describing the tools used for making this or similar pieces will be acceptable.

TO OBTAIN THE HEIGHT OF A SEGMENT WHEN THE AREA IS GIVEN

J. W. H.—How is the height of a segment found that contains one-third the area of a circle 4 inches diameter?

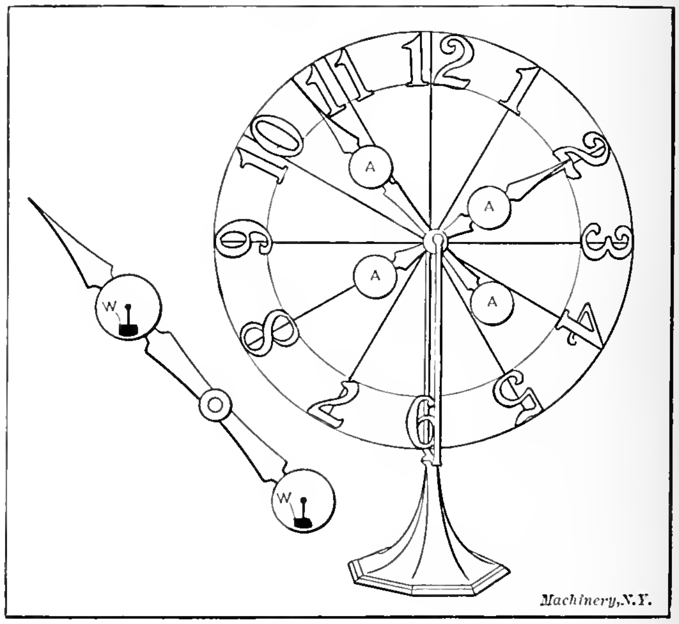
A.—Although the calculation of the area of a segment is comparatively simple, using the approximate formula

$$A = \frac{4h^2}{3}\sqrt{\frac{D}{h} - 0.608}$$

the converse proposition is more difficult, as there is no simple formula for finding the height or the chord of a segment when the area and diameter of the circle are given. Recourse must be made to tables of segment areas found in engineers' hand-books. The procedure in this case is as follows: First find the area of a segment that contains one-third the area of a circle having a diameter 1 inch. $1^2 \times 0.7854 = 0.7854$ square inch; $0.7854 \times 1/3 = 0.2618$ square inch, area of segment. Reference to a table of segments shows the height of the middle ordinate to be 0.3675 inch. The height of the corresponding segment of a circle 4 inches diameter is $0.3675 \times 44 = 1.5000$ inch, the required result. This is one of the several problems involving areas of segments, lengths of elliptic arcs, areas of zones, etc., that can be solved by ordinary mathematical processes only by reference to tables.

A CLOCK WITHOUT WORKS?

O. A. A.—What appears to be a most wonderful clock has recently come under my observation, and I would like to have the principle of its action explained. This clock is apparently without works, but it records the time accurately, and when the hands, which are easily moved in either direction, are



spun on their axes, they always come back to the correct position. The dial may also be whirled around, but even though the hands and the dial be set in motion simultaneously, they always come back to their correct relative positions.

A.—This clock is an interesting mechanism, but we believe that it is comparatively simple in its construction. The idea has been used for years in the construction of jewelers' clocks and other clocks where it is desired to attract attention. Usually the hands are made with large hubs in which the clock movements are located, and the hands are driven by the reaction of these movements against a counterweight within the hub. In the case of the clock referred to by our correspondent (see accompanying illustration), there are probably two movements for each hand, which are located in the cylindrical parts *A* and cause the rotation of the hand by reacting against counterweights. These counterweights *W* hang with their centers of gravity below the center of the clock mechanism, and as the hands are perfectly balanced, the action of the works is transmitted through the reaction of the counterweight to the hands, causing them to assume the hour and minute positions. Probably the action of the hands will be more easily understood if we assume that the weights *W* are being continually swung from their vertical position, to the right, thus shifting the hand's center of gravity and causing it to revolve. The two movements in each hand run in unison, the set for the hour hand being geared to revolve once in twelve hours while the minute hand revolves once in an hour. As this construction makes connection with the fixed support unnecessary, the hands, when spun around on their axes, will always come back to the correct position which is determined by the relative positions of the counterweights to the hands in which they are suspended. The dial is easily

made to finally stop in the correct position after it has been spun around, by adding a little additional weight to the bottom, thus throwing it out of balance.

MUTILATION OF U. S. COINS

W. H.—In the December, 1906, number of MACHINERY W. L. McL. described the making of a pretty stick-pin by filing out the profile of the head on a dime. I would like to know if the law regarding the mutilation of coins would apply to this case. If I make a pin in this way am I liable to prosecution?

A.—Technically the making of a stick-pin from a United States coin in the manner described is a violation of section 5459 of the revised statutes. Any defacement or mutilation of gold and silver coins short of complete destruction of the coin or change in shape which will make it impossible for it to circulate as money is, in the opinion of the chief law officer of the treasury department, illegal. It is not likely that an individual who merely makes an ornament for himself or a friend in the manner described would be prosecuted, especially if it were gold-plated afterwards, but anyone *manufacturing* ornaments from mutilated coins probably would get into serious trouble. The chief of the Secret Service informs us that jewelers who make a practice of transforming gold and silver coins into articles of jewelry usually fit a band of like metal around the coin and make any necessary attachments to that band rather than to the coin itself. In this way the coin is preserved in perfect condition, and there is not even a technical violation of the statute.

TO OBTAIN AN ANGLE BY COMBINING THE FEEDS OF A BORING MILL

H. N. K.—To what angle must I set a boring mill head to turn a taper at an angle of 45 degrees with the base when using both feeds in combination. The cross-feed screw is four threads per inch or ¼ inch feed for one turn of the handle, and the down feed is 3/16 inch for one turn of the handle. The pinions on the feed shafts have the same number of

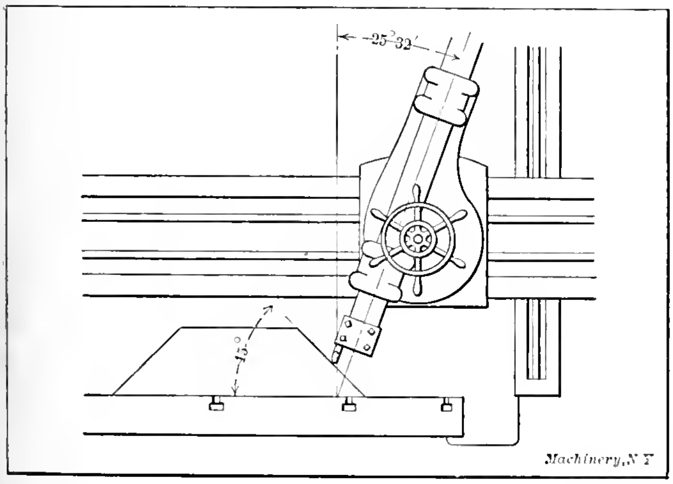


Fig. 1

teeth, and the ratio of feeds, therefore, is as 3/16 to 1/4. I would like to know if there is a method, table or formula for obtaining any desired angle with combined feeds.

A.—The angle can be found graphically in the following construction Fig. 2: Draw the horizontal line AB to represent the boring mill table and the line CD at an angle of 45 degrees, representing the angle to be produced. Now we require to strike two arcs with radii in the proportion of 3/16 to 1/4. To secure the desired accuracy, it is desirable to use longer radii, and we multiply 3/16 and 1/4 by, say, 32, giving as results 6 and 8 inches. With the dividers set at 8 inches, strike an arc from D as a center intersecting AB at E. With E as a center and with a radius of 6 inches, strike another arc intersecting CD at F. Then FEG, the angle made with the vertical EG, is the required angle to which the head should be set. The angle measured with a protractor is 25½ degrees. The method of solving when DEF is less than 90 degrees is:

$$\sin EFD = \frac{H_f \times \sin EDF}{V_f}$$

in which

H_f = horizontal feed,
V_f = vertical feed,
EDF = angle required on work,
FEG = angle to which the head must be set to produce angle EDF,

$$\sin EFD = \frac{1/4 \times 0.7071}{3/16} = 0.9428.$$

$$\text{Angle } FEG = (EFD + EDF) - 90$$

The angle whose sine is 0.9428 is found in a table of sines to be 70 degrees 32 minutes. Angle EDF = 45 degrees. Then

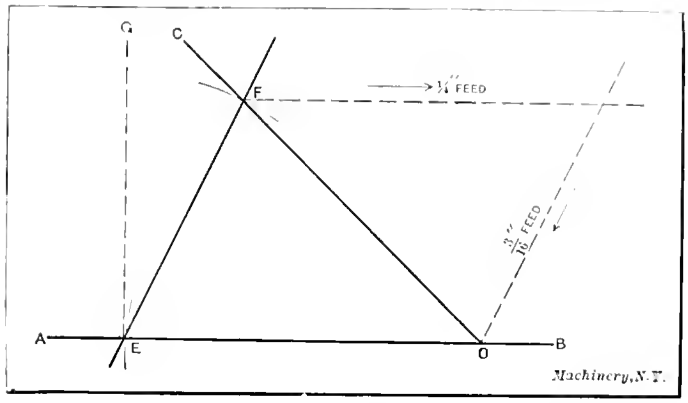


Fig. 2

angle GEF = (70 degrees 32 minutes + 45 degrees) — 90 degrees = 25 degrees 32 minutes. The same methods may be used for finding the angles produced by combined vertical and horizontal planer feeds.

* * *

FORMULAS FOR CALCULATING A FRICTION DISK BRAKE*

JOHN WILL†

In the following article will be given a set of formulas for calculations relating to the well-known mechanical brake used on electric hoists. A diagrammatical sketch of such a brake is shown in Fig. 1. An example illustrating the use of the formulas given will also be worked out.

The object of the brake shown is to permit the lowering of the load at a constant speed with the power reversed, and the holding of the load suspended when the current in the motor is shut off. When the load is lowered it rotates, by means of the drum and gearing, the flange D against the ratchet disk H; the flange E is mounted as a nut on the screw A; the flange C is keyed to the shaft as shown. The pawl engaging with the ratchet disk does not permit it to rotate when the load is lowered. As the ratchet disk thus is stationary, the work of the motor and of the lowered load must equal the work absorbed by the friction surfaces in the brake. When hoisting, the motor rotates the flange D against the nut E so that then there is no pressure on the friction disks; the motor is thus free to hoist the load without any frictional resistance.

The amount of opening between the friction disks should be as small as possible, and the number of teeth in the ratchet disk as great as possible, consistent with required strength. In this way excessive pressure on the ratchet teeth, due to the sudden dropping of the load when the current in the motor is shut off after hoisting, may be avoided. The drop of the load, of course, is proportional to the opening between the friction disks, and the amount the pawl allows the ratchet disk to rotate before engaging a tooth and stopping it positively.

The action of the load and the motor on the brake may be explained by a simple illustration. In Fig. 2 the bar A is shown resting on two wedges B between the walls C. The load P is a constant pressure acting downward on the bar A. This pressure, however, is not great enough to overcome the frictional resistance between the wedges B and the walls C. If an additional downward pressure P_1 is put on the wedges, so that the combined pressures P and P_1 equal or exceed the frictional resistance, then the bar and the wedges will slide

* Answer to an inquiry in the How and Why department, January, 1905.
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downward as a whole. In the mechanical brake in Fig. 1 the load on the hook may be considered as the pressure P in Fig. 2. The pressure P_1 may be assumed to be the effort exerted by the motor in order to lower the load.

In the formulas following, the notation below will be used:

E = energy absorbed by friction disks in foot-pounds per minute,
E_1 = energy of the lowered load in foot-pounds,
E_2 = energy of the motor in foot-pounds,
e_1 = total efficiency of mechanism between load and flange D, Fig. 1,
e_2 = total efficiency of the mechanism between the motor and flange C, Fig. 1.
T = torque in inch-pounds on pinion F,
r = mean radius of screw in inches,
r_1 = inside radius of friction disks in inches,
r_2 = outside radius of friction disks in inches,
n = number of friction surfaces,
N = number of revolutions per minute of flanges C and D,
A = area of each friction disk in square inches,
W = total pressure in pounds on friction disk,
f = coefficient of friction between the flanges and the friction disks,
P = lead of the screw in inches,
ϕ = angle of repose of screw in degrees,
α = helix angle of the thread of screw in degrees,
y = number of thermal units of heat conducted away per square inch of bearing surface per minute; y may be considered to be from 4 to 7, when the mechanism is exposed to a current of cold air and in intermittent service, and as equal to 0.75 to 1 in tolerably cool places with intermittent service.

When a sufficient number of quantities are known, energy absorbed by friction, the pressure on the disks and the lead P of the screw in the brake may be found by the following formulas:

$$E = E_1 e_1 + E_2 e_2 \tag{1}$$

$$E = 0.349\, n\, f\, W N \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2} \tag{2}$$

$$W = \frac{T}{r \tan(\alpha + \phi)} \tag{3}$$

$$P = 2\pi r \tan \alpha \tag{4}$$

$$y = \frac{E}{778 \times 2A} \tag{5}$$

[Formula (2) is based on the theoretical assumption that the mean radius at the end of which the resultant of the frictional forces may be considered as applied, equals

$$\frac{2}{3} \times \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}$$

thus taking the radius to the center of gravity of the small trapezoids into which the annular ring may be supposed to be divided. Although this is correct both theoretically and practically when the brake is new and the pressure distributed uniformly over the entire surface, the disk wears faster on the outside edges than on the inside, resulting ultimately in greater pressures at the inner edge, and it has been found that a formula considering the mean radius as the arithmetical mean between the outside and inside radii gives better results for working conditions.—EDITOR.]

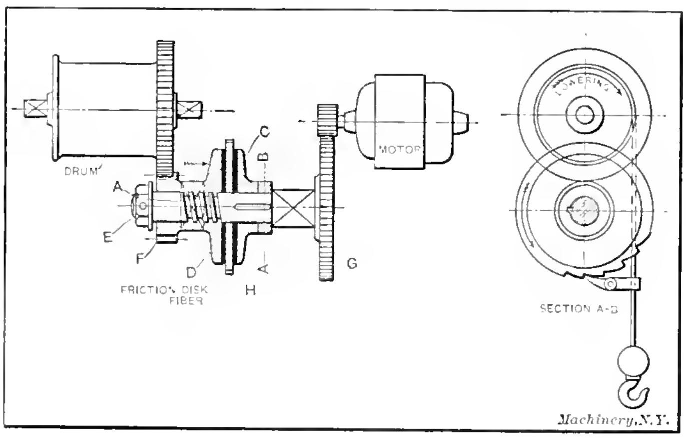


Fig. 1

Example:—Assume that we have the following data: At 230 volts and a speed of 1,000 revolutions per minute, 25 amperes are required for hoisting the load. At a speed of 1,500 revolutions per minute, 9 amperes are required for lowering the load. The motor efficiency is 80 per cent, the drum is 12 inches in diameter, the drum gear ratio is 1 to 7, and the motor gear ratio is 6 to 1. The efficiency of each set of gearing is 90 per cent. The outside radius of the friction disks is 7 inches, the inside radius 3 inches, and the mean radius of the screw, 1¼ inch. The number of friction disks is 2, as shown in Fig. 1, the number of revolutions of the friction disks is 1,500 ÷ 6 = 250, the coefficient of friction between the flanges and the friction disks is 0.07, and the angle of repose of the screw, 8 degrees 30 minutes. From this data we find that the maximum load of 2,200 pounds may be hoisted at a speed of 75 feet per minute and lowered at a speed of 112.5 feet per minute, as follows:

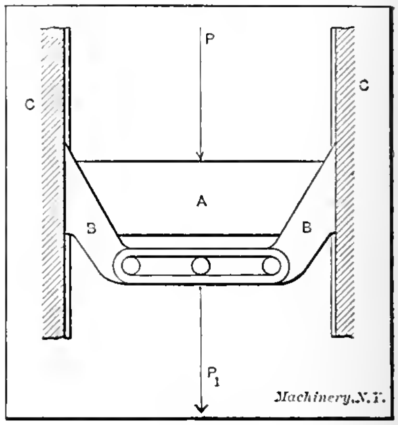


Fig. 2

$$\frac{1{,}000 \times 12 \times 3.14}{6 \times 7 \times 12} = 75 \text{ (hoisting speed)},$$

$$75 \times 1.5 = 112.5 \text{ (lowering speed)},$$

$$\frac{230 \times 25 \times 44.2 \times 80 \times 90 \times 90}{75 \times 100 \times 100 \times 100} = 2{,}200 \text{ pounds, nearly.}$$

We will now find the lead P of a screw which will give a lowering speed of 112.5 feet per minute with the given conditions.

$$E_1 e_1 = 2{,}200 \times 0.90 \times 112.5 = 222{,}750 \text{ foot-pounds.}$$

$$E_2 e_2 = 230 \times 9 \times 44.2 \times 0.90 \times 0.80 = 65{,}900 \text{ foot-pounds.}$$

From formula (1):

$$E = E_1 e_1 + E_2 e_2 = 222{,}750 + 65{,}900 = 288{,}650 \text{ foot-pounds.}$$

From formula (2):

$$W = \frac{E}{0.349\, n\, f N \dfrac{r_2^3 - r_1^3}{r_2^2 - r_1^2}} = \frac{288{,}650}{0.349 \times 2 \times 0.07 \times 250 \times 7.9} =$$

3,000, approximately.

From formula (3):

$$\tan(\alpha + \phi) = \frac{T}{Wr} = \frac{[(2{,}200 \times 6) \div 7] \times 0.90}{3{,}000 \times 1.25} = 0.453.$$

Hence, $\alpha + \phi = 24° \, 20'$, and $\alpha = 24° \, 20' - 8° \, 30' = 15° \, 50'$.

From formula (4):

$$P = 2 \times 3.14 \times 1.25 \times \tan 15° \, 50' = 2.23 \text{ inches.}$$

This gives a screw of practically 2¼-inch lead. If a double thread is used the pitch will be 1⅛ inch.

From formula (5):

$$y = \frac{288{,}650}{778 \times 2 \times 125.6} = 1.48,$$

which would be satisfactory when the brake is well exposed to the air.

The maximum allowable pressure per square inch on the friction disks should be limited to 200 pounds. In the example above we find that the pressure equals

$$\frac{W}{A} = \frac{3{,}000}{125.6} = 24 \text{ pounds per square inch, approximately.}$$

* * *

Don't start a piece of work until you have measured and examined the stock to see if it is correct for size and kind.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

MILWAUKEE PLAIN MILLING MACHINE

In the department of New Machinery and Tools in the August, 1908, issue of MACHINERY was described the No. 3B Milwaukee universal milling machine, made by the Kearney & Trecker Co., of Milwaukee, Wis. The same general lines of design followed in that machine have now been applied by the makers to their plain milling machine, which is here described and illustrated, with the changes permitted by the absence of the swivel carriage for the table. In connection with this plain design of machine, we are able to show a number of details of the very interesting driving and feed mechanism employed.

The main features of this line of machines are the geared feed and speed changes, the provision for continuous lubrication from an oil reservoir, and the permanent arrangements incorporated in the machine for supplying lard oil or other compound to the cutting edges of the mill. In connection with the first point, it will be remembered that the makers of this machine built it with geared drive only, their confidence in this construction being such that they have entirely abandoned the cone pulley, and do not employ it in any size or style of their products.

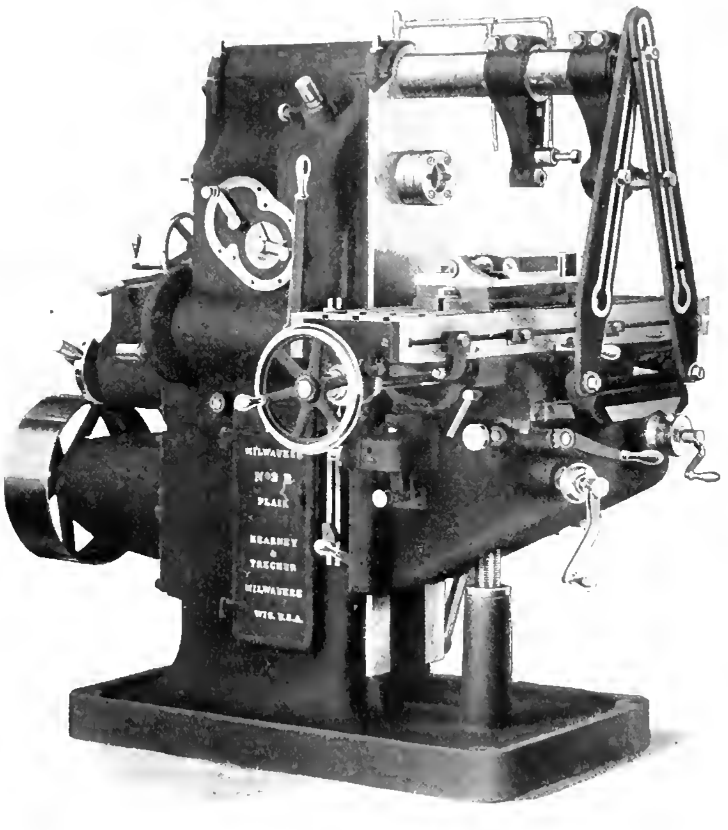


Fig. 1. Milwaukee No. 2B Plain Milling Machine, with Geared Drive and Feed

Structural Features

Rigidity in the framework is a fundamental requirement for an accurate and productive tool. In this machine the column is cast in one piece, with strong internal ribs. It has a box section, with as few and as small openings as possible, and it increases in depth as it extends downward toward the pan-shaped base. This latter is sufficiently high to leave room for heavy ribbing, which makes masonry and cement foundations unnecessary where the floor is strong enough to carry the load. The sliding surfaces for the knee extend clear to the top of the column around the spindle box, thus giving the needed additional metal at this point. The upward extension of the slide serves also as a convenient means of fastening the various attachments, which thus become practically an integral part of the machine, and capable of very severe service.

The knee is of the enclosed box form, with as few openings as possible, none being permitted in the upper surface. This is important as it obviates all danger of the closing together of the surfaces under the strain of clamping the saddle. It also obviates the necessity of a sliding cover to keep chips out of the knee mechanism. A long bearing is provided for the knee on the column, extending up above the saddle bearing.

The over-arm is a solid steel bar, located with great accuracy parallel to the spindle. The arbor supports are firmly clamped to this. The arm braces have been especially designed with regard to convenience in handling, there being no single piece too heavy for one man to adjust with ease. Throughout the structural design metal has been added with the single purpose of securing strength and ridigity; it has not been placed here and there in a haphazard way, merely for the purpose of getting a high total weight for selling purposes.

Spindle Driving Mechanism

The arrangement of the drive is best shown in the vertical section through the column, Fig. 2, in connection with the small details in Figs. 3 and 5. The driving pulley *A* runs at constant speed in one direction, there being no necessity for cone pulleys or a reverse clutch in the countershaft. The shaft on which it is mounted carries an integral pinion meshing with gear *B*, which is loose on the shaft above it. The hub of this gear carries a steel jaw clutch engaging a similar clutch on the face of gear *C*, which is keyed to the shaft. *B* is shifted longitudinally to engage or disengage the clutch connection by means of the vertical hand lever shown on the left side of the column in Fig. 1. Gear *C* meshes with *D*, which, in turn, may be connected with constant speed shaft *E*, either directly or through the medium of idler gears *F*. The shifting of pinion *G* by handle *H* governs this connection, and thus reverses the spindle.

In transmitting the motion from shaft *E* to *J*, six changes of speed are provided for by an interesting modification of the tumbler gear type of speed change mechanism. In this case a compound tumbler gear *K* having three steps, is used as shown. This meshes with the keyed sliding gear *L* on shaft *E*, and is carried by the swinging frame *M*. Either one of the three steps of gear *K* can be made to engage with either of gears *N* or *O* on shaft *J*, thus giving the six changes of speed.

The solid support given to the sliding gear *K* should be noted. It revolves on a hardened steel stud, firmly fastened in the steel frame. This latter is securely supported on both sides of the tumbler on one side by shaft *E* which is, for this purpose, made much larger than would otherwise be required; and on the other side by the teeth of the long pinion *P*. This latter is rocked by handle *Q* to raise or lower the tumblers into proper position to mesh with the gear *N* or *O*. The shifting of the tumbler lengthwise is effected by the lower swinging handle on the front of the frame in Fig. 1, operating through the segmental gear and rack shown at *R* in Fig. 4.

Three additional changes of speed are effected by sliding gear *S*, which may be shifted to the rear so that its small diameter engages with gear *O*, or it may be set in a central position where its larger diameter, as shown in Fig. 2, engages gear *N* on shaft *J*. Moving it still further to the right clutches it, by means of the driving pin shown, to the large gear *T*, which runs loosely on the spindle, driven by a pinion on shaft *J*. Eighteen changes of speed are thus provided for through a mechanism which is strong and direct.

The feed change mechanism is identical in principle with that provided for the spindle changes. Twelve rates of feed are provided for, controlled by convenient levers and indicated by an indexing plate. The feed is driven directly from the shaft on which gear *D* is mounted, so that it is driven at a

constant rate, giving definite feeds in inches per minute. This construction has become standard for efficient milling machine design, since it permits all the feed changes to be practically applicable to any speed, and thus allows a greater number of effective changes for the whole range of speeds, from that required for small mills on soft metals, down to the heaviest work the machine is capable of.

In any geared feed and speed mechanism the efficiency and durability of the gearing, bearings, etc., is largely dependent on the care with which they are lubricated. In this machine a reservoir of machine oil is provided from which a stream is kept constantly flowing whenever the driving pulley is in motion, over all the gears and into all the journals. These journals are provided with oil grooves open at the ends to permit a constant and rapid flow, thus keeping them constantly cool and flushed of foreign matter. This point in the design of these machines is so well known that it is not necessary to expatiate on it further.

For holding the spindle in inserting or removing cutters, etc., or for using fly cutters, a stop is provided which engages the teeth of large gear T. This engagement extends over several of the teeth, which it fits accurately. It thus holds the spindle without play and without danger of breakage. For turning the spindle through small fractions of a revolution, a handwheel is provided at the rear end of shaft J as shown. This makes possible more delicate adjustment than can be obtained even on the belt-driven machine. A knock-out for arbors and taper shank mills is permanently mounted in the machine. Large face mills are driven by a key and keyway set into the front face of the spindle. They are clamped in place by four screws passing through the mill into the spindle flange. This arrangement is preferable to the thread usually provided for the purpose, since this thread, if too fine, permits the cutters to jam in place under the strain of a heavy cut, and makes it difficult to remove them; while, if the lead be made steeper, there is a constant tendency to work loose.

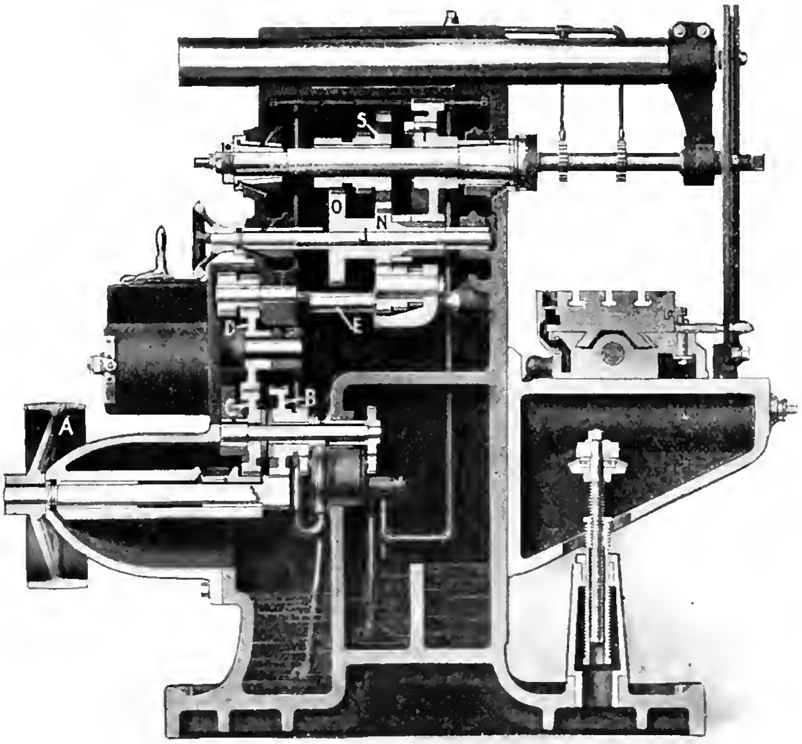


Fig 2. Section through Column, showing Spindle Drive

Details of the Feed Control

Another detail of the machine is seen in Fig. 4, which shows a vertical section through the knee, exposing the mechanism by which the table cross and vertical feeds are interlocked with each other so that no two can be engaged simultaneously. The telescopic shaft from the feed box leads to gear U, from which, through the intermediate gearing and clutch shown, the motion is transmitted to gear V. The clutch W serves to reverse the feed for movements in all directions.

Gear V gives movement to any one of three shafts, X, Y and Z. X is for the table feed, Y for the cross-feed and Z for the vertical movement. As shown in the engraving, with lever A_1 in the central position, clutch X is engaged, and consequently the table feed gearing is in motion. Whether the feed is in actual operation or not depends, of course, on whether the feed handle at the front of the table is thrown in. Now in order to have the plunger of lever A_1 enter the hole provided for it in the central position, it must pass through a hole in lever B_1 which must consequently also be in its central position. B_1 controls the clutches at Y and Z, respectively, which thus are always disengaged whenever the clutch at X is thrown in.

Lever B_1 and the clutches with which it is connected are operated by a lever at the front of the saddle, which thus serves to throw in or out the vertical and cross movements, respectively. Since these movements are locked, as explained, when the table feed is engaged, it is necessary before using either of them to disengage that feed. This is done by throwing lever A_1 to either one side or the other (depending on whether cross or vertical movement is desired) and locking it in this position. Lever B_1 and the clutches with which it is engaged are thus free to swing from the central or off position to one side or the other under the influence of the lever at the front of the saddle. It is thus possible to use this lever for throwing in or out either the vertical or the cross feed, depending on which side of the center lever A_1 is located.

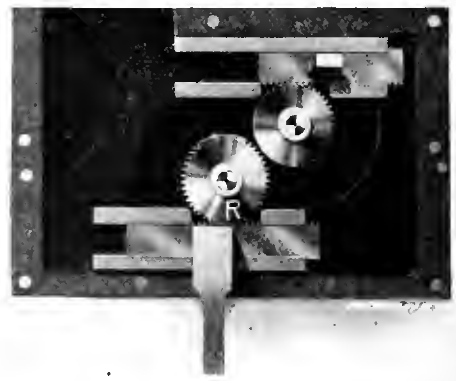


Fig. 3. Spindle Change Gear Controlling Mechanism

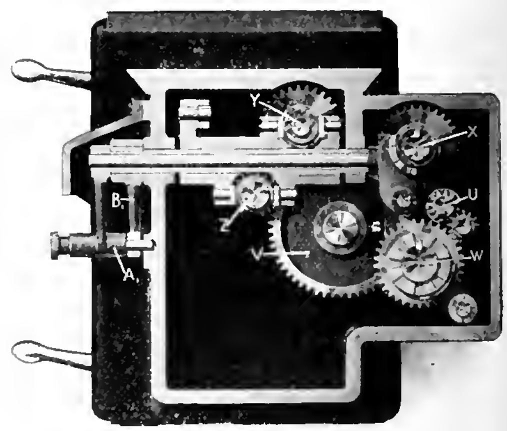


Fig. 4. Interlocking Feed Control in Knee

Fig. 2 shows the two sets of oil reservoirs and pumps supplied. The pump in the double front compartment forces a constant supply of cooling fluid over the cutters through piping regularly provided. Chip channels are formed in the table and a jointed pipe drain connection leads the lubricant back into the settling chamber again, so that a constant stream is provided to cool the cutters. This gives better finish, allows heavier cuts, and prolongs the life of the cutting edges of the tools. This useful provision is regularly furnished and does not have to be specially specified.

General Design

It will be seen that these machines are designed with the idea of providing for ample spindle power, for rigidity suffi-

cient to permit the highest output of any cutter that may be used, and for the accuracy required for interchangeable manufacturing. The convenience of the changes also adds highly to the productive capacity. Besides the universal type previously illustrated and the plain machine here described, the builders furnish this tool in a simplified form which they call their manufacturing machine. This retains the same features of feed and speed change and the same general construction throughout, but has a simpler feed mechanism in the knee and saddle, the power feed being applied only to the longitudinal table movement.

The bracket on which the constant speed driving pulley *A* in Fig. 2 is mounted is interchangeable with two other styles, so that any machine may be fitted up as required by the customer. One of these alternative forms gives a right angle constant speed pulley drive, for use where the line shaft and floor arrangements make this style preferable. The third style of bracket provides for the mounting of a constant-speed motor of any standard commercial type. It should preferably be of 5 horsepower, and capable of carrying 50 per cent overload for an hour without danger. The three systems of drive can be interchanged with each other at any time, without special preparation or changes in the machine.

The following dimensions refer to the No. 2B plain milling

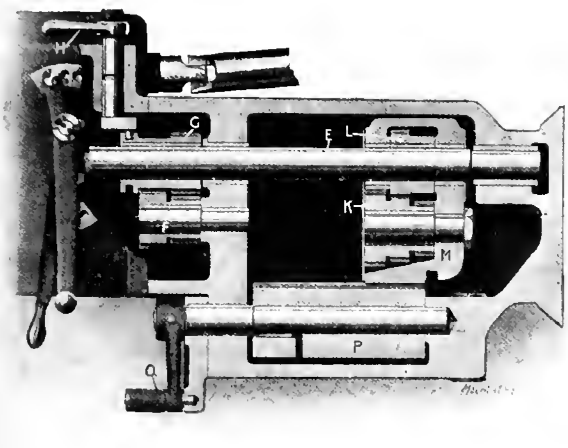


Fig. 5. Design of Tumbler Gearing for Spindle Drive

machine. The driving pulley is 16 inches in diameter for the 4½-inch table belt, and runs at 300 revolutions per minute. The spindle is of forged crucible steel, running in bronze bearings, adjustable for wear; it has a No. 11 Brown & Sharpe taper hole. Eighteen spindle speeds are provided in geometrical progression, ranging from 15 to 360 revolutions per minute with a maximum gearing ratio of 20 to 1. The twelve feeds range from ½ to 60 inches per minute. The table has a working surface of 47 by 12 inches with three T-slots. A plain vise and all necessary wrenches are furnished with the machine. The net weight is about 3,900 pounds.

FUNK MACHINE CO.'S POSITIVE PRESSURE BLOWER

An interesting type of rotary blower has just been brought out by the Funk Machine Co., 23-27 City Hall Place, New York. This firm, which manufactures printing and book-binding machinery, designed this blower for use in connection with a feeding machine. When the blower was tested, it proved so efficient that it was decided to place it on the market. An exterior view of the blower is shown in Fig. 1, while Fig. 2 shows the interior mechanism which consists of only a suction and discharge valve, and a piston with the two impeller blades. The valves which are closely fitted between the outer cylinder and the piston or central drum, are driven from the main shaft by gearing, as indicated in Fig. 1. This gearing is so proportioned that each valve makes two revolutions to one of the main shaft. The valves are crescent shaped in cross-section, and have solid disks on each end. Each valve is so set in relation to the impeller blades that the crescent-shaped part, which extends the width of the cylinder, rolls over the end of each blade as it passes. The impellers may be rotated in either direction, as a change in the direction of their movement simply causes a corresponding change in the position of the suction and discharge outlets.

If we assume that the piston, when viewed from the side shown in Fig. 2, is given a counter clockwise movement, the action of the blower would be as follows: As one blade passes the lower, and what in this case would be the suction opening, the air is drawn in back of it, the valve just above this opening being closed. As this blade moves around toward the top of

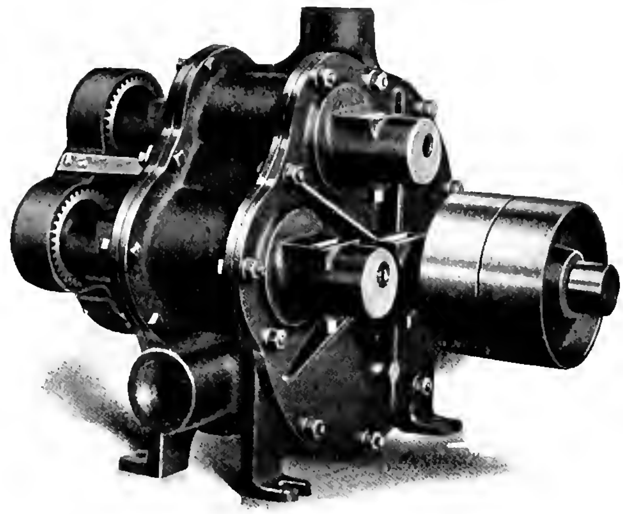


Fig. 1. Rotary Blower built by the Funk Machine Co.

the cylinder, this air is forced out through the discharge port by the following blade, as the space between the piston and cylinder is closed by the upper or discharge valve. When a blade is passing the discharge valve, the suction valve is closed, and remains so until the discharge valve has again moved around sufficiently to seal the space between the cylinder and the central drum or piston.

The impeller blades are of steel, and are firmly attached to the piston. Neither the blades nor the piston bear against the cylinder, but they are made with as little clearance as possible in order to reduce the friction to a minimum. An important point in the construction of this machine is that the friction remains practically constant as the discharge pressure increases. The valves are of bronze, as are also the pinions

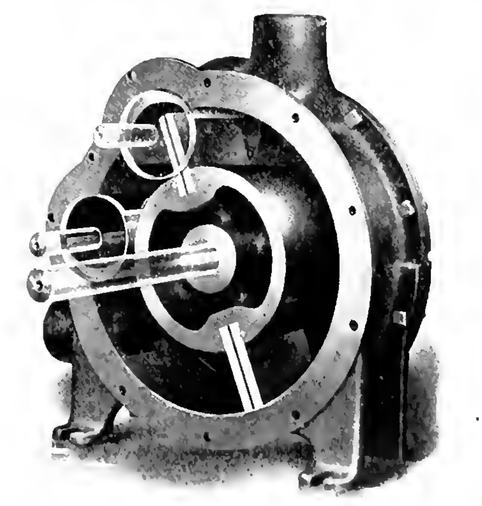


Fig. 2. Interior View of the Rotary Blower

by which they are driven. All bearings are self-oiling, and there are no parts that are likely to become deranged. These machines are built, at present, in three sizes, designated as Nos. 1, 2 and 3. The makers state that during a test run the smallest size delivered 45 cubic feet of air per minute, and maintained a pressure of 2 pounds against five openings ¼ inch in diameter, with a power consumption of 1-10 horsepower. The capacities of the two larger sizes are two and three times that of the smallest size, respectively. Obviously, this blower may be used either for exhausting or compressing air, or for both purposes simultaneously.

NEW LINE OF KELLY CRANK SHAPERS

A new line of crank shapers is now being manufactured by the R. A. Kelly Co., Xenia, O. In designing these shapers, one size of which we illustrate herewith, the company gave special attention to the proper distribution of the metal in order to have a machine with sufficient strength to resist the greatest working strains that are likely to be imposed on it by the use of high-speed steel. The question of strength in this connection, has not alone been considered, as the driving mechanism for each size is so proportioned as to give the greatest output within the limits of high-speed steel tools. This has been accomplished by using wide-faced, accurately-

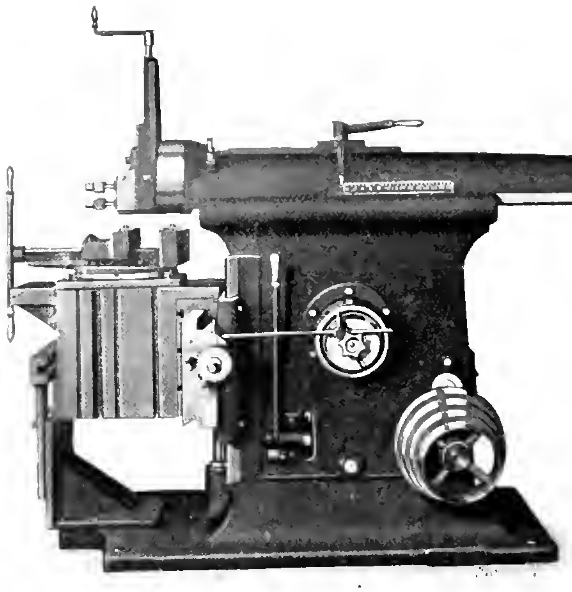


Fig. 1. New Design of Kelly Crank Shaper

cut gears, and employing high gear ratios, ranging from 24 to 1 to 33.2 to 1 in the 16- and 26-inch machines, respectively.

The arrangement of the driving mechanism is illustrated in Fig. 2. The drive is transmitted from a 4-step cone-pulley to the bull-wheel through either of two trains of gears, depending on the speed desired. By shifting the double-ended pinion *A*, which is free to slide on the driving shaft, to either of its extreme positions one of these trains is brought into action. The position of pinion *A* is changed by the vertical lever seen just back of the cross-rail in Fig. 1. It will be seen

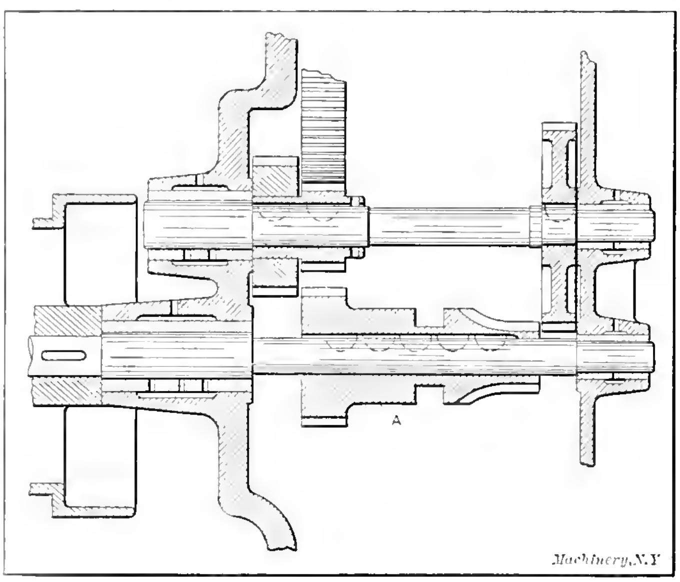


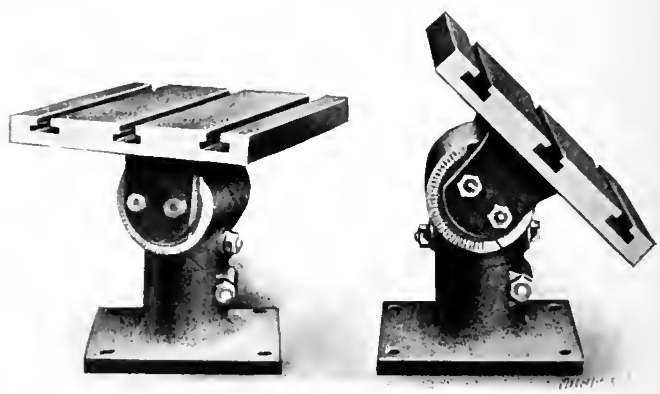
Fig. 2. Detail of the Driving Mechanism

then that the four cutting speeds obtainable from the four steps of the cone-pulley, may be doubled by this arrangement of back gears, giving eight speeds in all. The machine may, of course, be stopped by shifting the driving pinion to its neutral position between the gears with which it meshes.

The bases of these machines are very heavy, and are provided with internal ribs giving them great rigidity. The table, which is of box form, is rigidly supported at its outer end as the engraving indicates. All the bearings in the column are cast integral with it, and those on the larger machines are bored and bushed with Lumen metal. These bearings are of ample length, and all are provided with oil pockets that will hold enough lubricant for one week's steady work. All of the machines have power elevating screws which are so arranged that they can be used as a power down feed on a great deal of work that is ordinarily done on a shaper. Each screw is of the telescoping type, thus making it unnecessary to bore clearance holes in the floor. The stroke of the ram can be changed while the machine is in motion or at rest, and a suitable scale indicates what the stroke is. A study of the machine illustrated, indicates that considerable thought has been given in the design, to the convenience of the operator. This is, of course, an important feature, as the efficiency of a tool of this kind, which is usually employed on a great variety of work, depends largely on the ease and convenience with which various changes, incident to the operation of the machine, can be made. Any of these machines will be arranged for electric drive if desired. The makers are also prepared to furnish any shaper attachments such as index centers, concave attachment, moldmakers' vise, etc., which may be wanted.

WILLIAMSON UNIVERSAL MACHINE TABLE

A new style of universal drill press table or angle-plate is now being made by the Williamson Vise Co., Bradford, Pa. Formerly the shank of this table was clamped to the table-arm of the drill press, the regular table being removed. The new design, which is illustrated herewith, is provided with an in-



Views illustrating the Movements of the Williamson Universal Table

dependent base which makes special changes, incident to its use, unnecessary. This table may be supported either on the regular platen, or on the machine base for large and heavy work. As the engraving indicates, the table may either be rotated in a horizontal plane or swung about its bearing to any desired position from the horizontal to the vertical. The angle for any position is indicated by suitable graduations. These tables are made in six different sizes: The platen of the smallest is six inches square, and its height, when in a horizontal position, is eight inches. The corresponding dimensions of the largest size are 30 and 41 inches, respectively. The usefulness of such a tool in a shop is so obvious that further comment is unnecessary.

SPRINGFIELD 36-INCH MOTOR-DRIVEN LATHE

Among the firms to recognize the superiority of the electric drive for machine tools, may be mentioned the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. This firm has given particular attention to the design and arrangement of the electrically-driven engine lathes which it manufactures. One of the heavy lathes built by this company, which has recently been equipped with a motor drive, is illustrated herewith. This machine has a swing of 37 inches over the bed and 24 inches over the carriage. The driving motor is of $7\frac{1}{2}$ horsepower and it has a speed range varying between

600 and 1200 revolutions per minute. Special attention has been given to the design of the headstock, which is completely enclosed and of symmetrical proportions. This enclosed type of headstock not only lessens the danger of accident, but greatly adds to the massiveness and strength of this part. The driving mechanism is provided with gears having wide faces, and is strongly constructed throughout. There are six mechanical changes of speed, which, together with the changes obtained from the motor, give all the necessary speeds required for a lathe of this size.

A sectional view of the headstock is shown in Fig. 2. The drive from the motor shaft is through a rawhide pinion that is shown directly back of the gear with which it meshes. This driven gear is keyed to a shaft which may properly be called the countershaft. On this countershaft there are three sliding gears which are tied together as one unit. These are brought into engagement with corresponding gears on the lathe spindle by means of the handle shown in the end elevation. By engaging first one and then the other of these gears three variations or mechanical changes of speed are obtained. These three changes are doubled by the use of back gears as in the ordinary lathe. The controller of the motor is mounted on the right side of the carriage, so that while it is convenient for the workman, it is not located so as to interfere with the operation of the lathe. As the illustration shows, this controller is connected through bevel gears to a splined rod extending the length of the bed, which transmits the movement to the starting box. This method of operating the motor from the carriage has proved so satisfactory that all the motor-driven lathes made by this company are so arranged. This lathe is adapted to cut threads ranging from 1/16 inch to 4 inches pitch. The lead-screw is prevented from sagging by a support which travels on the bed with the carriage and automatically stops off at certain points. This insures a longer life to the lead-screw and more accurate work from the machine. The lathe is equipped with power feeds for either longitudinal or cross movements, and, in addition, there is also power feed for angular positions of the compound rest. A dial in front of the headstock is so arranged as to give three changes of feed for screw cutting. There are also two intermediate positions in which the lead-screw remains stationary. This dial, together with a few change-gears, gives all the necessary changes ordinarily required for feeding or screw cutting on a lathe of this size.

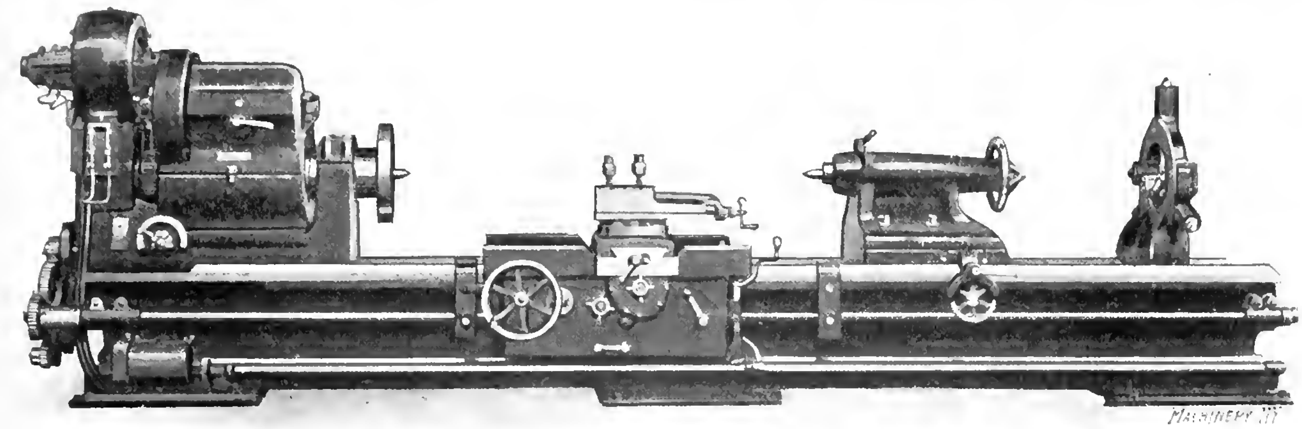


Fig. 1. Heavy Motor-driven Lathe built by the Springfield Machine Tool Co.

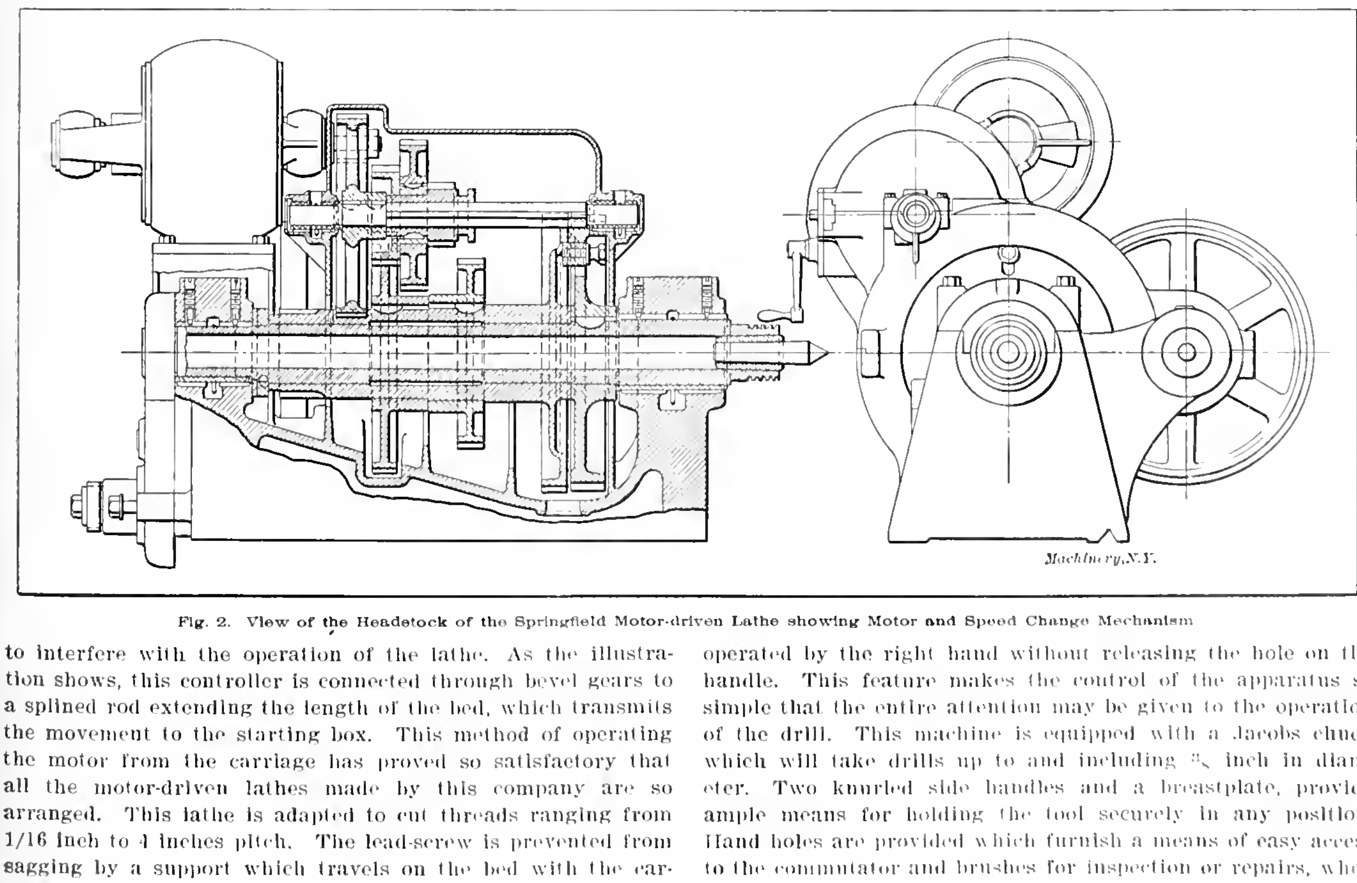
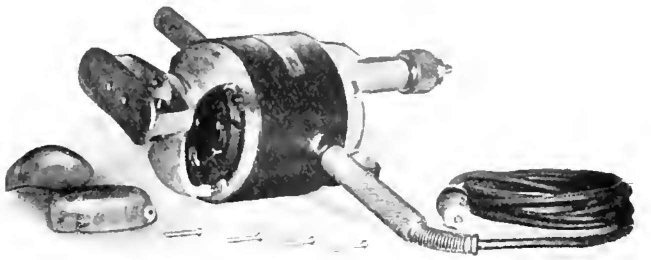


Fig. 2. View of the Headstock of the Springfield Motor-driven Lathe showing Motor and Speed Change Mechanism

ALTERNATING-CURRENT PORTABLE DRILL

The direct-current type of breast drill which has been manufactured for some time by the General Electric Co., Schenectady, N. Y., has worked so satisfactorily that the company has now placed on the market a drill designed for an alternating current. This tool, which is illustrated herewith, while possessing the ruggedness of design required to withstand the hard usage incidental to its service, is constructed as lightly as possible, the weight being only 21 pounds. Lightness, of course, is a desirable feature in a tool of this kind. An indicating control switch for starting and stopping the motor, is located conveniently near the right handle so that it can be operated by the right hand without releasing the hole on the handle. This feature makes the control of the apparatus so simple that the entire attention may be given to the operation of the drill. This machine is equipped with a Jacobs chuck which will take drills up to and including 3/8 inch in diameter. Two knurled side handles and a breastplate, provide ample means for holding the tool securely in any position. Hand holes are provided which furnish a means of easy access to the commutator and brushes for inspection or repairs, when

necessary. The drill is shown in the accompanying illustration with these hand hole covers removed. An idea of the capacity and adaptability of this tool may be had from the following approximate data: A hole three-eighths-inch in diameter and one inch deep may be drilled in cast iron in 27 seconds, or in machine steel in 95 seconds. The machine will

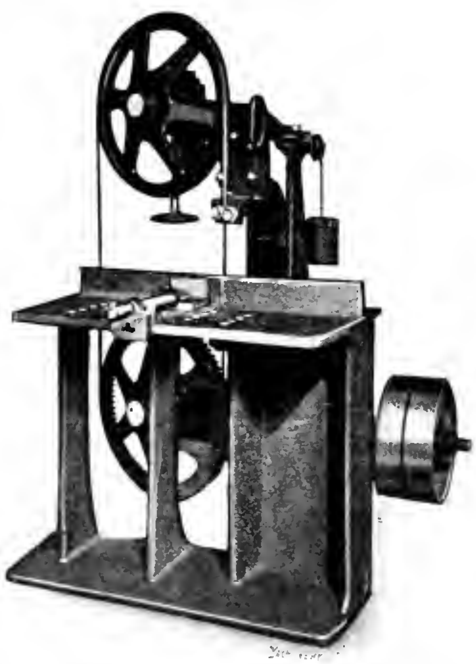


General Electric Co.'s New Drill for Alternating Current

also satisfactorily operate a $\frac{3}{4}$-inch wood bit. From these figures it is evident that much time can often be saved by the employment of this tool, as it will render unnecessary the moving of heavy castings to the stationary drill for many of the minor drilling operations. This machine is designed for operating on either a 110- or 220-volt, 60-cycle circuit, to which it may be quickly connected by simply screwing an attached plug into a standard lamp socket.

BAND-SAW MACHINE FOR CUTTING METAL

A band-saw that is intended for doing practically the same line of work in the machine shop as that which is ordinarily done by the power-driven hack-saw, is now being built by E. R. Klemm, 103 West Monroe St., Chicago, Ill. This machine, as the engraving shows, resembles somewhat in its design the



Metal-working Band-saw with Gravity Feed

band-saw of the wood-working shop. There are, however, a number of radical changes in its construction which were necessary to adapt it to the work for which it is intended.

The frame of this saw, on which are mounted the band-saw wheels, is free to swing about a bearing at its lower end, and it is by this movement that the saw is fed into the work. The feed is by gravity acting on the weight seen suspended by a chain at the rear. This chain, after passing over the pulleys shown, is attached to the swinging frame which is thus pulled forward. It will be noticed that the band-saw wheels lie in a vertical plane that is inclined considerably to the back or locating strip on the table against which the work is clamped. These wheels are located in this way in order that long stock will not come into contact with the idle side of the saw blade. Means are provided for changing the center-to-center distance of the band-saw wheels, to accommodate saws of different lengths and for varying the tension. The machine is strongly built, and it is provided with a large table equipped with a suitable vise for holding the stock. Practically any shape whether round, square or flat can be held securely and cut to any desired angle. The drive is through a shaft at the rear which has on its end a bevel pinion meshing with teeth cut on the lower band-saw wheel. Two disks, which are located a short distance above the table and on either side of the saw blade, deflect the latter so that it is square with the work.

The maker states that this saw cuts as squarely as any on the market, and also that it severs the stock with considerable speed and with a low power consumption.

BAIRD WIRE FORMING AND FERRULING MACHINE

In Fig. 1 is shown an interesting machine made by the Baird Machine Co., of Oakville, Conn., for the automatic production of pieces such as shown in Fig. 2. These pieces, which are bent in various shapes, have a ferrule around them,

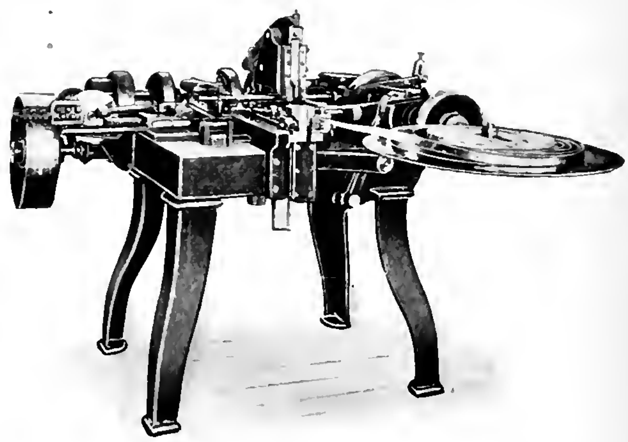


Fig. 1. Automatic Machine for Wire Bending and Ferruling

usually over the closed joint, made from strip metal. Such parts are used extensively for suspender loops, buckles, easel stands for photograph frames, etc.

The machine is a combination of two mechanisms, one of which performs the bending operations, while the other forms the ferrule. The action is entirely automatic. The wire is received from the coil, is straightened, threaded, cut off and formed; and at the same time a strip of sheet metal is received from a reel, is cut off, formed and pressed in place around the work as shown in Fig. 2. The capacity for completely ferruled work is from 60 to 80 per minute, according

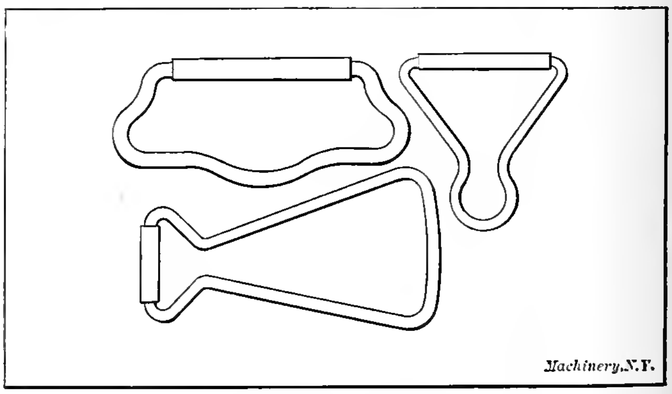


Fig. 2. Character of Work produced

to the size and shape. No further attention is required than that of keeping the machine supplied with strip metal and wire, and removing the finished product.

This machine is built in various sizes and for various styles of work. A high-grade of workmanship and construction is employed throughout, liberal use being made of hardened and ground tool steel for lining, tools, etc. All sliding surfaces are carefully scraped.

SPECIAL LE BLOND MILLING MACHINE FOR JIG BORING

The milling machine is now generally used in the tool room for the purpose of drilling bushing holes in jigs and fixtures, as well as for the machining of the various flat surfaces required in that work. The use of the miller is due to the convenient provisiou it offers for adjusting the work in two directions at right angles to the spindle, in the provision of a feed in line with the spindle, and in the rugged design and accurate construction, which permit much finer results to be obtained than would be possible on the ordinary drill press, even though supplied with the required adjustments.

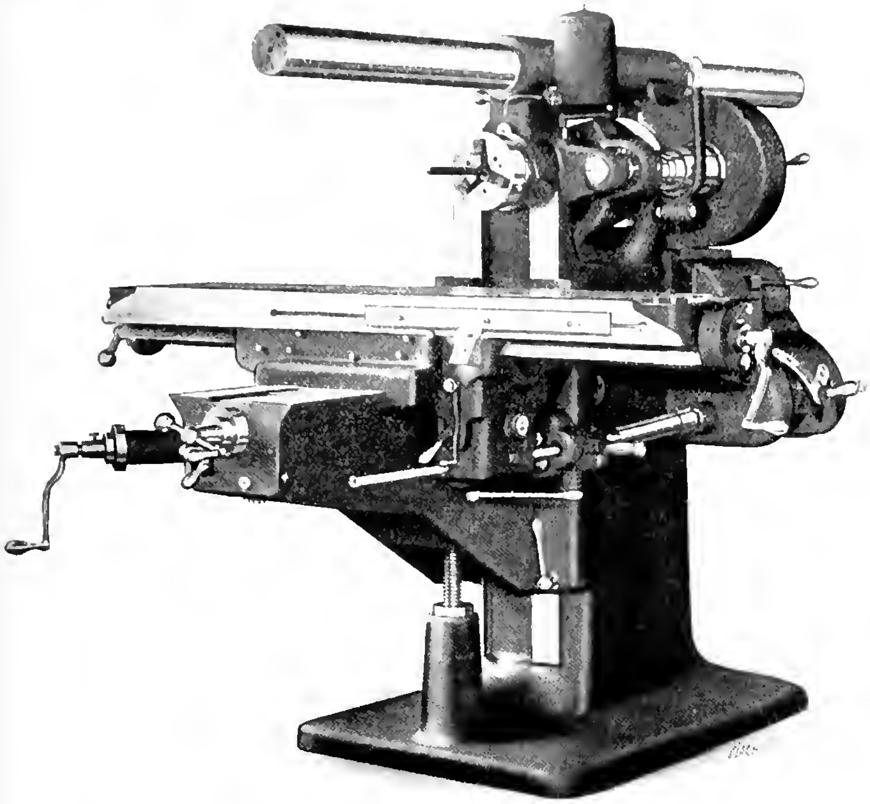


Fig. 1. Miller provided with Vernier Gages and other Conveniences for Jig Boring

The usual method of locating the holes for boring in the milling machine is by the use of ground bushings or "buttons," located by accurate measurements in the positions where it is desired to bore the holes. The buttons thus located are, in turn, lined up with the spindle of the machine by means of indicating devices, and the holes are then bored to the required size.

This button method is exceedingly accurate, but is correspondingly tedious. Another method which has sometimes been adopted consists in fitting accurate scales with vernier attachments to the miller, so as to read the various movements directly without requiring the setting of jig bushings or buttons with special instruments. This greatly increases the rapidity with which such work may be done, but, in general, it has not given as good results as have been obtained by the button method.

The R. K. Le Blond Machine Tool Co., 4609 Eastern Ave., Cincinnati, O., has, however, a special milling machine equipped with vernier scales, in which such care has been taken, both in design and construction as to insure close work. As a result the accuracy in jig and fixture work produced is high enough to meet all except what might be called extreme laboratory requirements, and this accuracy can evidently be obtained with a great saving of time and work for the toolmaker.

The salient features shown by an inspection of Figs. 1 and 2 are the heavy column and wide range of movement provided for the cross and table feeds, the special design of the automatic feed mechanism on the saddle, the increased stiffness of all the structural members and the modified arrangement of the handles, to permit the workman to use them while in a convenient position in relation to the work.

The spindle is unusually heavy. The front taper bearing is hardened and ground and runs in a close-grained cast iron box of special mixture. This insures a permanent bearing that will run indefinitely, showing no wear and requiring little attention. The rear journal is straight and runs in a bronze box fitted to a taper hole in the housing. This box is split and can be drawn into the taper to take up the wear on the rear journal. The end thrust of the spindle is taken by a hardened steel and a babbitt collar. An oil slot is milled in both boxes connecting with reservoirs in the column. These slots are filled with felt, through which the oil filters to the bearings. The arbor is driven by a clutch milled in the end of the spindle nose. An arbor bolt is provided which extends through the hollow spindle, and provides a convenient means of inserting and removing the arbors.

The cone is three-stepped, the largest step being 13 inches in diameter for a 3½-inch belt. The back gears are of the maker's double friction type, which, in addition to all the advantages of double back gears, provides a means for quickly stopping and starting the machine, a feature of equal value to the friction head on a chucking lathe.

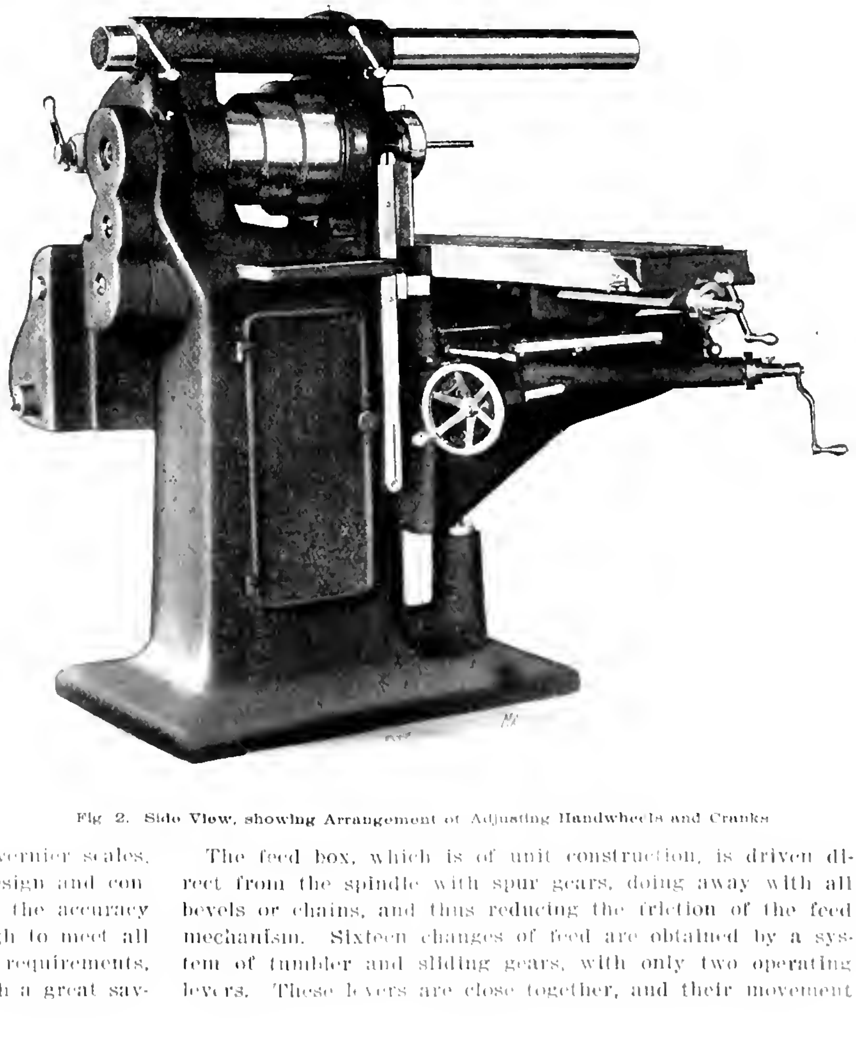


Fig. 2. Side View, showing Arrangement of Adjusting Handwheels and Cranks

The feed box, which is of unit construction, is driven direct from the spindle with spur gears, doing away with all bevels or chains, and thus reducing the friction of the feed mechanism. Sixteen changes of feed are obtained by a system of tumbler and sliding gears, with only two operating levers. These levers are close together, and their movement

is such that a direct reading index plate enables the operator to tell at a glance the correct position for a given feed. The table feed is driven with a direct spur drive on the end of the saddle, instead of the usual construction of coming through the center of the knee and saddle, which further reduces the frictional losses in the feed mechanism. The reverse and trip for the table feed are operated by one lever, the mechanism being carried in a box on the end of the saddle. When the feed is tripped there are no gears or clutches running idle on the screw or in the saddle.

The table is unusually heavy, with arched ribbing to counteract the strains of bolting work on its surface. The bearing is taken on the outside of the dovetail and extends the full width of the table. Large oil pockets extend entirely around the table, and the oil is drained to each end, where it may be removed through cocks provided for that purpose. The table feed-screw is $1\frac{3}{4}$ inch in diameter, of coarse pitch, and geared 2 to 1 on the quick return. The thrust is taken on ball bearings at the ends of the table, and the screw is therefore always maintained under tension, regardless of the direction of movement.

The knee is made in box section, ribbed and braced transversely and laterally. The column bearing is extended up almost to the top of the table, which adds greatly to its rigidity. The saddle bearing is wider than the column bearing, giving support to the ends of the saddle. The cross feed screw is set in the center of the knee, overcoming all side strains and giving an easy movement. The saddle is of unusual length, and is braced its entire length with arched ribs through which the table screw passes. The taper gib for the table bearing is made with a tongue to avoid any tendency to lift. The lower gib as well as the gib on the column bearing are made with two angles, adjustment being effected with fine thread screws. Locking screws with fixed handles are provided on both gibs, which draws them in like wedges, and these provide metal to metal contacts the entire length of the gibs.

The machine has a longitudinal feed of 34 inches, a vertical feed of 20 inches and a cross feed of 18 inches. The unusual length of the cross movement is one of the chief advantages over an ordinary plain miller for boring jigs, as it permits the use of long boring bars for box jig work and for deep holes. In order to use the machine to the best advantage in boring, the cross feed is arranged in such a manner (see Fig. 2) that its movement can be controlled from the rear of the table—a position most convenient to the operator. This is accomplished by the introduction of the diagonal shaft through the knee which is connected to the cross feed screw at the front by means of bevel gears.

The longitudinal and vertical movements are fitted with vernier scales 24 inches in length, thus enabling the operator to lay off centers with extreme accuracy without the use of auxiliary measuring instruments. An interesting feature in connection with the completion of this machine was the testing of the accuracy of the screws. The vernier scales provided an ideal condition for such a test, which showed the screws so accurate that the error was invisible to the naked eye in a length of twenty inches.

MASSACHUSETTS FAN CO.'S "SQUIRREL CAGE" FAN

The increased use of mechanical ventilation and the extent to which motors and steam turbines are now employed, has resulted in what is called the high-speed or multi-blade fan. This type, because of its high rotary speed, is, of course, for the same capacity, smaller than the older types, for, naturally, the higher speeds make possible a reduction in the wheel diameter; in fact, this diminution in diameter was necessary to keep the rim velocity within practical limits. One of the greatest losses of power in the operation of a fan, is in the creation of an inlet velocity that is entirely destroyed before the air is delivered. In order to decrease this velocity, the area of the inlet is increased to as great an extent as the depth of blade will permit. It is well known that there is a very exact proportion existing between the volume of air delivered and the blade area of the wheel, and in order that the proper blade area may be maintained, a reduction in the depth of the blade must be accompanied by an increase in the number.

By increasing the size of the inlet, using many shallow blades in place of a few deep ones, and increasing the rotary speed, a marked increase in the air delivered and a greater capacity in a given space has resulted. In fans of the older designs, commonly known as the "paddle-wheel" type, the blades were wide apart at the periphery and nearer together at the inner ends. With the blades arranged in this way, the greater density of air at the outer ends caused the formation

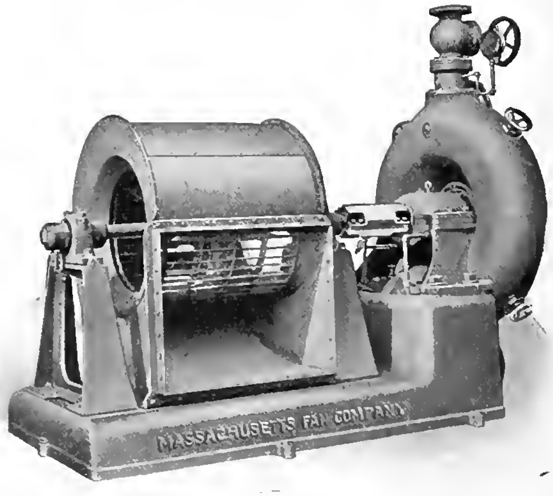


Fig. 1. Turbine-driven "Squirrel Cage" Fan built by the Massachusetts Fan Co.

of eddies and pulsations which reduced the efficiency and caused noisy operation at high speed. In order to reduce the effect of eddies, multi-blade fans were designed so that the air would be subjected to blade action during the shortest period possible. To accomplish this, blades were made very shallow.

The Massachusetts Fan Co., of Watertown, Mass., employs in addition to the blades around the periphery of the blast-wheel or cage, a few long and tapering blades, which extend toward the center of the wheel. These blades may be seen in Fig. 2, which shows a view of the blast-wheel for a double inlet blower. The theory is that these extra blades work with a scooping action which gives the entering column of air a slow whirling motion and a rapid radial motion toward the shal-

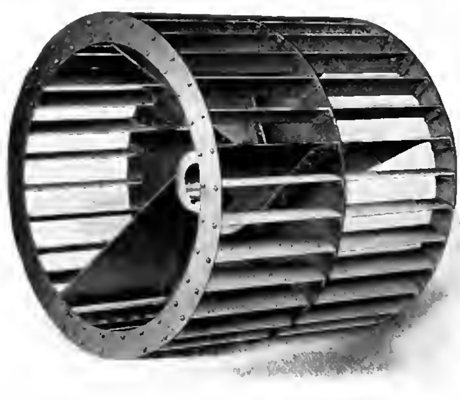


Fig. 2. Blast-wheel or Fan Runner of the Double Inlet Type

low peripheral blades, thus increasing the efficiency of the fan. Inasmuch as the centrifugal force acting on the entering column of air varies with the speed, the angle of these inner blades should be changed for different peripheral speeds. In order that fans working under different conditions will have a maximum of efficiency, the company referred to has developed three standard designs of the "squirrel-cage" type; these are as follows: Type A for the low peripheral speeds which have been found to be best adapted for building work, and for certain conditions for high pressures when the fans may be driven by a direct-connected steam engine; type B for higher peripheral speeds such as those of high-speed motors,

especially of the alternating current type; type C for very high speeds, as when driven by steam turbines.

One of these squirrel-cage fans of the double-inlet type is shown in Fig. 1 directly attached to a steam turbine.

SPECIAL WALTHAM BENCH LATHES

The Waltham Machine Works, Newton & Cutter Sts., Waltham, Mass., has for many years manufactured a line of bench lathes which are used for general manufacturing and special work, where parts to be made are small or require great precision in workmanship. These lathes are regularly provided with tailcenter, slide-rest, etc., and used in the same way as the largest size engine lathes in the machine shop.

A number of special appliances are provided for them, however, by means of which they may be converted into special machines. Some of these arrangements, of recent design, are herewith illustrated and described.

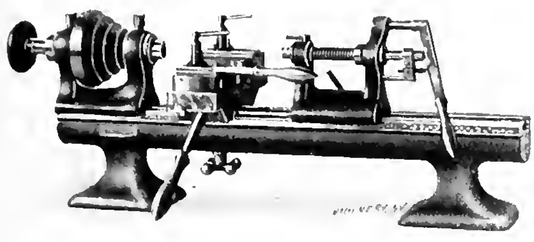


Fig. 1. Precision Drilling, Turning and Cutting-off Lathe

In Fig. 1 is shown a drilling, turning and cutting-off lathe, consisting of a plain head with a spring chuck, a double slide-rest and lever tailstock, mounted on a two pedestal bed. The movements of the various slides are controlled by lever, so that the action is very rapid. Stops are provided in all directions. The front toolpost on the cross-slide is mounted on a compound block which may be set to any desired angle, so that either cylindrical or taper surfaces may be turned and bored by the manipulation of the upper handle.

Fig. 2 shows a shortened one-pedestal lathe bed on which is mounted a headstock and a grinding wheel slide. This machine is intended for grinding small short work, one end of which is held in a spring chuck, while the other is supported by a center in a bracket attached to the back side of the headstock. A grinding wheel is mounted on a traverse spindle in a swivel support which may be set to any angle desired.

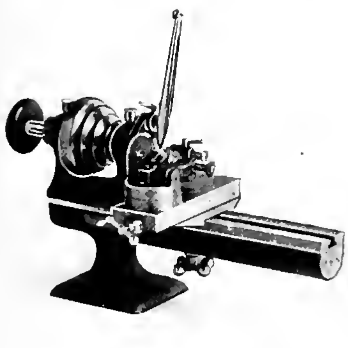


Fig. 2. Special Grinding Lathe with Self-contained Measuring Indicator

An indicator is shown, which is provided with a sapphire point bearing against the work. This records the diameter, so that it is not necessary to stop the spindle and take measurements for every piece, this being done only occasionally.

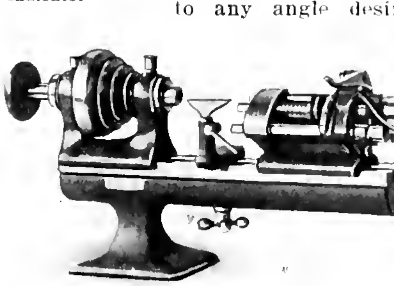


Fig. 3. Precision Lathe with Three-spindle Tumble Tailstock

The machine shown in Fig. 3 is a combination of a plain chuck headstock, a hand-rest and a three spindle "tumble" tailstock, mounted on a single pedestal bed. The center spindle of the tailstock can be driven by a belt, thus making it an excellent tool for spotting, drilling and reaming small holes.

The machine illustrated in Fig. 4 is provided with a headstock of special construction. The cross-slide is similar to that shown in Fig. 1. The lathe tailstock is of the "half bearing" variety, which may be provided with a multiplicity of spindles, each containing one tool of a number which it may be desired to use. Each spindle has its own stop, so that each may be set independently. To change from one to the other it is only necessary to pick out one tool and lay in the next in order. The headstock is of the slide spindle type, with a lever-operated chuck and wire feed. A two-step cone pulley

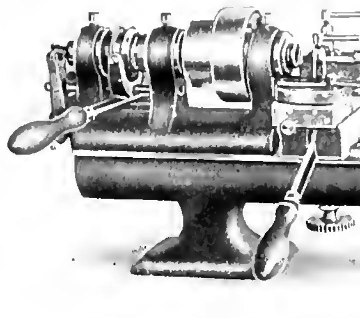


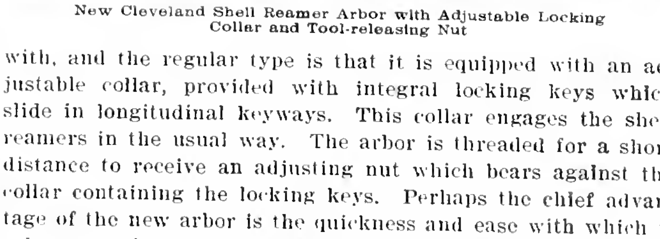
Fig 4. Lathe with Double Lever Cross-slide and Half-bearing Tailstock adapted to Screw Machine Work

is provided. This equipment is used in much the same way and for the same kind of parts that in larger work would be placed on a hand or automatic screw machine.

The various lathes here illustrated have, for the most part, a swing of 3¼ inches and a chuck capacity of 5/16 inch. Three other sizes are made, however, swinging 6¾, 7 and 8 inches, with 3/8, 1/2 and 5/8 inch chuck capacity, respectively. These lathes, with special equipment, are usually made only to order, though the makers occasionally have some of the parts in stock. As all the equipment of one size is interchangeable, any style of headstock can be used with any style of tailstock and slide rest, giving several other combinations in addition to those shown.

CLEVELAND TWIST DRILL COMPANY'S SHELL REAMER ARBOR

The Cleveland Twist Drill Co., Cleveland, O., is about to place on the market a new patented arbor for shell tools. The principal difference between this arbor, which we illustrate here-



New Cleveland Shell Reamer Arbor with Adjustable Locking Collar and Tool-releasing Nut

with, and the regular type is that it is equipped with an adjustable collar, provided with integral locking keys which slide in longitudinal keyways. This collar engages the shell reamers in the usual way. The arbor is threaded for a short distance to receive an adjusting nut which bears against the collar containing the locking keys. Perhaps the chief advantage of the new arbor is the quickness and ease with which it releases a shell tool, no matter how tightly it may have become jammed on the arbor. This is accomplished by a turn or two of the adjusting nut, and without the necessity of removing the arbor or resorting to the vise and hammer methods which often cause considerable damage. Another decided advantage is that the collar can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage the collar keys.

CINCINNATI-BICKFORD 2½-, 3- AND 3½-FOOT RADIAL DRILLS

The radial drilling machines made by the Cincinnati-Bickford Tool Co., Cincinnati, O., (formerly made by the Bickford Drill & Tool Co.), are well known in their general characteristics. The smallest sizes of this line (2½-, 3-, and 3½-foot) have recently been redesigned by the makers. The main characteristics have been retained and there is, in fact, com-

paratively little change in their appearance. Improvements have been made, however, throughout the whole structure and mechanism of the machines, radically affecting the strength, durability, convenience, accuracy and productive capacity.

The design has a column extending to the top of the sleeve, ribbed internally so as to furnish a high degree of stiffness. It is mounted on a base which has been considerably strengthened at the point where the flange is bolted down. The ring which supports the elevating screw and takes the weight of the arm itself, is now supported on ball bearings, greatly reducing the force required to swing the arm. The pipe section of the arm has been retained, giving a high degree of strength and stiffness. In fact, in the matter of the general structure of the machine, all that was good in the old design has been kept, with the addition of improvements that increase its efficiency.

The power of the drive has been augmented by putting on a larger driving pulley, giving, consequently, a greater belt capacity. The well-known form of gear box provided, allows changes to be made while the machine is running at a high speed, by the simple tossing of the lever from one notch to the other. This can be done without taking special precaution to prevent breakages. The settings for the different diameters of drills are given below the notches in which the change gear lever rests. Gears subjected to hard service are of hardened steel. The bevel gears transmitting the power to the column have been increased in size, so as to make them proportionate to the greater power transmitted.

The back-gears are located in the head. They are of simple construction, consisting of three gears and a clutch, and may be engaged or disengaged while running. The clutch is made of high-grade carbon steel and has hardened teeth. The gear-box and back-gears give twelve changes of speed, ranging from 38 to 356 revolutions per minute, making them correct for a cutting speed of 35 feet per minute for drills from 3/4 inch to 3½ inches in diameter. This increased speed range is a new feature in this design.

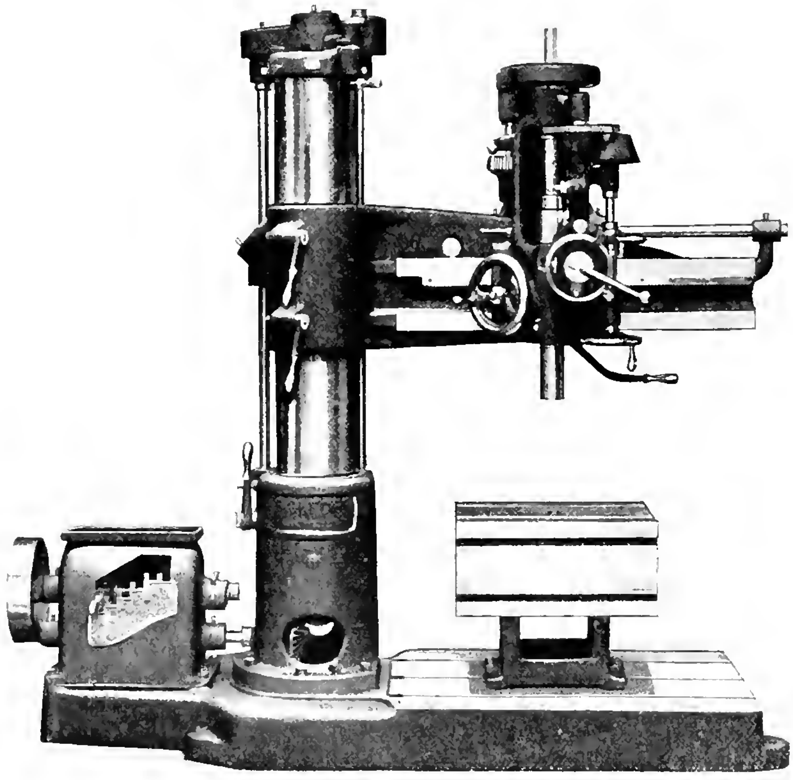


Fig 1. Improved Design of Cincinnati-Bickford Radial Drill

The reversing clutch, the lever for which may be seen extending below the head in Fig. 1, is now expanded by a plunger and toggle-joint arrangement, whereby its capacity is increased many times over that of the wedge type of clutch formerly used. Adjusting screws permit the friction rings to be set to any tension desired. The reversing lever is employed for starting and stopping the machine as well, being within convenient reach from the operator's position.

The feed change device operates by means of a ball handle controlling a driving key mechanism. This gives four changes ranging from 0.008 to 0.020 inch advance per revolution of the spindle. Any one of these feeds is instantly available. The feed clutch is made of hardened steel. The thrust of the feed worm is taken on a ball bearing instead of on a fiber washer, reducing the power consumed by this member of the machine. The spindle sleeve also exerts its pressure on the spindle through a ball thrust bearing, reducing the power to run the machine nearly 22 per cent. This, with the increased diameter of the driving pulley, makes the machine capable of doing much heavier work than formerly.

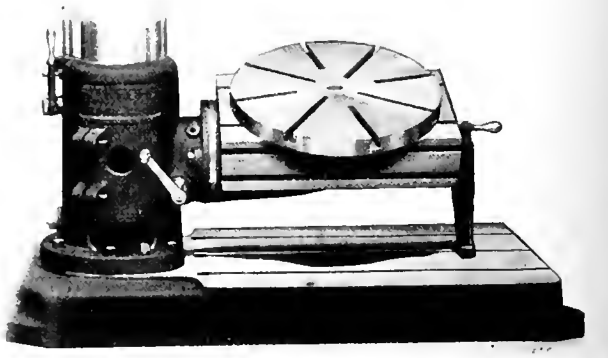


Fig. 2. Universal Swinging, Tilting and Rotating Work Table

The quick return handle on the feed pinion shaft is now provided with a toggle-joint type of adjustable clutch. This requires but a slight force to engage it, thereby avoiding the possibility of throwing the handle out of position by a sudden violent effort. Instead of graduating the spindle sleeve as formerly, depths are now read from a dial permanently located on the quick return head on the feed pinion shaft. The automatic stop is also made a part of the depth gage, and it may be set in position instantly without requiring trial cuts or measurements.

The guide on the top of the arm for the adjustment of the head is made flat instead of angular as usual, thereby allowing the head to move more easily, and minimizing the tendency for it to rock on the arm while the machine is in operation. The head clamping device has the important feature of tightening the gib in the head instead of lifting it away from it. This gib is now made taper instead of flat and is fitted with an improved adjusting device which eliminates the undesirable feature of having the weight of the head rest on the point of two screws. It also prevents the possibility of any end play.

Three forms of table are provided. Fig. 1 shows the box table clamped on the base of the machine, and provided with working surfaces on both sides as well as on the top. Fig. 2 shows a swiveling table provided with a wormwheel adjustment for setting it to any angle about a horizontal axis, the angle being indicated by a graduated ring of large diameter; a dowel is provided for locating it in the horizontal position. This design is also furnished, if desired, as a plain swinging table, without the swiveling attachment. The round work-table shown is a supplementary device which may be placed on the box, swinging or swiveling tables.

Special attention should be called, in Fig. 1, to the very complete set of gear guards provided. This is in line with the modern tendency of safe-guarding the workman. It has other advantages as well, however. It protects the gears from accidents, such as are particularly likely to occur in shops having traveling cranes. It prevents the throwing of oil over

the clothes of the operator. Besides all this, it adds so much to the appearance of the machine that it would seem to be a commercially profitable policy to provide complete gear guards on that score alone.

These machines are made in 2½, 3- and 3½-foot sizes, which dimensions give the radius of the circle to the center of which it is possible to drill on the base of the machine. The vertical adjustment of the arm is about 53 inches for each of the three sizes. The maximum height of the end of the spindle above the base is about 4 feet 3 inches. The vertical range of the spindle is 11 inches. It is bored for a No. 4, Morse taper. The weights of the 2½-, 3-, and 3½-foot machines with swinging table, are, respectively, 4,100, 4,250 and 4,400 pounds.

SIBLEY HIGH-SPEED GEARED DRILL

The Sibley Machine Tool Co., South Bend, Ind., makes a high-speed drill, which was illustrated in the department of New Machinery and Tools in the November, 1909, number of MACHINERY. This machine has recently been equipped with an all-geared power feed, which is illustrated in the accompanying engravings together with details of the speed change mechanism.

The gear-box for the feeds is mounted at the side of the lower spindle head, being connected in the casing at the top of the column with the horizontal spindle driving shaft. Four sets of gear ratios are provided, the change from one to the other being made by the sliding key mechanism operated by the knob plainly shown in the hub of the handwheel, which, it will be seen, places it within convenient reach of the operator.

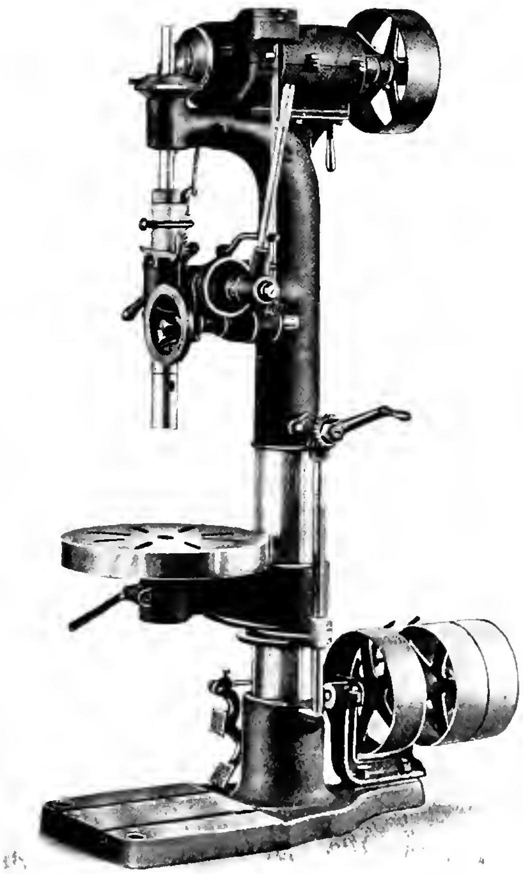


Fig. 1. Sibley Drill Press with Geared Quick-change Speeds and Feed

The usual drop worm mechanism is provided in connection with an automatic stop, actuated by an adjustable clamp dog on the spindle sleeve. A lever is provided for quick handling of the spindle for light drilling operations, while the handle at the left-hand end of the pinion shaft serves for the quick return movement.

The control of the spindle speeds will be understood by reference to Figs. 2 and 3. The constant speed driving pulley may be connected by either of two sets of gearing with the horizontal shaft at the left of the casing. The change from one set of gearing to the other is made by the lever shown in Fig. 2, just in front of the driving pulley at the top of the machine. This second shaft also carries a set of four gears meshing with a corresponding set of four gears on the spindle driving shaft, to which the driving bevel gear is connected. By the manipulation of the lever at the front, any of the four ratios provided may be obtained. The combination gives eight changes in all. The elimination of the cone pulleys permits the use of a wide belt running constantly at a high speed, giving greater power, besides having the obvious advantage of simpler and more rapid manipulation.

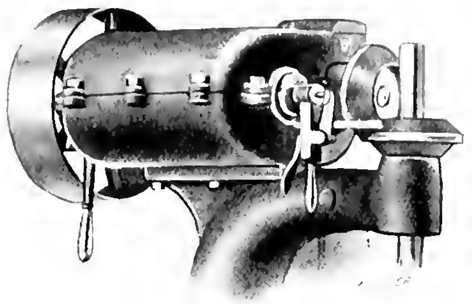


Fig. 2. Speed Change Box and Handles for Operating

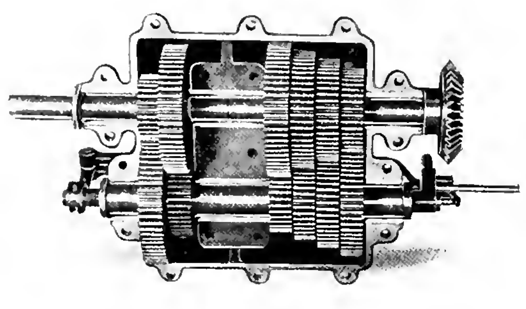


Fig. 3. Arrangement of Gearing in Speed Box

The bearings in the speed box are of bronze, the gears run in oil, and the whole construction is rugged and strong. All the changes of spindle speeds and feeds can be controlled without leaving the operator's position at the front of the table. The speed change is of the selective type—that is, the required speed may be obtained without running through the intermediate speeds and without stopping the machine. All the bearings are long, and the spindle and shafts are ground. The stiffness of the column is apparent in the illustration.

This style of machine is built at present only in the 22½-inch swing size. The total height of the machine is 6 feet, 5½ inches. The maximum distance from the spindle to the base is 39¾ inches, and from the spindle to the table, 19½ inches. The table is 19 inches in diameter. A No. 4 Morse taper hole is provided in the spindle. The eight speeds range from 99 to 600 revolutions per minute, while the feeds range from 0.0052 to 0.0169 inch per revolution. The spindle has a feed of 7 inches. The weight of this machine is about 850 pounds.

ROCKFORD ADJUSTABLE COLUMN GANG DRILLING MACHINE

In Figs. 1 and 2 is illustrated a novel design of gang drill, made by the Rockford Drilling Machine Co., of Rockford, Ill. As will be seen, the new feature is the provision made for adjusting the columns to different spaces along the planed top surface of the base. This allows the machine to be used, of course, for ordinary gang drilling operations, in which its merit over the use of four separate machines is principally that of compactness; but it makes it available as well for a large range of work which comes under the head of multiple spindle drilling—that is to say, it is adapted to the drilling of four holes in a line simultaneously on a given piece of work, or two holes in two pieces of work; and the spindles may be spaced to drill these holes at the different dimensions required.

The base has a planed top surface, provided with two T-slots in which each column is clamped by four stout bolts. A tongue in the rear T-slot serves to guide the columns and keep them in line. Each pair of columns is connected with

a screw by means of which they are adjusted along the top of the bed to the desired position. In this adjustment one column is clamped, while the other one is free to move under the influence of the screw. When this column has been moved to the desired position, it is clamped, in turn, and the other one is loosened and adjusted by the operation of the same screw. The minimum adjustment is 13 inches, center to center, for each of the pairs, and the maximum 30½ inches, center to center, between the adjacent spindles.

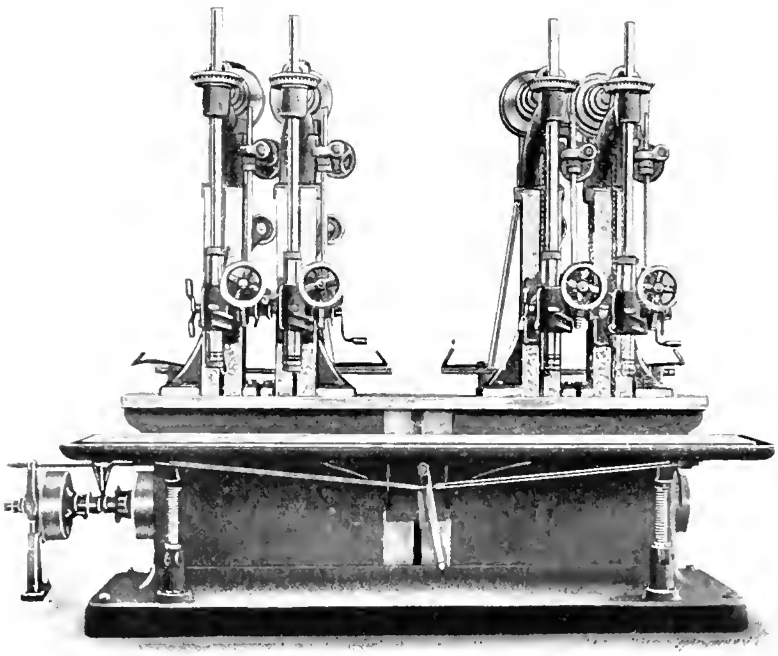


Fig. 1. A Four-spindle Gang Drill with Adjustable Columns

This adjustable column arrangement introduces a problem in the provision of a suitable belt drive, and bracing for supporting the belt pull. These problems have been solved in a way best shown in the rear view of the machine, Fig. 2. In place of the usual solid brace, running from the lower drive cone frame to the arm at the top of the machine, a strut has been provided which is pivoted at both top and bottom. At the lower end this is fitted into a socket where it is held by screws. Before the adjustment on the columns of the bed is changed, these screws are loosened, permitting the strut to slide freely in and out. When the adjustment has been made and the column is clamped in place, the screws are again tightened, to provide the compression strains due to the belt tension with a resisting member at this point. The tension under the varying adjustments is maintained by means of the idler pulleys shown, which work on the slack side of the belt, and may be adjusted to the belt's position.

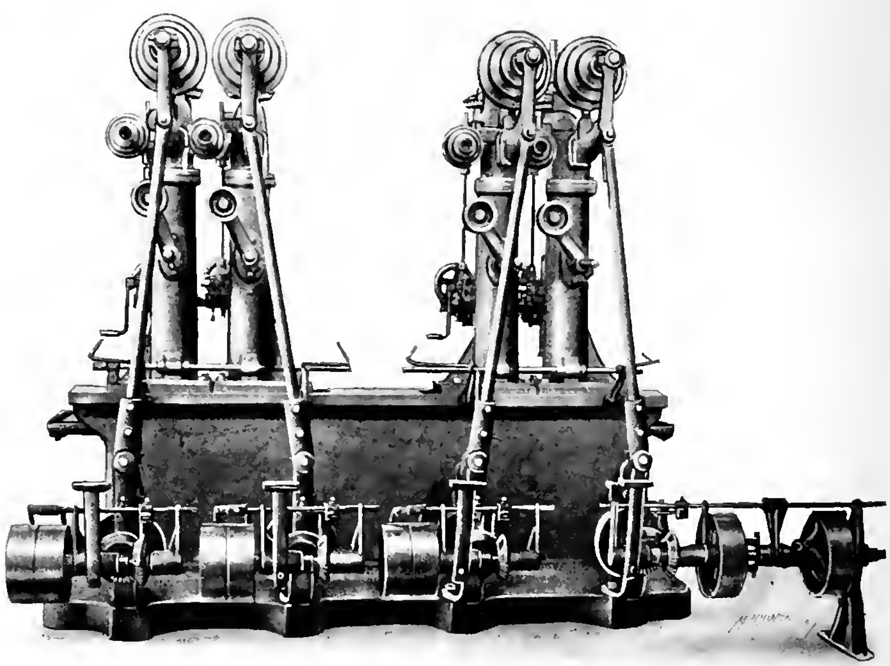


Fig. 2. Rear View of Gang Drill, showing Adjustable Back Braces and Belt Idlers

Each head is provided with a separate set of cone pulleys and a separate countershaft with its own tight and loose pulley and shifting lever, which is brought around to the front of the machine between the columns, where it can be readily handled by the operator. Power feed with automatic stop is provided for each of the spindles, thus making them independent.

The tool illustrated has the same dimensions and capacities for the individual spindles as the makers' regular 28-inch gang drill. Eight speeds are provided by the use of the internal back-gears, and there are four changes of power-driven feed. The table is mounted on two raising screws, geared together for changing the height adjustment. It is tongued and gibbed to the column, and may be rigidly clamped in place.

ALMOND GEARED DRILL CHUCK

T. R. Almond Mfg. Co., of Ashburnham, Mass., has made further improvements in the chuck with which its name has been connected for many years. The new design has the same internal construction as the original standard chuck, the improvements consisting in the application of a tightening device operated by a bevel pinion cut on the end of the tightening wrench. This construction is shown in the engraving.

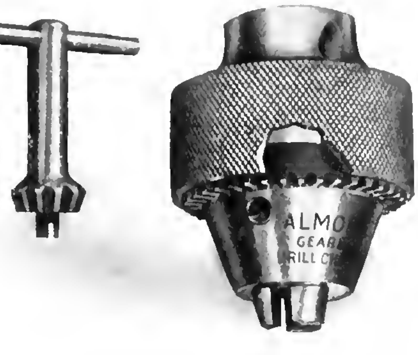
The main point of advantage in the new design relates to the gear teeth. Instead of being cut on the knurled sleeve as usual, they have been formed on the edge of the split nut or ring which operates the jaws. This nut is made of hardened and tempered tool steel, giving a great increase in durability and strength as compared with former designs in which the teeth are cut on ordinary mild, case-hardened metal in the sleeve. There is also an advantage in applying the tightening power directly to the nut, since it has been noticed that the frequent pressing of the sleeve on or off of the nut for cleaning purposes in the old design, tended to loosen the fit, so that the sleeve would slip when a firm tightening pressure was applied. The knurled sleeve is still, of course, available for quick adjustment by hand, the same as with the original construction.

Another improvement consists in bushing with hardened steel the holes in the body of the chuck, which receive the pilot of the pinion wrench, when the jaws are being tightened. These holes are subject in ordinary workshop practice to very severe usage, and by bushing them in this manner the fit of the gear teeth and the consequent satisfactory action of the chuck is prolonged indefinitely. This new design employs the same size pinion for both sizes of chuck, so that they are interchangeable. The wrench may, in fact, be chained to the drill press the same as the drift key, and be used for whichever size of chuck the workman happens to employ.

Improvements in general construction have resulted from the cutting of the teeth on the nut instead of on the edge of the sleeve. One result is the increase in the diameter of the nut and the consequent enlarging of the thrust area. The surfaces are thus better adapted to withstanding the pressure and

wear imposed on them when the jaws are forced out to receive the tool. The lubricant is also retained in these surfaces for a much longer period. This means that a greater tightening force may be safely employed, giving a higher gripping power.

The Almond chuck is made in three sizes. No. 1 takes up



Geared Drill Chuck of Improved Construction

to 3/16 inch, No. 2 up to 5/16 inch, and No. 3 up to 1/2 inch diameter. The two larger sizes only are furnished in the geared style, as No. 1 size will hold securely by hand tightening anything up to its capacity. The geared and standard designs in the larger chucks are furnished at the same price. The pinion wrenches are made of high grade tool steel, tempered, and have a high durability, so that replacements are

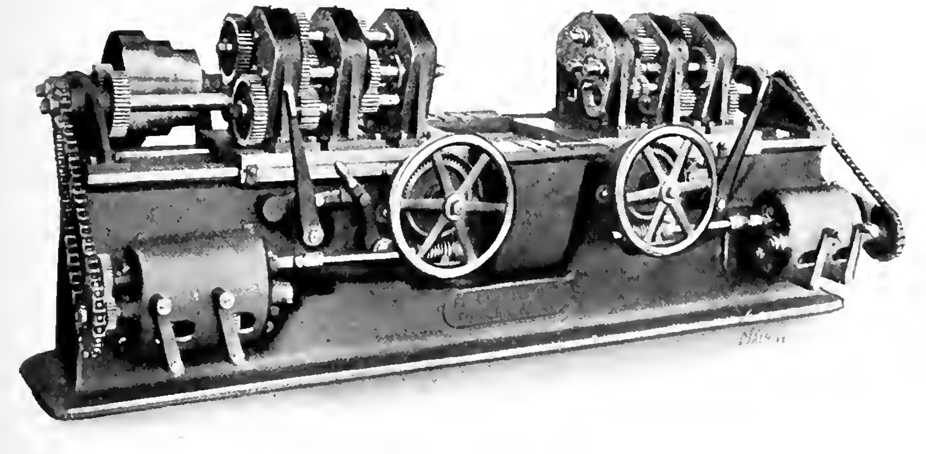


Fig. 1. A Transmission Case Boring Machine which provides for a Variety of Lay-outs

unnecessary. As in previous designs, long life and continued accuracy in the chuck itself have been secured by the high quality of materials employed, and a high grade of workmanship.

BEAMAN & SMITH TEN-SPINDLE TRANSMISSION CASE BORING MACHINE

The accompanying illustrations show a ten-spindle boring machine made by the Beaman & Smith Co., of Providence, R. I. It is intended for the special work of boring the shaft and intermediate stud holes in automobile transmission gear cases. These holes are bored from both ends of the case simultaneously, and provision is made in the arrangement of the spindles for different lay-outs for the positions of the shafts in the work. In the example shown the spindles are arranged for cases of four different designs, as indicated in Fig. 2; three of these are of the vertical type (Nos. 1, 2 and 4), while the other (No. 3) is of the horizontal type. The distances between the main shafts in Cases 1 and 3 are the same, and in Cases 2 and 4, but the lay-outs for the intermediate stud may be different for each, by having two of the spindles for these in one head and two in the other.

The general arrangement of the tool will be easily understood from Fig. 1. The machine consists of a long base provided with ways on its top surface on which slide the two spindle heads. These latter are each driven by separate cone pulleys and each is provided with its own feed mechanism, so that the two may be operated entirely independently of each other, both as to feeds and speeds. The work fixture is clamped to the top surface of the slide brackets which may be seen extending out front and back of the machine between the heads. Suitable T-slots and grooves are provided for

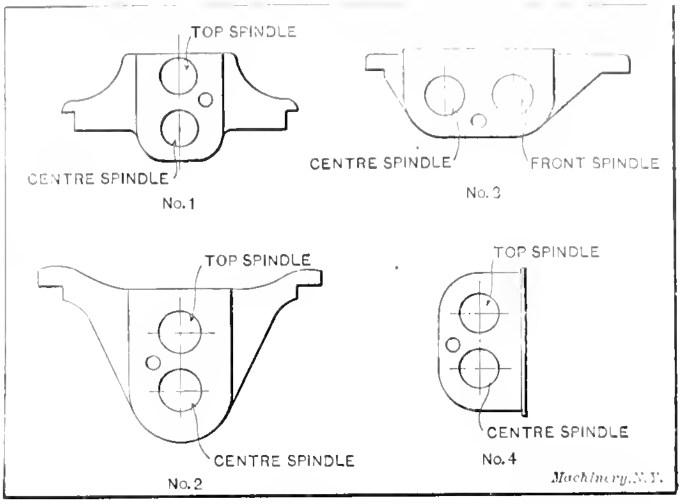


Fig. 2. Four Designs of Case for which Machine is adapted

locating it and bolting it down. The spindle head slide will be seen to extend forward of the heads, passing underneath the fixture when fed up to the work. The various boring tools are thus firmly supported, having a thrust directly downward onto the bed of the machine without any real overhang.

Three threaded spindles and two smaller slotted ones are provided on each head. The former bore the holes for the main and secondary bushings, while the latter drill the holes for the intermediate studs. Not more than three spindles in a head are in use at one time. The ordinary arrangement would be to have three employed in one head and two in the other, since the intermediate stud hole is found at one end of the work only. For boring the vertical type of gear-box, the top and center spindles, as shown in Fig. 1, would be used, with the upper of the two slotted spindles. For the horizontal type, the center and front spindles would be used, with the lower of the slotted spindles for the intermediate stud. The arrangement of the intermediate stud holes may be somewhat different in the left-hand head, making provision for different lay-outs, as has been explained.

The method of driving the various spindles and of chang-

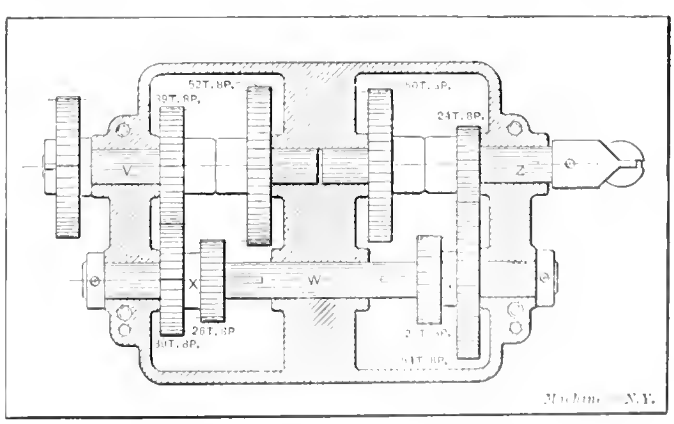


Fig. 3. Arrangement of Gearing in Feed Box

ing the connections for either the horizontal or vertical types is most plainly shown in Fig. 1. Gears *E* and *F* are driven from the pinion on the driving shaft geared to the cone pulley (see Fig. 1), and revolve continuously. Gear *E* drives shaft *A*, which has mounted on it a slip gear *D*, which may be changed to take the position *D'* if desired. In the position *D*,

this slip gear engages gear G on the center spindle H. (It should be understood that this diagram is a development and not a plan.) In the position D' it drives gear J, which is connected to the top spindle K. This spindle, in turn, carries a gear L which, through intermediate gear M, drives pinion

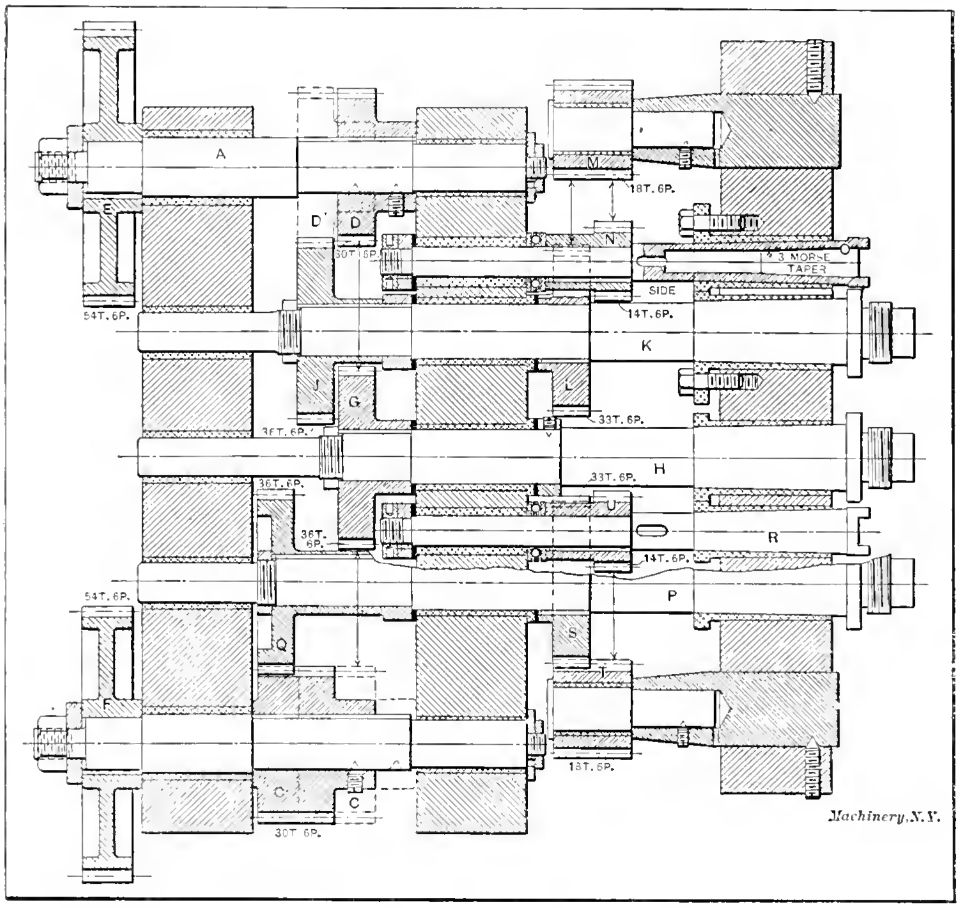


Fig. 4. Arrangement of Head Gearing, by means of which Spindle Movements are controlled

N on slotted spindle O. Thus in position D, center spindle H is driven, while in position D', top spindle K and slotted spindle O are driven.

In a similar manner, gear C has two positions. In the position shown, it drives front spindle P through gear Q and also slotted spindle R, which is connected with P through gears S, T and U. In position C', center spindle H only is driven through gear G.

It will be seen that in the position shown, with the slip gears at C and D, spindle H, slotted spindle R and front spindle P are being driven. This is the combination used for the horizontal transmission case. For the vertical case, the slip gears are changed to position C' and D', driving top spindle K, slotted spindle O and center spindle H. The three-step cone pulleys provide three changes of speed for each head.

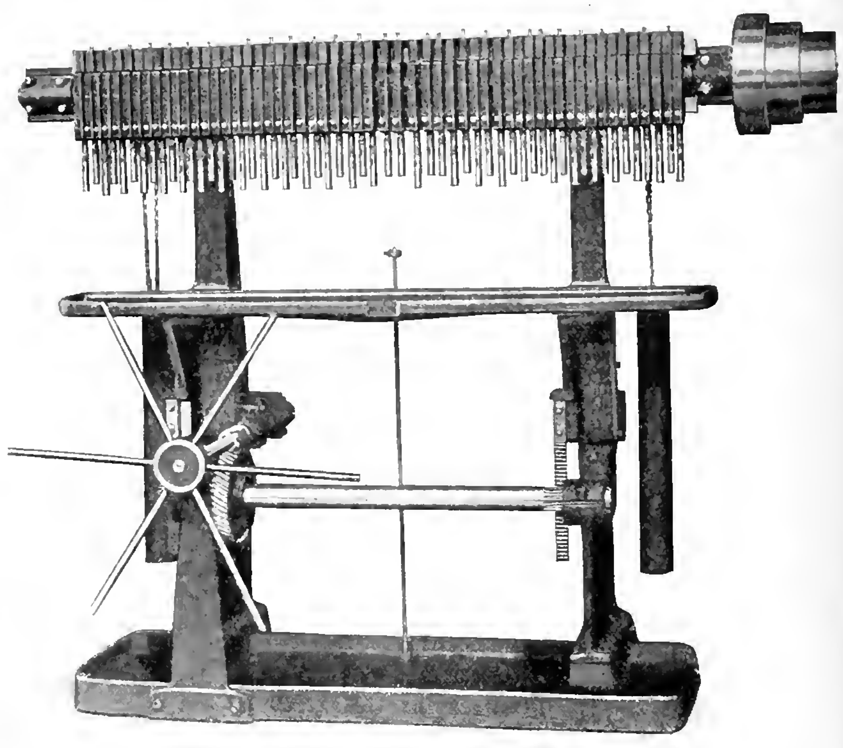
The gear-box gives four changes of feed; the construction is shown in Fig. 3. Motion is received by shaft V, which is provided inside the casing with two gears, one of 39 and the other of 52 teeth, as shown. On the intermediate shaft W is mounted the double gear X, either end of which may be engaged with the corresponding gear on shaft V by manipulating one of the handles shown at the front of the casing. At the other end shaft W carries a similar double gear Y, either side of which may be thrown into engagement with the mating gears on shaft Z by the operation of the second lever on the front of the casing. Four speeds may thus be given to shaft Z for each speed of shaft V, by the manipulation of the two levers of each gear-box. The feed is through a rack and pinion motion, driven by worm-gearing. An automatic stop is provided to arrest the feed, when the proper depth of boring has been reached. The length of feed is about two feet, and quick power movement is provided in each direction. The control handles are all in convenient reach of the operator. All feeds and speeds are positive. The machine is shown in Fig. 1 with all the gearing exposed. This is done simply to show the arrangement of the drive in actual use. Guards are provided which completely protect the gears from accident, either to themselves or to the operator.

This machine will, of course, be furnished with heads to suit any lay-out of transmission case. It weighs about 9,500 pounds.

MOLINE MULTIPLE SPINDLE DRILL

The multiple spindle drill made by the Moline Tool Co., of Moline, Ill., is unique in a number of particulars, especially in the closeness of spindle spacing permitted by the construction, the wide range of horizontal adjustment provided, and the ingenious arrangement of the drive. These characteristics are well illustrated in the special drill of recent design shown herewith.

The cross-rail at the top of the machine is provided with ways along which the narrow spindle heads are adjusted. Journal bearings are placed at each end for supporting a spiral gear which extends the full length of the ways. This spiral gear has further support besides that given by the journals, having a continuous bearing on its outside diameter in a seat formed



A Fifty-eight Spindle Drill, permitting Unusually Close Spacing

in the cross-rail. The heads are of steel to give them the required strength and stiffness in the very narrow width allowed them. The spindles are of tool steel, ground to size,

and run in bronze bushings. They are provided with ball thrust bearings. The lower bushing is threaded to give a vertical adjustment accommodating different lengths of drills. These heads are but ⅞ inch thick and may be brought close up into contact with each other, so that the minimum spacing possible is ⅞ inch.

The table is mounted on brackets gibbed to ways on the face of the housings at each end of the machine. The feed is by a rack and pinion movement. The pinion teeth are cut directly in the heavy feed shaft shown. In the particular case here illustrated, hand feed only is provided, being applied by a pilot wheel connected to the shaft by worm-gearing. Power feed will be furnished when desired. The table is counterweighted, and a stop is provided for its vertical movement, thus limiting the depth of holes drilled.

In the machine here illustrated, fifty-eight spindles are provided, but, of course, only as many of these will be furnished as are required by the purchaser. The adjustment range gives a minimum of ⅞ inch and a maximum of 5 feet. The machine is intended for light drilling particularly, but where comparatively few spindles are used drills as large as 5/16 inch may be employed.

IMPROVEMENTS IN KINKEAD SHAFT LEVELING APPARATUS

In the June, 1909, issue of MACHINERY, we illustrated a line of shaft leveling apparatus made by the Kinkead Mfg. Co., 7 Water St., Boston, Mass. This apparatus consists essentially of a special architect's level, a portable target hung from the shafting to be lined up, and a fixed target attached to a wall or other convenient permanent support. A line is established between the level at one end and the fixed target at the other. The portable target is moved along the shafting, to successive locations near each of the hangers, in turn. Error in alignment is noted through the telescope of the level by direct reading on notched graduations provided in the target. The method of doing this is given in detail in the article referred to, and will not be enlarged on here.

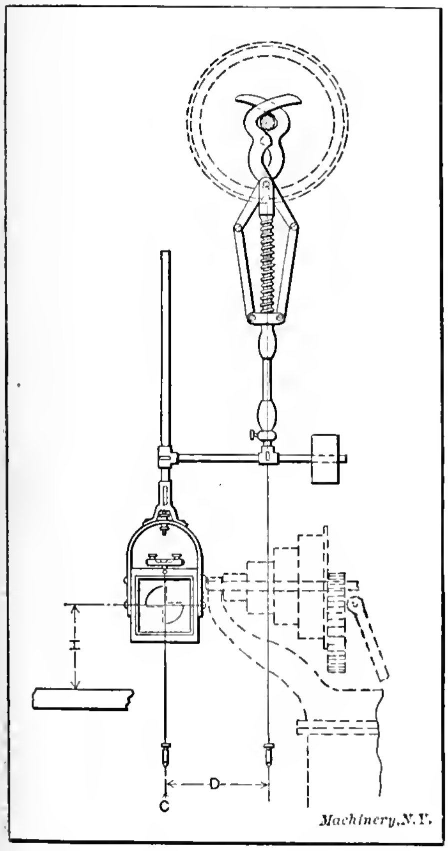


Fig. 1. Running a Line around Obstructions

The makers of this device have recently provided attachments and improvements which enlarge its range and increase its convenience, particularly in the aligning of shafting located in other positions than the usual one of suspension from the ceiling. The various attachments and methods of using them are illustrated in Figs. 1 to 4, inclusive.

Fig. 1 shows a difficulty occasionally met with. In this case, owing to the location of machines or other obstructions, it is impossible to run a straight line directly beneath the shafting, so offsetting the line has to be resorted to. In this case a special offset fixture is provided, as shown, with an adjustable counterweight which is used to bring the device into plumb in the vertical position. The vertical plumb bob is used as in the regular apparatus to determine when this vertical position has been obtained.

Occasional cases are found in which shafting is laid in pits or beneath the floor. Provision for lining up shafting thus located is shown in Fig. 2. Here the portable target is reversed, being supported in this upright position by an adjustable leg at the side, as shown. The plumb-bob also has to be reversed, of course, being hung from the target itself.

For shafting located in pillow blocks on piers, the arrangement shown in Fig. 3 is employed. This is preferable to the vertical arrangement shown in Fig. 2 since this shafting is usually very heavy and the pulleys on it large, and the horizontal position enables the operator to work from the floor.

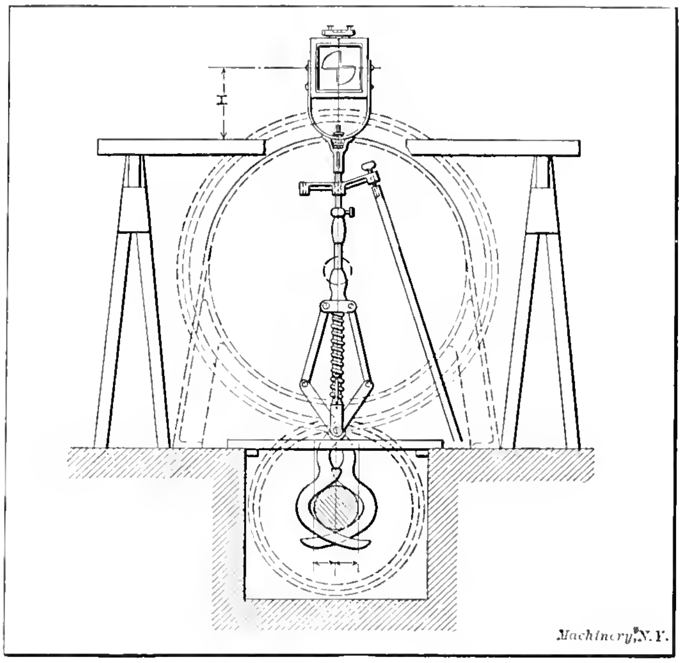


Fig. 2. Lining up Shafting carried in a Pit

The spirit level is attached to the face of the target by means of a special casting designed for the purpose. The target is supported by means of the rod shown, on which the adjustable thumb-screw rests.

It is common in a great many industries to arrange machines on benches, and drive them from a lineshaft beneath. For such work the arrangement shown in Fig. 4 may be employed. The portable target is mounted in fixtures which bring it at right angles with the clamping mechanism and bring it in a suitable place for working the architect's level and the fixed target.

All the various arrangements described provide for the accurate locating of both the level and the fixed target in positions convenient to the operator, and by means which permit

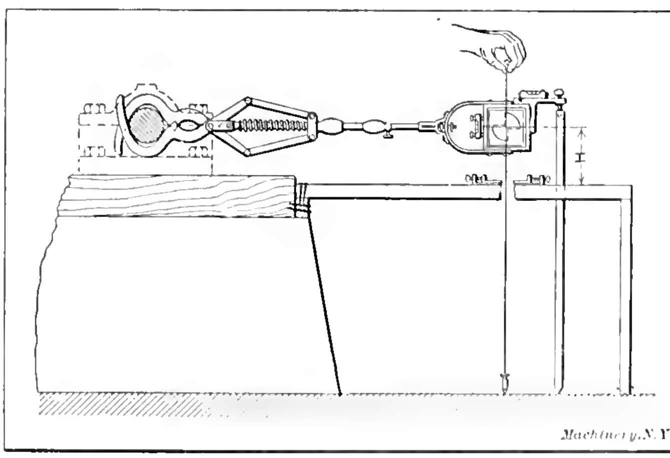


Fig 3. Application to Shafting carried on Pillow Blocks

of the accurate alignment of the shafting. It will be remembered in connection with the former description that the jaws for gripping the shafting are so designed that they will clasp varying diameters without making any difference in the distance from the center line to the center of the target, as they automatically compensate for changes of diameter.

This equipment will be found useful in other ways. It may be employed for running lines of shafting through walls, or for setting up counter- or jack-shafts. It is also applicable to such jobs as the grading of steam and water pipes, the setting up of machinery, and the common problems in surveying

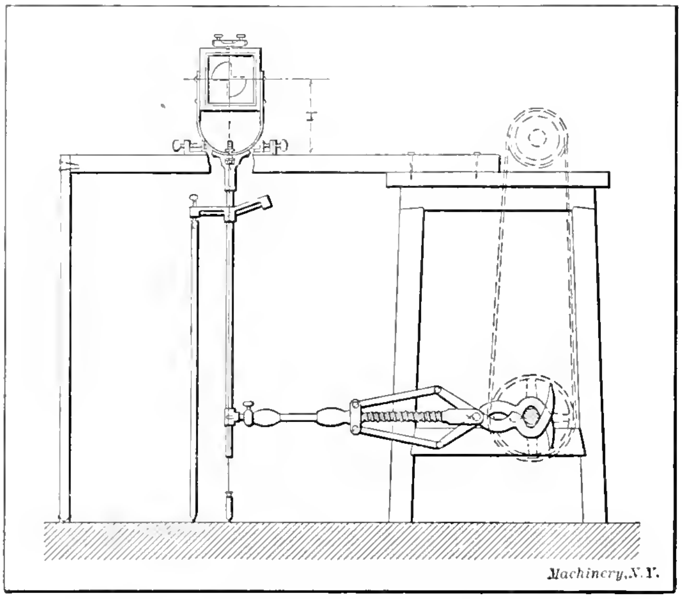


Fig 4. Special Attachments for Lining up Shafting Mounted under the Bench

met with around manufacturing plants. This apparatus is now in use in many large and important mills and manufacturing establishments. It has been found that the accurate testing and maintenance of alignment in line shafting results in a surprisingly large saving of power, and the consequent avoidance of much trouble and expense.

PRENTICE 12-INCH GEARED HEAD REVERSING LATHE

The Prentice Bros. Co., of Worcester, Mass., has built for a number of years a geared head high-speed lathe, which has come into extensive use. The headstock provided with this lathe gives eight spindle speeds, any of which may be obtained while the lathe is in motion, since the changes are made by means of friction clutches of special design, operating without shock or danger to the gears. The arrangement is

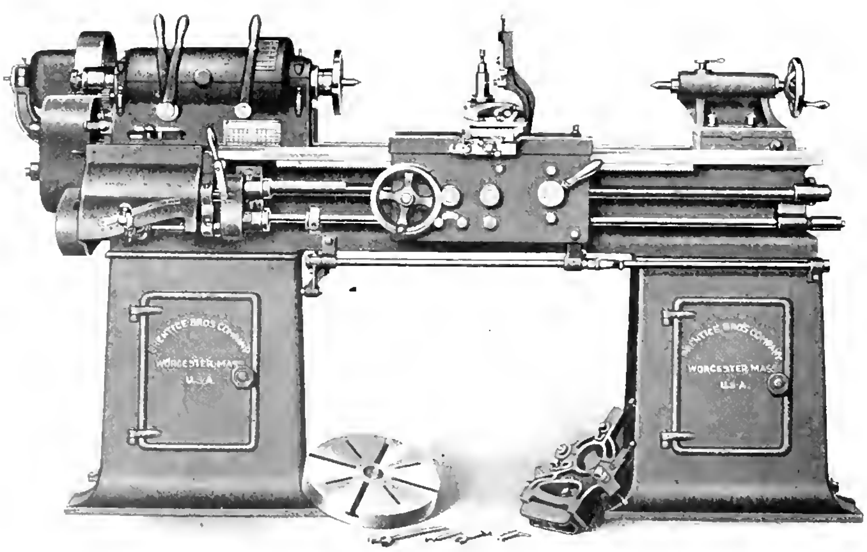


Fig 1. Geared-head Prentice Lathe with Reversing Mechanism incorporated

such that it is impossible to engage two conflicting gear ratios at the same time. The advantages of a constant speed pulley drive of this kind are now well understood, in the matter of giving a constant belt horsepower at any speed throughout the whole range. On this 12-inch swing machine, the belt has a capacity for about 10 horsepower when the countershaft is speeded at the proper rate of 400 revolutions per minute.

An improvement recently incorporated in the design of this machine is shown applied to the lathe in Fig. 1; it is illustrated in detail in Fig. 2. The improvement consists in doing away with the countershaft, by making the reversing mechanism a part of the headstock drive. This is located on the driving shaft and consists, as shown in Fig. 2, of three bevel gears and two friction clutches, together with a lever for operating them.

One bevel gear, *A*, is mounted on the hub of the driving pulley *B*, and when this is engaged to the driving shaft by clutch *C*, a forward movement is given to the spindle through driving shaft *D*. For reversing the spindle, clutch *C* is disengaged and *E* is engaged, so that the spindle movement in the opposite direction is transmitted through gears *A*, *F* and *G*. These bevel gears transmit power, it will be seen, only when the shaft is reversed for threading or similar work. The lever for operating this reversing mechanism is located on and travels with the apron, so that no matter how long the lathe bed may be, the operator always has immediate control of the starting, stopping and reversing of the lathe spindle.

With this reversing mechanism, the countershaft becomes unnecessary, thus saving the two pulleys, shaft, clutches and hangers usually required when using a double friction countershaft. Whenever it is convenient, the lathe may be located underneath line-shafting and belted directly to it.

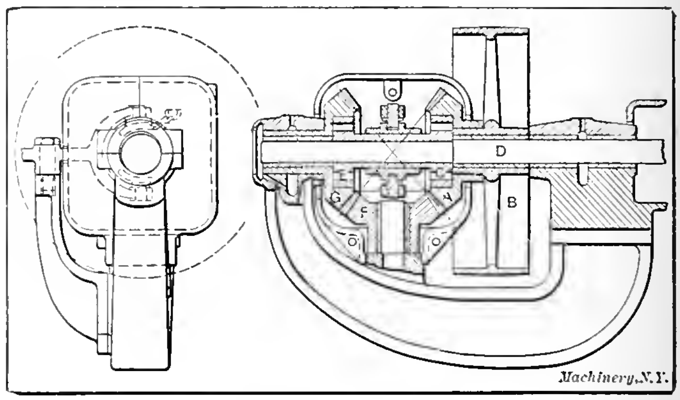


Fig. 2. Arrangement of Gearing and Clutches for Reversing

This construction also has advantages in the application of motor-drive to the lathe; the only additional mechanism that has to be furnished in this case is the motor itself. This is mounted on a bracket which is bolted to the rear side of the head-end cabinet leg. The motor is bolted directly to the driving pulley of the lathe. Provision is made for adjusting the height of the bracket and the tightness of the belt. One of the greatest objections to motor-driven lathes in the past has been the delay in obtaining the motors. This construction will do away with practically all trouble from this source, as any standard type may be used.

As mentioned, the lathe is practically of the same mechanical design as those previously built. It has, however, been redesigned throughout with the idea of making it heavier and capable of more severe service. The carriage is rigid, with an unusually stiff bridge, has a long bearing on the V's and is gibbed to the bed. The end thrust of the spindle is taken by a step bolted to the end of the headstock and entirely independent of the spindle bearing. A gear mechanism is furnished which permits the instantaneous change from one feed to another. There are 44 ratios available for screw cutting, ranging from 4 to 60 threads per inch. The index plate provided makes these changes so simple that an inexperienced hand can operate the mechanism without danger of mistake. An automatic stop to the feed is provided, which disengages a clutch on the feed rod at any desired length of cut.

Large and small faceplates, center-rest and follow-rest, and

the required wrenches, are supplied with each lathe. When specified, the makers will supply at extra cost, taper attachment, countershaft (either of the tight or loose pulley styles) and electric motor attachment of any style or make of motor. The net weight of the machine with a 6-foot bed is 2,065 pounds.

CELFOR TAPER SHANK TWIST DRILL

The Celfor Tool Co., of Buchanan, Mich., has for some time past been supplying a drill made from a flat bar of high-speed steel. These drills are twisted while hot in especially designed machines. The resulting form has an increase of torsional strength of nearly 50 per cent over that of the flat bar from which it is made.

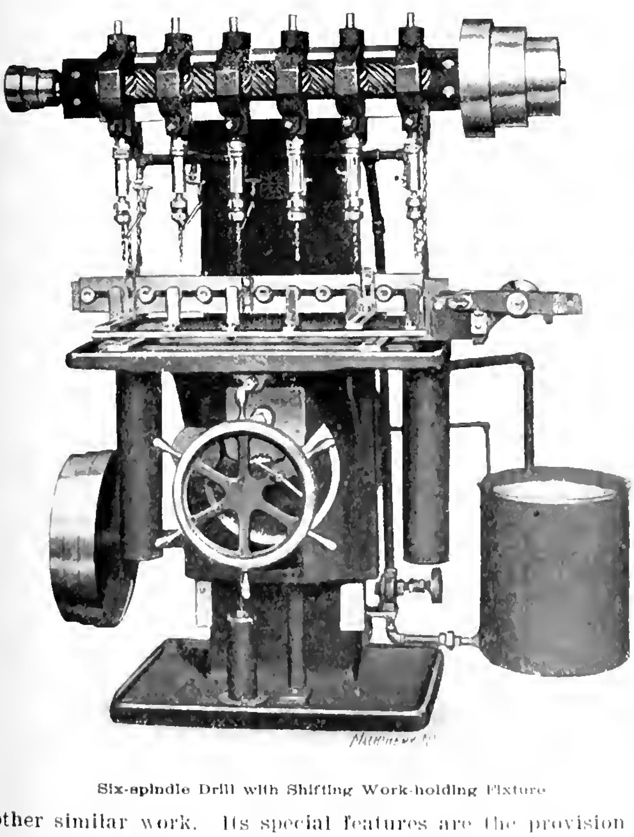
This drill has previously been left with the flat tang, and so has required a special form of drill chuck. The manufacturers are now, however, furnishing it with standard Morse

Celfor Drill, Twisted from Flat Stock, and set in Taper Shank

tapers, so that they can be used in the drill press spindle directly. The drills themselves, which are unchanged, are set into these taper shanks. The taper is one size larger than the standard employed for twist drills, so that ample driving power is assured, avoiding the difficulties met with in the failure of the tang on high duty work. As compared with the standard twist drill, the Celfor type is nearly twice as thick through the center, and has nearly 60 per cent more clearance space for the escape of chips. This results in requiring less operating power, owing to the relief from the clogging of the chips in a deep hole. The drills are accurately finished, being milled and ground in accordance with the best practice for such work.

MOLINE CONTINUOUS SIX-SPINDLE PIN DRILL

The machine shown herewith is made by the Moline Tool Co., Moline, Ill. It is designed especially for the rapid and economical drilling of cotter holes in brake pins, or for any


Six-spindle Drill with Shifting Work-holding Fixture

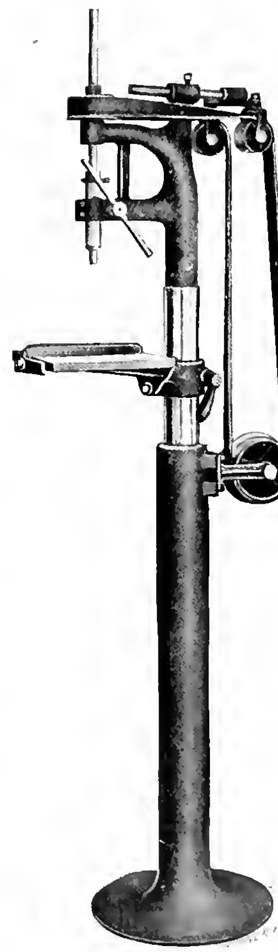
other similar work. Its special features are the provision of an adjustable jig for holding pins of different diameters and different lengths with precision, and also the arrangement for inserting and removing one set of parts while the others are being drilled. The machining operation is thus practically continuous.

The jig has twelve stations, while the machine has but six spindles. The operator places the pins to be drilled in every alternate station of the jig, which he then slides endwise to bring beneath the drill spindles, after which he starts the feed. While these are being drilled, the operator removes the work from the other stations and fills them again, ready to be shifted in their turn under the spindles as soon as the first lot is completed. The feed mechanism, as will be seen, is effected by a cam movement, so that the work-table drops instantly when the holes are drilled through. This movement is continuous, although it can be thrown out and the table lowered by hand if desired. There is an adjustable stop under the table so that it drops only far enough for the jig bushings to clear the drills. This can be dropped out of position and the table lowered clear down.

The spindle drive and the spindle head construction is along the lines of the regular multiple spindle drills made by this firm, and illustrated in connection with the fifty eight spindle drill described elsewhere in this number. The spindles have ball thrust bearings and vertical adjustment for different lengths of drills. The machine is furnished with or without pump tank, piping, jigs and chucks. It may be used as a regular six-spindle adjustable drill when the special jig is removed.

TEN-INCH FLOOR DRILL

The bench sensitive drill press made by the Rockford Lathe & Drill Co., of Rockford, Ill., and described in the department of New Machinery and Tools of our number of November, 1909, is now furnished by the makers as a floor machine. The accompanying illustration shows it so arranged. It will be furnished with or without countershaft. It is provided with a belt-tightener and endless belt as shown. A tool-pan is mounted on the column, which does not appear in the engraving.


Ten-inch Sensitive Floor Drill

The spindle is 17 inches long and 3/4 inch diameter. It is provided with a lever feed of 3 inches. The table has a surface of 8 by 8 inches and a vertical adjustment of 9 inches. The greatest distance from the spindle to the table is 12 inches. The driving pulley on the countershaft is 5 inches in diameter, 1 5/8-inch face, and should run 550 revolutions per minute.

The advantages of the swiveling and tilting table and adjustable gage, furnished with this machine, have been described in connection with previous designs.

FRITZ "IDEAL" DRAFTING TABLE

The Fritz Mfg. Co., of 60 Alabama St., Grand Rapids, Mich., builds a line of drafting tables designated as the "Ideal," which is intended to meet the demand of draftsmen, students, etc., who need a good piece of furniture at a reasonable price. The construction is designed to be strong, durable and unusually rigid.

The standards are slotted and the cross bar is tenoned into the slot. The cross bar is bored its full length for a rod, carrying a hand nut at one end, by means of which the legs are clamped in place. By loosening this adjustment the table

may be raised or lowered. When the nut is turned up, the table is held firm and rigid and does not allow the slightest vibration. The table can be tilted from a vertical to a horizontal position. This is effected by metal slides and braces. After the adjustment, it is clamped at both sides by a single thumb-nut at the right-hand side.

A Rigid and Inexpensive Drafting Table

When desired, a carefully finished tool cabinet will be furnished. This cabinet is provided with two drawers, the upper one of which may be drawn out to be used as a tray. These drawers are 6 by 20 inches; the upper one is two inches deep, and the lower three inches deep, inside measurement.

The frame of the table is of hard wood. The top is ordinarily made of soft wood, but for the smallest size (22 by 30 inches) it will be furnished in hard wood if desired. Four sizes are made, ranging up to 37 by 48 inches.

KEMPSMITH NEW UNIVERSAL DIVIDING HEAD

One of the most important accessories used with a milling machine is the universal dividing head, and many considerations must be taken into account in its construction. The dividing head is used frequently and on greatly varying classes of work, and the work done must, as a rule, be accurate. It is, therefore, necessary that the dividing head be carefully designed and accurately made; at the same time it must be of such construction that the requisite strength is provided. The accuracy must be preserved, facilities for proper adjustments must be included, and when in use it must be convenient to handle and operate, as well as universal in its scope.

An improved universal dividing head as illustrated in the accompanying half-tone, Fig. 1, has recently been brought out by the Kempsmith Mfg. Co., Milwaukee, Wis. In the design of this dividing head the various considerations referred to above have been given due attention. The dividing head is substantial and compact in its construction, and there is a notable absence of complicated mechanism.

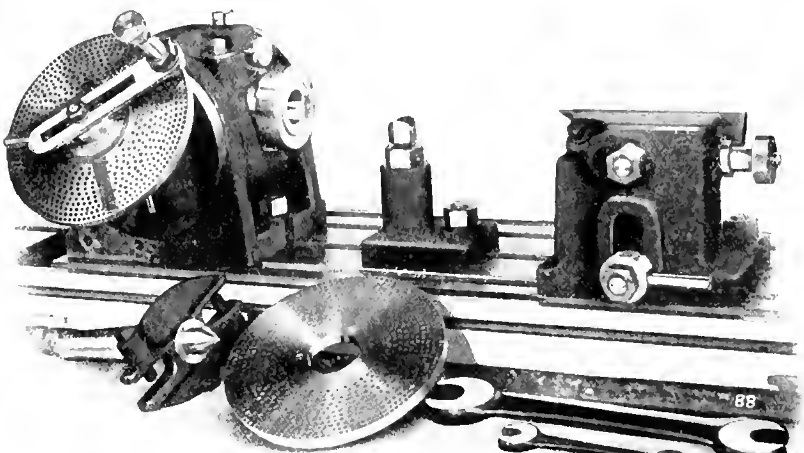


Fig. 1. New Type of Universal Dividing Head, brought out by the Kempsmith Manufacturing Co., Milwaukee, Wis.

Dividing Mechanism

It is evident that the most important feature of any dividing head is the dividing mechanism, and a large diameter of the worm-wheel is essential for accuracy. The usual method employed for making the worm-wheel of large diameter is to mount it at the extreme end of the spindle, practically outside of the main frame. This method, however, is objectionable because it brings the working strain on one end of the spindle, and the worm-wheel casing is in the way when work is to be done close to the head. On the dividing head shown in the illustrations, the worm-wheel is mounted centrally inside of the head, between the front and rear spindle bearings. It is pressed on the spindle and keyed, thus insuring a positive movement of the spindle when the wheel is engaged by the worm. The angular position has been adopted for the worm-shaft. It is at an angle of 36 degrees with the horizontal, which brings the point of contact of worm and worm-wheel correspondingly around at an angle with the vertical. This arrangement makes it possible to increase the diameter of the worm-wheel because the angular position of the worm-shaft and index plates avoids interference of the latter with the table. In the head of 10½ inches swing, the diameter of the worm-wheel is 5¼ inches, and in the head of 13¼ inches swing, the diameter is 6½ inches. Fig. 2 shows the rotating arm or block with the spindle and worm-wheel in place, and Fig. 3 the spindle and worm-wheel assembled. In Fig. 4 is shown a horizontal and vertical section of the dividing head, giving a general idea of its design.

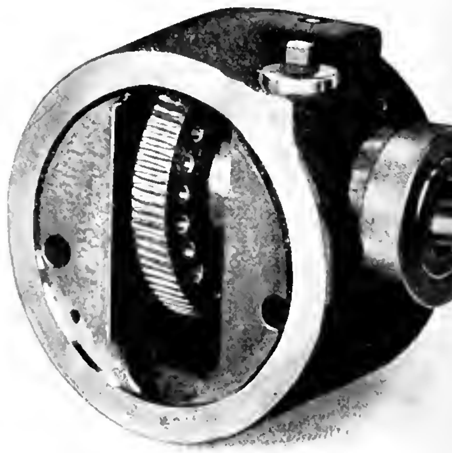


Fig. 2. Rotating Block of Kempsmith Dividing Head

As will be seen, the worm is in one piece with the worm-shaft, which is mounted in a long bearing extending up to the shoulder formed by the worm itself. This arrangement provides for a strong bearing support close to the point of contact between the worm and the worm-wheel. The worm runs in oil, the oil pocket being shown in Fig. 3 and in the vertical section of Fig. 4. An outside adjusting screw is provided by means of which the wear between the worm and worm-wheel is taken up. This adjustment is in a straight line, perpendicular to the axis of the worm-wheel, and thus preserves the alignment and accuracy, even after repeated adjustments. When direct rapid indexing is required, the worm can be

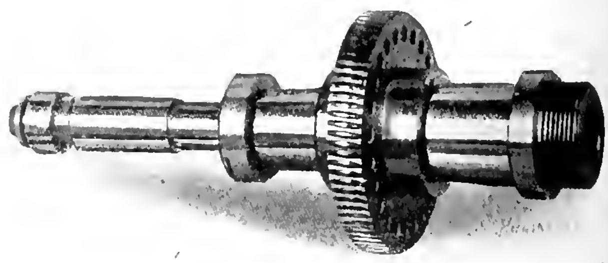


Fig. 3. Dividing Head Spindle and Worm-wheel Aseembled

easily disengaged from the worm-wheel. The arrangement for disengagement is entirely independent of the adjustment, so that this latter is not disturbed. Another advantage of the disengagement is that when tightening the nut on arbors put into the spindle, the worm-wheel teeth do not take the stress.

Range of Index Plates

Two index plates are regularly furnished, providing divisions for all numbers up to 60, and for all even numbers and all multiples of 5 up to 120, and a very liberal number of divisions between 120 and 400. Three specially high number index plates can also be furnished, providing 122 additional divisions between 61 and 400. These plates include all divisions up to 200, which are not obtained by the standard index plates. The arrangement of mounting the index plate at an angle permits of still larger plates being used, if for any extremely special case this should be required, without it being necessary to increase the swing of the dividing head to provide room for the larger plate.

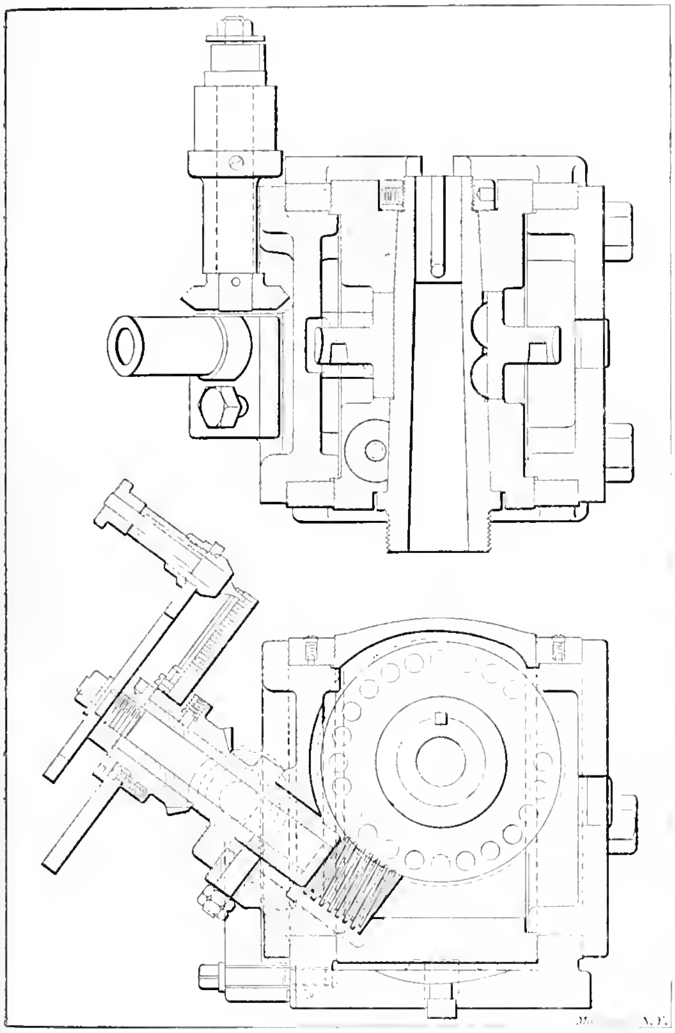


Fig. 4. Horizontal and Vertical Sections of Dividing Head

The index handle is mounted directly on the worm-shaft as shown in Fig. 5, so that its movements are directly transferred to the worm-wheel, leaving no chance for error or inaccuracy through a train of gears. The angular location of the index plate makes it much easier for the operator to see it clearly when indexing, because it is directly in his line of vision as he stands in his natural operating position. It is not required that he stoop down, as in the case when the index plate is vertical.

Direct indexing is easily accomplished with the worm and worm-wheel disengaged. A plunger engages a circle of holes in the front of the worm wheel, as shown in the vertical section of Fig. 4. The spindle is graduated correspondingly on the front of the shoulder, so that the movements can be easily determined. This quick indexing is valuable for small numbers of divisions—for example, when milling hexagons, or the flutes in taps or reamers.

Spindle and Rotating Block

The spindle is of liberal diameter and is mounted in taper bearings provided with a simple but efficient locking device, as indicated by the clamping bushing in the horizontal section in Fig. 4. The taper hole and the threaded nose on the index head spindle are the same as on the main spindle of the milling machine with which the dividing head is regularly furnished. Thus all tools are interchangeable between the main spindle and the dividing head. A large hole runs clear through the spindle. The rear end is arranged to receive an extension stud which is used when the spindle is geared directly to the feed-screw. This arrangement is used when cutting spirals of very short leads as will be mentioned later. This stud is shown in place in Fig. 3. The rotating block which carries the spindle is capable of swinging through an arc of 150 degrees, from 10 degrees below the horizontal to 50 degrees beyond the perpendicular. It is firmly clamped in whatever position set by means of two large bolts with hexagon heads placed in the rear of the head.

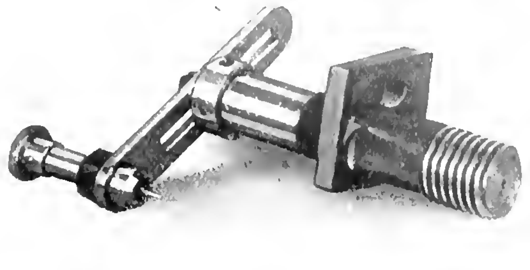


Fig. 5. Worm and Worm-shaft with Index Handle

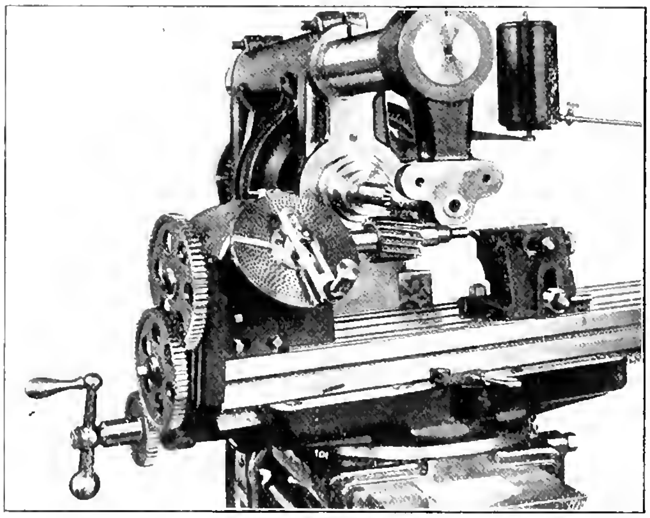


Fig. 6. Dividing Head arranged for Spiral Milling

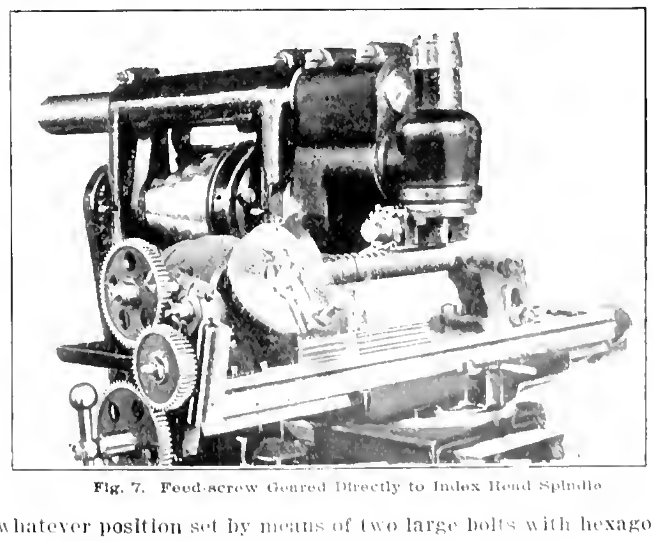


Fig. 7. Feed-screw Geared Directly to Index Head Spindle

Change Gears for Spiral Milling

Twelve change gears are furnished with the dividing head for spiral milling. The change gear bracket is quickly attached or removed. The drive from the change gearing to the

worm-wheel is through two miter gears, one being on the same stud as the last gear in the change gear train, and the other being attached directly to the index plate. In Fig. 6 is shown the dividing head arranged with a train of change gears in the usual manner for cutting a spiral, the work in this case being a spiral milling cutter three inches in diameter, 18 teeth, with 48-inch lead of spiral. When the lead is less than 1½ inch, the gear ratios become so high that too much

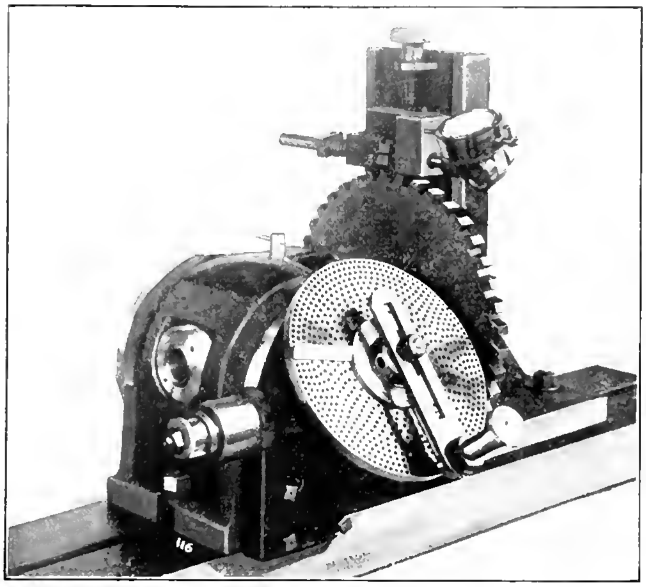


Fig 8. Testing the Worm-wheel

power is consumed in transmission and these leads, therefore, cannot be cut in the usual manner. A very interesting method is, therefore, used for short leads, in that the gear train is led directly from the feed-screw to the dividing head spindle, as already mentioned, the extension stud being provided on the spindle for this purpose. A gearing arrangement of this kind is shown in Fig. 7, which also shows the use of the universal milling attachment when the angle between the cutter and the work is greater than that which can be obtained through the swiveling table. In the charts which accompany the dividing head, the gears required for leads from 0.120 to 1.500 inch are given for direct gearing, and for leads from 1.550 to 100 inches for gearing in the ordinary manner.

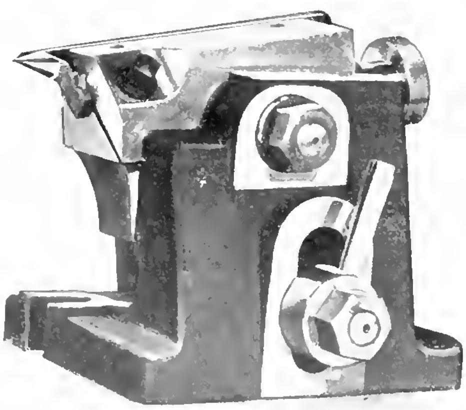


Fig. 9. Tailstock of Kempsmith Dividing Head

Testing the Worm-wheel

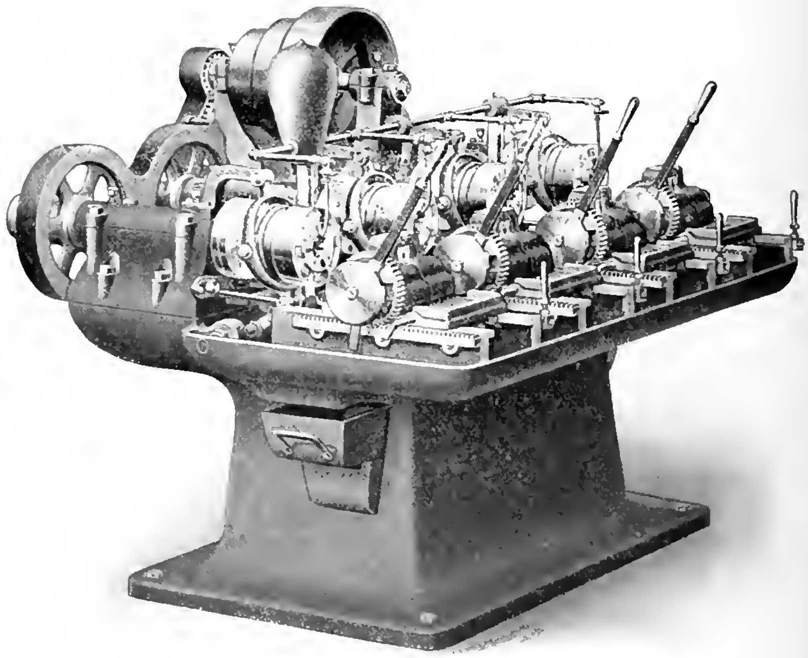
The method employed in testing the accuracy of every tooth in the worm-wheel may be of interest, and is shown in Fig. 8. The master plate is mounted in the spindle. This plate has 40 perfect divisions, and, therefore, makes it possible to test the relative and cumulative error for the individual teeth. The maximum relative error allowed on the master plate itself is 0.0005 inch, and the maximum cumulative error at any point on the master plate is 0.002 inch. The average is less than one-half of this. The master plate is 11 inches in diameter and the worm-wheel for the 10½-inch swing head, 5¼ inches, as already mentioned; hence errors on the master plate are correspondingly reduced on the worm-wheel proper.

The Tail-stock

The tail-stock is of the side center type and is shown in Fig. 9. The center is set into the tail-stock at an angle so that the actual center is within ⅛ inch of the inner side of the tail-stock and within ⅛ inch of the top. This arrangement is of great importance as it provides for clearance for cutters and makes it possible to use much larger cutters on many classes of work than would otherwise be possible. This, again, often effectually increases the output of the machine in such instances. The center, by a special arrangement, as indicated in Fig. 9, is firmly fixed in the tail-stock, and a rapid and easy adjustment is provided. A rack and pinion furnish means by which it can be elevated for milling tapers, after which it can be tilted and clamped in alignment with the work.

NATIONAL QUADRUPLE-SPINDLE BOLT CUTTER

The National Machinery Co., of Tiffin, Ohio, is building the four-spindle bolt cutter illustrated herewith. This is provided with the makers' standard opening die and is built in several different sizes. The convenient design of this machine makes it possible for a workman, where the thread is of reasonable length, to feed all four spindles with as little loss of time as when handling the ordinary single or double spindle bolt cutters. A patented single lever vise and carriage movement is used, which enables him to control the carriage and the gripping of the work with a single lever. This is operated with the left hand, leaving the right hand free for placing and removing the work in the vise. The machine is thus particularly adapted to large lots with comparatively long lengths of thread.



National Quadruple-spindle Bolt Cutter

A combined automatic and hand opening and closing device for each head will be furnished, and these heads can be run independently or in unison. The drive is furnished by a three-step cone pulley, placed on top of the machine. This reduces the floor space, enables the shaft to be supported at both ends, and keeps the belt free from grease and chips. The die heads provided on the machine are self-contained, and do not depend on outside mechanism to control the locked position. This makes the head practically a solid die when closed, insuring accuracy in the product. The makers' interchange-

able case dies are used. The machine has a forced-feed lubricating pump, with adjustable stroke for regulating the flow.

WALKER "SINGLE STROKE" SURFACE GRINDER

The accompanying engravings illustrate a very attractive design of rotary surface grinder of the cup wheel type, made by the Walker Grinder Co., Worcester, Mass. This machine differs from other cup wheel surface grinders in that no reciprocating movement is provided for, the work being mounted on a rotary magnetic chuck, while the wheel is fed straight down against it until it has been finished to the proper thickness. It thus has a large field in the accurate surfacing and sizing of such parts as piston rings, thrust collars, small dies, milling saws and other work of a like nature.

General Design

The general design of the machine comprises a stiff colnmn of vertical form, provided with two vertical slides, the lower of which carries the rotating wheel-spindle, which is adjustable for height to give the desired thickness of work; the upper or wheel-slide carries the wheel-spindle, and is fed down against a positive stop to obtain the proper thickness in the parts being ground. A single pulley drive is employed which provides power for all the movements of the machine, and makes it easily adaptable to motor driving. Two work-spindle speeds are furnished. The single lever which controls

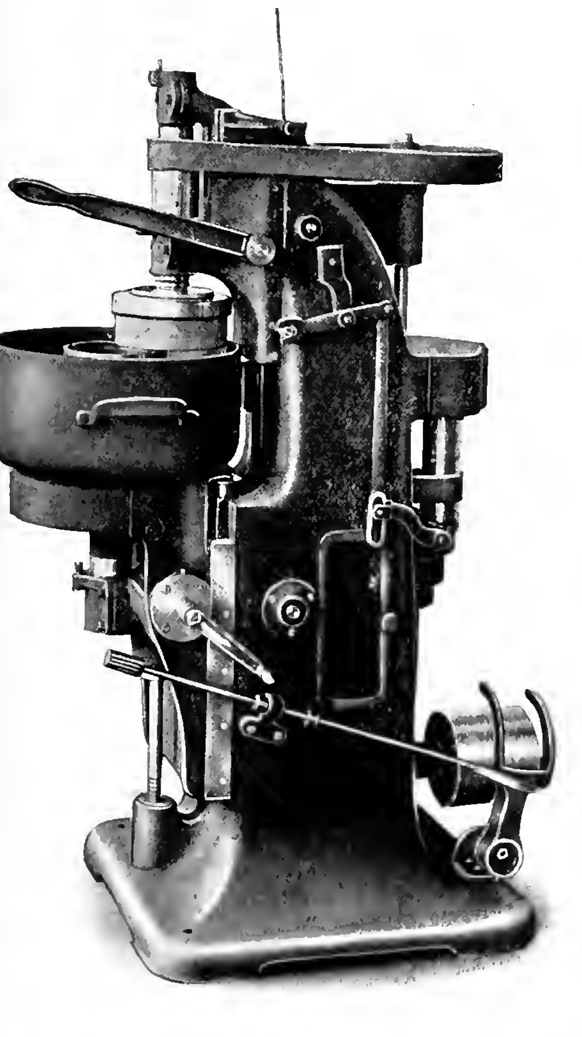


Fig. 1. A Rotary Surface Grinder, provided with Magnetic Chuck

the feeding movement of the wheel-spindle slide also operates to control the starting and stopping of the work-spindle, the switching on or off of the magnetizing current for the chuck, and the control of a demagnetizing current for eliminating the residual magnetism, to permit the work to be removed easily and without scratching. These last features are recent inventions of Mr. Walker, which will be described further on. Their use, in combination with the other improvements furnished, has made possible the rapid manipulation of the machine, and, consequently, gives it a very high output.

The Driving Mechanism

The details of the construction are best shown in Fig. 3, which should be studied in connection with the elevations in Figs. 1 and 2. The tight and loose driving pulleys are shown at *A*. A belt shifter is provided whose handle extends forward to the operator's working position. The pulley *B*, inside

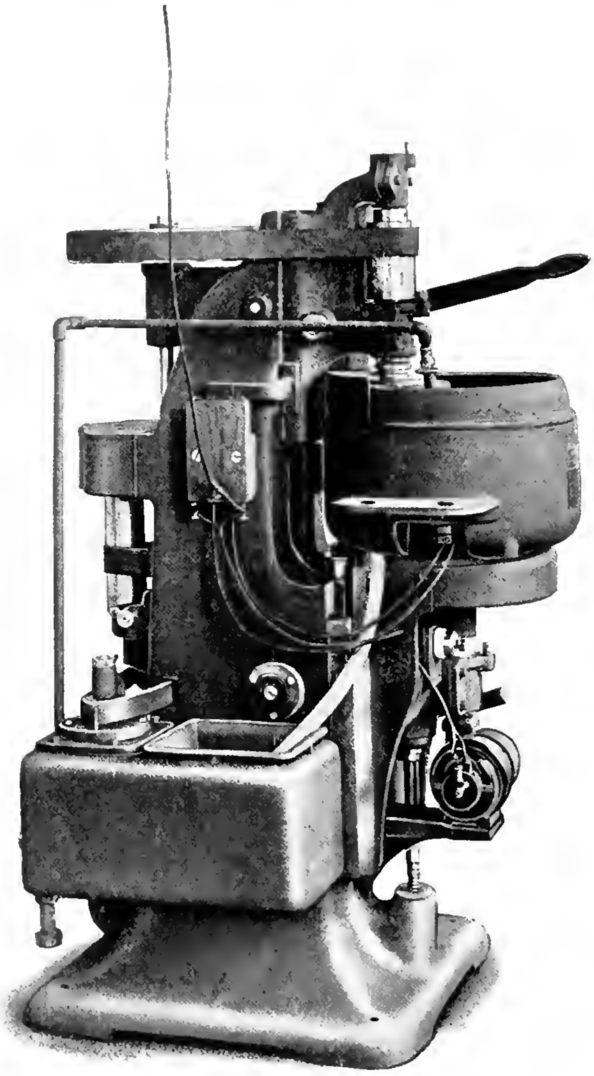


Fig. 2. Machine as arranged for Wet Grinding

the column, is connected by a quarter turn belt with pulley *C* on a vertical driving shaft, the upper end of which carries a large pulley *D*, belted to the driving pulley *E* on the wheel-spindle. The latter has a long enough face to permit the free vertical movement of the wheel-slide *F* by the operation of handle *G*. The wheel-spindle is provided with ball thrust collars on both sides of its lower bearing. Vertical shaft *H* is also connected by gearing at *K*, with drum *J*. This gearing gives a change of speed for the work-spindle. Pulley *L* on the latter is belted to this drum *J* over an idler. *J*, it will be seen, is long enough to permit the vertical adjustment of work-slide *M* throughout its whole range.

The Automatic Control of Work-spindle Drive, Magnetizing Current, etc.

The grinding wheel *N* is brought down to the work and is fed against it by the operation of hand lever *G* and the rack and pinion movement connected therewith. The positive stop which limits this downward movement is shown at *O*. This wheel-slide is counterbalanced by a weight inside the column, as shown, so that when the handle is released it returns to its upper position, leaving plenty of room under the wheel for the easy placing and removal of the work. The link and lever connections shown at *P* connect the wheel-slide *F* with a jaw clutch inside of drum *J*, disconnecting the latter from the shaft on which it is mounted when slide *F* is in the upper

position. By this means the work-spindle is automatically stopped whenever the wheel is raised from the work.

The automatic control of the magnetizing current is effected by a switch mechanism enclosed in the casing shown at the side of the frame in Fig. 1. The wheel-slide carries an arm provided with electrical contacts, which slide over corresponding contacts in the switch box. In the lowermost position, when the wheel is pressed against the work, the direct current is flowing through the chuck. As the wheel is withdrawn, this contact is broken and a new one is made, sending a demagnetizing current through the coils of the chuck. In the final upper position of the slide, the chuck is entirely disconnected from the current, leaving it free for the removal of the work.

The Work-spindle and its Slide

As explained, the wheel-spindle slide is brought down each time to a positive stop. The adjustment for thickness of the work is therefore obtained by raising or lowering the work-spindle slide *M*, by means of the crank shown at the side of this slide in Fig. 1 and connected with elevating screw *R* in Fig. 3. When this adjustment is once made, it holds for successive operations, except as it is affected by the wear of the wheel. For this, compensation is made by the gradual raising of the work-spindle slide. The slide is very long in proportion to its overhang, so that there is little elasticity or lost motion.

Special Provisions for Wet Grinding

Fig. 2 shows the machine as arranged for wet grinding, and Fig. 1 for dry grinding. It will be noted that besides the provision of the standard type of centrifugal pump, reservoir and piping, a blower at the lower end of the work-spindle has been furnished. The purpose and construction of this is most plainly shown in Fig. 3, where it is shown at *Q*. It is driven, as shown, by a direct connected motor, and exhausts into the hollow work-spindle, where the current of air is forced through its whole length up into the interior of the chuck, through the magnet coils, and out under the guards into the water space. This current of air effectively prevents moisture from getting into the coils, and thus obviates any difficulty arising from cross-circuits or other electrical troubles, which are otherwise difficult to avoid where a flood of water is employed. Guard *U*, fixed to the lower slide, and *V*, attached to the upper one, keep the water from flying over the machine and operator.

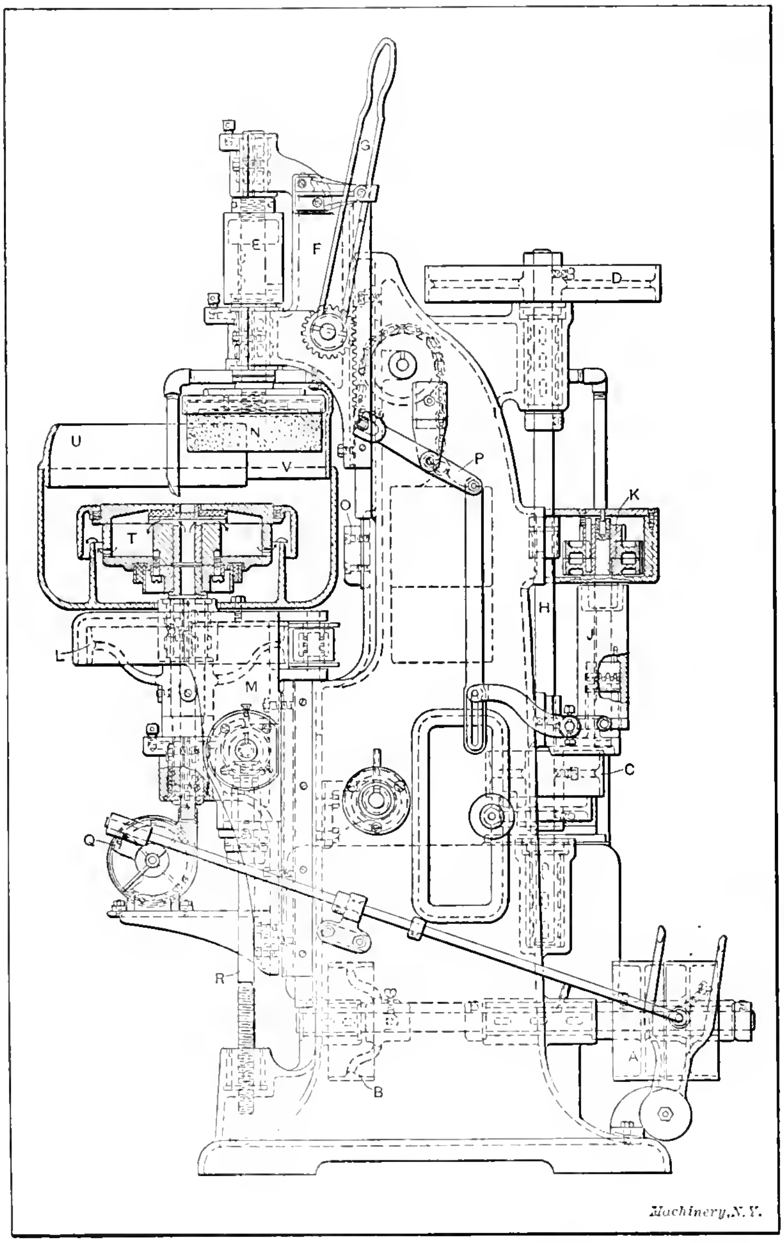


Fig. 3. Details of the Driving and Feeding Mechanism

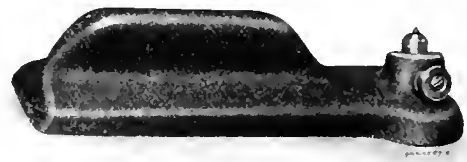


Fig. 4. Tool for Truing, which permits Adjustment of Carbon to present Fresh Cutting Edges

Truing Device for the Wheel

One of the difficulties met with on this style of grinder is the use of the diamond in truing the wheel. The surface of the wheel must obviously be kept true and parallel with the chuck face. To secure this it is necessary that the diamond be mounted in a holder which slides on the chuck face or platen, underneath the wheel. It will be seen that with this arrangement, the wear must necessarily come in one place on the carbon, resulting in a gradual flattening of the cutting edge, and the consequent glazing of the wheel.

Fig. 4 shows an improved carbon truer designed to overcome these objections. In this device the stone is set in a shouldered stem, fitted in the top of a flat holder. This stem is set at a considerable angle from the vertical. With this arrangement, when a flat spot has been worn on the carbon, the stem can be swiveled slightly and fastened in a new position, thus providing a means of obtaining new cutting points on the carbon and a keen cutting surface on the grinding wheel. Means are also provided for disconnecting the automatic switch so that both the magnetizing and the demagnetizing currents are cut off, allowing the free manipulation of the carbon holder when truing the wheel.


An Inexpensive Outfit for Wire Belt Lacing

The diameter of the wheel is 8 inches, and that of the chuck is 10 inches. By reason of the provision of the magnetic chuck, a large number of small pieces may be held at once, making the machine especially suitable for rapid and accurate manufacturing.

MUMFORD WIRE HINGE BELT LACING DEVICE

In the department of New Machinery and Tools of the July, 1909, number of MACHINERY, we illustrated a belt-lacing device made by the Mumford Mfg. and Supply Co., 258 West 22nd St., New York City. This device makes a lacing of the type in which a coil of wire is threaded through each end of the belt. When these coils are interlocked a raw-hide pin is drawn between them, forming the hinged wire belt lacing which has become so largely used on account of its efficiency and durability.

The improvements in the device consist in making provision for both single and double belts and in avoiding the necessity for turning the templet over for lacing the opposite ends of the belt. The way in which these improvements are made will appear from the description. The templet is fastened to the bench in any convenient way. As shown, it is done by staples which project through slots in the plate, and it is locked by a wire rod passing through the staples. The end of the belt is inserted in the turned-up front of the templet, where it is held by lightly driving in one or two wire nails as shown. The slots serve to guide the workman in making the holes with the awl, and in threading the wire through them with a pair of pliers. The wire lacing is threaded over a mandrel placed in the templet in front of the belt as shown.

It will be noted that the slots run right-hand on one side of the center and left-hand on the other. For narrow belts, such as that shown in the engraving, the belt may be doubled back so that both ends are laced at once, one of them right-hand and the other left, allowing the laced ends to interlock properly. Wide belts should be placed in the templet evenly spaced on each side of the center line, so that half of the lacing is right-hand and the other left-hand. When the other end is placed in the similarly laced templet the other side up the two ends will interlock. The original construction provided right-hand slots at one end of the templet and left-hand ones at the other end, necessitating a reversal for each operation. In this improved construction the templet at one end provides for single thickness belts and for double thickness at the other. The slots for the latter are alternately long and short, allowing for staggered lacing.

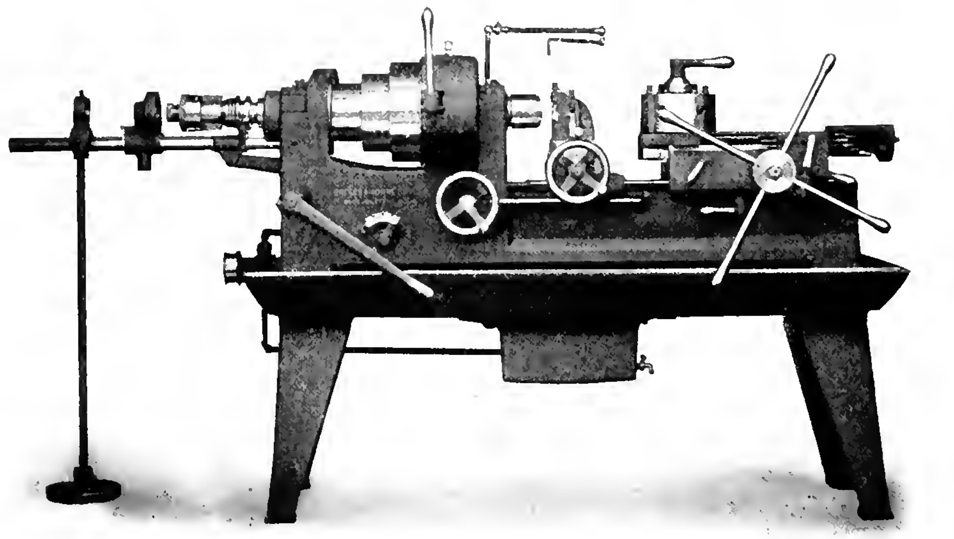
While the device has a width of only 6 inches, it may be used on any width of belt by shifting from one position to another. It is the only tool of its kind which can be used for a belt wider than itself. As previously described, the equipment comprises the templet, the necessary mandrels, an awl, pliers, and a supply of wire and raw-hide pins.

DRESES POWER FEED SCREW MACHINE

The illustration shows a very complete screw machine made by the Dreses Machine Tool Co., Cincinnati, O. This machine is provided with an automatic chuck and wire feed, friction back-gears, positive quick-change feed gearing, power feed for turret slide, separately adjusted automatic stop for each hole in the turret, and fine longitudinal adjustment for cross-slide. The facilities thus provided, in combination with the general excellence of design and workmanship, produce a machine which should be well adapted to a wide range of manufacturing work.

The headstock and bed are cast in one piece, and the design of the headstock provides within itself for the adequate protection of the feed and back-gearing. The spindle is driven by a three-step cone. The frictions for the back gears are of the toggle-joint type, and are so designed that the entire operating mechanism can be put in place or removed without taking out the spindle. These clutches are powerful, easily adjusted and noiseless in operation. The spindle bearings are of the highest grade of babbitt metal, upset into their seats. The nose of the spindle is of an improved construction which provides two blank cylindrical portions each side of the thread, fitting the thimble or faceplate of the chuck. There is no bearing on the thread itself, which merely serves to hold the chuck on and does not in any way affect the alignment. The nose is made very short to bring the work close to the spindle bearing. The thrust is taken up against the inner rear housing of the head, allowing play in the front bearing for the elongation of the spindle from temperature changes. This also reduces the overhang and the length of the front bearing, compared with what would be necessary if the thrust were taken up at that point.

The standard design of chuck and stock-feeding device is used, but special attention has been given to simplifying the operating mechanism, and arranging it for convenient handling. The operating lever, as will be seen, is placed in a position where the workman can exercise the greatest force with the least exertion. The split hub and clamp nut provide for changing the position of this lever to agree with the build or strength of the operator. It will be noted that the thimble for spreading the chuck fingers at the rear end of the spindle is provided with steps, which permit of a considerable variation in the diameter of the stock used without requiring the machine to be stopped for readjustment.



Dreses Screw Machine with Improved Friction Head, Geared Feed and Multiple Stops

The turret has an index ring of as nearly the full diameter as is practicable. A long square gibbed locking bolt holds it firmly into position. By the construction employed, the wearing surface of the turret and slide is not interrupted by the locking bolt, and no particle of metal from the wear of this member in its seat can abrade the surface. Provision is made for taking up the wear of the turret on its stem.

The turret slide is provided with a series of six stops, one for each hole in the turret, mounted on a bracket in the turret slide base. An abutment on the turret slide is provided, which is shifted from one of these stops to the other by a cam placed on the bottom of the turret. This abutment or stop dog makes about one-quarter revolution between the extremes of its movement. By means of an automatic locking plug, it may be instantly put out of action so as to clear all six stops. The bracket in which the stop screws are placed slides in a dove-tail on the turret slide bed. When the stop dog strikes one of the screws, it moves this bracket forward, knocking off the power feed. A slight additional movement can be given it by the pilot wheel for taking a finishing cut on a shoulder, and for cleaning out the chip left by the tool. A geared power feed of four changes is placed in the rear of the bed, and the changes are controlled by the small crank-handle shown beneath the headstock.

The cutting-off rest has a fine longitudinal adjustment on the bed by means of the handwheel, bevel gears and adjust-

ing screw shown. The cross-feed screw is provided with a graduated dial on the handwheel hub. The toolposts are of an improved design. They are open at the left-hand side, permitting them to be adjusted close to the face of the chuck. The wedges under the tools have a single dove-tail to keep them back in position, and knurled thumb-screws are provided for shifting them to adjust the tools to height.

Provision for a large supply of cutting oil or compound is provided by the very deep pan, mounted under the bed of the machine. The oil reservoir is hinged to the pan so that it can be readily cleaned. The inside is provided with two chambers, in the first of which the grit and dirt is separated and deposited before passing into the second or supply chamber, where the pump suction is placed. The leg at the small end of the table is provided with a hinge-joint, so that the machine rests, in effect, on a three-point bearing support, and the alignment is not disturbed by irregularities in the pull.

The tool weighs about 2,600 pounds. It is built in three sizes to take 1, $1\frac{1}{2}$ and $2\frac{1}{4}$ inches through the wire feed. The illustration shows the $1\frac{1}{2}$-inch machine.

ONEIDA STEEL-REINFORCED INDEPENDENT CHUCK

The line of four-jaw independent chucks made by the Oneida National Chuck Co., of Oneida, N. Y., has recently been greatly improved by an ingenious and inexpensive improvement, the nature of which will be readily understood from an examination of Figs. 1 and 2. This improvement consists in furnishing a steel reinforcement for the cast-iron body of the chuck, so located as to receive the tensile stress imposed by the tightening of the jaws on the work, and at the same time furnish a durable steel seat for the thrust bearing of the screws.

Fig. 1. Independent Chuck, Reinforced for Tensile Strains with a Steel Ring

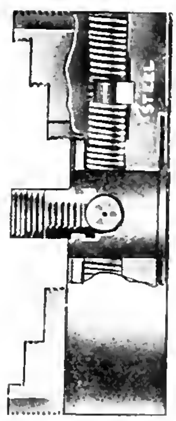


Fig. 2. Showing Steel Ring Cast into Iron Body

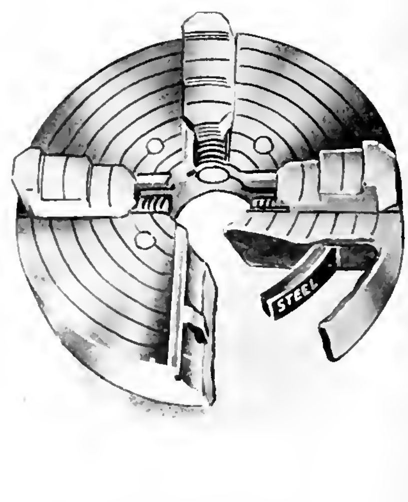
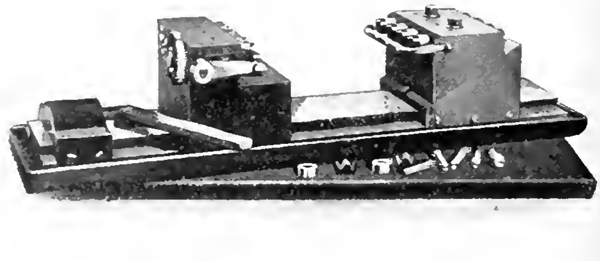


Fig. 3. Showing Location of Reinforcement at Screw Thrust Bearing

The interesting point in this construction is the way in which the steel is located in place in casting. The steel reinforcement is made in the form of an electrically welded ring of bar stock, which is centered in the mold when the chuck body is cast. When the iron is poured it surrounds this steel ring and incorporates it in the casting. Thus no fitting or machining or extra trouble has to be taken at all in the construction. The various machining operations are gone through with as before, and the added expense of the reinforcement is, consequently, negligible. When the chuck is completed, however, the steel bearing surfaces and the steel ring will be found in their proper places to take care of the tensile forces and to furnish the step bearing for the screw.

Fig. 2 best shows the effect of the ring chuck. It ties the body together, as will be seen. All disruptive strain, due to the tightening down of the jaws, is received by the steel in tension, thus relieving and reinforcing the iron, which is notoriously weak for a stress of this kind. Fig. 3 shows most plainly the way in which the thrust bearing is reinforced by the ring, which gives added durability at this point.

The chuck itself is of high-grade construction, with steel operating screws and jaws properly tempered and hardened. The screws, having a center bearing for the end thrust, are threaded to the extreme outer and inner end, giving the jaws the greatest possible capacity for large diameters. Owing to the reinforcement, it is possible to provide a deep seat for the jaws in the body, giving them unusual resisting power to strains tending to overturn them. The enlarged bearing area thus provided also adds very materially to the length of the useful life of the tool.



Four Spindle Index Head Designed for Rapid Manipulation and Convenient Adjustment

Three sizes of this chuck are now in stock, the 10-, 12- and 14-inch, and it is expected to have all sizes ready shortly after February 1. Inasmuch as this improvement is so inexpensive as not to add to the cost of the chuck, its advantages to the purchaser are obvious.

BICKFORD & WASHBURN FOUR-SPINDLE INDEX CENTERS

The tap and reamer fluting device herewith illustrated is made by Bickford & Washburn, 12 Chapman Street, Greenfield, Mass. It is an apparatus of simple construction for a common operation, and is one of a large number of similar devices which have been in use for many years. In spite of the fact that the purpose of the tool is not new, however, we think it will be agreed, after examination, that the designers have succeeded in incorporating a number of new and valuable features in its construction.

The tool comprises a base provided with a dove-tail slide, on which are mounted a tailstock adjustable for height, a headstock carrying the indexing mechanism, and a clamping block and lever for locking the work in place. This base, with the parts mounted thereon, is clamped bodily in place on the table of the milling machine, so that the device is handled as a single unit.

The headstock contains four spindles, connected together by spur gearing so that they are indexed in unison. The front spindle has mounted on it a bevel gear, meshing with a bevel pinion, which latter is provided with a crank and mounted in a bracket attached to the front of the headstock. One revolution of this crank or handle indexes the work between each cut. By changes in the gearing, 3, 4, 5, 6, 7 or 8 cuts may be taken, and a corresponding number of flutes given to the tap

or reamer. The changes in indexing are made by using different bevel pinions to engage with the large bevel gear on the first spindle. One of these pinions is shown in place in the machine and five more are lying on the bench in front of it. The large bevel gear has seventy teeth cut on one side and seventy-two on the other, further extending the range of indexing mentioned. The fact that the index crank is turned exactly one revolution, whatever the number of flutes being cut, is one of the good points of the design, as it makes mistakes in indexing impossible.

The work is held between drivers on the headstock spindles and center points on tailstock spindles. Two forms of these drivers, one for square and the other for round shanks, are shown on the bench in front. The squared ends are driven by the socket shown with square tapered holes, while round work is held and driven by the prong type of driver.

The headstock is a close sliding fit on the dove-tailed base, and it is moved in for clamping, or withdrawn for releasing by the operation of a toggle joint connected with the handle shown. The thrust is taken against the fixed block clamped to the left-hand end of the slide. The tailstock centers are each backed by heavy coiled spring, the strength of whose compression is adjustable by means of the screws and lock nuts shown at the rear of the block. As the headstock is pressed forward by the clamping lever, the blanks are brought up against the spring-supported tail centers to a greater or less degree, depending on the over-all length of the pieces of work. This spring pressure has the advantage over a positive abutment of taking up the looseness which results from the pressing together of the drivers and work at the headstock end under the thrust of the cut. The center points on the tail-stock are easily renewed in case of wear or accident.

Attention should be called to the means provided for facilitating the removal and insertion of the work. When the headstock is drawn back, the work, while still confined by the drivers at the left-hand end, drops off the tail centers into the notches on the support shown, whence they may be lifted out all together with one hand. In putting the work in the machine this support serves the same purpose, as the blanks are placed in the drivers at one end and dropped into the notches on the support at the other, which brings the center holes at the right height for the tool centers. A single movement of the toggle handle then serves to clamp all four blanks in place.

Another improvement, which will be seen from an examination of the engraving, is the provision of an adjustment for varying the height of the tool centers for cutting taper flutes. This obviates the necessity for blocking up the tail stock on operations of this kind. The tail centers are mounted in a wedge-shaped block which is adjustable on the inclined base provided for it, as shown, thus raising or lowering the tail center points. This gives a vertical adjustment of one inch.

The special advantages of this multiple spindle indexing device may be summed up as follows: First, it provides for great rapidity of action, owing to the use of the support for holding and locating the work before clamping, and the provision of a single movement of the lever for locking four pieces of work in place; second, and perhaps most important, the work when pressed back by the cutter into the driving dogs, is followed up and held fast by extra heavy springs, without the loosening which would result with screw tightened or other positively operated centers; third, taper work is provided for without blocking up. The size shown has a capacity for taps or reamers from ½ to 3 inch.

* * *

The annual reunion of the sales organization of Hill-Clarke & Co., Chicago, Ill., at which were present a large number of the manufacturers whom they represent, was held in the banquet hall of De Jonge's restaurant in Chicago on January 11, and the following evening they attended the theater as guests of the firm.

* * *

"Signs make business. . . . Apart from all business interest a sign on a factory is an ethical courtesy to the traveling public.—*Industrial Department Circular, Erie Railroad.*

NEW MACHINERY AND TOOLS NOTES

Double-end Angle Wrenches in Sets: Frank Mossberg Co., Attleboro, Mass. This firm provides its double-end angle wrenches in sets put up in a neat compartment canvas case, to be used for machine equipment, automobile kits, and standard engineers' and machinists' sets. The wrenches are carefully proportioned and made of a high grade of material. The five wrenches, being double ended, fit ten sizes of bolts and nuts.

Ball Bearing Hanger: Hess-Bright Mfg. Co., Philadelphia, Pa. This firm has devised a special form of hanger particularly adapted to the application of ball bearings to line shaftings. The hanger frame is of box section, and the bearing is provided with adjustments both vertically and horizontally. The design is such as to make the hanger simple in construction and easy to erect and adjust. The line comprises five sizes, practically covering the field for work of this character.

Independent Pump Hydraulic Jack: Duff Mfg. Co., Pittsburg, Pa. This jack, which the makers call the "Duff-Bethlehem," is of the type in which the pump is independent of the ram cylinder, being connected therewith by an 8-foot length of flexible copper tube. This construction permits the use of the jack in confined places and at any convenient angle. It is possible to use one pump for operating several jacks. It may also be employed for general shop work as a small hydraulic press. This apparatus is made in various capacities from 100 to 500 tons, with strokes ranging from 6 to 12 inches.

"Vulcan" Auto Tool: J. H. Williams & Co., Brooklyn, N. Y. This tool is a solid one-piece forging, which combines in itself a remarkable number of functions. It may be used as a hammer, tire lug wrench, cotter pin puller, gas tank wrench, wire insulator scraper, air tank wrench, spark plug wrench, alligator wrench, cotter pin spreader or screw-driver. As a screwdriver it should be particularly effective for confined places, as three blades are provided, set in three different positions. The category of its useful qualities would not be complete without mentioning also the provision of a bottle opener.

"Arpeco" Pipe and Nut Wrenches: Rogers, Printz & Co., Warren, Pa. These wrenches are of unusually simple construction, being formed only of two drop forgings, a drawn steel sleeve of seamless tubing, and a small screw, which serves to hold the parts together. The adjustment consists of the simple sliding of the parts on each other by the fingers of the hand which operates the wrench. A wedge action locks the jaws as soon as the operating pressure is applied. A special thin model is furnished of only ¼-inch thickness for the purpose of getting in small spaces.

Motor-driven Combined Vertical Milling and Slotting Machine: R. M. Clough, Tolland, Conn. This well-known machine is primarily a vertical miller, provided with a simple slotting attachment operated by a worm and worm-gear connection with the milling spindle. It is especially adapted for diemaking and similar work. It has recently been provided with a single motor drive; the connection between the machine and motor is made by a Morse silent chain. A 1½-horsepower, 120 volt Ridgway motor is used for the No. 2 size of machine.

Hydraulic Cold Tire-setting Machine: West Tire Setter Co., Rochester, N. Y. The well-known tire-setting machine made by this firm has recently been adapted to automobile work. When this machine is to be used, the tire is forged large enough so as to be strained beyond the elastic limit when pressing it on the wheel. The forcible compression has been found to densify and improve the metal. A recent machine was provided with 18 hydraulic rams, capable of exerting a pressure of 100 tons each, with a supply pressure of 2,000 pounds per square inch. For an ordinary automobile rim for a 4-inch tire, not more than 15 tons pressure for each ram would be required.

Combined Hand and Power Pipe Machine: Crane Co., Bridgeport, Conn. This machine has a capacity for pipe from ⅛ inch to 2 inches diameter, inclusive, and may be furnished with bolt threading dies as well in sizes ranging from ¼ to ½ inch. The main frame, consisting of the base and bed, is cast in one piece. Compactness for the electric drive is secured by mounting the motor under the rear overhang of the headstock, so that it requires no additional floor space. The action of the motor is by a belt or chain drive. Three speed changes are effected by a geared mechanism, controlled by a single lever. A rotary oil pump is provided for giving continuous lubrication to the dies.

Horizontal Riveting Machine: H. P. Townsend Mfg. Co., Hartford, Conn. The Townsend riveting machine (which was described in a note in the department of New Machinery and Tools in the February, 1909, number of Machinery) is now furnished in horizontal form as well as in the vertical design then described. It is intended for long or bulky work which it is inconvenient to handle in a vertical position. The action of the machine causes a series of disks to strike the end of the riveting hammer, giving a great number of blows per minute, the variation in blows being obtained by variation in speed. The machine will handle rivets from 1/64 up to 5/64 inch in diameter.

MULTIPLE SPINDLE MILLING MACHINE: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This machine was built for special work, but involves a number of new features which might, perhaps, be applied to advantage in a great many general shop operations. The machine is of the planer type, with a horizontal spindle, having a driving head on one column and an outboard support on the other. The cross-rail carries two heads with vertical spindles. These heads are, however, adjustable, so that the spindles may be set at any angle out of the vertical desired, permitting the cutting of angular surfaces with ordinary end and face mills. The machine will mill work up to 16 feet long and 30 inches wide.

COMBINED BENCH CENTER AND CENTERING MACHINE: Artisan School, Syracuse, N. Y. This machine as indicated by its name serves the double purpose of indicating the truth of work mounted on centers and drilling center holes in rough stock with the standard form of combination center drill. The machine is provided with a graduated indicating pointer for showing the amount by which the work runs out of true. An adjustable V-block is provided for supporting work which otherwise would require a "third hand." The rod for knocking out the center drill or center (as may be required) is permanently mounted in the machine. The design of the framework and the general construction of the tool is unique, but of convenient and rational form.

COMBINATION BENCH AND VISE STAND: New Britain Machine Co., New Britain, Conn. This device consists of a 5-inch vise, mounted on a solid iron tripod, either alone or in combination with a tray or bench top. The whole arrangement is compact and occupies a minimum of floor space. It is sold as a unit and is ready for service as soon as it is attached to the floor, on which it rests firmly no matter how uneven it may be. Any make of vise preferred by the customer will be furnished. When one of the swivel base type is used, the binder for locking it operates in a pocket in the front of the tripod rod. When a pipe vise is used, the shelves form a convenient place for dies, cutters or tongues. The size of the table is 20 by 40 inches. The weight complete is 375 pounds.

TAPPING ATTACHMENT FOR SENSITIVE DRILL: Taylor & Fenn Co., Hartford, Conn. We have previously described a number of designs of this make of drill press (see, for instance, the department of New Machinery and Tools in the May, 1909, number of MACHINERY). In this machine the speed changes for the spindle are obtained by a geared change mechanism in the base of the adjustable spindle column. The improved tapping attachment consists of a reversing mechanism, located at the same point and operated by a small projecting lever. The reverse of the spindle is effected by a clutch in combination with a set of bevel gears. The vertical movement of the spindle and its reverse can be controlled by the same hand, though a positive connection between the two movements will be furnished if desired.

ELECTRIC TACHOMETER: Industrial Instrument Co., Foxboro, Mass. This device is essentially an electrical generator, positively connected (by silent chain or otherwise) with the part whose speed is to be measured, and electrically connected with a special volt meter calibrated directly in revolutions per minute. The generator is of the alternating type, so that the uncertain action of brushes and other sliding contacts is avoided. Irregularities in the voltage and consequent vibration of the meter needle are avoided by driving the generator through a fly-wheel, whose connection with the motive power is through a coil spring, which absorbs momentary speed changes. As many indicating dials as may be desired can be attached to a single generator, so that information as to speed may be given in a number of places simultaneously.

INSERTED LATHE TOOL-HOLDERS: G. R. Lang Co., Meadville, Pa. These tools are made in a variety of designs, one of which is particularly interesting in obviating the use of the regulation spherical ring and tilting shoe. The tool is clamped solidly down onto a block on the cross-slide, no adjustment for height of tool being furnished or required, owing to the fact that the point of the tool is ground on the end and not at the top, thus keeping the height constant at the right position. Tools of this design are used for turning, side facing, cutting off, etc. A special cutting-off tool-holder (another new product) permits the use of a blade having flat top and bottom, the proper gripping force being provided without dove-tailing these surfaces as usual. Side clearance is provided so that the blades cut as well as a properly forged tool of the old style.

HAND-FEED AND AUTOMATIC THREAD ROLLING MACHINES: Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. This firm has redesigned its line of reciprocating thread rolling machines, and has introduced a number of improvements. An offset crank is used in place of the former quick return movement for giving a slow, powerful threading stroke. A new device is applied to prevent the possibility, in the automatic feed machines, of getting a blank into the feeding guides in a wrong position, and thus clogging the feed. Extra long dies are used, and provision is made for an extra length of thread as well. The six sizes have a maximum capacity for work from 1/4 to 1 inch in diameter, and for a depth of die ranging from 1 to 3 inches. They are built in horizontal form with automatic feed for small and medium work, and hand feed for the heaviest; and in an inclined form for automatically feeding headless blanks. All the mechanism of the machine is thoroughly guarded.

MICRO-ADJUSTABLE BORING HEAD: Porter-Cable Machine Co., Syracuse, N. Y. This tool is intended for use in connection with the maker's sensitive high-speed universal milling attachment, but may be applied to milling machines and drill presses in general. It consists of a shank mounted in the spindle of the machine, carrying a head with cross-slide ways formed in it, on which the tool-holder is adjusted. This adjustment is effected by a micrometer screw with graduations reading to thousandths of an inch. The tool head is provided with a split chuck for holding the cylindrical shanks of the boring tools, and has suitable clamping arrangements for binding it firmly to the tool when the adjustment has been made. The tool itself has a 1/2-inch shank, and the draw-in chuck furnished is fitted for boring tools of 1/4-inch shank. The cross adjustment is 3/8 inch, making it possible to enlarge a hole 3/4 inch without change of tool. This device will be found very useful in the accurate boring of small holes in jigs, fixtures, dies, etc.

TELESCOPING INSIDE GAGE: L. S. Starrett Co., Catalogue 18D, Athol, Mass. This gage is intended for use in measuring the exact size of holes or slots by the use of an outside micrometer caliper; the tool is, in fact, a transfer gage, very solid and accurate in construction. In general form it resembles a T-head wrench in which one of the arms of the T telescopes into the other, against spring pressure. After pressing together, it is locked by a thumb screw at the outer end of the shank and inserted in the hole. Releasing the thumb-screw allows the measuring arm to spring open to the diameter of the hole being measured. Locking the knurled thumb-screw again clamps the arms in this position, after which the tool is removed and the diameter measured. The end of each of the heads is hardened and ground to the radius of the smallest hole the tool enters. The instrument possesses advantages over the inside caliper in the matter of stiffness and accuracy. The gages are made in five sizes, having a range from 1/2 to 6 inches.

FAN DYNAMOMETER FOR TESTING GASOLINE AND OTHER MOTORS: Joseph Tracy, 116 West 39th St., New York City. We have illustrated various arrangements of fans for absorbing the power when testing engines. These appliances have all been of the home-made order. The above manufacturer has now placed on the market a well-designed and compact apparatus for this purpose which offers several improvements over the home-made construction, the most noticeable of which is the provision of a tachometer directly connected with the spindle so as to give speed readings at all times. The resistance blades on the arms of the fan are radially adjustable to absorb more or less power. For any given position of these blades the tachometer dial may be calibrated to read directly for the power appropriate to a given speed. A series of dials is provided for different positions of the blades, so that the machine will read the power absorption directly over a range running from 1 horsepower at 180 revolutions to 70 horsepower at 980 revolutions.

END MILLS FOR PRECISION WORK: Porter-Cable Machine Co., Syracuse, N. Y. These end mills are built for high-speed operation on fine work, and range in size from 1/16 inch to 5/8 inch in diameter. The mills from 1/16 to 5/32 inch are provided with but a single tooth, which is cut to the center so that the tool may be fed directly into the work like a drill. The sizes from 3/16 to 1/4 inch have two teeth, also cut to the center. All of these mills have straight teeth. For the sizes from 1/4 to 5/8 inch diameter, four or six teeth are used, cut spirally; the larger sizes are made of high-speed steel. The teeth of the mills are given a peculiar form which greatly increases their strength, effecting a large saving in the matter of drill breakages. The unusually small number of teeth used has been found by the makers of exceptionally great advantage. Each tooth has a much stronger backing and is much less liable to break. Their metal-removing capacity is as great as in the older multiple tooth styles, since it has been found that in most cases but one tooth at a time would work anyway. While these tools were designed particularly for the maker's high-speed milling attachment, they are applicable as well to any high-speed milling machine built for accurate work.

AUTOMATIC TEMPERATURE REGULATOR FOR GAS FURNACES: American Gas Furnace Co., 24 John St., New York City. This device is designed to work in connection with a thermo-electric pyrometer, and it is so constructed that the exceedingly delicate movements of the needle of that instrument control a mechanism for opening and closing the gas and air valves without interfering to the slightest degree with the sensitiveness of the operation of the indicating mechanism. It will be admitted that this is something of an achievement in mechanical construction. The power for the valve movements is furnished by a small fan motor connected by a 1/4-inch pipe

with the regular air supply of the furnace, so that no special motive power connections are required. The mechanical control of this motor by the needle is effected by a system of interferences, which that needle offers to members driven by the motor. This interference is effected without restraining to the slightest degree the movements of the needle itself. The instrument is designed to hold the temperature control steady within five or ten degrees of a given point of temperature. It may be instantaneously adjusted to any point on the temperature scale, and it is so constructed and enclosed as to be durable and fool-proof.

ENGINE FOR FAN AND GENERATING SETS: B. F. Sturtevant Co., Hyde Park, Mass. This firm has for many years built a line of engines for driving either by belt or direct connection the fans and generators which they manufacture. They recently placed on the market a new model of vertical single engine for this work, which incorporates all the improvements which their past experience in this line has suggested. It is of the high-speed, closed type, having openings fitted with dust-proof covers which can be easily removed. A distance piece is provided between the cylinder and the frame which permits access to the stuffing box, and provides, as well, a watershed for keeping the oil from the frame out of the cylinder, and for keeping the water of condensation from the cylinder out of the frame. An oil reservoir is mounted on the frame, from which the oil flows to all the bearings, through piping equipped with sight feed regulators. A reservoir cast in the base receives the oil, where it is filtered through a fine screen and then pumped back to the reservoir. The pump may be dispensed with by keeping the reservoir at the top full, drawing off the excess from the bottom. The Rites inertia governor is used, and provides for a maximum variation of speed between no load and full load of not more than 1½ per cent. For direct connection with a pump, fan or similar apparatus, the base is extended so as to make the whole installation a complete unit. These engines are carefully tested before leaving the works. Particular stress is laid on compactness, economy, dependability and smooth running features, making the engines particularly adapted to isolated electric plants.

* * *

WAGE RAISE RECOMMENDED BY N. M. T. A

Commissioner Robert Wuest, of Cleveland, Ohio, in his monthly letter for January to the members of the National Metal Trades Association, recommends that the members raise wages of their employes wherever possible to keep pace with the great increased cost of living. He says in part:

"To increase wages as the demand for labor increases is good business. That it is doubly good business when an era of great prosperity is at hand cannot be denied. Let us see what would follow this increase of wages of our employes: First, it will keep them in their shops instead of driving them into other shops; second, it will keep them contented and ready to work with hearty good will; third, it will keep our products up to the standard of practice of the times because it will enable us to retain efficient workmen.

"Speaking generally, it is fair to say that the wise policy of manufacturers is to pay their employes the best wages that they can afford to pay. Voicing the sentiment which pervades the councils of the National Metal Trades Association, we wish to impress upon our members the importance of remembering this. The more it is remembered and practiced, the longer we will be immune from strikes and their consequences.

"The papers of the country at this time are full of talk about the increased cost of living. The reasons assigned for this increase are many and varied. . . . But be the reasons what they may, the fact is undeniable that a dollar does not go nearly so far to-day as four or five years ago. It would seem to be good business for all our members to take to heart the foregoing on the wage question. Good wages, the proper education of employes—especially apprentices—the adoption of practical and equitable profit-sharing systems are important factors in the solution of the labor problem."

* * *

TENTH INTERNATIONAL AUTOMOBILE SHOW

The Tenth International Automobile Show was held in the Grand Central Palace, New York City, December 31, 1909, to January 7, 1910, under the management of the American Motor Car Manufacturers' Association. There were over eighty exhibitors of vehicles, and a great number of exhibitors of accessories, the exhibition being distributed over the main floor and the two balconies. The American Motor Car Manufacturers' Association numbers forty-three members, and it is of some interest to note the principal features of the cars brought out by the members of the association. In all, there are 183 different pleasure cars and 86 commercial vehicles made by the members of the association and specified as 1910 models. Of the pleasure cars, only 6 are one-cylinder cars, 14 are two-cylinder cars, one is a two-cycle three-cylinder car, 19 are six-cylinder cars, and the remaining 143 are four-cylinder cars. Of the commercial vehicles the smaller sizes in general are two-cylinder cars, these numbering 50, while 36 are four-cylinder cars. Of the pleasure vehicles only 12 are specified as air cooled, one is either air- or water-cooled, while 170 are water-cooled. Of the commercial vehicles 4 are air-cooled, 7 are either air- or water-cooled and 75 are water-cooled. As regards the approximate power of the cars, 12 of the pleasure cars are of less than 15 H. P.; 30 are between 20 and 25 H. P.; 38 are of 30 H. P. or thereabouts; 21 of 35 H. P.; 20, 40 H. P.; 14, 45 H. P.; 25, 50 H. P.; and 18, 60 H. P. or more. Of the commercial vehicles, 10 are of 20 H. P. or less; 9 of about 25 H. P.; 29 of about 30 H. P.; 4 between 30 and 50 H. P.; 33, 50 H. P.; and one 60 H. P. As regards price, 27 of the pleasure vehicles are priced at less than $1,000; 29 between $1,500 and $2 000; 45 between $2,000 and $2,500; 29 between $2,500 and $3,000; 24 between $3,000 and $4,000; and 29 at over $4,000. Of the commercial vehicles 11 are specified at a price below $1,000; 10 between $2,000 and $3,000; 9 between $3,000 and $4,000; 17 between $4,000 and $5,000, and 10 above $5,000. The price of a number of commercial vehicles is furnished only on application, so that the figures above do not include the whole list of all makes.

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TENTH A. L. A. M. AUTOMOBILE SHOW

The Tenth National Automobile Show took place under the auspices of the Association of Licensed Automobile Manufacturers at the Madison Square Garden, January 8 to 15. There was a total of 56 exhibitors of complete cars, 21 motor-cycle exhibitors, and 246 exhibitors of accessories and parts. The tremendous growth of the automobile industry in the last few years was plainly in evidence to anyone who has had an opportunity to see the National Automobile Show from year to year. On the main floor and on the elevated platform were placed only gasoline pleasure cars, while electric pleasure vehicles were exhibited in an exhibition floor of their own. The basement was occupied by commercial vehicles and motorcycles, while the concert hall and balconies accommodated the exhibitors of accessories. The Madison Square Garden was exquisitely decorated for the event, it being stated that more than $35,000 was spent on decorations. In all, there were 91 gasoline pleasure cars, 2 steam pleasure cars, 22 gasoline commercial cars, and 23 electric pleasure cars exhibited. Of the gasoline pleasure cars 65 were four-cylinder cars and 26 six-cylinder cars. Of the gasoline commercial cars one was a one-cylinder car, 4 were two cylinder cars, and 17, four-cylinder cars. All the pleasure cars, with the exception of five, and all the commercial cars, with the exception of six, were water-cooled. As regards the power of the cars 2 of the gasoline pleasure cars were of less than 20 H. P., 29 were between 20 and 30 H. P., 20 were between 30 and 40 H. P., and 20 were between 40 and 50 H. P., while 18 were 50 H. P. and over. The power of two of the gasoline pleasure cars was not specified. Of the commercial cars 5 were under 20 H. P., 10 were between 20 and 40, and 6 were 40 H. P. and over. As regards price, 3 of the exhibited cars were priced at less than $1,000, 10 between $1,000 and $1,500, 12 between $1,500 and $2,000, 7 between $2,000 and $2,500, 10 between $2,500 and $3,000, 27 between $3,000 and $4,000, 31 between $4,000 and $5,000, and 30, $5,000 and over.

* * *

A. L. Pfitzner recently made an exhibition flight at Hammandsport, N. Y., with a monoplane equipped with a new balancing device which, it is claimed, does not infringe upon the Wright patents on the warped plane principle. The Pfitzner device consists of two sliding panels at the outer ends of each wing. These panels are mounted on tracks under the wings, and are controlled by cords leading to the operator's seat. Changing the position of the panels accomplishes the same results in the balancing of the monoplane as warping the wings in the Wright models.

* * *

Don't think you are a machinist until you can take a set of drawings and produce from them what the draftsman wants made.

A METHOD FOR LOCATING THE DECIMAL POINT IN SLIDE RULE CALCULATIONS

CHAS. G. RICHARDSON*

The location of the decimal point in the results of multiplication and division has proven a vexatious problem to most users of the slide rule. The formulas heretofore given have proved cumbersome and confusing; inapplicable, practically, to examples of any length. It is believed, therefore, that the following easily remembered method will commend itself to all interested. Bearing in mind that when the words "left-hand figures" are used, *the number of figures to the left of the decimal point* (or in the integral portion of the number) is meant, there are two short rules which must be thoroughly memorized.

RULE No. 1. *Multiplication.* The left-hand figures in the product equal the sum of the left-hand figures in the factors, *except* that one left-hand figure must be subtracted for each time the slide projects to the right.

RULE No. 2. *Division.* The left-hand figures in the quotient equals the left-hand figures in the dividend minus the left-hand figures in the divisor, *except* that one left-hand figure must be added to those in the dividend for each time the slide projects to the right.

These two rules embody the whole method, and once having been learned, there only remains their application. Note that absolutely no reference is made to slide projections to the left.

The "left-hand figures" would be

3 in 843.210
2 in 41.189
1 in 6.922
0 in 0.632
—1 in 0.028
—2 in 0.003 etc.

The use of the two rules will now be illustrated by examples chosen at random, leading from simple problems to those more complex. The calculations are given in detail, but after a little practice the decimal point can be determined mentally with great rapidity.

(Note: It is understood that the lower scales on the slide rule are used.)

Example: $8 \times 5 = 40$.

The slide does not project to the right, therefore add the left-hand figures of the factors, giving two in the product.

Example: $8 \times 5 \times 12 = 480$.

The slide projects once to the right, therefore add left-hand figures of factors and subtract 1, giving 3 units in product.

Example: $8 \times 5 \times 12 \times 0.16 \times 0.08 = 6.14$.

The slide projects twice to the right, therefore $(1 + 1 + 2 + 0 - 1) - 2 = 1$ left-hand figure in the product.

Example: $123.1 \times 132.16 \times 14 \times 11 \times 0.008 \times 0.61 = 12720$.

The slide projects three times to the right, therefore $(3 + 3 + 2 + 2 - 2 + 0) - 3 = 5$ left-hand figures in the product.

Example: $\dfrac{140}{20} = 7$

The slide does not project to the right, therefore subtract the divisor's left-hand figures from the dividend's, or $3 - 2 = 1$ figure in the quotient.

Example: $\dfrac{360}{24} = 15$.

The slide projects once to the right, therefore add 1 to the dividend's left-hand figures and then subtract the divisor's, or $(3 + 1) - 2 = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 12} = 12.5$.

The slide projects twice to the right; therefore $(4 + 2) - (2 + 2) = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 0.12 \times 0.004 \times 18} = 17360$.

The slide projects three times to the right, or there are $(4 + 3) - (2 + 0 - 2 + 2) = 5$ left-hand figures in the quotient.

In formulas involving a combination of multiplication and division, the value of the method especially asserts itself.

Example: $\dfrac{12 \times 8}{16 \times 2} = 3$.

Alternately dividing and multiplying to save unnecessary settings, gives one projection to the right in *division*, but none in multiplication. Therefore, adding 1 to the dividend's left-hand figures and subtracting the divisor's, we have $(2 + 1 + 1) - (2 + 1) = 1$ left-hand figure in the result.

Example: $\dfrac{16 \times 14 \times 24}{30 \times 72 \times 0.8} = 3.11$.

Here we have one projection to the right in *multiplication*, but none in division and consequently $(2 + 2 + 2 - 1) - (2 + 2 + 0) = 1$ left-hand figure in the result.

As we proceed to longer examples it becomes rather difficult to separate *mentally* the number of projections to the right in multiplication from those in division. Short vertical lines may be used to keep this score, as it might be called, these marks being placed either above or below the division line according to whether the operation is respectively one of multiplication or division. Inasmuch, however, as a projection to the right in multiplication *subtracts* 1 and a projection to the right in division *adds* 1 to the left-hand figures in the dividend, it is unnecessary to score every projection to the right, as such a projection in division often may be immediately balanced by moving the runner to the next number in the dividend. In other words, it is only the *unbalanced* projections to the right which it is necessary to record.

To illustrate:

$$\text{Score}\begin{cases}\mathrm{I} \\ \mathrm{II}\end{cases} \quad \frac{114 \times 232 \times 1.98 \times 0.0006 \times 188}{196 \times 0.064 \times 72 \times 0.12 \times 14 \times 12.6} = 0.309.$$

Taking the solution step by step

114 ÷ 196	......slide is to left	
Multiply by 232	......slide is to left	
Divide by 0.064	......slide is to left	
Multiply by 1.98	......slide is to right	(mark above line)
Divide by 72	......slide is to left	
Multiply by 0.0006	......slide is to left	
Divide by 0.12	......slide is to right	} balance
Multiply by 188	......slide is to right	} balance
Divide by 14	......slide is to right	(mark below line)
Divide by 12.6	......slide is to right	(mark below line)

Now the excess of the lower group of "marks" over the upper is 1, therefore the slide has gone to the right once more in division than in multiplication, and 1 is to be added to the dividend's left-hand figures before subtracting the divisor's, or $(3 + 3 + 1 - 3 + 3 + 1) - (3 - 1 + 2 + 0 + 2 + 2) = 0$.

It makes no difference as to the order in which the problem is solved; the *excess* of one group of projections over the other will be the same. Gratifying "results" will certainly follow a little careful study and practical application of the simple principles enumerated.

* Address: Builders' Iron Foundry, Providence, R. I.

* * *

A new 14-inch gun for battleships is being constructed at the Washington Navy Yard. This gun will have an extreme range of 25 miles, although the range at which it will be fired in regular action will be about 5 miles. The projectile from this new gun leaves the muzzle at the velocity of 2,000 feet per second, and when fired with a full charge of 365 pounds of powder it will penetrate 22.7 inches of Krupp steel armor plate, when leaving the muzzle. The projectile weighs 1,400 pounds and the total length of the gun is 53½ feet.

* * *

A prize of 50,000 francs has been offered by the Turin (Italy) Chamber of Commerce, in connection with the Turin Exposition of 1911, for that invention or discovery, made before 1908, that has proved in practice of the greatest advantage in promoting national economy. Applications are to be made, in Italian or French, before April 1, 1911, to "Commissione per il Concorso a Premis, Camera di Commercio, Torino, Italia."

NEW SHOPS AT PURDUE UNIVERSITY

The new buildings which are now under way for the Department of Practical Mechanics at Purdue University, Lafayette, Ind., are worthy of notice as representing a notable advance in the efficiency of practical instruction at that institution.

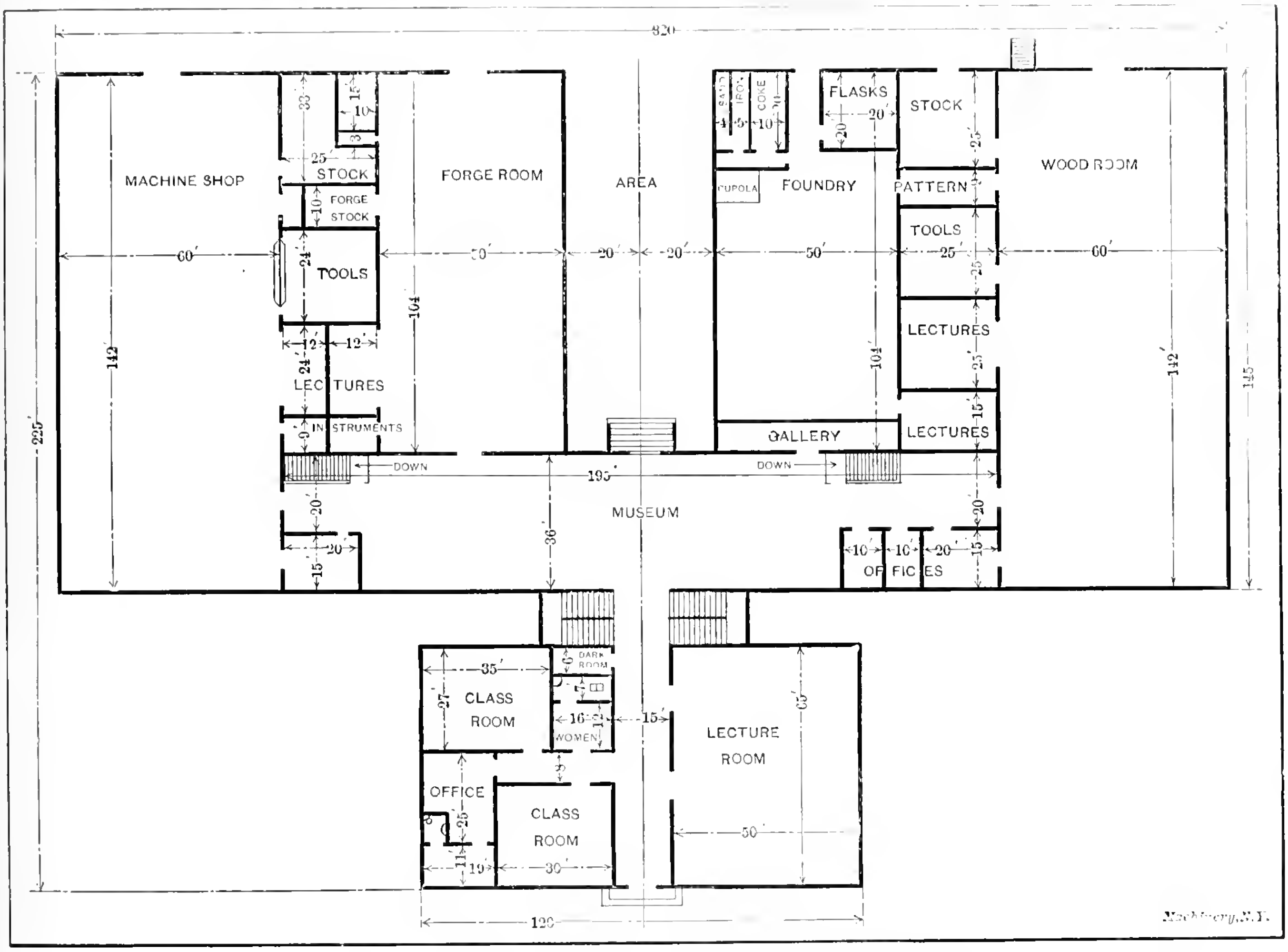
The organization of this branch of work at Purdue is somewhat different from that in most other technical schools. The department of Practical Mechanics stands by itself, independent of the School of Mechanical Engineering and bearing to the latter somewhat the same relation as do the departments of Mathematics or Applied Mechanics. The department is in charge of a staff of professors and instructors and covers the work done in elementary mechanical drawing, descriptive geometry and shop instruction.

In 1909 the State Legislature recognized the crowded condition of the present shops and drawing rooms and appropriated the sum of $170,000 for new buildings and equipment. Plans and specifications were prepared, contracts let and in May of that year work was begun on the new plant.

As may be seen from the outline plan, the buildings form a connected group containing a front or main building, a longitudinal corridor and transverse wings. The general construction is of the factory type with concrete foundations, brick walls and roofs lighted from above. The main building, 65 by 120 feet, three stories high, furnishes accommodations for class-room instruction and for drawing. On the ground floor are offices, class-rooms and a lecture room 50 by 65 feet. The second and third floors each contain two large drawing rooms and the necessary offices, blue-print rooms, etc.

The remaining buildings are one story in height. A long corridor joining the shops proper has in the basement the heating plant and space for lockers and wash-rooms, while its ground floor contains offices and cases for exhibits and models. The wood shop, 60 by 142 feet, and the foundry, 50 by 104 feet, each under a separate roof, form one wing with an intermediate space of 25 feet used for tools, stock and demonstration rooms. Each building is lighted from overhead as well as from the sides and is capable of indefinite extension in the rear. A basement under the wood shop accommodates stored lumber and contains the shafting and motors for driving the machinery on the main floor. A similar group on the south side contains the machine shop, the foundry and the connecting store rooms and demonstration rooms. The basement of the machine shop will be used for storage.

The buildings will be lighted throughout by electricity and heated by a combined radiation and blower system, insuring uniform temperature and thorough ventilation. The machinery in the shops will be driven by electric motors, both group and independent drives being employed. Alternating and direct currents will be available for the two classes of transmission used.



Plan of New Shops for Department of Practical Mechanics Purdue University

We are indebted to Prof. Charles H. Benjamin, dean of the Schools of Engineering and Director of the Engineering Laboratory for the foregoing information.

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LUBRICATION AND LUBRICANTS

At the regular monthly meeting of the American Society of Mechanical Engineers, January 11, papers on the subject of lubrication and lubricants were read and discussed. The authors of the papers were Dr. Charles F. Mabery, professor of chemistry at the Case School of Applied Science, of Cleveland, Ohio; Prof. F. H. Sibley, of the University of Alabama, and Dr. P. H. Conradson, of the Galena Signal Oil Co.

Dr. Mabery's paper dealt especially with laboratory tests of lubricants containing deflocculated graphite, but contained also considerable matter of direct practical application. The various fields of usefulness of different lubricants were referred to. Greases compounded with graphite, for example, are of particular advantage on low-speed bearings, under heavy load, while natural graphite serves an excellent purpose in cast iron bearings, where it appears to smooth the surface of the porous metal. On close grained surfaces highly finished, however, care must be exercised so that it does not collect and scratch and abrade the journals and bearing

Some of the tests on the deflocculated graphite gave very interesting results. It was found that a very small amount of graphite suspended in water serves its purpose as an efficient lubricant. For example, an amount of only 0.35 per cent of graphite in water will sustain a pressure of 70 pounds per square inch in the bearing, and a larger amount than that is superfluous. Experiments were also carried out with graphite deflocculated in kerosene and various lubricating oils. It was found that one cubic inch of graphite in three gallons of oil is sufficient to give excellent results and materially reduce friction. Experiments were also undertaken with a view to determine the rise in temperature with the various lubricants, and the most remarkable result in this direction was that graphite suspended in water is an excellent lubrication means for keeping the temperature of the bearings constant. The increase in temperature when testing with this lubricant did not exceed 5 degrees F.

Prof. Sibley's paper described experiments undertaken to determine the relation between viscosity and the wearing and lubricating qualities of oils, and the effect of the constituents of various oils on the lubricating qualities. Twenty-two oils were tested, the method of procedure being to find the chemical composition and viscosity of each oil, and then use it as a lubricant in a journal bearing. The viscosity of an oil is measured by its resistance to flow, a strong resistance to flow indicating a high viscosity. The experiments showed that the viscosity of an oil affects its lubricating quality in the following way: If the oil is adapted to the load put upon it, then the lower the viscosity the better the oil as a lubricant. The oil, however, must conform to the character of the load, a light oil being unsuitable for heavy loads.

While the two previous papers dealt particularly with laboratory tests of oils, Dr. Conradson's paper dealt more directly with practical conditions, and oils suitable for steam turbine plant lubrication, railroad journal lubrication, etc., were discussed by him, as well as several other practical considerations affecting lubricants.

In the discussion following the reading of the papers, Mr. Henry Souther made some interesting remarks relating to the lubrication of automobile cylinders. He had found by practical experiments that a high flash-point oil is not desirable, because of the gum and residue that always results from oils of this kind. These oils give good lubrication while running, but make it difficult to start the engine after it has been standing. The most desirable lubricant for an automobile cylinder is an oil which will take care of the main shaft bearing and the main pin bearings of the piston, and then passing up the piston into the explosion chamber, will disappear as much as possible, so as not to leave any considerable amount of residue oil. Such oils have viscosity of 40 to 50 seconds at 210 degrees F., as measured by the Saybolt viscosimeter, and a specific gravity of from 28 to 31 Beaume.

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PERSONALS

The present address of P. L. Joselevitsch, formerly of 733 E. 16th St., Minneapolis, Minn., is desired by the editor.

W. B. Engler, formerly assistant chief engineer of the Reliance Motor Truck Co., Owosso, Mich., has now been made superintendent of that company.

John J. Grant has been made consulting engineer of all the constituent plants of the Everitt-Metzger-Flanders Co., automobile builders, Detroit, Mich.

Oscar Stegeman has associated himself with Messrs. Landau & Golden, consulting engineers, New York, as a western engineer. He will be located in Milwaukee, Wis.

George H. Hall was recently transferred from the Boston office of the Sprague Electric Co. to its motor and generator department in the company's general office, New York City.

John J. Murphy, blacksmith foreman for the Wabash R. R. at Moberly, Mo., has been appointed to a similar position at Decatur, Ill., succeeding Christopher Jackson, resigned.

Joseph J. Reid has taken charge of the eastern sales department of the Harris Automatic Press Co., with the title of eastern manager. He succeeds E. E. Barney, resigned.

Christopher Jackson, blacksmith foreman at the Wabash Car Shops, Decatur, Ill., left January 1 for Dayton, Ohio, to become superintendent of forges for the Barney & Smith Car Co.

H. C. Fay, of the engineering department of the Remington Arms Co., Ilion, N. Y., has been appointed foreman of the chucking and punch press department to succeed W. H. Dotzauer, resigned.

W. J. Greer, better known as "Genial Jack" Greer, is back again among his own in Pittsburg representing the interests of the Van Dorn Electric and Mfg. Co., maker of electric drills and reamers.

C. E. Chambers has been appointed superintendent of motive power of the Central Railroad of New Jersey, with office at Jersey City, N. J. Mr. Chambers succeeds Mr. William McIntosh, who was superintendent of motive power for many years.

Cyrus F. Raymond, organizing engineer and industrial expert recently employed by the Warner & Swasey Co., Cleveland, Ohio, and later by the Coe Mfg. Co., Painesville, Ohio, has been made superintendent of the Davis-Bournonville Co., New York.

George S. Brown has resigned the position of foreman of the screw department of J. Stevens Arms and Tool Co., to take the management of the Mellor Mfg. Co., Springfield, Mass., a recently established plant for making screw machine products.

Paul Stoner has joined the selling force of the American Emery Wheel Works, Providence, R. I. Mr. Stoner was connected with the Landis Tool Co. for several years, and later with the Allis-Chalmers Co. and the Cleveland Automatic Machine Co.

W. R. Lathrop, who for several years has been connected with the Niles-Bement-Pond Co.'s New York and Birmingham office, has severed his connection and has associated himself with M. E. Dewstoe of Birmingham, Ala., forming the Dewstoe-Lathrop Machinery Co.

George W. Johnson, who lately resigned the superintendency of the Chapman Valve Mfg. Co., Springfield, Mass, has established the Springfield Equipment Co. to do a general mill and factory supply business. He will locally represent the Heller Bros. Steel Co., Newark, N. J.

P. J. Illing, manager of Ludw. Loewe & Co.'s commercial department, sailed for New York the latter part of January on the *Kaiser Wilhelm der Grosse*. He intends to visit the principal machinery manufacturing plants with the object of renewing and opening business connections.

W. H. Dotzauer, foreman of the chucking and punch press department of the Remington Arms Co., Ilion, N. Y., and who has also held the position of foreman in several other departments for the last fifteen years, has resigned to take the position of superintendent of the automobile hub department of the Weston-Mott Co., Flint, Mich.

H. E. Frentzel, for many years superintendent of the shops of Pawling & Harnischfeger, Milwaukee, Wis., retired January 1. He was succeeded by Otto A. Ruemelin, for several years past assistant superintendent. Mr. Frentzel was presented with a handsome silver service by his associates in the shop and office as a mark of their friendship and esteem.

W. R. Wilson, formerly general superintendent of the Columbus Brass Co. and the Columbus Iron Fittings Co., Columbus, Ohio, is now general manager and receiver for the Standish Machine & Supply Co., of that city, manufacturer of the Robinson right angle drive. Under Mr. Wilson's efficient management it is expected that the company will soon be in first-class shape.

J. D. Cox has been elected president of the Cleveland Twist Drill Co., Cleveland, Ohio, to succeed Mr. F. F. Prentiss, who resigned on account of ill health. Mr. Cox is the founder of the business, and has always been the practical man of the concern. He has probably had more experience and been closer in touch with the manufacture of twist drills than any other man now living.

F. A. Hall, who for the past twelve years was manager of the chain block and hoist department of the Yale & Towne Mfg. Co., New York and Hartford, has resigned to take the position of vice-president and treasurer of the Cameron Engineering Co., Brooklyn, New York. Mr. Hall is succeeded by R. T. Hodgkins, who for several years was his chief assistant and who is thoroughly qualified by experience and ability to fill the position.

Henry J. Smith has been promoted from the position of assistant foreman to the foremanship of the Water Shops of the United States Armory at Springfield, Mass. Mr. Smith was promoted from machinist to assistant foreman in 1898. The position of assistant foreman in the Water Shops is practically the same as that of foreman in civilian shops, the term being applied to the heads of departments such as milling, drilling, drop forging, etc.

J. W. Coyle, who was connected with the W. N. Best American Calorific Co. until its retirement from business, is now with the Rockwell Furnace Co., New York, and is giving special attention to oil and gas furnaces for railroad work. Mr. Coyle is an experienced railroad man, having formerly been master blacksmith for the Lehigh Valley R. R. at Wilkes-barre, and later was in charge of the drop hammer and machine department at the forge shops of the Philadelphia & Reading Ry., Reading, Pa.

George Walworth Hayden has been appointed general plant manager of the works of the Pratt & Cady Co. at Hartford, Conn. Mr. Hayden was for nineteen years with the Crane Co. of Chicago working in all departments and rising to be general manager of all its factories, having been chief draftsman, foreman, superintendent and general manager of all the brass, malleable and cast iron departments. He was also in the employ of the United States Steel Corporation and of the McNab & Harlan Co. as works manager at Newark, N. J.

C. H. Ladd has retired from the position of foreman of the Water Shops of the United States Armory at Springfield, Mass., after serving in that capacity for seventeen years. Previous to going to the Water Shops Mr. Ladd was at the Smith & Wesson revolver factory for fourteen years holding the position of foreman and superintendent. He is a Civil War veteran. In civilian shops the position he filled would be called superintendent. He had about five hundred men under him in several departments, including tool-making, hand, drop and rolled forging, milling, drilling, rifling, etc.

At a meeting of the board of directors of the Pennsylvania R. R., January 12, F. E. Abercrombie, superintendent of the New York division, C. F. Dabney, superintendent of the Central division, and W. A. Bannard, superintendent of the Maryland division, were delegated to the general manager's office at Philadelphia to assist in exhaustive investigations of various transportation problems. These men, who are to be known as special agents on the staff of the general manager, are well fitted for their duties on account of long experience in the operating department, especially divisional work, of the railroad.

Charles Kirchhoff, who recently retired from the editorship of the *Iron Age*, was given a tribute of regard in a luncheon at the Engineers' Club, New York, January 16, just prior to sailing on a cruise to the West Indies. The luncheon was attended by about 120 manufacturers, professors, editors, chemists, etc., prominent in the business world and their professions. Letters of regret were read from Andrew Carnegie, Ambrose Swasey, John Hayes Hammond, H. G. Prout, Prof. Henry M. Howe and others. Mr. Kirchhoff was presented with a bronze statue by Picault entitled "La Source du Pactole," by his colleagues on the *Iron Age*, as an evidence of regard and admiration. Mr. George W. Cope, who made the presentation, said in part referring to the gift: "It is emblematical of your profession as well as of the cause in which you have so long employed your energies and your talents. The engineer holding in one hand the dividers and in the other a hammer, contemplates the Pactolian stream, and as he muses we can well believe that he exults in the thought that his labor is also productive of wealth. How much and how effectively your labors have contributed to the material benefit of those who have for years used the *Iron Age* as an important factor in the conduct of their business is beyond my power to estimate."

* * *

OBITUARIES

Samuel E. Riendeau, assistant foreman of the screw department of the J. Stevens Arms and Tool Co., Chicopee Falls, Mass., died at his home December 21, aged thirty-eight years.

George S. Taylor, treasurer of the Belcher & Taylor Agricultural Tool Co., Chicopee Falls, Mass., since its incorporation in 1864, died of pneumonia at his home in Chicopee Falls, Mass., January 3, after an illness of four days, aged eighty-eight.

William Baxter, Jr., died at his home in Jersey City, January 12, after a brief illness with pneumonia, aged fifty-six years. He was born in Troy, N. Y., and was given an academic education. He acquired considerable valuable experience in designing steam and hydraulic machinery between 1860 and 1880 with his father, William Baxter, Sr., who was a well-known builder of engines and machinery and an inventor of considerable reputation. William Baxter, Jr., inherited the inventiveness of his father and made several inventions of merit in electrical apparatus, elevators, etc. He entered the electrical engineering field in the early eighties and afterwards devoted himself largely to this work and elevator improvements. He was a pioneer motor inventor and manufacturer. He invented the first enclosed arc lamp about 1882. He put stationary motors on the market in 1886 and railway motors in 1890. He was the first to design and place on the market the single reduction type of railway motors now universally used on trolley cars. Previous to Mr. Baxter's improvement, motors were double reduction with intermediate shaft between the motors and car axle. This arrangement was used to obtain sufficient power to operate the car without making the motor too heavy. Since 1895 Mr. Baxter had acted as a consulting engineer and writer. He wrote extensively for various mechanical and electrical journals on nearly all the industrial applications of electricity, and on elevators of all kinds. His series, "Electrical Railway Machinery and Apparatus," recently published in the railway edition of MACHINERY, is a case in point.

* * *

Don't grind a lot of clearance on one side and no clearance on the other side of a thread tool.

COMING EVENTS

April 13-14.—Annual convention of the National Metal Trades Association at the Hotel Astor, New York. Robert Wuest, commissioner, 605 New England Building, Cleveland, Ohio.

April 17-June 1 (April 4 to May 19, O. S.).—International exhibition of internal combustion motors under the auspices of the Imperial Russian Technical Society of St. Petersburg on the premises of the society Panteleimonskaia No. 2. The object of the exhibition is to acquaint the consumer as well as the general public at large with the development and present condition of internal combustion motors, and to show the comparative advantages of each of the existing systems. The exhibit will be divided into sections as follows: Motors for agricultural purposes, motors for artisan in small industries, and domestic use, motors for factories, motors for marine, railway, tram car, automobile, aeronautical and similar purposes, motor details and accessories, literature on motors, drawings, diagrams, etc.

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-August 31.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel, when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

June 6-10.—Convention and exhibition of the Foundry & Manufacturers' Supply Association, Detroit, Mich., C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary. American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary. American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 23-28.—International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology at Dusseldorf, Germany. For information apply to G. C. Lloyd, 28 Victoria St., London.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

SOCIETIES AND COLLEGES

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS, organized in 1901, elected the following new officers at the last annual meeting at Lima, Ohio, November 19-20: president, O. F. Rabbe, Toledo, Ohio; vice-president, Grant Miller, Toledo, Ohio; secretary and treasurer, Prof. F. E. Sanborn, Columbus, Ohio; managers, Ira Cole, Lima, Ohio, C. F. Baker, Covington, Ky., E. M. Adams, Akron, Ohio.

SOCIETY OF ENGINEERS, 17 Victoria St., Westminster, S. W. England will award a status prize each year for the next four years ending 1913 for the best paper written by any person on the subject "How to Improve the Status of Engineers and Engineering with Special Reference to the Consulting Engineer." The prize will be books or instruments or both to the value of three guineas selected by the author of the winning essay. Essays should be written in the third person and should contain not fewer than 4,000, or more than 6,000, words.

STEVENS ENGINEERING SOCIETY, Hoboken, N. J. Program of lectures for the season 1909-10. The society is affiliated with the American Society of Mechanical Engineers. The speakers yet to appear are Samuel Whinery, February 8, subject, "Pavements for City Streets;" David S. Jacobus, February 15, subject, "Power Plant Economics;" Henry L. Gantt, February 21, subject, "The Engineer as a Manager;" John F. O'Rourke, March 1, subject, to be announced; Hermann F. Cuntz, March 8, subject, "Automobiles;" William J. Hammer, March 15, subject to be announced; Charles R. Richards, March 22, subject "Art and Industries of the Orient;" George V. Wendell, March 31, subject, "The Gyrostat and its Application;" Lewis A. Martin, April 5, subject, "The Theory of Gyrostatic Motion;" Frank B. Gilbreth, April 12, subject, "Methods and System in Relation to Handling Concrete Work;" John C. Ostrup, April 19, subject, "Notable Examples in Modern Construction;" David Watson Taylor, April 26, subject, "Development of the New Navy;" Charles F. Kroeh, May 3, subject, "Immortality;" John A. Brashear, May 10, subject, "The Contribution of Photography to our Knowledge of the Stellar Universe."

NEW BOOKS AND PAMPHLETS

GOOD ROADS. Bulletin No. 20. 53 pages, 6 x 9 inches. Published by the University of South Carolina, Columbia, South Carolina.

OCCLUDED GASES IN COAL. Bulletin 52. By S. W. Parr and Perry Barker, 28 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS. 270 pages, 6 x 9 inches. Issued from the secretary's office, 170 Broadway, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE TRAVELING ENGINEERS' ASSOCIATION HELD AT DENVER, COLO., September 7-10. 396 pages, 6 x 9 inches. W. O. Thompson, secretary, Buffalo, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION AT NIAGARA FALLS, N. Y. August 17-19, 1909, 189 pages, 6 x 9 inches. A. L. Woodworth, secretary, Lima, Ohio.

INDUSTRIAL PEACE AND INDUSTRIAL EFFICIENCY. 30 pages, 5¼ x 8 inches. Published by the Anti-Boycott Association, 27 William St., New York.

This pamphlet is a reprint from an English publication giving the terms of Sir Christopher Furness' co-operative scheme, or "The Treaty of the Hartlepools."

FUEL TESTS WITH HOUSE-HEATING BOILERS. Bulletin No. 31, by J. M. Snodgrass. 108 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin reports 139 tests of anthracite, Pocahontas, coke and Illinois coal made in connection with two types of house-heating boilers. The efficiency obtained varied from 44 to 66 per cent.

LOCOMOTIVE BREAKDOWNS. By George L. Fowler and William W. Wood. 292 pages, 4¼ x 6½ inches, illustrated. Published by Norman W. Henley & Son, New York. Price $1.00.

This work, which was first published in 1903, has passed into the sixth revised and enlarged edition. It is in catechism style, the questions selected being based on the experience of engineers, air brake inspectors, and others connected with locomotive operation and maintenance. The contents by chapters are: Defective valves; accidents to the valve

motion, Stephenson link gear; accidents to cylinders, steam, chests, and pistons; accidents to guides, crossheads, and rods; accidents to the valve motion, Walschaerts radial gear; accidents to running gears; truck and frame accidents; boiler troubles; defective throttle and steam connections; defective draft appliances; injector troubles; accidents to cab fixtures; tender accidents; miscellaneous accidents; accidents to compound locomotives; tools and appliances for making engine repairs; locating and remedying air-brake troubles; the Pyle National electric headlight; rules, tables and other information. The details of the Pyle National electric headlight are illustrated on a folding plate.

PRACTICAL ENGINEER POCKET-BOOK AND DIARY FOR 1910. 684 pages, $3\frac{1}{2}$ x $4\frac{1}{2}$ inches, in addition to which are many pages of advertising and blank pages for the diary. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, London, England. Price, leather, 1s. 6d.; cloth, 1s.

A great fund of useful engineering information is contained in the limits of this convenient pocket-book, as is shown by the following partial statement of contents: Standard of weights and measures, areas of small circles advancing by decimals, areas of circles up to six inches diameter advancing by thirty-seconds and sixteenths, areas of circles advancing by tenths from 1 to 100 inclusive, tables of squares, logarithms, chords, wire gage and metric conversion, steam boilers and furnaces, chimneys, boiler fittings, feed water, boiler joints, boiler trials, steam consumption, properties of saturated steam, indicator dimensions, steam engine details, sizes of steam pipes, relative strength of solid and hollow shafts, heating of buildings, condensers, steam engine regulation, springs, beams, steam turbines, gas producers, gas engines, refrigeration, water turbines and Pelton wheels, pumps, gearing, belting, chain driving, rope driving, emery grinding, limit gages, speed of cutting tools, power required for machine tools, pyrometry, cranes, ball bearings, roller bearings, reinforced concrete, strength of materials, etc.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1908. 801 pages, 6 x 9 inches; illustrated. Published by the Smithsonian Institution, Washington, D. C.

This well-known publication contains the report of the Smithsonian Institution and, as has been the custom for some years, a series of valuable technical articles on various phases of scientific development, as follows: "The Present Status of Military Aeronautics," by Major George O. Squier; "Aviation in France in 1908," by Pierre-Roger Jourdain; "Wireless Telephony," by R. A. Fessenden; "Phototelegraphy," Henri Armat; "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds," by Lovell N. Reddie; "On the Relations Between Matter and Ether," by J. J. Thomson; "Development of General and Physical Chemistry, during the past Forty Years," W. Nernst; "Development of Technological Chemistry during the last Forty Years," by O. N. Witt; "Twenty Years' Progress in Explosives," by Oscar Guttmann; "Recent Researches in the Structure of the Universe," by Prof. Dr. J. C. Kapteyn; "Solar Vortices and Magnetism in Sun Spots," by O. G. Abbott; "Climatic Variations: Their Extent and Causes," by Prof. J. W. Gregory; "Uranium and Geology," by Prof. John Joly; "An Outline Review of the Geology of Peru," by George I. Adams; "Our Present Knowledge of the Earth," by E. Wierchert; "The Antarctic Question—Voyages Since 1898," by J. Machat; "Some Geographical Aspects of the Nile," by Capt. H. G. Lyons; "Heredity, and the Origin of Species," by Daniel T. MacDougal; "Angler Fishes: Their Kinds and Ways," Theodore Gill; "The Birds of India," by Douglas Dewar; "The Evolution of the Elephant," by Richard S. Lull; "Life and Work of Lord Kelvin," by Silvanus P. Thompson, etc.

THE GAS TURBINE. By Henry Harrison Suplee. 262 pages, 6 x 9 inches. 93 illustrations and diagrams. Published by J. B. Lippincott Co., Philadelphia, Pa. Price, $3.

The intention of the author in publishing this work was to place in the hands of engineers and experimenters such theoretical and practical data as are now available in the solution of the problems of the gas turbine. The historical chapter describes early experiments and illustrates some early forms of gas turbines. Papers read before the Institute of Mechanical Engineers are digested, as well as a paper presented before the Society of Civil Engineers of France. Chapter V discusses the actual behavior of gas engine nozzles, giving account of experiments of Dr. Charles E. Lucke, and describes and illustrates the practical work of Messrs. Rene Armengaud and Charles Lemale. In the last chapter the author draws some general conclusions. So far as predictions may be made, it appears that the most immediate results are to be expected from the so-called "mixed" turbine, that is the type in which the injection of water for cooling purposes causes the machine to partake of the combined nature of the gas and steam turbine. Also, the turbine of the explosive type appears to have arrived at the practical stage already, notwithstanding its low thermal efficiency. Its efficiency, however, is about the same as that of the steam engine of the same capacity. The advantages of the turbine type are so great for certain purposes that Prof. Langley is quoted in speaking of the engine of his flying machine, whereof he said: "It might burn gold, if necessary, so long as it fulfills all the other requirements of the problem." In short, the mechanical advantages of the gas turbine may outweigh its disadvantages, in thermal efficiency and other respects. In this connection it is interesting to note that a new development in gas turbines will soon be announced that will startle the aeronautical world because of the simplicity of the motor and propeller.

MODERN GAS ENGINES, AND THE GAS PRODUCERS. By A. M. Levin. 485 pages, 6 x 9 inches. 100 illustrations. Published by John Wiley & Sons, New York. Price, $4.

The literature on the gas engine is rapidly assuming the importance and profuseness of that on the steam engine. It is fitting that it is so, for the internal combustion engine undoubtedly is the coming motor. It, with the gas producer, will gradually displace the steam engine for the majority of power-producing purposes. The thermal efficiency of the gas engine is higher than that of the steam engine; in certain industries, as the steel manufacture, it offers means of directly converting waste gases into power without the loss and complicated apparatus inseparable from the steam engine. The author in his foreword speaks of the importance of economy in national fuel resources and points to the gas engine as being one means of conserving them. The contents by chapters are as follows: Introduction to Thermodynamics; Design Constants and Formulas; Theoretical Analyses of Gas Engine Cycles; Power, Size and Speed of Gas Engines; Fuels and Combustion; the Proportioning of Mixtures and the Relation of these to the Size of the Engine; Alcohol Fuels; Features of Practical Gas Engine Cycles; the Fly-wheel; the Crankshaft; Engine Details; Governing; Engine Auxiliaries; Various Gas Engine Types; Producer Gas and Gas Producers. The work treats of gas engines with particular reference to the stationary types for general power purposes. While automobile engine design is not neglected, the importance of this specialized type would seem to have merited considerably more attention than the author gave it, especially when it is conceded that the automobile development has had a great improving influence on small internal combustion motor design. Space will not permit of a more detailed reference to the otherwise excellent phases of the work, except to say in conclusion that it is essentially a book for the designing engineer. The treatment of stresses in crankshafts, thermodynamics, etc., should give the average designer bases on which to work in almost all phases of gas engine design.

GAS, GASOLINE AND OIL ENGINES. By Gardner D. Hiscox. 476 pages, 6 x 9 inches. 370 illustrations. Published by Norman W. Henley & Son, New York. Price, $2.50.

This book, which was first published in 1897, has passed into the eighteenth edition. It was revised and extended by the author before his death. In the foreword he says that the gasoline engine has almost superseded the windmill for farm and suburban use and many manufacturers are employing it in preference to electricity for portable machines. It is estimated that there are about 10,000 manufacturers of gas, gasoline and oil engines in the United States. The author gives an account of the historical progress of the internal explosive motors, and follows with the theory of gas and gasoline engines, isothermal and adiabatic law, formulas and examples, tables, utilization of heat and its efficiency in explosive motors, temperatures and pressures, formulas and examples, retarded combustion, wall cooling and compression efficiencies, advanced ignition, compression in explosive motors and its work, causes of loss in efficiency in explosive motors, form and influence of combustion chamber, economy of gas engine for electric lighting, merits of the two- and four-cycle type, gas engine fuels, carbureters and vaporizers, cylinder capacity of gas and gasoline engines, governors and valve gear, explosive motor ignition, cylinder lubrication, constructive details and dimensions, measurement of power, gas engine testing, marine gas engines, motor bicycles, producer gas and its product, etc. The automobile and marine types of internal combustion motors are exhaustively treated, a large number of forms and constructions being illustrated and described. This section makes this work particularly acceptable to many designers concerned with the design of small motors. Practical hints on assembly are given in the chapter of construction and details and parts of explosive motors. The well-known method of using strips to set the piston rings when entering the piston into the cylinder, is illustrated and described. The author saw fit to give credit for it to a gas engine designer, but as a matter of fact, this method was in common use long before the engineer named was born. The work as a whole is heartily commended.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Circular of tungsten automobile electric lamps.

WARREN WEBSTER & CO., Camden, N. J. Booklet on the Webster modulation heating system.

MCDOWELL, STOCKER & CO., 121 N. Jefferson St., Chicago, Ill. List of second-hand machine tools.

NEW YORK MACHINERY EXCHANGE, 50 Church St., New York. List of second hand machine tools.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Circular of "Sanitor" closet seats and tanks.

UNIVERSITY OF ILLINOIS, Urbana, Ill. Circular of information of the Department of Mining Engineering.

SPRAGUE ELECTRIC CO., New York. Bulletin No. 110 superseding bulletin No. 107 on Sprague electric generators.

SARGENT STEAM METER CO., 271-285 East Madison St., Chicago, Ill. Catalogue of Sargent automatic gas calorimeter.

CINCINNATI-BICKFORD TOOL CO., Cincinnati, Ohio. Circular R-50 illustrating and describing the Bickford $2\frac{1}{2}$-, 3- and $3\frac{1}{2}$-foot plain radial drill.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, Ohio. Handbook and stock list of machines and small tools for the fabrication of iron and steel.

PAWTUCKET TOOL CO., Pawtucket, R. I. Circular of Thompson automatic tapping chuck, which is made in both reversing and non-reversing types.

HUNTER SAW & MACHINE CO., 37th and Butler Sts., Pittsburg, Pa. Circular and price list C of circular metal-cutting saws, saw sharpening machines, etc.

LEIMAN BROS., 62 John St., New York. Circulars of pressure blowers (see MACHINERY, January, 1909), sand blast apparatus, melting furnaces, etc.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletins No. 5131 and 5132 on motors and generators, type IL, and interpole motors, type ELC.

ECK DYNAMO & MOTOR CO., Belleville, N. J. Circular of Eck motors and dynamos of protected, enclosed, Manchester, back geared, vertical, variable speed and worm gear types.

HOWELL & MURRAY, Waverly, N. Y. Circular of the Howell adjustable work clamp for clamping work to lathe faceplates, boring mill tables, planer platens, etc.

SPRAGUE ELECTRIC CO., New York. Circular of Sprague "multilets." These junction boxes for electric service are made of stamped steel in two sizes with a set of covers for each size.

RICHARD W. JEFFERIS CO., Camden, N. J. Folder illustrating the Jefferis pressed steel lockers, unit construction, for use in armories gymnasiums, factories, clubs, stores, schools, offices, etc.

COMMERCIAL MOTOR CAR CO., Times Building, New York. Circular of commercial motor vehicles of gasoline and electric types for transportation systems, comprising light and heavy express wagons, trucks, etc.

E. C. BLISS MFG. CO., 91 Sabin St., Providence, R. I. Circular of the Bliss milling attachment for upright drills and drill presses. With this attachment, the ordinary drill can be converted into a vertical milling machine.

BROWN & SHARPE MFG. CO., Providence, R. I. Pamphlet on differential indexing, containing formulas and examples for differential indexing, and tables giving gears and index moves from 2 to 382 divisions, inclusive.

WHEELER CONDENSING & ENGINEERING CO., Carteret, N. J. Booklet entitled "A Radical Improvement in Jet Condensers," being a reprint of the article published in the *Iron Age* on the improved condenser made by the company.

NAYLOR BROS., 50 Church St., New York. Price list No. 1 of power transmission apparatus comprising Naylor adjustable ball and socket shaft hangers made with double brace parting hanger, wick oiling and babbitted bearings.

VILLINGER MFG. CO., Williamsport, Pa. Circular of the Williamsport 14-inch friction drill with quick-change speed device. The machine will drill to the center of a $14\frac{1}{2}$-inch circle and its spindle is fitted with No. 1 Morse taper.

WESTERN ELECTRIC CO., 463 West St., New York. Bulletins Nos. 1001, 1002, and 1105 on magneto non-multiple switch-board with manually restored line signals, magneto multiple switch-board with self-restored line signals, and intercommunicating telephone system, respectively.

KINKEAD MFG. CO., 7 Water St., Boston, Mass. Pamphlet describing the Kinkead method of aligning and leveling shafting, including setting up machinery, countershafts, grading steam and water pipes, and the common method in indoor and outdoor surveying for manufacturing plants of all kinds.

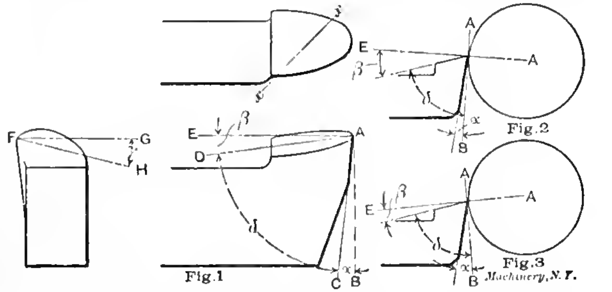
CHARLES GREINER, New Haven, Conn. Card advertising high-speed elastic blow combined riveting and spinning machine which is especially adapted for the assembly of general hardware, typewriters, etc. The machine strikes 6000 blows per minute, and is claimed to rivet faster than work can be handled.

Supplement to MACHINERY, March, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Tool Grinding"

SHOP OPERATION SHEET NO. 127

Franklin D. Jones MACHINERY, March, 1910



Meaning of Terms Used in Tool Grinding

NOTE.—In order that the tools which are used in turning or planing may work efficiently, they must be properly ground, but before considering the shape of the tool point, we shall first explain the meaning of the terms used in connection with tool grinding.

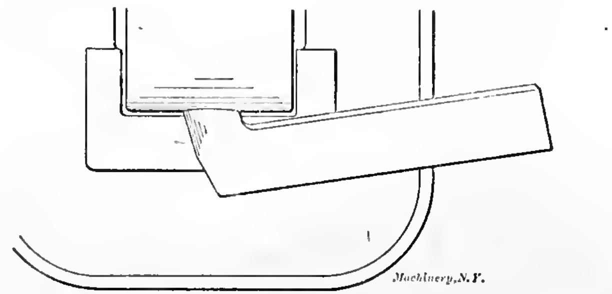
1. The clearance angle of a tool is the angular distance α between a line A-B, which is at right angles to the tool shank and the flank A-C of the tool. The angular distance β between a line A-E, which is parallel to the shank, and a line A-D, is known as the angle of back slope. When the top of the tool slopes to one side as well as backward, the angle γ between the lines F-G and F-H, is the angle of side slope. When a tool is without side slope, the angular distance δ represents the lip angle or the angle of keenness. If, however, the tool has both back and side slopes, the lip angle would more properly be the angle between the flank and the top of the tool when measured diagonally along a line x-x, as at this point the lip angle would be the most acute.

2. The base-lines A-B and A-E from which the angles of clearance and back slope are measured, do not always occupy the position with relation to the tool shank, shown in the engraving. The base line A-E, for a lathe tool which is being used, coincides with the point of the tool and the center of the work. Therefore, the position of this base-line is different from that shown in Fig. 1, when the tool point is either above or below the work center. This is illustrated in Figs. 2 and 3, where the tool is shown in different positions. As the line A-B is always at right angles with A-E, the former is also changed when the tool is presented differently to the work. It is evident then, that as the tool point is raised above the work center, as in Fig. 2, the effective angle β of back slope increases and the clearance angle α diminishes; whereas the lowering of the tool, as in Fig. 3, has the opposite effect. The effective angle of keenness also changes as the height of the tool point varies, as this angle, when the tool is in use, is the angular distance δ.

3. As the point of a planer or shaper tool usually acts along a line at right angles to the tool shank, the tool being clamped in one position, it will be seen that the angles of clearance and back slope when the tool is in action, are the same as the theoretical angles, or those of the tool alone. If, however, the tool were clamped in an inclined position, obviously the effective angles of clearance, keenness, and back slope would be affected.

SHOP OPERATION SHEET NO. 128

Franklin D. Jones MACHINERY, March, 1910



Grinding a Lathe Roughing Tool—1

NOTE.—The shape of the cutting end of a tool is governed by the particular work for which it is intended. While tools for different machines and intended for different purposes are shaped differently, the various forms are largely based on certain underlying principles, which will be briefly considered in the following description of the grinding of a lathe roughing tool.

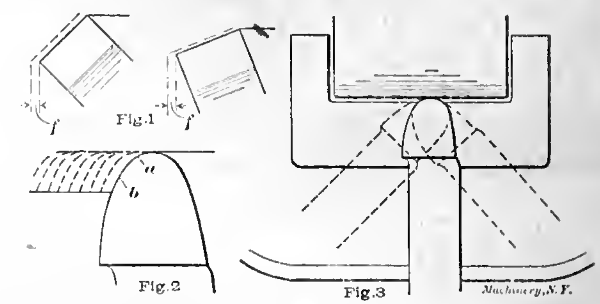
1. The top of the tool is first ground by holding it against a wet emery wheel or grindstone in the position shown in the engraving. By inclining the tool with the wheel face, it will be seen that both the back and side slopes may be ground simultaneously. With a given amount of clearance, the lip angle will depend on the angles of back and side slope; and, obviously, a given lip angle may be obtained by grinding the tool so that it has back slope without side slope, or *vice versa*, or by a combination of these two angles. It has been demonstrated that the latter method is the best, and also that the lip angle should be obtained principally by side slope. The advantage in having considerable side slope is that the chips run from the side of the tool and do not come in contact with the tool shank or the holder; in addition there is less side pressure on the tool and less resistance to feeding. A certain amount of back slope is needed, however, as otherwise the chips tend to push the tool away, thus impairing the finish and accuracy of the turned part. The angles of back and side slope should, for most work, be approximately as follows:

2. Tools for turning soft steel should be ground with a back slope of 8 degrees and a side slope of 22 degrees. Tools intended for cast iron and steel of medium hardness should have a back slope of 8 degrees and a side slope of 14 degrees. For hard material, such as tire steel, the angle of back slope should be 5 degrees, and the side slope 9 degrees. It will be seen that as the metal becomes harder, the angles of back and side slope decrease, and, consequently, the lip angle increases and the tool is more blunt; this is to give it increased strength at the cutting edge to prevent the edge from crumbling. If the lip angle is too great, however, it will affect the cutting speed and result in an excessive chip pressure on the tool.

NOTE.—There is great danger of burning tools when grinding them, that is, drawing the temper, even when the wheel used is provided with water. The tool, particularly when grinding the top, should be slightly but frequently drawn away from the stone to prevent it from becoming overheated.

SHOP OPERATION SHEET NO. 129

Franklin D. Jones MACHINERY, March, 1910



Grinding a Lathe Roughing Tool—2

NOTE.—Experiments have shown that the thickness of the chip severed by a lathe tool, greatly affects the cutting speed. When the chip is thin, the speed of the work may be much higher than for a thicker chip, without injury to the cutting edge of the tool. The thickness of the chip, for a given feed, may be varied by changing the angle that the cutting edge of the tool makes with the axis of the work. This is illustrated by the dotted lines in Fig. 1, where a broad-nosed tool is shown in different positions. When the tool is set as shown to the right, the chip is thinner for the same feed, f, and the speed may be increased. It is principally this relation between the angle of the cutting edge and the cutting speed, that adapts a tool having a rounded cutting edge so well to rough turning. With the rounded edge, the thickness of the chip removed by a point a (Fig. 2) on the tool, is much less than at b, as is illustrated by the dotted lines. Because of this thinness of the chip toward the tool point, the cutting speed that will dull the part b, will not affect the part a or the point to the same extent. We see then that the part of the cutting edge which sizes the work, remains keen after the rest of the edge has become dulled, provided the tool is ground with a curved cutting edge.

1. When grinding the flank of the tool, it should be held on the tool rest of the emery wheel or grind-stone, as shown in Fig. 3. In order to form the curved cutting edge, the tool is turned about the face of the stone while it is being ground, as indicated by the dotted lines. This rotary movement can easily be effected by supporting the inner end of the tool with the left hand while the shank is being moved to and fro with the right. The curve of the cutting edge should be approximately like that shown in Fig. 2. If the radius of the tool point is too large, the tool, while capable of a higher cutting speed, is liable to cause chattering.

2. It will be seen that at this grinding, the cutting edge is given both its shape and clearance. Generally speaking, the clearance of any metal-working tool should be just enough to ensure that the tool will cut freely. If the clearance is unnecessarily great, the tool, because of its decreased lip angle, is weakened. As a lathe tool traverses a spiral path, there must be sufficient clearance below the cutting edge to prevent the tool flank from rubbing. A turning tool should have approximately eight or nine degrees of clearance. Six degrees is sufficient, but unless a tool grinding machine is used, it is not advisable to grind too close to the limit.

See the Article in this number entitled "The

TYPICAL D. C. MOTOR WIRING DIAGRAM.

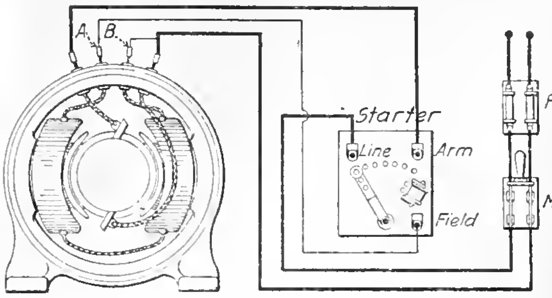


Diagram 1- To Reverse Rotation Interchange Connections A B.

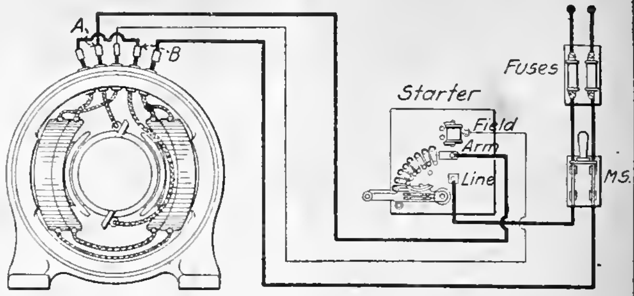


Diagram 2- To Reverse Rotation Interchange Connections A B.

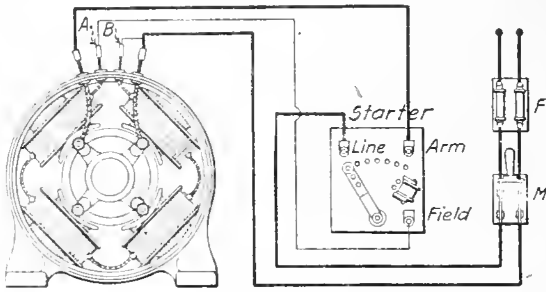


Diagram 3- To Reverse Rotation Interchange Connections A B.

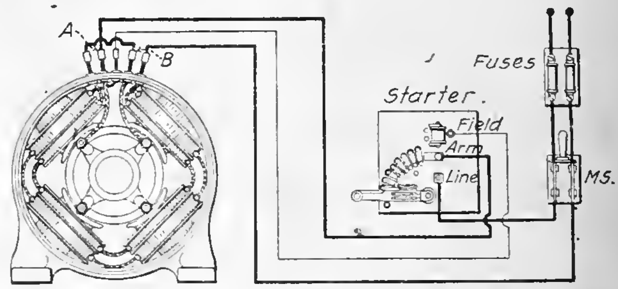


Diagram 4- To Reverse Rotation Interchange Connections A B.

Connections Between Motor and Line for Two- and Four-Pole Direct-Current Single Speed Uni-Directional Motors.

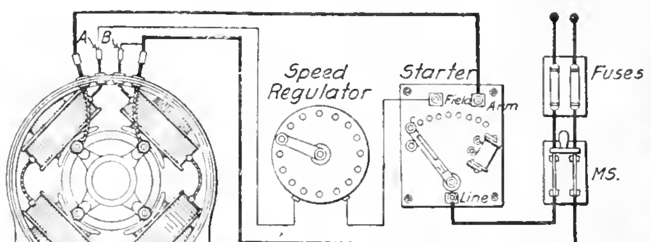
Diagrams 1 and 3 are for shunt wound, and 2 and 4 for compound wound machines. Main switch MS is shown closed, and lever of starter is in the stop position. Fuses can be connected between main line and MS, as shown, or placed below MS.

To start motor, close MS, and then swing starter lever slowly around as far as it will go.

To stop motor, open MS, and starter lever will fly back to stop position; if it does not, move it back before starting again.

Contributed by William Baxter, Jr.

TYPICAL D. C. MOTOR WIRING DIAGRAM.



To Reverse Rotation Interchange Connections A B.

Diagram 5- Shunt Motor.

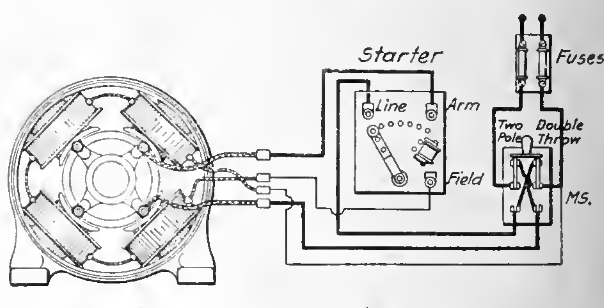
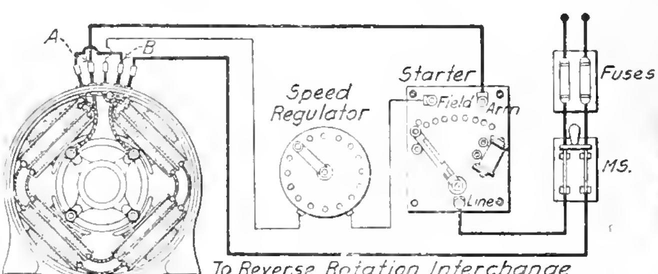


Diagram 7- Shunt Motor.



To Reverse Rotation Interchange Connections A B.

Diagram 6- Compound Motor.

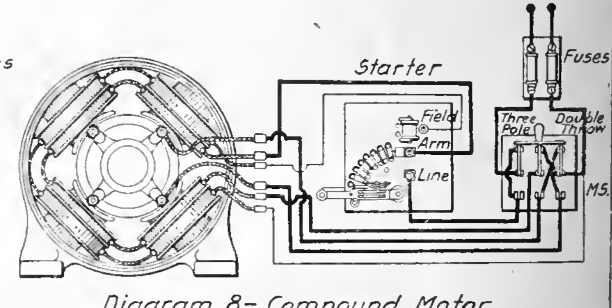


Diagram 8- Compound Motor.

Diagrams 5 and 6 show connections for variable speed direct-current motors. To change velocity, turn switch lever of speed regulator until desired speed is obtained.

Diagrams 7 and 8 show connections for motors arranged to be reversed at will. The reversing is accomplished by using a reversing main switch. A simple motor starter is shown is these diagrams.

The starters are also made combined with a speed regulator, a reversing switch, or both. If the starter is combined with a speed regulator, connections will be as in Diagrams 1 to 4. If combined with a reversing switch, connections will be as in Diagram 3 for shunt motors, and as in Diagram 4 for compound machines, with the additions of two more wires running from the starter to the motor.

Contributed by William Baxter, Jr.

TYPICAL A. C. INDUCTION MOTOR WIRING DIAGRAM.

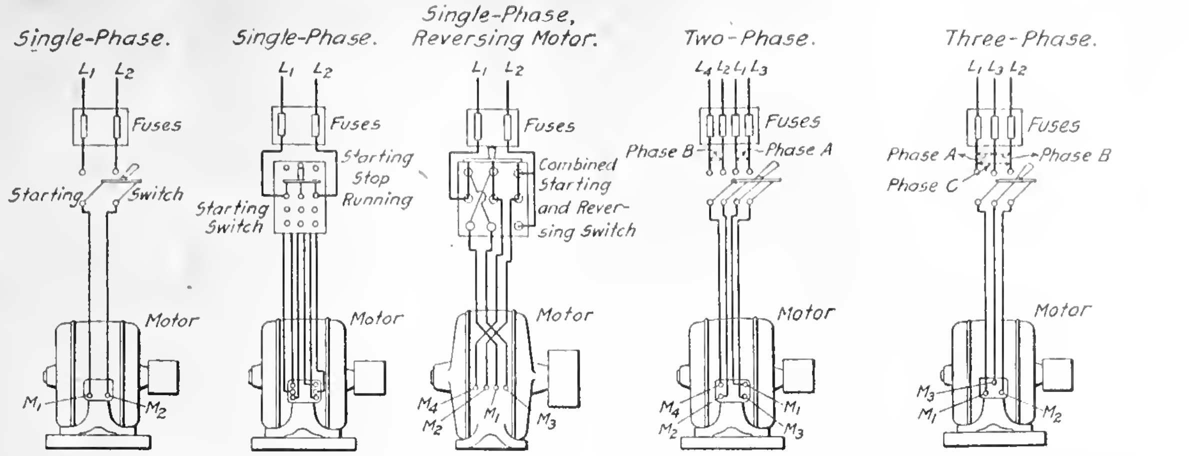


Diagram 9. Diagram 10. Diagram 11.

To Reverse Rotation Interchange Connections M_2 and M_4, or M_1 and M_3.
Diagram 12.

To Reverse Rotation Interchange any Two Connections to M_1 M_2 M_3.
Diagram 13.

Connections for Alternating Current Induction Motors.

Single-phase motors are not self-starting. Diagram 9 shows connections for small motors of this type. They are started by giving the belt a few quick pulls. Large single-phase motors are made self-starting by acting as two-or three-phase machines in starting; when up to speed, connections are changed to single-phase. They are also arranged to start as repulsion motors, and when running at nearly full speed, connections are automatically changed to single-phase induction motors. Diagram 9 shows connections for large motor arranged to start as repulsion motor. Diagram 10 shows connections for single-phase motors arranged to start as three-phase motors. To change to single-phase, move down the starting switch lever (which is thrown upward to start).

Motors starting as repulsion machines are made reversible by using a reversing switch, with connections as shown in Diagram 11. Small two-and three-phase induction motors are connected with the mains in the way shown in Diagrams 12 and 13.

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TYPICAL A. C. INDUCTION MOTOR WIRING DIAGRAM.

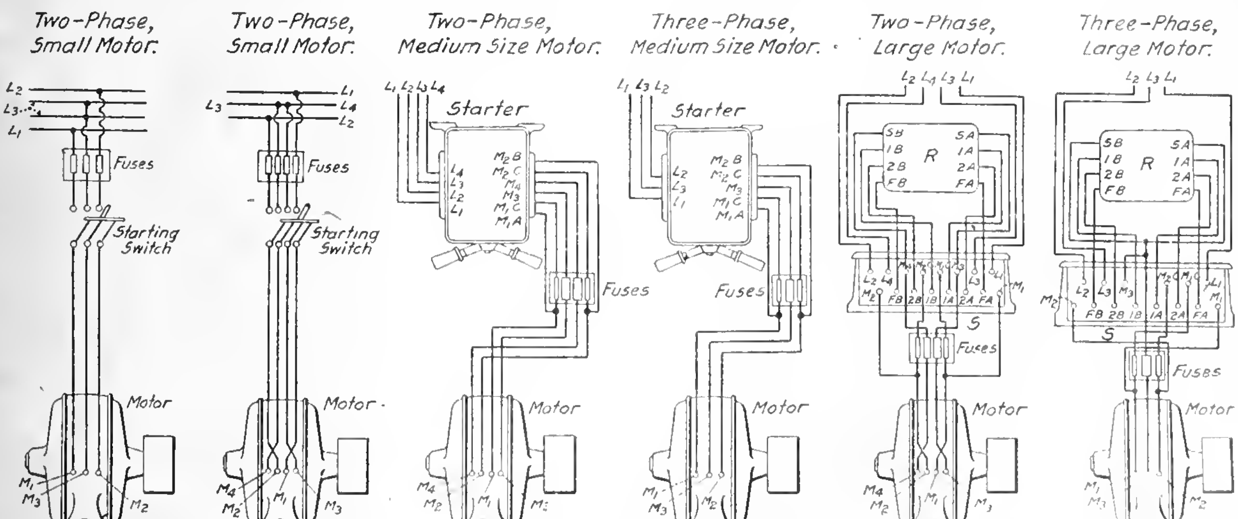


Diagram 14. Diagram 15. Diagram 16. Diagram 17. Diagram 18. Diagram 19.

When a three terminal motor is connected with four main wires, connections are made as shown in Diagram 14, one of the motor terminals being connected with two line wires.

When the motor has four terminals and three line wires, connections are made as in Diagram 15, two motor terminals being connected with one of the line wires. In medium size motors, regulator and starting switch are combined in one, the connections with the motor and line being as shown in Diagram 16 for two-phase, and in Diagram 17 for three-phase motors. When the motor is large, regulator and starting box are made separate, and are located as near to each other as possible. Connections are made between the mains, the starter, the regulator, and the motor. These connections are made as shown in Diagram 18, for two-phase motors, and in Diagram 19 for three-phase motors. The starting switch is marked "S" and the regulator "R".

Contributed by William Baxter, Jr.

MACHINERY

March, 1910

METAL SPINNING—1*

By WILLIAM A. PAINTER†

THE principal object of this article is to describe in detail the various operations of spinning metal so that a tool-maker or machinist who has not access to a metal spinner, will be able to make his own tools, rig up an engine or speed lathe, and make the simple forms or models that are required in experimental work. To do this intelligently, it is necessary to follow in detail every step in metal spinning from the circular blank to annealing, pickling, dipping, burnishing, etc., and also to know how to make the simpler forms of spinning tools, what lubricants to use on the different kinds of metals, what material to make the spinning chucks of, and how far the metal can be worked before annealing.

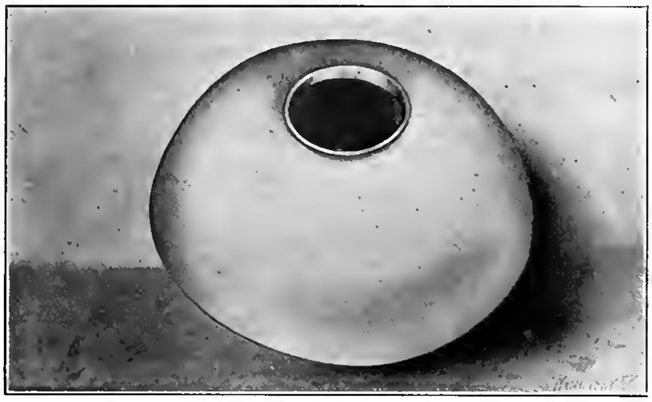


Fig. 1. Zinc Lamp Shade Spun in One Operation without Annealing

Spinning metal into complicated and elaborate shapes, is an art fully as difficult as any craft, and the man is truly an artist that can make artistic and graceful outlines in metal, especially when only a few pieces are required and the cost will not allow of making special chucks to do the work on and with no outline chucks to govern his design, the forms being made by skill and manipulation of tools alone. Such skill is far superior to that of the Russian metal worker, who, instead of making a vase or ornament of one piece, cuts up several sections and soft solders them together, after covering them with crude "gingerbread" work to disguise his poor metal work.

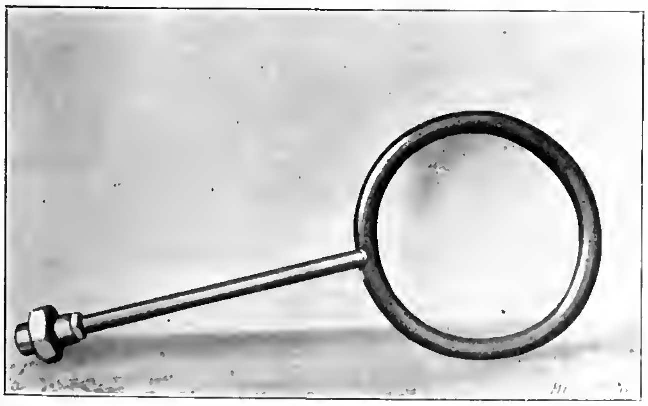


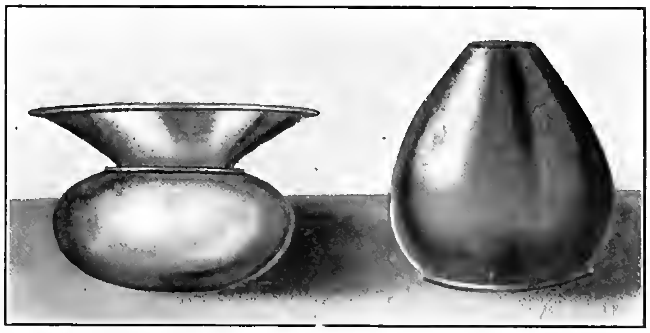
Fig. 2. Gas Burner for Heating Spinning Chuck

The amateur can imitate the Russian work, but never the work of the skilled spinner. There are several grades of spinners, most of them never attaining the skill of the model-maker or the facility for handling the different metals. A man that has had several years of experience spinning brass or copper would not be able to spin Britannia or white metal without stretching it to a very uneven thickness. As brass or copper is harder than the other metals mentioned, they resist the tool more and require more pressure in forming, and if the operator used the same pressure on the softer metals, he would stretch or distort them, so that they would be perhaps one-quarter of the original thickness at angles and corners where the strain in spinning would be greatest, which would ruin the articles. The best test for skill in ordinary spinning, is to take a long difficult shape, after being finished, and saw it in two lengthwise, and if the variation in thickness is less than 25 per cent of the original gage, it is good practice. Some spinners can keep within 10 per cent of the gage on ordinary work, but they are scarce.

The spinning trade in this country is mostly followed by foreigners, Germans and Swedes being the best. The American that has intelligence and skill enough to be a first-class spinner, will generally look around for something easier about the time that he has the trade acquired. It is an occupation that cannot be followed up in old age, as it is too strenuous, the operator being on his feet constantly, and having to use his head as well as his muscles.

General Remarks on Metal Spinning Chucks

For common plain shapes, a patternmaker's faceplate, with a tapered center screw, is sufficient for holding the wood chuck. The hole in the wood should be the same taper as the screw, thus giving an even grip on the thread. If a straight hole only is used, and it is not reamed out before screwing to the plate, it will only have a bearing on one or two threads, and if the chuck is taken off and replaced on the faceplate, it will not run true. Care should also be taken to face off the end of the chuck flat, or to slightly recess it, so that it will screw up evenly against the faceplate, as a high center will cause it to rock and run out of true.



Figs. 3 and 4. Examples of Aluminum and Copper Spinning

In large chucks (over five inches) it is best to have three or four wood screws, besides the center screw. The holes for these can be spaced off accurately on a circle in the iron faceplate, and drilled and countersunk. It is best to have twice as many holes as screws; that is, if four screws are used there should be eight holes, so that if the chuck has to be replaced at any time and the wood has shrunk, it can be turned one-eighth of a revolution further than the original chucking.

Where a chuck has to be used several times, it is better practico to cut a thread in the wood and screw the chuck directly to the spindle of a lathe, not using the faceplate. This thread can be chased with a regular chasing tool, where the operator has the skill, and, if not, the wood can be bored out and a special wood tap used. Such a tap has no flutes and it is bored hollow, there being a wall about 3/16 inch thick. One tooth does all the cutting, that being the end of the thread. The chips go into the hollow part of the tap. The end of the tap for about 1/4 inch should have the same diameter as the hole before threading to act as guide for the cutting tooth.

* See also the article, Methods and Tools Used in Metal Spinning, published in the December, 1909, number of MACHINERY.

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It is essential that a chuck should run very true and be balanced perfectly, as the high speed at which it runs will cause it to vibrate and run out of true, causing the finished metal to show chatter marks. The best wood for chucks is hard maple, and it should be selected for its even grain and absence of checks and cracks. It is best to paint the ends with paraffine or red lead, or to immerse the chucks in some vegetable oil after turning. Cotton seed oil is very good for this purpose, but care should be taken not to soak the chucks too long.

For a man not skilled in spinning, it is better to use metal chucks than wood, for if there are many shells of a kind, the operator is liable to bear too hard on the tool, thus compressing the chuck and making the last shells smaller than the first. Corners and angles that are not well supported might also be knocked off. I prefer cold rolled steel for chucks up to 6 inches in diameter and cast iron for the larger ones, but where good steel castings can be obtained a good chuck can be made by turning roughly to shape a wood pattern, allowing enough for shrinkage and finishing, and hollowing

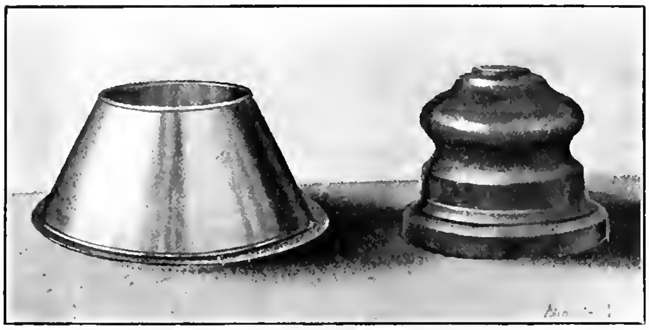


Fig. 5. German Silver Reflector Fig. 6. Open-hearth Cold-rolled Steel Shell

out the back to lighten it. When the casting is finished all over in the lathe, it should balance much better than a cast iron one as there are not the chances of having blow holes in the iron thus throwing the chuck out of balance.

Annealing

The distance that metal can be drawn without annealing, can only be learned by experience. A flat blank rotated on the lathe, being soft, will offer little resistance and it can be gradually drawn down by a tool held under the chuck and against the blank. This tool is pushed from the center outward and forward at the same time, and every time it passes over the blank or disk the metal becomes harder by friction and the change of formation and the resistance at the point of the tool greater. This can be felt as the tool is under the operator's arm. When the spring of the metal is such that the tool does not gain any but only hardens the metals, the shell should be taken off and annealed. If the metal has

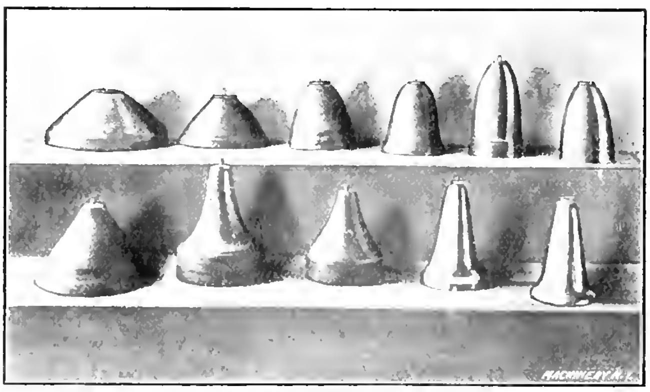


Fig. 7 Various Steps in Spinning the Two Brass Shells at the Right

been under a severe strain, it should be hammered on the horn of an anvil or any metal piece that will support the inside. The hammer should be a wood or rawhide mallet, but never metal, the object being to put dents or flutes in the metal to relieve the strain when heating to anneal; if this is not done the shell will crack.

After annealing the shell it should be pickled to clean the oxide or scale from the surface; otherwise the metal will be pitted. Where the scale is crowded into the metal and when it will not finish smooth after spinning to shape, the metal can be finished by skimming or shaving the outer surface which cuts out all tool marks; it can then be finished with medium emery cloth or the shell can be bright dipped, and be run over with a burnishing tool before buffing. Burnishing can be done on the spinning chuck, but the speed should be

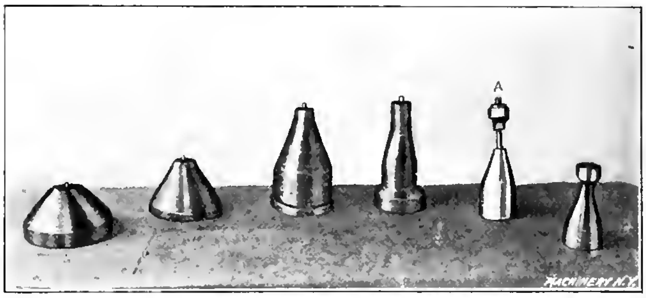


Fig. 8. Another Brass Spinning Operation; the Chuck used is shown at A

higher than for spinning; this requires some skill for a good job, and it can be done only on metal chucks.

Annealing is best accomplished in a wood or gas oven, where a forge fire is used. The metal should never touch the coke or other fuel but it should be held in the flame above the fire. Where only part annealing is required, the shell can be immersed in water, the part to be annealed being exposed above the water, and a blowpipe used on it. The remainder of the shell will then be hard. This way of annealing is sometimes necessary on special shapes.

Brass should be heated to a cherry red, and held at that point for a few minutes, in a muffle furnace. If an open furnace is used, just bring the metal to a cherry red and then dip it in water; this method anneals better than waiting for it to cool, the action being just the opposite to that of steel. Brass such as the common yellow brass is not suitable for spinning there being but 55 per cent copper and 45 per cent

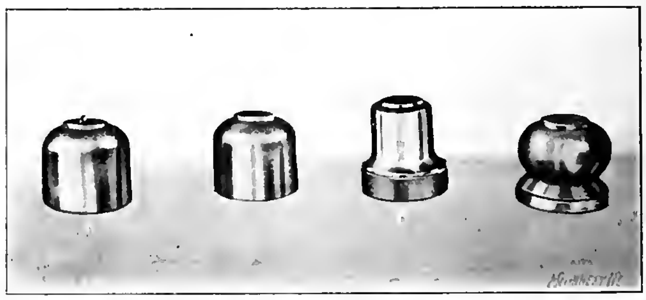


Fig. 9. An Example of "Air Spinning" and the Chucks used

zinc. There are two grades of brass suitable for spinning. These are known as "spinning and drawing," having 60 per cent copper and 40 per cent zinc, and "extra spinning and drawing" having 67 per cent copper and 33 per cent zinc. There is also a better grade known as "low brass" having from 75 to 80 per cent copper; it has the color of bronze and is only used on very deep and difficult spinning.

The scale, after annealing, should be pickled off in an acid bath (described further on in this article), and the part thoroughly washed in running water. Brass, German silver and the harder metals should be hammered before annealing; it is not necessary to hammer zinc, copper, aluminum, etc.

A pyrometer in an annealing furnace would be an advantage where quantities of the softer metals such as zinc, aluminum, etc., are being heated. Copper is annealed the same as brass and is also pickled. Zinc is coated with oil before being put in the oven, and when the oil turns brown, which occurs when the temperature is about 350 degrees, the metal is ready to take out; it should then be plunged in water to shed the scale but not pickled. The melting point of zinc is 780 degrees F. Aluminum can be annealed the same as zinc, as the melting point is 1,140 degrees F.

Steel should be annealed by heating to a cherry red and then allowing it to cool slowly; it should be scaled in a special pickle, thoroughly washed, and then put back in the fire long enough to evaporate every particle of acid that may have remained from the pickling operation. Any acid remaining

on the steel will neutralize any lubricant that is applied when spinning. Annealing should be avoided wherever possible. Open hearth steel only should be used. It should be free from scale and preferably cold rolled. Bessemer steel is not suitable, except for very shallow spinnings. Tin plate made from open hearth steel can be spun about one-half as deep as its diameter where the shape is not too irregular. German silver is difficult to spin, especially when it is over 15 per cent nickel; it has to be hammered before annealing, the same as brass, to avoid cracks.

Lubricants

Common yellow soap cut up in strips about ½ inch or ¾ inch square is a good lubricant for spinning most metals. It should be applied evenly to the disk or blank while it is revolving, by holding the soap in the hand and drawing it across the surface. Beeswax is the best for spinning steel, but it is expensive. Lard oil mixed with white-lead is a fair substitute. Either mutton or beef tallow applied with a cloth swab is very good on most all metals; also vaseline and graphite mixed to a paste and applied the same as tallow.

Fig. 10. Miscellaneous Collection of Spinning Chucks

Examples of Spinning with Various Metals

The different metals are malleable, ductile and tenacious in the following order: white metal or Britannia, aluminum, zinc, copper, low brass, high brass, German silver, steel, tin plate. White metal does not harden in spinning, but it requires special skill in handling, or the metal will be of very uneven gage. The best metal for an amateur to start on is copper, as it is both tenacious and ductile, and will stand much abuse in the fire and on the lathe. One of the peculiar properties of zinc is that it has a grain or texture, and when spinning, the two sides that went through the rolls lengthwise will be longer than the sides that have the cross grain, requiring the shell to be trimmed off quite a distance to even the edge.

To show the possibilities of working the different metals, and their relative spinning values, a number of articles made from different materials are illustrated herewith.

A zinc lamp shade is shown in Fig. 1 that is 14¼ inches in diameter and 4¾ inches deep. This shade was spun in one operation, without annealing, from a flat circular blank. All zinc should be warmed before spinning, either over a gas burner at the lathe or in hot soap water, and the chuck also should be heated, as otherwise the blank will soon chill, if spun on a cold metal chuck, as the chuck absorbs the heat long before the operation is finished. Of course this does not apply to wooden chucks. The chuck may be heated by using the burner shown in Fig. 2, which is located around the spindle of the lathe. The size of the burner should, of course, be in proportion to that of the chuck used. The burner illustrated is 8 inches in diameter. It has several small holes drilled for the gas on the side facing the chuck. The heat of the chuck is regulated by varying the supply of gas to the burner. The blank is heated before it is put on the chuck and the friction of the spinning tool helps to keep it warm until it comes in contact with the chuck. The metal retains its heat until the job is finished, and this sometimes saves an annealing operation.

In Fig. 3 is shown an example of aluminum spinning. The article illustrated is a cuspidor having a top 7¾ inches in diameter, a neck with a 4-inch flare, a diameter at the top of 9½ inches, and a height of 6½ inches. This shell was spun without annealing, which shows the extreme ductility of aluminum. The copper shell shown in Fig. 4, has a maximum diameter of 7 inches, and a depth of 8 inches; it was spun with four annealings. A German silver reflector, which is 10 inches in diameter at the largest end and 5 inches deep, is shown in Fig. 5. The spinning of such a reflector, when made from this material, is quite difficult. An open hearth cold-rolled steel shell with a maximum diameter of 3 inches and a depth of 4 inches is shown in Fig. 6. This shell was spun without annealing which shows that the grade of steel used is well adapted for this work.

In Fig. 7 two finished brass shells are shown to the right, and also the number of operations required to change the form of the metal. The upper shell is 6 inches long and 3½ inches in diameter at the large end, while the lower one is 7¼ inches long by 3¾ inches in diameter. It was necessary to anneal these shells between each operation, the upper shell being annealed four times and the lower one three times. These pieces were made in quantities sufficient to warrant the making of chucks for each operation, which enabled them to be spun with less skill than would be required if a finishing chuck only were made. When a single finishing chuck is used, the various operations in spinning a shell of this kind would be left to the judgment of the spinner, who would decide the limit of the stretch of metal between the operations before annealing.

A brass shell that is made in five operations and with four annealings is shown in Fig. 8. The finishing chuck used is a split or key chuck on which it is necessary to cut out the end of the shell in order to withdraw the key after the shell is spun. This shell, which is shown finished to the right, is 5½ inches long. It is spun smooth on a machine steel chuck, and is not skimmed, but gone over with a planishing tool at the last operation. The two pieces shown in Fig. 7 were also finished in this way.

Fig. 9 shows a brass shell, which is a good example of "air spinning," so called because the finishing or second operation on part of the shape is done in the air, thus avoiding the use of a sectional or split chuck. The shell shown is about 5½ inches in diameter. The first or breaking-down chuck is shown at *A*. The neck or small part of the piece, and also a portion of the spherical surface, is formed by the spinning tool without any support from the chuck. After the shell is spun, or broken down on chuck *A*, it is annealed and pickled. It is then put back on chuck *A* and planished or hardened on the part that is to retain its present shape. The work is then placed on the chuck *B* and the soft part is manipulated by the tool until it conforms to the shape shown to the right. While this soft part of the metal is being formed, the part which was previously hardened retains its shape.

Fig. 11 Another Group of Spinning Chucks. Those in the Upper Row are of the Split or Key Type

Various Types of Metal-spinning Chucks and Their Construction

A miscellaneous collection of spinning chucks is shown in Fig. 10. As will be seen, the larger ones are machined out in the back to lighten them, and also to give them an even balance. The larger of those illustrated measure about 9½ inches in diameter, and they are made of cast iron, while the smaller chucks shown in this view are of machine steel. The chuck marked *A* is a key chuck. Another collection of spinning chucks of various shapes is shown in Fig. 11. Those in the upper row are all key or split chucks, and the keys are shown withdrawn from the sockets. All these chucks, up to 6 inches in diameter, are made of machine steel; those seen in the lower row are shapes which are comparatively easy to spin.

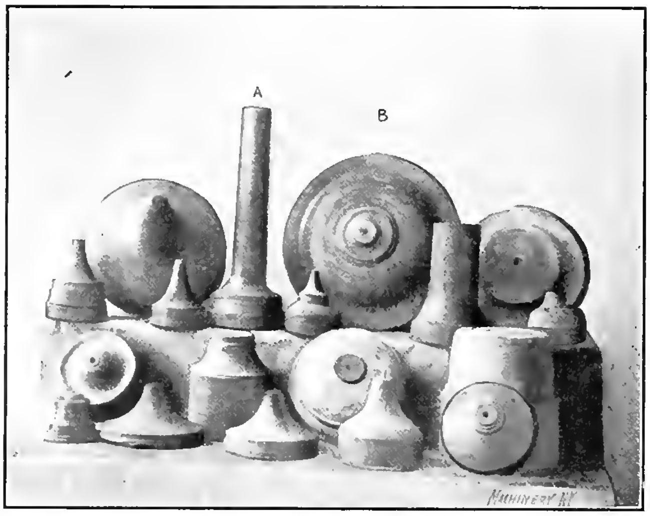


Fig 12. Various Forms of Spinning Chucks made from Hard Maple

A collection of hard maple chucks is shown in Fig. 12, some of which represent shapes that are difficult to spin. The chuck *A* is 15 inches long, and the maximum diameter of *B* is 12½ inches. These figures will serve to give an idea of the proportions of the other chucks. All of the chucks shown have threads cut in them and they are screwed directly to the spindle of the lathe, the faceplate being dispensed with. Some of the larger wooden chucks used measure approximately 5 feet in diameter. A chuck of this size is built up of sections which are glued together.

A number of bronze sectional split chucks are shown in Fig. 13. When spinning over a sectional chuck, it is first necessary to break down the shell as far as is practicable on a solid chuck. Care should be taken, however, to leave sufficient clearance so that the work may be withdrawn. The shell is then annealed, after which it is put on the sectional chuck and the under cut or small end is spun down to the chuck surface. When the entire surface of the shell is spun down to a bearing, the shell is planished or skimmed to a smooth surface; the open edge is also trimmed even and the shell is polished with emery cloth.

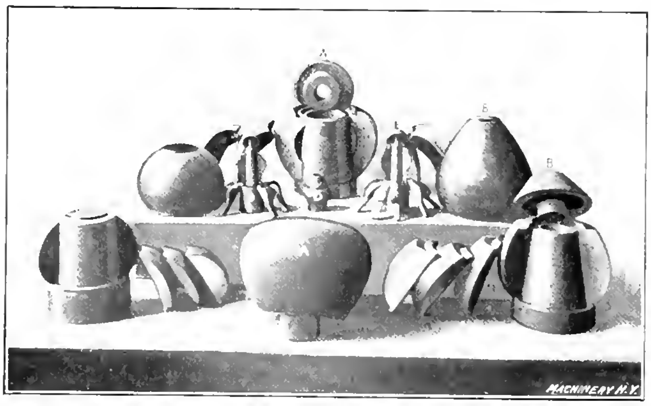


Fig. 13. A Group of Bronze Sectional Chucks

A large bronze chuck of seven sections, one of which is a key section, is shown at *A*. The largest diameter of this chuck is 10 inches. It has a cast iron center hub and a steel cap at the top for holding the sections in place. This cap, when in place in the retaining groove shown, is flush with the top of the chuck. Another large chuck having five sections and one key section is shown at *B*. The retaining cap in this case is of a different form. The lower part of the sections of all these chucks fit in a groove at the bottom of the hub. A chuck of five sections, that is without a binding cap, is shown at *C*. This is not a good design as the hub or center is too straight, and all of the grip or drive is from the bottom groove, which is not sufficient. The shape shown at *D* is more difficult to spin than any of the others, as it is smaller at the opening in proportion to its size. This chuck also requires more sections in order that it may be withdrawn from the shell after the latter is spun. The chuck *E* is intended for a small shell that is also difficult to spin. The drive pins which prevent the segments of the chuck *E* from turning, may be seen projecting from its base. The centering pins at the outer end of chucks *D* and *E* and the binding caps may also be seen. The chuck *A*, because of its size, is hollowed out to reduce the weight. All of these chucks were made for hard service, and they have been used in spinning thousands of shells.

Another group of sectional chucks is shown in Fig. 14. There are mostly made from hard maple. The sections of chuck *A* are planed and fitted together and thin pieces of paper are glued to these sections before they are glued collectively for turning. By using the paper between the joints, the sections may be easily separated after they are turned to the proper size and form. If the different sections were glued without paper between them, the joint formed would be so good that the separation of the sections could not be controlled, and parts from opposite sections would be torn away. The use of the paper, however, between the glued joints, controls the separation of the sections. The chuck shown at *D* is also made with the paper between the sections. Chucks *B* and *E* are turned from the solid, care being taken to have the grain of the wood lengthwise. After they are turned to the required form, they are split into sections with a sharp chisel. Before doing this, the key-section should first be laid out. There should be as few sections as possible, the number being just sufficient to enable the withdrawing of the chuck from the shell after the latter is spun to shape. This method of making a chuck, while quicker than the other, is not good practice, except for small work.

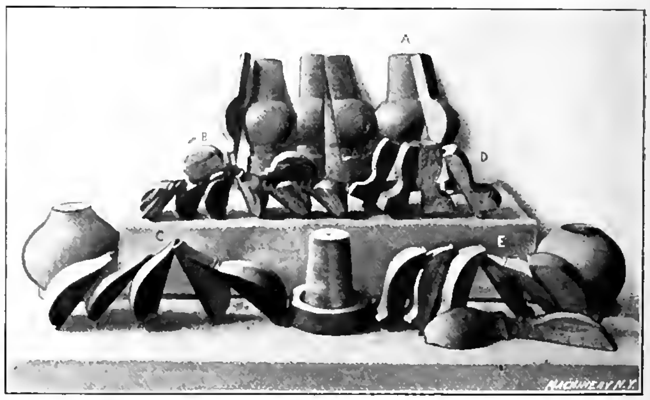


Fig 14. Sectional Chucks made from Wood

A lignum vitæ chuck is shown at *A* in Fig. 15 that was made with paper between the sections. The key-section is shown on top. This wood, while being more durable than hard maple, costs sixteen cents a pound in the rough and, counting the waste material, is not any cheaper than bronze, and is less durable. The hard maple chucks *B* and *C* were turned from the solid, after which the sections were split. The segments shown in the center of the illustration did not split evenly, owing to a winding or twisting grain.

The construction of a sectional spinning chuck is shown in Fig. 16. This illustration also shows the proper proportion for the central hub and its taper. This hub should never be straight, but should have from 5 to 7½ degrees taper on the central part. There should also be a taper of 1½ degree on the other binding surfaces as indicated. These parts are made tapering so that the shell can be released from the

lathe after spinning, without hammering or driving; when straight surfaces are used the work has to be pried off, and it is also harder to set up the sections for the next shell. Another disadvantage is that with straight fittings the wear cannot be taken up. An end cap or binder should be used wherever possible as it steadies the chuck. A drive pin should also be used and the hole for it drilled in the largest

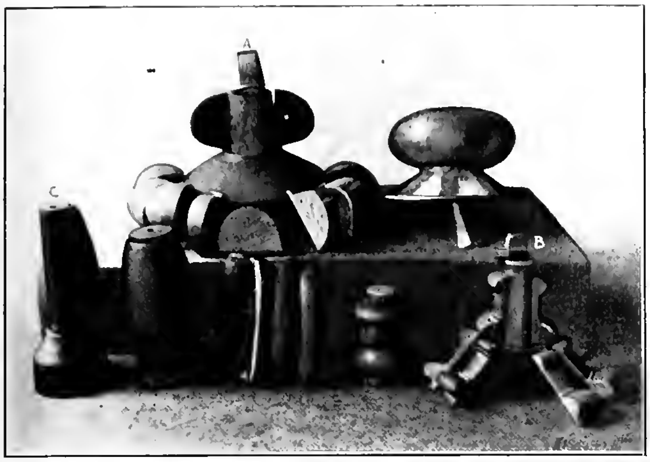


Fig. 15. Other Examples of Wooden Sectional Chucks

section; this is important, as it gives the sections a more positive drive. If they slip they will soon wear themselves loose and leave openings at the joints.

The plan view shows the method of laying out the various sections. The key should be laid out first. One key is enough for the particular form of chuck illustrated, but it is often necessary to use two key sections when the shell opening is small.

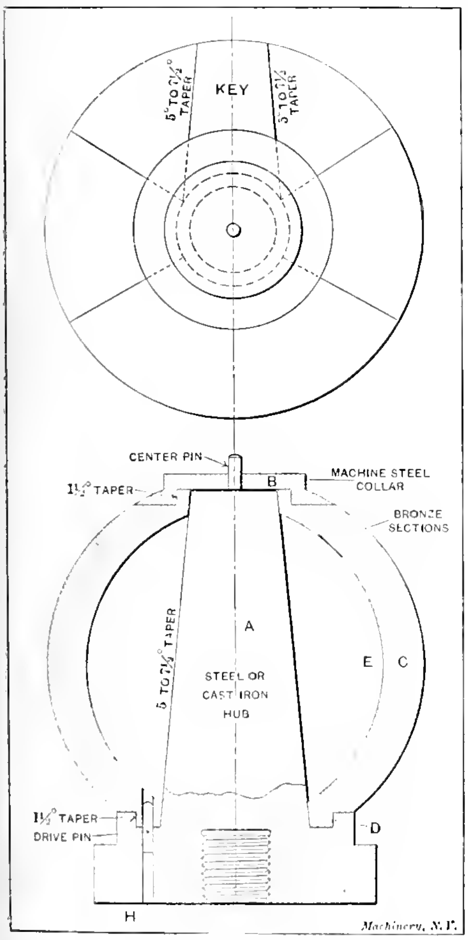


Fig. 16. Elevation and Plan showing Construction of Sectional Chuck

When a sectional chuck is to be made, it is important to decide first on the size of the central hub A, the number of sections C, and also the design of the cap or binder B. This cap must not exceed in size the opening in the finished shell, as it would be impossible to remove it after the chuck sections were taken out. After the size of the hub A has been decided upon, a wooden form should be turned that is a duplicate of A, except that a spherical surface E should be added. This spherical part should be slightly smaller than the inner diameter of the bronze sections in order to allow for machining them. In turning this wooden pattern on which the plaster patterns for the sections are to be formed, the shoulder D should be omitted, as a removable metal ring will take its place.

When the wooden hub is ready, two metal partitions or templets of the same outline as the chuck, though about one-half inch larger than its total diameter, for shrinkage and finishing, are fastened to the hub in the correct position for making a plaster pattern for the key section. These patterns should have extension ends so that the sections when cast, may be held by them while they are being turned. The templets should be banked around with a wad of clay, and they should also be coated on the inside with sperm oil to keep the plaster from sticking. There should be two brads driven in the hub for each section of plaster to hold the sections in place while they are being turned. After the plaster for the key section has hardened, the templets should be located, one on each side of the key section, so that the two adjacent sections may be made. In this way all the sections are finished. After about forty-eight hours the plaster will be hard enough to turn in the lathe with a hand tool. The form should be roughly outlined and plenty of stock left for shrinkage, as bronze shrinks considerably. Before taking the sections off the wooden frame, the metal band D should be removed to allow the sections to be separated. This should not be done, however, until they are numbered, so that they can be again placed in their proper positions. After the sections are cast, they should be surfaced on a disk grinder, or finished with a file, care being taken to remove as little metal as possible. Each section is next tinned on both contact faces, and then all are assembled and sweated or soldered together by a blow-pipe. It is sometimes necessary to put a couple of strong metal bands around the sections to hold them firmly in place when soldering and also to support them during the turning operation.

The central hub A should be machined first; then the assembled outside shell should be machined to fit the hub A, both on the taper part and at the point D. While the segments are being bored and faced, they are held by the extension ends (not shown) which were provided for this purpose. This outer shell should also be machined all over inside so that it will be in balance. It is then taken out of the chuck and a hole is drilled in the largest section for drive pin H. The hub A is then caught in the lathe chuck with the assembled sections on it, and a seat is turned for the cap B. After this is done the binder bands can be removed, but not before. The chuck can be finished with a hand tool and file after the roughing cut is taken. After the sections are removed from the hub and numbered at the bottom or inner ends, they can be separated by heating them. If the joints are properly fitted there will be only a thin film of solder which can be wiped off when hot.

* * *

A new iron has been produced and sold for a short time past by the American Rolling Mill Co., of Middletown, Ohio. It is a product of the open-hearth steel furnace, but in chemical composition and in mechanical properties it is so closely similar to wrought-iron that the term "steel" can no longer be applied to it properly. The makers have given it the trade name "American Ingot Iron." This ingot iron differs from steel in having its carbon, manganese and silicon contents reduced to small fractions of the amounts found in ordinary soft steel. A typical analysis is as follows: Carbon, 0.02 per cent; manganese, 0.01 per cent; phosphorus, traces; sulphur, 0.02 per cent, and silicon, traces. The metal is to all appearances identical with dead soft steel, or a good wrought-iron, though its fracture lacks the ropy fiber seen in the latter. Its strength is closely the same as that of wrought-iron. Several tests indicate an ultimate tensile strength of from 47,000 to 49,000 pounds per square inch. Its ductility is remarkably high, and the metal is rolled into sheets and the sheets used for drawing in the drawing press with good results. The prime quality of this ingot iron, however, is its resistance to corrosion. This was the object for which it was originally produced as an experiment, and when trials against steel in sulphuric-acid solutions showed the hope of high corrosion resistance to be borne out, it made the metal at once the most interesting appearance in iron metallurgy of the present time.

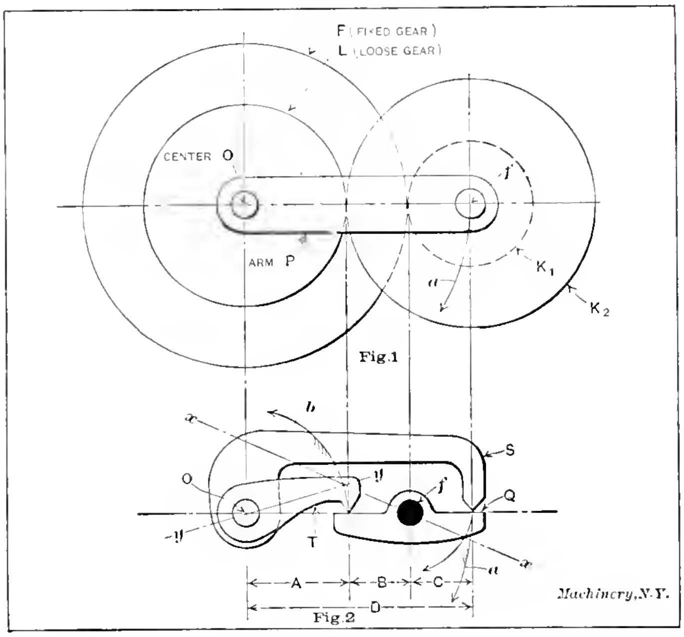
* * *

Don't forget that it is a high point in economy to put all necessary information and data on all drawings.

SOLUTION OF EPICYCLIC GEARING BY THE METHOD OF LEVERS*

By JOHN S. MYERS†

The solution of epicyclic, planetary, or as it is sometimes called, differential gearing, is often rather confusing. This is especially the case to the person who approaches the subject for the first time, and, unless some correct and systematic method be pursued, two different men working independently on the problem are quite likely to get entirely different results as to the velocity ratio, and resultant direction of rotation. The method which is probably most generally known is that of separate motions, and the only drawback to this method is the liability of getting the signs (+ and —) mixed.



Figs. 1 and 2. Diagram for the Solution of Problem in Epicyclic Gearing by the Lever Method

In the following problems the writer has illustrated the application of this method, at the same time applying a method which he has termed *the lever method*, in each case checking the latter by the former to prove the work.

The principal advantages of the lever method are: 1. That the resultant direction of rotation can be determined without calculation by a simple process of inspection, thereby reducing the chances of error to a minimum, and offering a ready means of checking the result obtained by some other method. 2. It facilitates finding the directions and amounts of the tooth pressures.

When applying the lever method for velocity ratios, instead of taking the actual radii of the various gears, these radii may be taken as the number of teeth in the respective gears if all the gears in the train are of the same pitch. If the gears are not all of the same pitch, take the number of teeth equivalent if they were all of the same pitch. For example, if in Fig. 1 the gears F and K_1 are 1-inch pitch and have 40 and 20 teeth, respectively, while gears L and K_2 are ¾-inch pitch and have 48 and 32 teeth respectively, we could reduce them all to the equivalent number of teeth at 1-inch pitch; when the number of teeth in L would be $\frac{3}{4} \times 48 = 36$, and in K_2, $\frac{3}{4} \times 32 = 24$. We would then consider these numbers as the radii of the respective gears. This eliminates slight errors due to dropping decimals when working out an actual pitch diameter and using it in the equations for velocity ratios.

Examples of Planetary or Epicyclic Gearing

In Fig. 1 is shown a train of planetary gears, in which F is the fixed or stationary gear, sometimes termed the sunwheel. K_1 and K_2 are the planetary gears which are keyed together and rotate about the center f at the same time as they are rotated bodily about the center O in the direction indicated by the arrow a, the arm P actuating the motion. The gear L is free to turn on its axis.

Problem 1.—a. What is the direction of rotation of gear L? b. What is the angular velocity of gear L as compared to that of arm P? ....

a. For a small fraction of a revolution, the action of a lever and a gear are similar, as far as direction and velocity ratios are concerned. Hence we may replace the gears and the arm P by a system of levers as shown in Fig. 2. The teeth of the fixed gear will always constitute the fulcrum of one of the levers, corresponding to the fulcrum f of lever Q in Fig. 2. The arm P in Fig 1 corresponds to the lever S in Fig. 2, while gear L corresponds to lever T, and gears K_1 and K_2 to lever Q.

Now assume that motion is imparted to lever S in the direction indicated by the arrow a; then lever Q will be inclined in the direction indicated by the line xx and being in contact with lever T it will cause this lever to move to the position indicated by the line yy, or to rotate in the direction of the arrow b. This arrow then shows the direction of rotation of gear L, which was to be determined. The answer to question (a) is, therefore, that gear L rotates in a direction opposite to that of arm P. This answer is arrived at by a very simple process, thus presenting the minimum chance of error..

b. It is now required that we find the ratio of the angular velocity of gear L to that of arm P. Referring to Fig. 2, we find that if lever S made one complete revolution, the end in contact with Q would move a distance equal to $2\pi D$, and consequently cause that end of lever Q which is in contact with lever T to impart motion to the latter lever, the amount of which would be $\dfrac{2\pi DB}{C}$

One turn of lever T would require this end to be moved a distance of $2\pi A$. It, therefore, revolves, for one turn of S, a number of revolutions equal to $\dfrac{2\pi DB}{C \times 2\pi A} = \dfrac{BD}{AC}$.

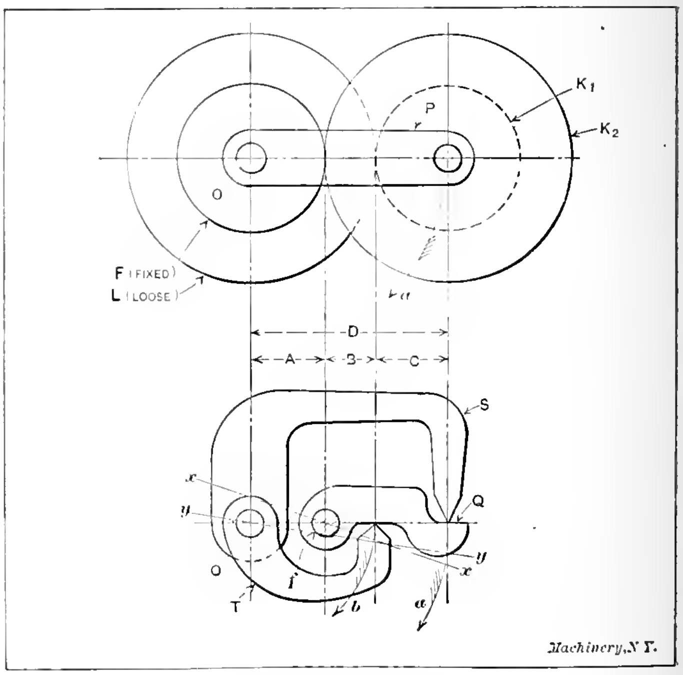


Fig. 3. Diagram for Problem 2

The gear ratio may therefore be stated thus:

Revolutions of P : revolutions L : : $1 : \dfrac{BD}{AC}$;

or since P is the driving and L the driven member, we would say that the gear reduction is $1 \div \dfrac{BD}{AC}$, or simply $\dfrac{AC}{BD}$. If this quantity be less than unity it indicates an inverse speed reduction.

The results obtained may be verified by a common method of separate motions. First lock the gears together and turn the entire mechanism one revolution to the right; call this direction positive (+).

* For additional information on epicyclic gearing, see the following articles previously published in MACHINERY: Epicyclic Gearing, August, 1899; May, 1900, and August, 1900; and Some Applications of Epicyclic Gearing, September, 1900. See also MACHINERY'S Data Sheet No. 102, Simple and Compound Epicyclic Trains.

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Second, hold arm P stationary and turn gear F back one turn in the negative (—) direction. The net or combined result on gear F is zero, or "no motion," while for gear L we have:

1st condition: Revolutions of $L = +1$.

2nd condition: Revolutions of $L = -1 \times \dfrac{A+B}{C} \times \dfrac{B+C}{A}$.

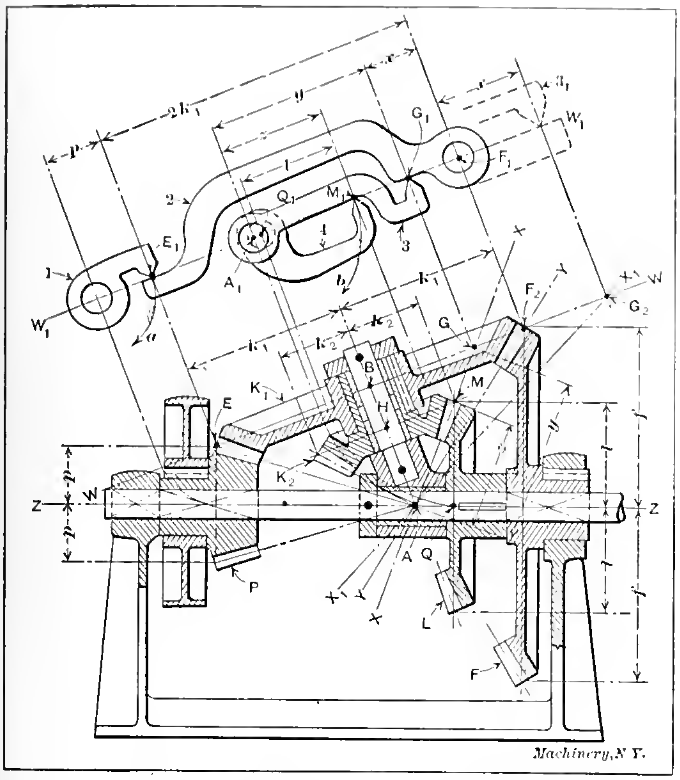


Fig. 4. Compound Bevel Gear Epicyclic Train

Adding these results, we have the number of revolutions of gear L for one positive (+) turn of arm P:

$$1 - \frac{(A+B)\ (B+C)}{AC} = -\frac{B\,(A+B+C)}{AC}$$

and since $A + B + C = D$, the number of revolutions $= -\dfrac{BD}{AC}$.

which is the same result as that obtained by the lever method, the minus sign only serving to show the direction of rotation of L, which is opposite to that of P.

Problem 2.—In Fig. 3 the small gear F is fixed and the

Fig. 5. Diagram for the Solution of Epicyclic Train in Fig. 4

larger gear L loose. Arrow a indicates the direction of motion of arm P, while arrow b shows the direction of rotation of the driven wheel L, or lever T, which for this case is the same as the direction of driver P. By the method of levers the revolutions of L for one revolution of P equals

$$\frac{2\pi BD}{(B+C) \times 2\pi\,(A+B)} = \frac{BD}{B\,(A+B+C)+AC} = \frac{BD}{BD+AC}$$

By the usual method of separate motions we would have the number of revolutions of L =

$$1 - \frac{AC}{(B+C)\ (A+B)} = \frac{B\,(A+B+C)}{B\,(A+B+C)+AC} = \frac{BD}{BD+AC},$$

thus showing that both methods are correct analyses of the conditions, as they both give the same results.

Compound Bevel Gear Epicyclic Train

In the train of bevel gearing shown in Fig. 4, P is the prime mover, L is the loose or driven gear, K_1 and K_2 are keyed together, and F is fixed. The action of gears P, K_1, K_2, and L is represented by levers 1, 2, 3 and 4 respectively. Point F_2 of gear F constitutes the fulcrum F_1 of lever 2. Points A and Q are projected upon line W_1W_1 at A_1 and Q_1. These points (A_1 and Q_1) form the fulcrums of levers 3 and 4, respectively. Now let:

T_P = any given number of revolutions of gear P,

T_L = resulting revolutions of gear L,

$R = \dfrac{T_P}{T_L}$ = gear reduction of entire train.

By reference to the leverage diagram it is seen that if gear P rotates in the direction of arrow a, gear L will rotate in the direction indicated by arrow b. Gears P and L thus rotate in the same direction. We further have, by the principle of levers:

$$T_L = T_P \frac{2\,\pi\,p\,x\,z}{2\,k_1\,y\,2\,\pi\,l} = T_P \frac{p\,x\,z}{2\,k_1\,l\,y} \qquad (1)$$

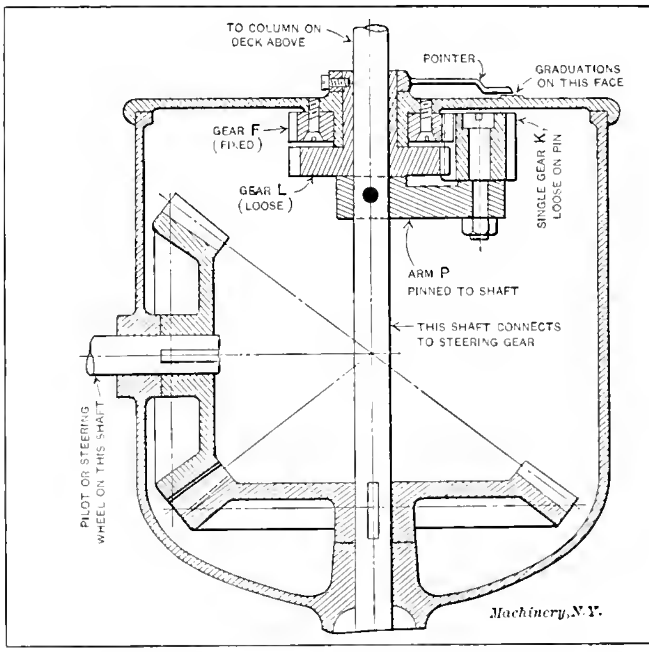


Fig. 6. Planetary Geared Indicator used on Steering Columns

It can be shown by the principles of geometry (see below) that

$$\frac{x\,z}{y} = \frac{2\,k_1\,l - 2\,k_2\,f}{f+p} \qquad (2)$$

Then

$$T_L = \frac{T_P\,p}{k_1\,l}\left(\frac{k_1\,l - k_2 f}{f+p}\right) \qquad (3)$$

from which

$$R = \frac{T_P}{T_L} = \frac{k_1\,l}{p}\left(\frac{f+p}{k_1\,l - k_2\,f}\right) \qquad (4)$$

The results obtained may be verified by the method of separate motions as follows:

First: turn the entire mechanism + 1 turn (arm locked).

Second: hold arm, and turn F back — 1 turn.

1st condition { revolutions of $P = +1$; revolutions of $L = +1$

2nd condition { revolutions of $P = +\dfrac{f}{p}$; revolutions of $L = -\dfrac{f\,k_2}{k_1\,l}$

Summing up the results of these two conditions:

Revolutions of $P = 1 + \frac{f}{p} = \frac{f+p}{p} = T_P$

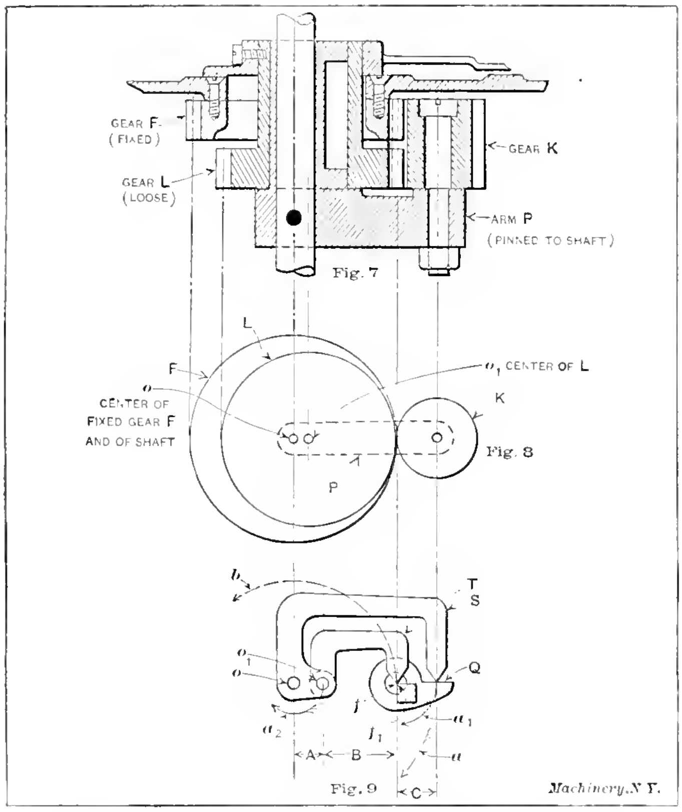
Revolutions of $L = 1 - \frac{f\,k_2}{k_1\,l} = \frac{k_1\,l - k_2\,f}{k_1\,l} = T_L$

Now

$$R = \frac{T_P}{T_L} = \frac{(f+p)\,k_1\,l}{p\,(k_1\,l - k_2\,f)} = \frac{k_1\,l}{p}\left(\frac{f+p}{k_1\,l - k_2\,f}\right)$$

It will be seen that this last equation is the same as equation (4). If the quantity $k_1 l - k_2 f$ is positive, then gear L will revolve in the same direction as gear P. If this quantity is negative, then gear L rotates in a direction opposite to gear P. If, however, this quantity equals zero, then there is no rotation of gear L, no matter what the velocity of gear P is. This is caused by the fact that the gear reduction R is then infinite.

These same deductions can be drawn from an inspection of Fig. 4. If gear K_2 be increased in size, line XX will incline more and more towards line YY, thus increasing the gear ratio in consequence of the decrease in dimension x. When line XX



Figs 7, 8 and 9. Diagrams for Solution of Gear shown in Fig. 6

coincides with line YY, point G has been moved to F_2, $x = 0$ and R = infinity, and there is then no motion imparted to gear L. If gear K_2 is further increased until line XX comes into a position outside of line YY, as indicated by X_1X_1, then the dimension x becomes negative, and gear L will rotate in a direction opposite to that of gear P. By the lever method of analysis, this condition becomes at once apparent, for if point G falls outside of point F_2 as at G_2, lever 3 would be located as shown in dotted lines at 3_1. It is seen then that levers 3 and 4 would rotate in a direction opposite to that of lever 1.

When the shafts are at right angles to each other $f = p$ and

$$R = \frac{T_P}{T_L} = \frac{2\,k_1\,l}{k_1\,l - k_2\,p} \qquad (5)$$

The method of obtaining equation (2) may need some further explanation (see Fig. 5).

$$EF = 2\,k_1;\ ET = f - p;\ BD = \frac{f+p}{2}$$

$$CS = TF = \sqrt{EF^2 - ET^2} = \sqrt{4\,k_1^2 - (f-p)^2}$$

$$AB = \frac{EF}{CS}\,BD = \frac{k_1\,(f+p)}{\sqrt{4\,k_1^2 - (f-p)^2}}$$

$$\sin a = \frac{ET}{EF} = \frac{f-p}{2\,k_1};\quad MJ = k_2 \sin a = \frac{k_2\,(f-p)}{2\,k_1}$$

$$HN = JQ = l - MJ = l - \frac{k_2\,(f-p)}{2\,k_1}$$

$$HA = HN\,\frac{EF}{CS} = \frac{\left[l - \frac{k_2\,(f-p)}{2\,k_1}\right] 2\,k_1}{\sqrt{4\,k_1^2 - (f-p)^2}} = \frac{2\,k_1\,l - k_2\,(f-p)}{\sqrt{4\,k_1^2 - (f-p)^2}}$$

$$\tan b = \frac{k_2}{HA} = \frac{k_2\sqrt{4\,k_1^2 - (f-p)^2}}{2\,k_1\,l - k_2\,(f-p)}$$

$$BG = AB \tan b = \frac{k_1\,k_2\,(f+p)}{2\,k_1\,l - k_2\,(f-p)}$$

$$x = GF = k_1 - BG = k_1 - \frac{k_1\,k_2\,(f+p)}{2\,k_1\,l - k_2\,(f-p)}$$

We further have

$$\frac{z}{y} = \frac{k_2}{BG} = \frac{k_2\,[2\,k_1\,l - k_2\,(f-p)]}{k_1\,k_2\,(f+p)}$$

Then

$$\frac{x\,z}{y} = \frac{2\,k_1\,l - 2\,k_2\,f}{f+p}$$

Indicator with Planetary Gears as used on Steering Columns

Fig. 6 shows a type of indicator used on steering columns. In practice, gear F may have 36 teeth, gear L, 35, and gear K, 18. Theoretically there should be two different sizes of planetary gears in place of the single gear K, in order that the teeth might mesh properly. In practice, however, the single gear is simpler and entirely satisfactory. In order to apply the method of levers to the solution of this problem, let us conceive of the device as constructed along theoretically correct lines. Fig. 7 shows, in section, a construction which would give theoretically correct results. In Fig. 8 is shown a diagrammatical plan view of Fig. 7, showing the pitch circles of the gears. In Fig. 9 is shown a system of levers which would have the same velocity ratio and the same direction of motion of the lever T as the gears in Fig. 7 would give to gear L. It will be noted that lever Q has one arm of the length C, while the length of the other arm is zero. It, therefore, has no influence upon the velocity ratio. The fulcrum of the lever Q is at f, while f_1 is the fulcrum, or more properly the abutment, of lever T. The end of lever T which is in contact with f_1 is stationary.

Now when lever S is rotated through a small arc in the direction indicated by arrow a, then lever Q is rotated as indicated by arrow a_1 and point o_1 and lever T are moved as indicated by arrow a_2. This movement of point o_1 is equivalent to rotating lever T about the point o_1 in the direction indicated by arrow b. Thus arrow b indicates the direction of rotation of lever T or of the gear L, which corresponds to T.

The ratio of the system of levers in Fig. 9, or of the gearing in Fig. 7, may now be arrived at by the method of levers as follows:

In one revolution of lever S, the point moving along the arrow a_2 would travel a distance equal to $2\pi A$. Dimension A has been shown enlarged in Fig. 9, in order to show the existing conditions more clearly. Now as far as the angular motion of lever T is concerned, we may consider this movement $2\pi A$ to have occurred at the end f in the direction of arrow b, and we may treat point o_1 as the center of rotation, which in fact it is for T or L. One turn of lever T about o_1 would require point f to be moved a distance of $2\pi B$; therefore, a movement of $2\pi A$ would revolve T as many revolutions as $2\pi B$ is contained in $2\pi A$; or, for one turn of lever S, lever T will make $\frac{2\pi A}{2\pi B} = \frac{A}{B}$ revolutions; and since S corresponds to arm P, and T to gear L, we may express the ratio thus:

Revolutions of P : revolutions of L : : $1 : \frac{A}{B}$.

Since P is the driver, we may say that the gear reduction is

$$1 \div \frac{A}{B} = \frac{B}{A}.$$

The ratio obtained by the method of separate motions agrees with the above, the final turns of L for $+1$ turn of P being

$$1 - \frac{A+B}{B} = -\frac{A}{B},$$ the minus sign indicating that L rotates in a direction opposite to that of P.

It will be noted that in this last problem the method of levers is rather cumbersome to apply, inasmuch as we are compelled to first make a theoretically correct layout, as was done in Fig. 7, before it was possible to solve the problem. The principal value of the method in a case like this may therefore be that of a check on the calculations. But velocity ratios and directions of rotation are not the only features with which the designer must deal. He must also find the tooth loads, pressures of bearings, etc., if he is to intelligently proportion the various parts. This is, in particular, where the lever method aids the designer. It makes it easier to determine the direction and amount of the various tooth and bearing pressures.

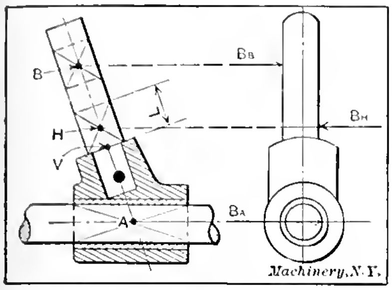


Fig. 10. Diagram for Determining Bending Moments on Main Shaft in Fig. 4

Tooth Loads and Bearing Pressures

Referring now to Fig. 4 let

T_E = tooth load at point E,
T_F = tooth load at point F_2,
T_M = tooth load at point M,
B_A = load on bearings at point A.

The horsepower and revolutions per minute of gear P being known, the tooth load at E will be found as below (p being in inches and N = revolutions per minute):

$$T_E = \frac{33{,}000 \times \text{H P} \times 12}{2\pi p \times N} \qquad (6)$$

In the system of levers this force T_E acts at point E_1 and has a turning moment about the assumed point G_1 equal to $T_E \times (2k_1 - x)$. The resulting force at F_1 is then:

$$T_F = \frac{T_E\ (2k_1 - x)}{x}. \qquad (7)$$

The tooth load T_M is the force acting at point M_1 in the lever system. Taking the moment of T_E about the point F_1 and dividing by x gave the force acting at point G_1. Taking the moment of this force about point A_1 and dividing by z will give the force acting at point M_1. Thus:

$$T_M = \frac{T_E \times 2k_1 y}{xz}. \qquad (8)$$

The load on the sleeve or bearing at point A is the force acting at point A_1 in the lever system and is found in a similar manner. Thus:

$$B_A = \frac{T_E \times 2k_1 (y - z)}{xz} \qquad (9)$$

Similarly the force acting on the bearing at point H is (see Fig. 10):

$$B_H = B_A \frac{AB}{BH}. \qquad (10)$$

and at point B

$$B_B = B_A \frac{AH}{BH}. \qquad (11)$$

Bending Moments

The forces T_E T_F T_M and B_A are now known, and the forces B_T and B_U, acting on the main bearings, may now be determined (see Fig. 11). According to the principles of static equilibrium, the algebraic sum of the moments of all the forces about any point must equal zero. Taking moments about point U, and calling all the upward forces positive (+) and all the downward forces negative (—) gives us:

$$T_F \times US - T_M \times UQ + B_A \times UA + T_E \times UC + B_T \times UT = 0$$

or

$$-B_T = \frac{T_F\ US - T_M \times UQ + B_A\ UA + T_E\ UC}{UT} \qquad (12)$$

Taking moments about point T gives us, in the same way,

$$-B_U = \frac{T_E \times TC + B_A \times TA - T_M \times TQ + T_F\ TS}{TU} \qquad (13)$$

When inserting the actual values and solving for B_T or B_U, if the sign is +, the force acts upwards, and if the sign is —, the force acts downwards, as indicated in Fig. 11.

All the external forces now being known, the bending moments at the various points may be determined. Before doing so, it is well to apply the principle of static equilibrium as a check on the values of B_T and B_U. The algebraic sum of all the external forces must equal zero. Thus for the present case:

$$\pm B_T + T_E + B_A - T_M + T_F \pm B_U = 0 \qquad (14)$$

In this formula, as well as in the following, the sign $\pm$ in front of B_T and B_U indicates that these quantities are to have their proper sign + or — as determined by inserting the actual values in equations (12) and (13).

For the bending moments in the shaft, the moment at any point is equal to the algebraic sum of the moments of all the forces at one side of the point. Let M_C, M_A, M_Q and M_S be the bending moments in the shaft at the respective points C, A, Q, and S. Then:

$$M_C = \pm B_T \times TC \qquad (15)$$
$$M_A = \pm B_T \times TA - T_E \times CA \qquad (16)$$
$$M_Q = \pm B_U \times UQ + T_F \times SQ \qquad (17)$$
$$M_S = \pm B_U \times US \qquad (18)$$

If the mechanism were actually constructed as shown in Fig. 4, account should also be taken of the belt pull on the driving pulley. There would also be torsion in the shaft from the point Q to some point beyond on the right-hand side (not shown in the engraving) where the power is taken off. These torsional stresses should be combined with the bending stresses and the shaft proportioned for the ideal or combined moment (see MACHINERY, July, 1908, engineering edition, "Maximum Stresses, Combined Torsion and Bending").

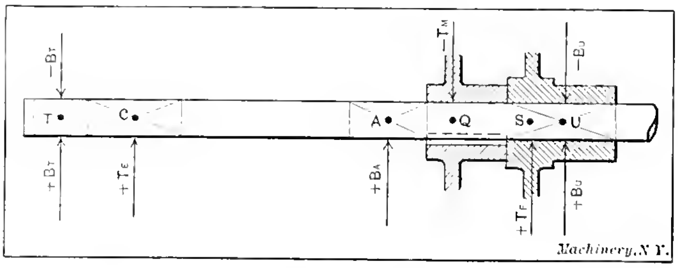


Fig. 11. Diagram for Determining Bending Moments in Stud for Translation Gears in Fig. 4

Referring again to Fig. 10, if points B and H are the centers of the bushings, and the loads are considered as concentrated at these points, the bending moment at H is

$$M_H = B_A \times AH \qquad (19)$$

More correctly the pressures should be considered as uniformly distributed over the whole length L of the bushing. Then the moment is:

$$M_H = B_A \times AH - \tfrac{1}{2} B_H \times \tfrac{1}{4} L$$

The bending moment at the point V is:

$$M_V = B_A \times AV$$

In all the foregoing calculations, the centers of tooth pressure have been assumed to act at the outside pitch diameters of the gears, which, of course, is not strictly correct. For the moments on the shaft in Fig. 11 the forces T_E, T_M, and T_F should be shifted to about the center of the gear faces.

SLIDE RULE FOR HELICAL SPRING CALCULATIONS

By M. E. DAVIS*

The accompanying illustration is a reproduction of the graduations on a slide rule used for calculations of helical springs. The graduations as shown are, in fact, for two slide rules. They have been reproduced in such a scale that they may be cut out and pasted on a wooden slide rule made similar to the regular calculating rules. If desired, they can be pasted directly on top of the regular scales on ordinary slide rules. They have been used for more than two years in the Ordnance Department drawing-rooms at the Washington Navy Yard, and have been the means of considerable saving in time. The chances for errors are also much less than when calculating directly by the formulas. The method of using the slide rule is easily grasped, even by those who are not familiar with the ordinary type. Those who cannot successfully use spring formulas will have no difficulty with this instrument. If one does not care to cut out the scales and paste them on a slide rule, one can use them to advantage by simulating the movement of the slides by means of measurements taken by a pair of dividers, thus arriving at the same results.

The lower set of scales for the deflection of springs was computed with a torsional modulus of elasticity of 12,600,000. If any other modulus is required, a correction for it is provided on the scale, as will be explained later.

In order to describe the use of the slide rule it is best to take a concrete example. The different scales are designated by letters as indicated below:

A	Stress	
B	Load	Slide
C	Diam. of Wire	Slide
D	Mean Diam. of Spring	

E	Load	
F	Deflection per Coil	Slide
G	Diam. of Wire	Slide
H	Mean Diam. of Spring	

Scales B and C are mounted on a slide and scales F and G are also mounted on a slide. All the other scales are on the stationary part of the slide rule or rules.

Assume that the dimensions of a spring which will sustain a load of 250 pounds when the fiber stress in the material is 80,000 pounds per square inch is required. The graduation 250 on scale B, giving the load in pounds, is brought opposite the graduation 80 on scale A, giving the stress per square inch in thousands of pounds. Scales C and D now give the diameter of wire and the mean diameter of coil, respectively. It will be seen that there is a series of springs that meets the requirements, the mean diameter of coil being in each case opposite the corresponding diameter of wire. Springs of the dimensions given below will be seen, for instance, to fill the conditions:

Mean Diameter of Spring	Diameter of Wire
1.0	0.200
1.5	0.229
2.0	0.252
2.5	0.271
3.0	0.288
4.0	0.317

Assume that the spring having a mean diameter of 2 inches and a diameter of wire of 0.252 inch, is selected. It is required to find the deflection of this spring under a load of 250 pounds. For this the lower set of scales is used. The graduation 0.252 on scale G is brought opposite the graduation 2 on scale H; opposite the load 250 on scale E, the deflection per coil, in this case 0.315 inch, is read off directly

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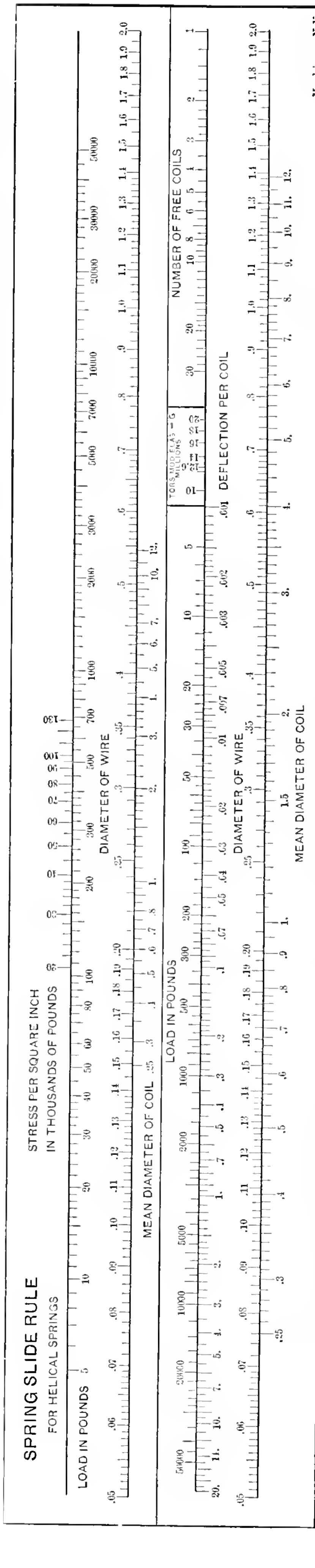

Finding Diameter of Spring and Wire

To find the dimensions of a spring to carry a given load at a given stress per square inch, first find the given stress in thousands of pounds on the *upper stationary* scale. Bring the graduation for the load in pounds on the *upper sliding* scale opposite it. The *lower sliding* scale now gives the diameter of wire required for a spring having a mean diameter as given by the corresponding graduation on the *lower stationary* scale. It will be seen that there are an indefinite number of possible sizes, but there is always one specific size of wire corresponding to a specific mean diameter.

Example:—Given: Stress per square inch, 80,000 pounds; load, 250 pounds.—Found: Diameter of spring 1.0, and of wire 0.200; or diameter of spring 2.0, and of wire 0.252; or diameter of spring 2.5, and of wire 0.271 inch, etc.

Finding Deflection of Helical Springs

To find the deflection per coil when the load in pounds, the diameter of wire and the mean diameter of spring are known, bring the graduation for the diameter of wire on the *lower sliding* scale opposite the graduation for the mean diameter on the *lower stationary* scale; then the deflection is read off on the *upper sliding* scale opposite the given load in pounds on the *upper stationary* scale. The deflection found is for a modulus of 12,600,000. If the deflection is required for any other modulus, move the slide so that the deflection found comes opposite 12.6 on the small scale marked "Tors. Mod. Elas. = G." Then read off, on the upper sliding scale, the deflection for any other modulus opposite this modulus.

Example:—Given: Diameter of spring 2 inches, of wire 0.252.—Found: Deflection for modulus of 12,600,000 equals 0.315; deflection for modulus of 15,000,000 equals 0.264 inch.

on scale *F*. The deflection for any other load can be read off without shifting the slide.

As stated before, the deflection is for a modulus of 12,600,000. If a modulus of 16,000,000 were to be used, a pair of dividers should be set to measure the distance between 12.6 and 16 on the short scale marked "Tors. Mod. Elas. = *G*," and then, by placing one leg of the dividers on the deflection obtained for a modulus of 12,600,000 the deflection for the new modulus, in this case 0.240 inch, will be found at the other point of the dividers, measuring off in the same direction as we measured off from graduation 12.6. The value can also be found directly by bringing the deflection 0.315 opposite the 12.6 graduation on the short scale and reading the new deflection 0.240 opposite the 16 million mark.

[Below the slides in the illustration are shown two sets of directions intended to be pasted on the back of the slide rules, giving in each case in concise language the directions necessary.—Editor.]

* * *

IMPROVING THE OUTPUT OF A KEYSEAT CUTTER

During a visit at the shops of the Colburn Machine Tool Co., Franklin, Pa., the superintendent of the firm explained some improvements made in the details of a Colburn keyseating machine, which had greatly improved its output and its accuracy. The improvement in output was estimated by the foreman in charge of the work to be as high as 25 per cent, taking all classes of work together. The accompanying illustrations show the nature of the changes.

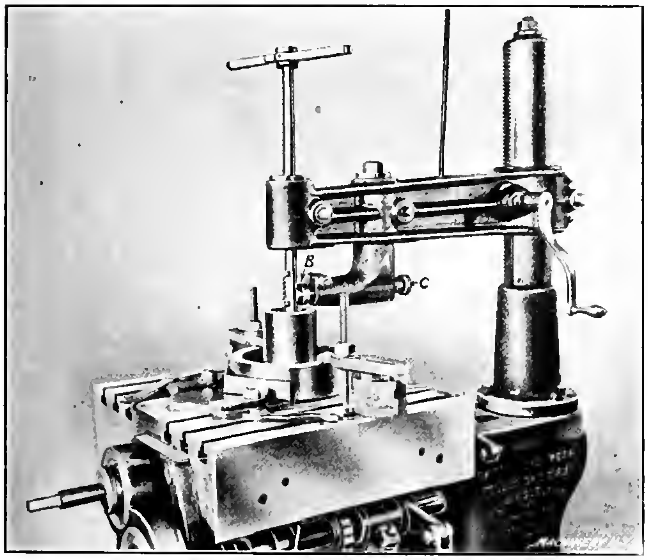

Fig. 1. Colburn Keyseater with Improved Back Support and Multiple Toothed Cutter

In Fig. 1 the keyseating machine is shown set up ready for work in the hub of a clutch member or similar part. Mechanics familiar with the machine will note the addition of a support for the cutter bar. The overhead supporting arm of this machine is regularly provided with two holes for the bushings through which these bars pass, the one on the outside for large diameter work and one further back for work of smaller diameter. In this case, however, the second hole has been utilized for holding the knee casting *A* for the support. This is provided with an iron back-rest at *B*, set up against the cutter bar by the knurled adjusting screw *C*. Clamp-bolts are provided, as shown, for locking the knee casting in the arm, and the back-rest in the knee.

The advantage of this arrangement lies in giving a backing to the bar close down to the work. The supporting bushing in the arm has of necessity to be raised considerably above the work to permit the cutter to clear, so its support is not as effective as it should be, particularly with a slender cutter bar. When a multiple-tooth cutter is used, as shown, the clearance necessary is considerably increased, so the auxiliary support becomes still more necessary.

Fig. 2 shows the construction of this particular form of cutter bar and cutter, which were also designed in this shop. The bar has two slots milled across it connected by the keyway in which the cutter is set. These slots furnish clearance for the keyway to run out into when it is machined, and at the same time they form solid abutments for the ends of the cutter blade, which has simply to be held from dropping out by a small screw, as shown. By providing a number of cutting edges in a blade, thus firmly bedded in the bar, much more rapid cuts can be taken than with the ordinary single-pointed tool.

As shown in Fig. 2, the first blade that strikes the work has the corners well beveled, the next one not quite so much, and so on until the last one, which comes out to sharp corners. This tends to make the tool more durable, as it is only the last cutting edge that gives the finishing shape to the keyway, and this has but a very light cut to take.

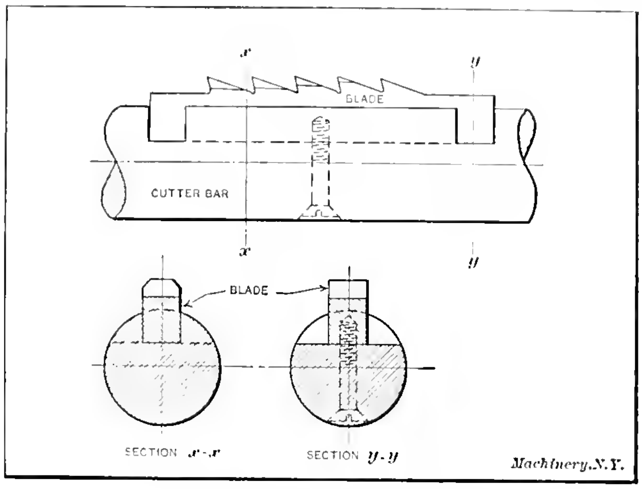

Fig. 2. Details of Multiple Toothed Cutter

Fig. 3 shows how the back-rest is turned around out of the way in removing the work. The cutter bar is withdrawn and the knee casting is loosened and swung around, leaving the table free for the removal and replacing of the work.

The Colburn keyway cutter is, of course, made by the Baker Bros., of Toledo, Ohio, though Mr. L. H. Colburn, of the Colburn Machine Tool Co., was the original inventor. The improvements in the cutter bar and its support, which we have just described, were originated by Mr. B. M. Weller, the superintendent of the latter firm.

* * *

It is stated by the *Scientific American* that Mr. George H. Cove of Somerville, Mass., has constructed a solar-thermo battery which is claimed to produce enough current in ten hours' sunlight to supply thirty tungsten lamps for three days. The apparatus consists of a frame of violet glass, like a large window, below which a number of metallic plugs are set in an insulating material. One end of each plug is constantly exposed to the sun while the other is shaded and cool; the sun's rays thus cause a constant flow of current to the storage batteries.

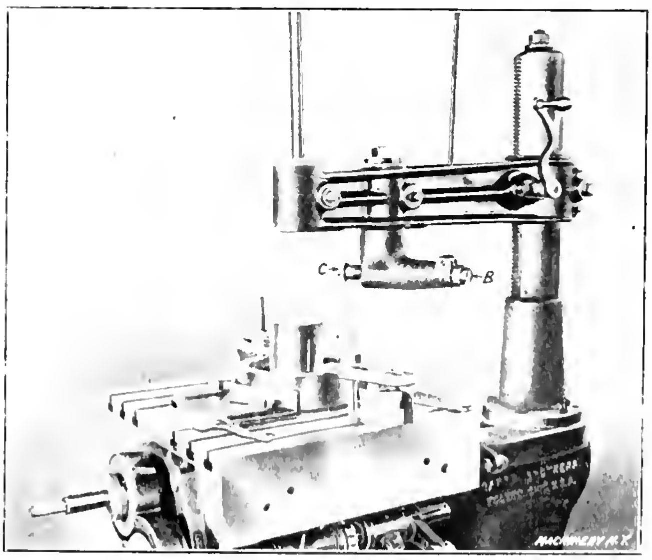

Fig. 3. Support swung back and Cutter raised, to remove Work

AIR COMPRESSOR TESTING*

By E. A. FESSENDEN†

Capacities of air compressors are usually stated in terms of the volume of free air compressed per minute or of the volume of air delivered per minute. The capacity of a given compressor may be determined experimentally by several methods among which may be mentioned: (a). The displacement method, and (b) the orifice method. Since these methods are commonly used, a discussion of them may not be out of place.

The Displacement Method

In its simplest form, the displacement method assumes that the volume swept through by the piston in one minute

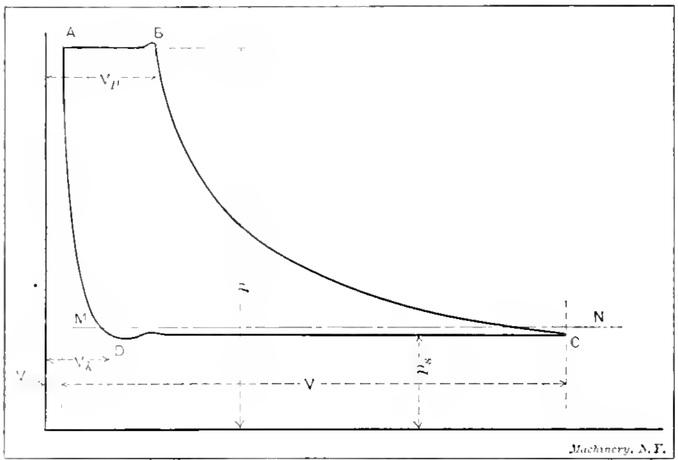

Fig. 1. Typical Air Compressor Diagram

is equal to the volume of free air drawn into the compressor at atmospheric pressure. The formula expressing the capacity under these conditions may be written:

$$Q = \frac{\pi d^2 N s}{4 \times 1728} \qquad (1)$$

where Q = volume swept through by piston in one minute, in cubic feet,

d = diameter of compressor piston, in inches,

s = stroke of compressor, in inches,

N = number of working strokes per minute.

For many purposes this rough method is sufficiently accurate. There are, however, many errors involved in the assumption that the volume of free air drawn into the cylinder is equal to the piston displacement, and these errors make the method unsuitable for accurate work. Before entering into a discussion of the inaccuracies involved in the displacement method together with the means for correcting some of the errors, it may be well to consider briefly the operation of an air compressor.

Fig. 1 represents a typical indicator card from an air compressor cylinder; MN is the atmospheric pressure line; the piston displacement is denoted by V and the clearance volume by V_c. During the suction stroke, air is drawn into the cylinder along the suction line DC. The pressure p_s inside the cylinder during the suction stroke must necessarily be less than the atmospheric pressure, or there would be no flow of air into the cylinder. At C the cylinder is full of air at pressure p_s, and the piston on its return stroke compresses this air along line CB. This compression line may be represented by an exponential equation having the form

$$p_1 v_1^n = p_2 v_2^n \qquad (2)$$

The value of n, according to Peabody,‡ may be as low as 1.2 for a "fluid-piston" compressor, and may approach 1.4 when the air is not effectually cooled during compression. A commonly accepted average value is $n = 1.29$. From this equation there results

$$V_p = (V + V_c)\left(\frac{p_s}{p}\right)^{\frac{1}{n}} \qquad (3)$$

as the volume of high pressure air in the cylinder at the point B. The valves now open and the air is driven out along the line BA until at the end of the stroke, at A, only the clearance volume, V_c, is filled with air at the pressure p. On the suction stroke, no air can be drawn into the cylinder until this clearance air has expanded until its pressure drops to p_s, less than atmospheric pressure, thus allowing the suction valves to open. For simplicity, the slight additional drop in pressure indicated by the wavy line at D, necessary to overcome the inertia of the suction valves, is disregarded. The volume V_k, of the clearance air expanded to the suction pressure p_s, is given by the equation

$$V_k = V_c\left(\frac{p}{p_s}\right)^{\frac{1}{n}} \qquad (4)$$

so that the volume of the new air in the cylinder at the end of the suction stroke is

$$V_s = V + V_c - V_k$$
$$= V - V_c\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right] \qquad (5)$$

It is evident that the assumption that the volume of free air drawn into the compressor per minute is equal to the piston displacement could only be true in a cylinder having no clearance volume, and also where the temperature and pressure of the air on the suction side of the piston are the same as the temperature and pressure of the atmosphere. A consideration of the temperature and pressure conditions during the suction stroke will, however, show that the actual volume of free air drawn in per stroke is less than V_s. Moreover, it should be noted that no account is taken of the leakage from the high pressure side of the piston to the low pressure side, nor of the leakage through the valves. The air leaking past the piston to the suction end of the cylinder takes the place of free air that would otherwise be drawn into the cylinder, so that the free air capacity will appear greater than it really is.

In order to cause a flow of air into the suction end of the cylinder, the pressure p_s must be less than atmospheric pressure; therefore, the air expands as its pressure drops in entering the cylinder, and the original volume of the free air drawn in is less than the volume V_s, occupied by this air after it is in the cylinder. Furthermore, the temperature of the air inside the suction end of the cylinder is higher than the atmospheric temperature, since the air is heated as it enters, by contact with the walls of the cylinder left warm by the previous compression stroke. This also causes expansion and still further diminishes the volume of air necessary to be drawn in from the outside to fill the suction space. It is possible to correct the errors due to these temperature and pressure differences by assuming that the air acts as a perfect gas, so that the equation

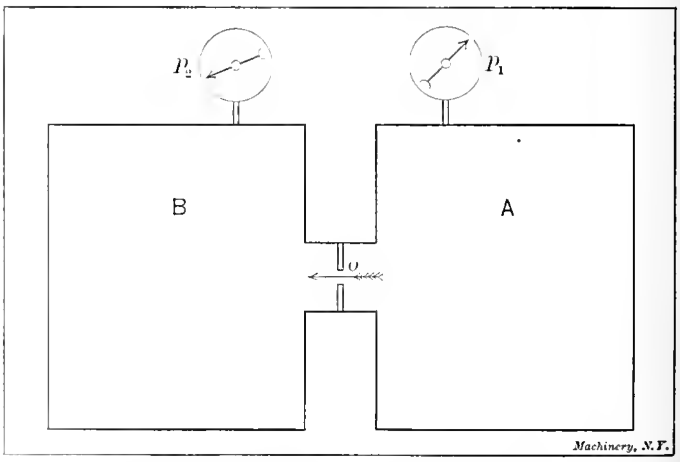

Fig. 2. Illustrating the Flow of Air between Two Reservoirs of Different Pressures

$$\frac{p_a V_a}{T_a} = \frac{p_s V_s}{T_s} \qquad (6)$$

is applicable. In this equation

* See MACHINERY, November, 1909, Engineering edition: Compressor Designing—The Distribution of the Load.

† Assistant Professor of Mechanical Engineering, University of Missouri, Columbia, Missouri.

‡ "Thermodynamics of the Steam Engine," Peabody, 1907 edition, page 361.

p_a = atmospheric pressure in pounds per square inch absolute,
p_s = suction pressure in pounds per square inch absolute, measured from indicator card,
V_a = volume of free air required per stroke, in cubic feet,
V_s = volume of air drawn in after entering cylinder,
T_a = absolute temperature of atmosphere,
T_s = absolute temperature of air in cylinder.

From equation (6) there results

$$V_a = \frac{p_s V_s T_a}{p_a T_s} \qquad (7)$$

It is practically impossible to accurately determine T_s in this equation, but it is probably safe to assume that T_s is about 30 or 40 degrees higher than T_a.

If the value of V_s from equation (5) is substituted in equation (7) there results

$$V_a = \frac{p_s T_a}{p_a T_s}\left\{V - V_c\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right]\right\} \qquad (8)$$

The clearance volume is usually expressed as percentage of the piston displacement, *i. e.*,

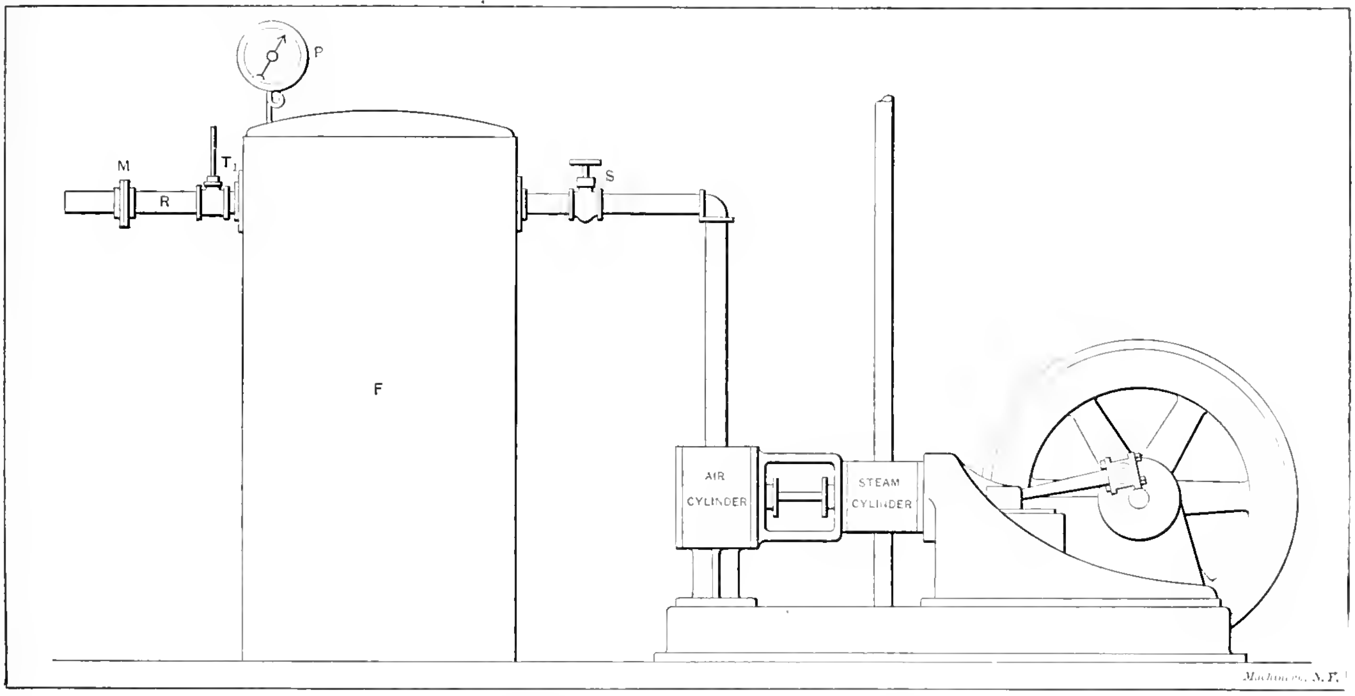

Fig. 3. Air Compressor and Tank arranged for Testing Capacity

$$V_c = \frac{V}{m} \qquad (9)$$

which, substituted in equation (8) gives

$$V_a = \frac{p_s T_a}{p_a T_s}\left\{1 - \frac{1}{m}\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right]\right\} V \qquad (10)$$

The free air capacity in cubic feet per minute for a given compressor is expressed by the formula

$$Q_1 = \frac{\pi d^2 N s}{4 \times 1728} \times \frac{p_s T_a}{p_a T_s}\left\{1 - \frac{1}{m}\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right]\right\} \qquad (11)$$

which is the same as equation (1) with corrections applied for clearance volume, and temperature and pressure of suction. Equation (11) may be corrected for leakage by introducing the factor $(1 - k)$, where k represents the per cent of air leaking past the piston, so that finally

$$Q = (1 - k)\frac{\pi d^2 N s}{4 \times 1728} \times \frac{p_s T_a}{p_a T_s}\left\{1 - \frac{1}{m}\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right]\right\} \qquad (12)$$

Equation (11) gives the free air capacity in cubic feet per minute of any air compressor if we could assume that there were no leakage of air past the piston and valves. This assumption can never be true, and equation (12) is an attempt to correct it. No very close approximation of the value of k, representing the amount of leakage, is possible, since the amount of this leakage is wholly dependent upon the perfection of fit of piston and valves, and this, in turn, is dependent upon the wearing qualities of the materials used in making the compressor and upon the workmanship. Furthermore, the quantities T_s and n in the equation cannot be determined with great accuracy.

The volume of air delivered by the compressor may be obtained from the free air capacity, by assuming that the air acts as a perfect gas and substituting in the formula

$$\frac{p V_d}{T_d} = \frac{p_a V_a}{T_a}$$

$$V_d = \frac{p_a V_a T_d}{T_a p}$$

$$Q_d = (1 - k)\frac{\pi d^2 N s}{4 \times 1728} \times \frac{p_s T_d}{p T_s}\left\{1 - \frac{1}{m}\left[\left(\frac{p}{p_s}\right)^{\frac{1}{n}} - 1\right]\right\} \qquad (13)$$

The displacement method, while it cannot be made entirely accurate with the data now at our command, possesses the advantage that it offers a ready method of quickly estimating the capacity of a compressor with reasonable accuracy without making an elaborate test. It may be applied to multi-stage compressers, in which case the volumes of the low-pressure cylinder alone are concerned in the determination of the free air capacity.

The Orifice Method

In Fig. 2, if a gas is allowed to pass from a vessel A in which the pressure p_1 is high, through a small opening o into a vessel B, where the pressure p_2 is low, it is evident that the volume of gas passing through o in one minute is constant as long as the pressures p_1 and p_2 are unchanged. If desired, the vessel B can be discarded, in which case the gas is allowed to discharge directly into the air, and p_2 becomes the atmospheric pressure p_a. This principle has been thoroughly investigated, and is used as the basis of many methods of measuring both gases and liquids. In all of these orifice methods the volume of air, gas or liquid actually passing through the orifice is measured. Hence, in applying them to testing they take into account all losses due to friction, leakage or other causes in the machine being tested.

Fliegner* has shown experimentally that for a vessel discharging directly into the atmosphere, the rate of discharge is directly dependent upon the pressure p_1 so long as p_1 is more than twice the atmospheric pressure. The results of his experiments have been confirmed by Zeuner and Weisbach. The following equations express the relations deduced from these experiments:

* *Der Civilingenieur*, vol. xx, p. 14

When p_1 is greater than $2p_a$:

$$w = 0.530\, a \frac{p_1}{\sqrt{T_1}} \qquad (14)$$

When p_1 is less than $2p_a$:

$$w = 1.06\, a \sqrt{\frac{p_a\,(p_1 - p_a)}{T_1}} \qquad (14a)$$

in which p_1 = absolute pressure in reservoir in pounds per square inch,

p_a = absolute pressure of atmosphere in pounds per square inch,

T_1 = absolute temperature of air in reservoir, degrees F.,

a = area of orifice in square inches,

w = weight of air discharged in pounds per second.

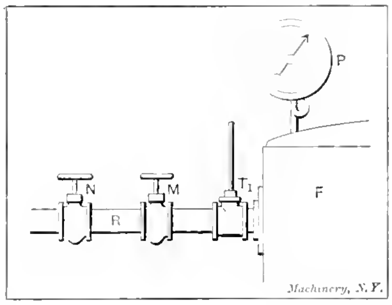

Fig. 4. Arrangement for Testing Capacity by a Modification of the Method shown in Fig. 3

Fig. 3 shows an air compressor arranged for testing by this method. The compressor discharges into a closed tank F, from which extends a pipe R containing an orifice at M. It is important to note that the discharge orifice should be very carefully constructed. It should be short and polished inside so that the friction losses will be reduced to a minimum. The entrance to the orifice must be well rounded and the cross section, preferably, circular. The diameter of the pipe R should be several times that of the orifice and the size of the orifice should be proportioned to the expected capacity of the compressor. A pressure gage P, and a thermometer inserted in a thermometer cup at T_1 show the pressure p_1 and the temperature T_1 of the air delivered to the orifice. Both gage and thermometer should be carefully calibrated, and the diameter of the orifice determined with a micrometer.

If the compressor is operated so that the pressure shown at P is maintained at the required discharge pressure, the speed of the compressor will be about normal if the orifice has been carefully proportioned. It will then be possible to read all

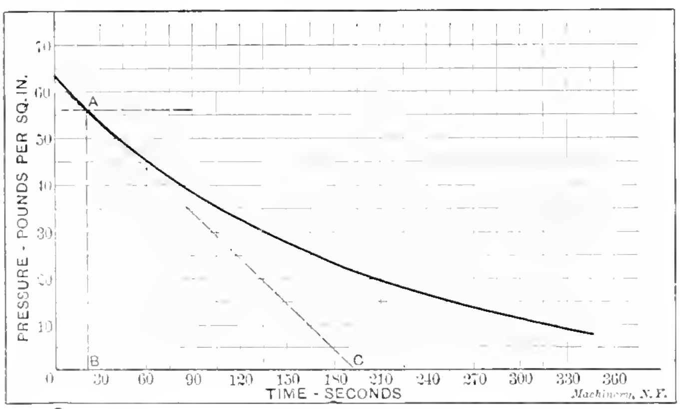

Fig. 5. Diagram plotted from Readings obtained when testing Capacity of Air Compressor

of the quantities required in equation (14), from which the volume of air discharged per minute is

$$Q_d = 60 \times w \times k_d \qquad (15)$$

where k_d = volume of one pound of air at the discharge temperature and pressure.

The value of k_d can be found by finding the volume of one pound of air at atmospheric pressure and at the discharge temperature, from tables published in many handbooks. (See Kent, page 481, 7th ed.); the volume at discharge pressure is then found by the simple rule that the volume of a perfect gas is inversely proportional to the absolute pressure.

Similarly, the volume of free air compressed is

$$Q = 60 \times w \times k_a \qquad (16)$$

in this case k_a being the volume of one pound of air under atmospheric conditions.

The formulas quoted above are for dry air. If much moisture is present a correction will be required for the weight of the water vapor present. This correction is usually disregarded.

Modified Orifice Method

One of the simplest, easiest and most accurate methods of determining the air delivered by a compressor is as follows: The compressor is connected to a receiver tank by an arrangement exactly similar to that shown in Fig. 3, except that an ordinary globe valve replaces the orifice at M, and an additional valve is provided at N as shown in Fig. 4. Since most compressors are furnished equipped with receiver tanks this arrangement should be easily accomplished. The pipe R may be the regular service pipe leading from the receiver. In this case means must be provided for disconnecting this pipe so that the receiver will discharge through the valves M and N directly into the atmosphere. If a receiver is not provided with the compressor equipment, almost any reasonably tight tank capable of holding air at the delivery pressure may be used. The volume should be quite large, the larger the better, and a few slight leaks will not affect the results in any manner whatever.

If it is desired to determine the volume of air delivered by the compressor, it will first be necessary to close off any pipes which may lead from the receiver tank except pipe R which should discharge into the air. Then, with the compressor running at its normal speed, close the valve M until the discharge is throttled down so that the pressure shown at P remains constant at the delivery pressure against which the

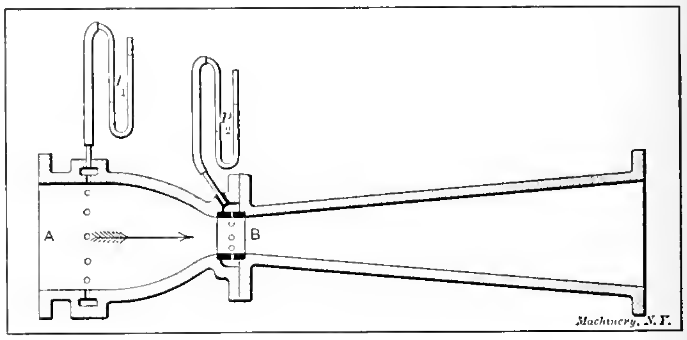

Fig. 6. Venturi Meter for Measuring Flow of Air

compressor is supposed to work. The compressor is now running under its normal working conditions. Now close the valve N tight so that the pressure in the tank rises to a value ten or fifteen pounds higher than the working pressure. Stop the compressor and close the valve S between the tank and compressor so that the tank now stands full of air at a pressure several pounds above the running pressure. Open quickly valve N wide and then take simultaneous readings of time and pressure as the pressure in the tank drops due to the escape of air through the partially opened valve M. This can best be done by two men, one holding a watch (preferably a stop watch) and calling "Read" at short uniform intervals of about fifteen or thirty seconds. The other man should read the pressure shown at P at the instant the signal is given. This should be continued until the pressure has dropped considerably below the working pressure.

Plot the readings just taken, thus obtaining a curve of pressure against time as shown in Fig. 5. (Fig. 5 is the curve taken from an actual test which will be referred to later.) It will also be necessary to determine the volume of the tank, including the piping between valves S and M. This can be done by weighing the amount of water required to fill this volume and then computing the equivalent volume, or the tank volume can be determined by direct calculation.

From the laws of gases we have the general equation

$$p\,V = m\,R\,T \qquad (17)$$

in which p = pressure in pounds per square foot,

V = volume of gas under pressure p, in cubic feet,

m = weight of gas under pressure p, in pounds,

T = absolute temperature in degrees F. of gas,

R = a constant = 53.37 for air.

In the case under consideration, the volume of the tank, V,

and the temperature of the air in the tank are supposed to remain constant. Equation (17) can be rewritten

$$m = \frac{V}{R\,T}\,p \qquad (18)$$

which, differentiated with respect to time gives

$$\frac{d\,m}{d\,t} = \frac{V}{R\,T}\,\frac{d\,p}{d\,t} \qquad (19)$$

in which $\frac{d\,m}{d\,t}$ is the rate of discharge of air in pounds per second. Let A be a point on the pressure-time curve of Fig. 5, corresponding to the working pressure of the compressor, and draw the line $A\,C$ tangent to the curve at A; also draw $A\,B$ parallel to the pressure axis. Then

$$\frac{d\,p}{d\,t} = \frac{A\,B}{B\,C} \qquad (20)$$

in which the values of $A\,B$ and $A\,C$ can be measured directly from the drawing.

It is evident that this method is only a modification of the first orifice method in which the valve M takes the place of the original orifice and the entire apparatus is calibrated at once by the pressure-time curve method. Leaks in the tank will not affect the results since they only serve to increase the area through which the air escapes and the determination is made independent of the area by determining the rate of pressure drop instead. If very accurate results are desired, it would be well to repeat readings for the pressure-time curve and then average the values of $\frac{d\,p}{d\,t}$ obtained.

In recapitulating, the valve M is adjusted to the proper opening to allow just enough air to escape under the working pressure to keep the compressor running steadily at its normal speed and discharging against the normal pressure; then the rate of discharge is found for this pressure and opening. After once adjusting the valve M it must not be moved or changed in any way during the entire test. It is important that the temperature of the air should be the same when the readings for the curve are taken as when the valve M is adjusted. The pressure gage at P must be carefully calibrated.

Example for Practice

As an example of the calculations involved in this method the data for a trial of a small 10 x 7 x 6-inch two-stage compressor are here reproduced. Fig. 5 is the pressure-time curve for this test.

$\frac{p}{144}$ = working pressure in pounds per square inch, absolute,

V = volume of receiver tank = 47.7 cubic feet.

T = temperature of air in tank = 87.1 degrees F. = 546.5 degrees absolute.

From pressure-time curve, Fig. 5, $A\,B = 56 \times 144$ pounds per cubic foot, and $B\,C = 174$ seconds.

The rate of discharge is

$$\frac{d\,m}{d\,t} = \frac{V}{R\,T}\,\frac{d\,p}{d\,t} = \frac{47.7}{53.37 \times 546.5} \cdot \frac{56 \times 144}{174}$$

= 0.0758 pounds per second.

At a pressure of 56 pounds per square inch absolute (42.3 pounds by the gage) and a temperature of 87.1 degrees F. one pound of air has a volume of 3.607 cubic feet. The discharge was therefore

$$0.0758 \times 3.607 = 0.2734 \text{ cubic feet per second,}$$
$$= 16.401 \text{ cubic feet per minute.}$$

One pound of air at atmospheric pressure and 32 degrees F. occupies 12.387 cubic feet, so that the volume of free air compressed, reduced to freezing point, was

$$0.0758 \times 12.387 = 0.9389 \text{ cubic feet per second,}$$
$$= 56.334 \text{ cubic feet per minute.}$$

If it be desired to make an economy test of a compressor under its working load it is only necessary to adjust valve M, determine the rate of discharge of air at the desired pressure as indicated above, and then run the compressor continuously while taking the steam consumption readings, allowing it to discharge into the tank, the air escaping through M. As long as the pressure and temperature of the air in the tank are constant, the volume of air flowing through the tank per second will not change. The pressure in the tank depends on the speed of the compressor, and the governor should keep it constant. The temperature of the discharge air depends largely upon the quantity of jacket water used. If this is kept constant in quantity and temperature, and if the machine is allowed to warm up thoroughly before beginning the test, there is no reason why the temperature of the discharge air should change.

The method just outlined has many advantages. It is rapid, simple, theoretically correct, and can be made very accurate in practice; all leakages and friction losses are taken into account; no expensive apparatus or appliances are required, and in many cases not even a change in piping will be necessary; and the manipulations and calculations are simple.

The Venturi Meter Method

The Venturi meter often used for the measurement of the flow of liquids may also be employed to measure the rate of flow of air or other gas, and very satisfactory results have been obtained, especially under conditions involving the measurement of a large volume of air under comparatively low pressure. A Venturi meter is in effect only a contraction in a pipe line with provision made for determining the difference in the static pressure of the moving fluid at the entrance A, Fig. 6, and at the waist or narrowest part B. The total head causing the fluid to flow through the pipe line is made up of "pressure head" and "velocity head," and if there is no friction in the pipe, the sum of these two is constant over all parts of a closed pipe system. The contraction in the pipe causes the velocity to be much higher at B than at A, consequently the velocity head is increased. An increase in the velocity head could only occur at the expense of pressure head, so that the pressure head indicated at B is less than that at A, and the difference in these two pressure heads is a measure of the increase in velocity. Knowing this change in velocity and the cross sectional areas of the pipe at A and B, we can find the velocity at B and from this the volume of fluid passing through the meter in a given time. When the Venturi meter is used for the measurement of water, the formula for the volume passing through the meter per second is

$$Q = \phi\,A_2\sqrt{\frac{2\,g\,H}{1-\left(\frac{A_2}{A_1}\right)^2}} \qquad (21)$$

where Q = volume passing per second in cubic feet,

H = difference in pressure head between A and B measured in feet of water,

A_1 = area of pipe at A in square feet,

A_2 = area of pipe at B in square feet,

ϕ = frictional coefficient, in most cases about 0.96 to 0.98 for usual construction of meter. (Extremes may be 0.95 to 1.00.)

When used to measure gases the derivation of the formula giving the rate of flow is somewhat complicated. The resulting equation is

$$Q = \phi\,A_2\left(\frac{p_2}{p_1}\right)^{\frac{1}{n}}\sqrt{\left(\frac{2\,g\,n\,p_1\,\gamma_1}{n-1}\right)\left[\frac{1-\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}}{1-\left(\frac{A_2}{A_1}\right)^2\left(\frac{p_2}{p_1}\right)^{\frac{2}{n}}}\right]} \qquad (22)$$

in which Q = cubic feet of air passing per second,

p_2 = pressure at waist in pounds per square foot,

p_1 = pressure at entrance in pounds per square foot,

n = exponent of v in equation (2); in this case assuming adiabatic expansion, n = 1.41,

γ_1 = density of gas (weight of one cubic foot) at pressure p_1,

g = acceleration due to gravity, in feet per second = 32.2,

A_2 = area at waist in square feet,

A_1 = area at entrance in square feet.

ϕ = frictional coefficient. (Usually negligible in a well-made meter.)

When a Venturi meter is used for measuring the flow of a gas or liquid, precautions must be taken to keep the pressure p_1 constant, and the pressures p_1 and p_2 must be measured with great care. For this purpose water columns are best. The meter tube must be smooth and polished inside in order to reduce the friction losses to a minimum. The shape of the tube must be such as to allow the change in velocity between A and B to be accomplished smoothly and easily with no opportunity for eddies, cross currents or sudden changes in velocity. Venturi meters are sometimes made self-recording so that a continuous record of the volume of gas or liquid passing is available.

* * *

HANGING UP REAMERS, STRAIGHTEDGES, ETC., FOR STORAGE

Figs. 1 and 2 show some of the tools used by the Colburn Machine Tool Co., of Franklin, Pa., and illustrate the way in which they are kept when not in use. Fig. 1 shows a row of heavy line reamers, while Fig. 2 shows a set of straightedges and a test-bar. The notion of hanging these tools up after using is a novel one, so far as we know.

The line reamers shown in Fig. 1 are used for finishing the upper and lower bearings for the spindle in the spindle sleeve of the Colburn boring mill. By reaming these two bearings together, assurance is given that they are concentric; this gives further assurance of a good fit on the spindle, if the latter is finished concentric all over as it should be. The I-bolts by which they are hung are primarily intended for suspending the reamers in the hole to be reamed, by means of a chain-block and tackle having a swivel connection. This is done

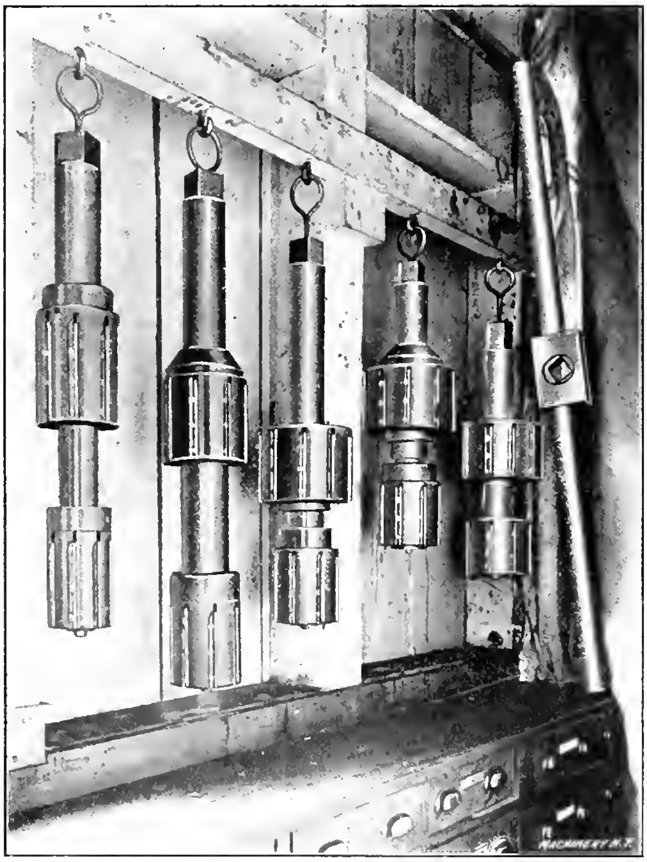

Fig. 1. Large Lining Reamers comfortably hung from Eye-bolts

because the weight of the reamers themselves is so great as to give too heavy a feed, with the very small amount of metal which has to be taken out. The chain-block is employed to lower the reamer gradually while the workmen rotate it.

For turning the reamers, use is made of the double-handled wrench shown at the right of Fig. 1. This is of the ratchet type, with a square socket on the ratchet which fits the squared shanks of the whole line of reamers. By using a ratchet wrench for this, a full revolution is not required, so it is possible to have the handles long enough to be easily manipulated, and still avoid interference with the housings or column of the machine. While the I-bolts were originally intended for use when the reamer is in active operation, as described, this provision naturally suggested hanging them up when they were not in use. When so held they are out of harm's way, as nothing can be laid on top of them and they are kept from contact with each other.

The row of straightedges shown in Fig. 2 is kept at one end of the erecting floor. As shown, a stout cross-beam is mounted on projecting joists, and provided at the top with notches for locating the bent ends of the long hook rods, on which the tools are hung. These grooves space the hook rods evenly and

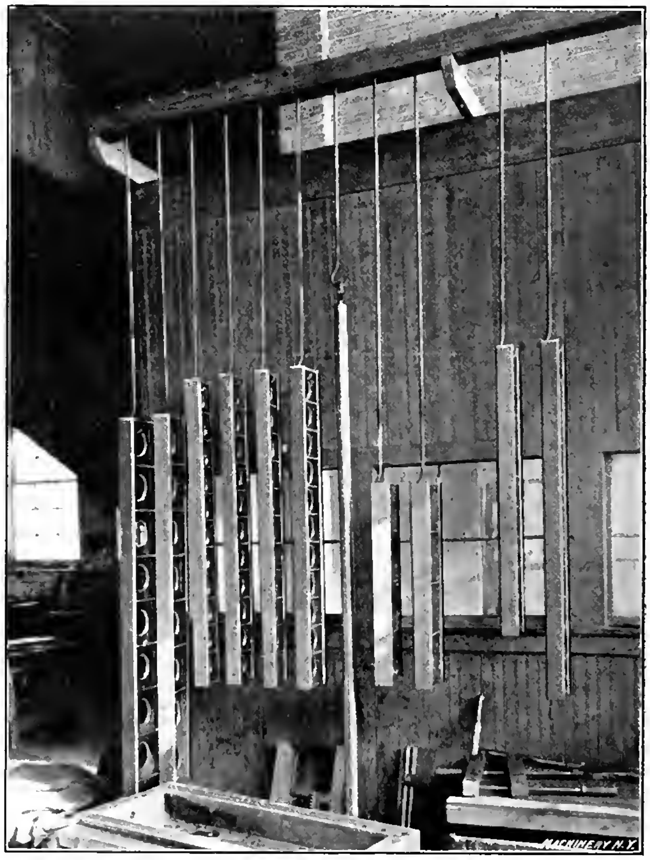

Fig. 2. Suspended Straightedges and Test Arbors, which are thus preserved from Distortion

prevent them from twisting around and dropping out. It might almost be said that these straightedges and test-bars have a *comfortable* look when stored this way. It is said that they preserve their shape better, showing less tendency to warp than when left lying flat in the case as usual. This seems to be a natural position for such tools to take when at rest.

* * *

Electric heat is being employed more and more in the industries. It is, for example, successfully applied in the manufacture of food products. The Natural Food Co. of Niagara Falls manufactures a product called "triscuit," this being a cracker of shredded wheat, baked or toasted by having heat applied on both sides at the same time. The operation consists in passing the product through a machine between two endless belts, enclosed except at the ends. The links of these belts are electric stoves so arranged that the cracker is fed and held pressed between the faces of two of these miniature stoves throughout a complete circuit of the machines. The operation is continuous, and each machine, being provided with about 2,500 stoves, is capable of producing 17,500 triscuits an hour. The company is operating about 10,000 electric stoves, and the failures in operation have been exceedingly small. Another application of electric heat is in the embossing and burning of designs on wood. A form of electric heater is inserted in a hollow cylinder, the outside surface of which has the design engraved on it. The cylinder is slowly revolved, and pieces of soft wood placed between it and a corresponding roller, the wood being fed between the rollers in a manner similar to that of clothes being put through a wringer. In this manner five or six impressions can be burnt per minute.

CIRCULAR FORM AND CUT-OFF TOOLS*—1

PRACTICE FOR THE BROWN & SHARPE SCREW MACHINES

By DOUGLAS T HAMILTON†

When a screw machine is to be fitted up for the making of any given piece of work, the methods of arranging the operations and the tools to be used should be decided upon before designing the cams. One of the first things to consider is the method of applying the circular form and cut-off tools. These methods, of course, will vary to a considerable extent, according to the shape of the piece to be made.

When Circular Form and Cut-Off Tools can be used to Advantage

Forming with circular tools as shown in Fig. 1, when the piece permits, is usually the best and quickest method; it is quicker than using the turret tools, on account of eliminating the necessity of revolving the turret. The tools can also be easily and quickly changed when setting up for another piece. This method is recommended when the length of the work is not more than 2½ times the smallest diameter of the piece when finished. For example, when the smallest diameter *a* in Fig. 1 is ¼ inch and dimension *b* not more than ⅝ inch, it is most economical to use the form and cut-off method. The operations for making this piece would be as follows: The stock is first fed out to the stop, then the form tool *A* is brought in, forming the body *a*, and just as the tool *A* is finishing, the tool *B* is brought in and severs the piece from the bar. Another example is shown in Fig. 2 where a shouldered screw is being made; here the tool *C* is brought in and forms the part c and the neck *e*; then the die threads the screw, and the tool *D* is brought in and severs the piece from the bar, and forms the part *d* for the next screw at the same time; the stock is then fed out to the stop and the operations continued. This order of operations necessitates one complete revolution of the turret, for each screw, and if the time utilized by the tools *C* and *D* is not long enough to allow the turret to be revolved, so as to bring the stop into position for the next piece, extra time would have to be added for revolving the turret.

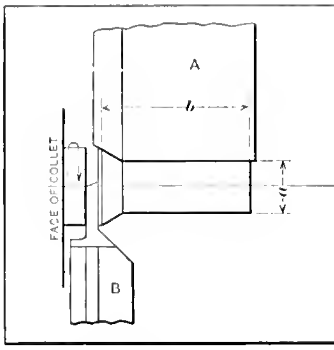

Fig. 1. Illustration showing Relation between Smallest Diameter of Work and Length of Forming Tool

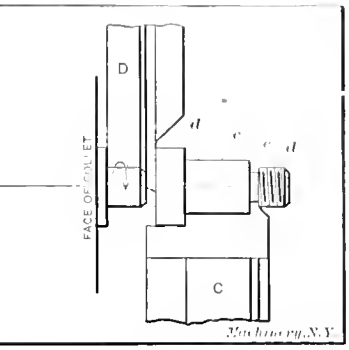

Fig. 2. Illustration showing a Case where the Cut-off Tool forms Part of the Piece

Applications of Circular Tools

When making short screws similar to that shown at *A*, Fig. 3, where the circular form and cut-off tools finish the screw, except the threading, it is good practice to apply the circular tools as shown, and if the time utilized by the tools is not long enough so the turret can be revolved to bring the stop into position for the next piece, two sets of tools, *etc.*, two stops and two die holders, should be used in the turret. The method shown at *B*, Fig. 3, is not commendable, inasmuch as the feeding of the stock varies to such an extent that the form tool will break off the screw when the latter is much reduced at *a*, in case there be an excessive amount to face off the end of the screw. The turret would also require to be indexed, to clear the slotting arm, so that very little time could be saved by adopting a method of this description, except

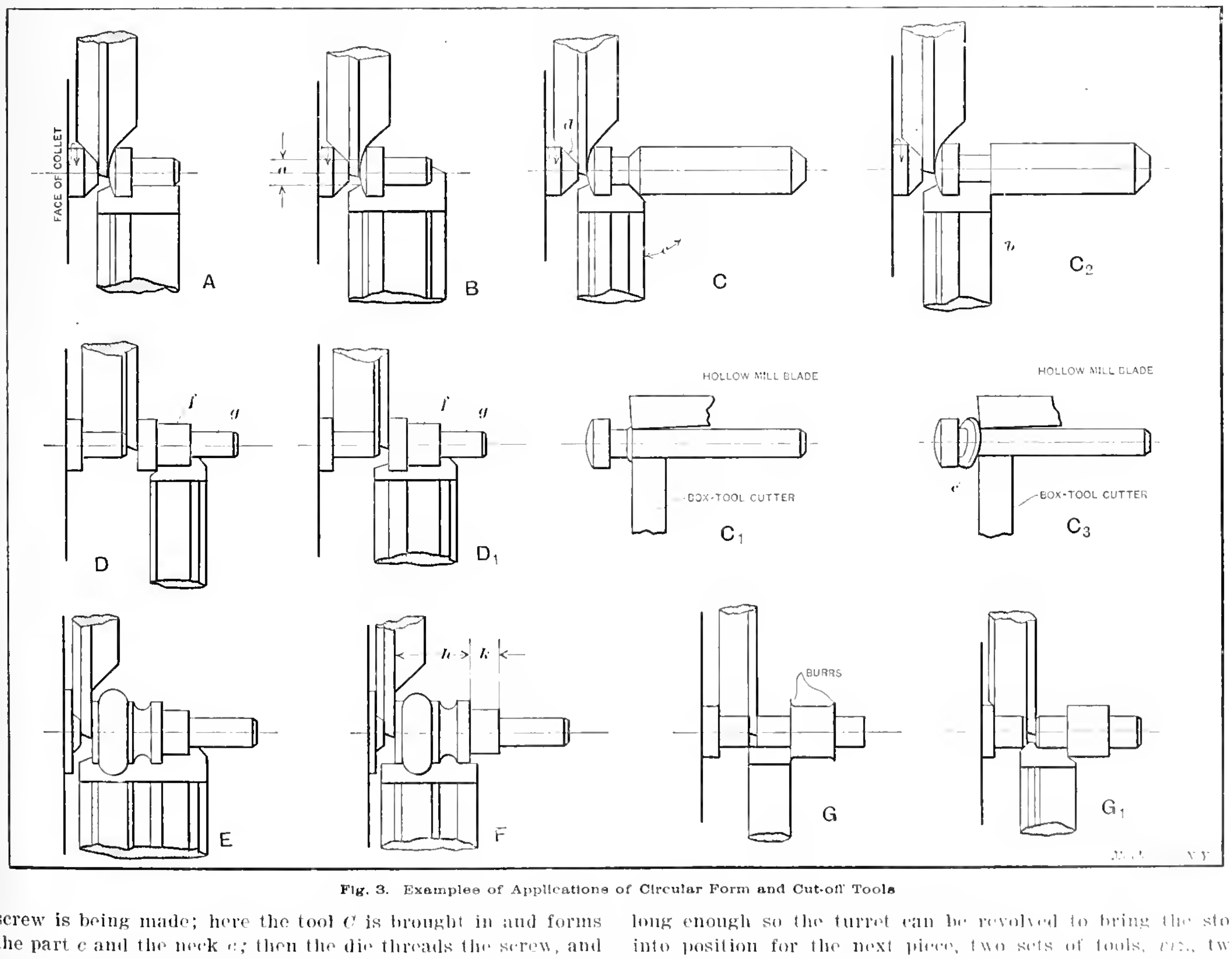

Fig. 3. Examples of Applications of Circular Form and Cut-off Tools

* For previous articles on screw machine work, see MACHINERY, September, 1903, Directions for Camming the Brown & Sharpe Automatic Screw Machine; June, 1908, Making Watch Parts in the Commercial Automatic Screw Machine; November, 1908, engineering edition, Attachment for Cutting Squares and Hexagons in Automatic Screw Machines; November, 1908, Some Interesting Automatic Screw Machine Work; April, 1909, Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machine; June and July 1909, engineering edition, Knurls and Knurling Operations.

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when the part a is large in diameter and the screw is short in length. It is, therefore, obvious that a method of this kind should be avoided if possible.

When a box-tool or hollow-mill follows the forming operation, the forming tool should be beveled, as shown at e in C; this leaves a beveled shoulder on the piece, so that when the box-tool or hollow-mill is fed in as shown at C_1, it completely removes the superfluous material without leaving the objectionable ring which would be produced if the face of the form tool were square, as shown at b in C_2. This ring of metal is shown at c in C_3; it prevents the finishing box-tool or die

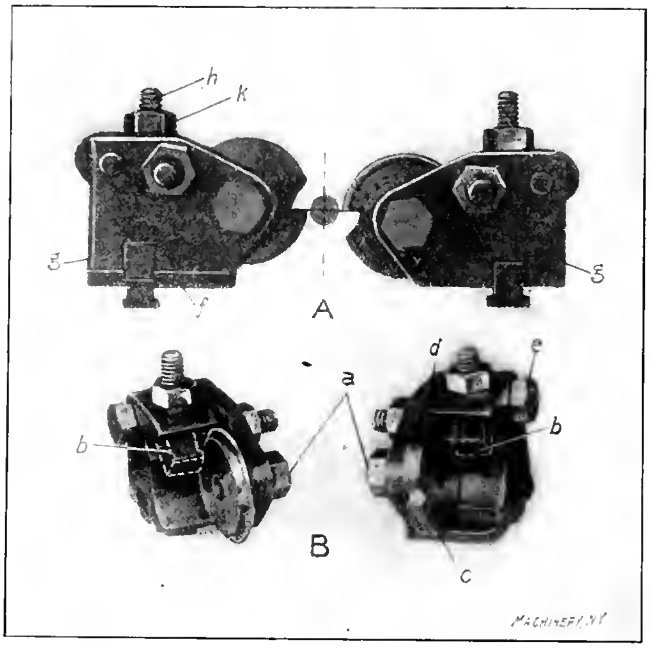


Fig. 4. Holders for Circular Form and Cut-off Tools

from being fed up to the shoulder. It is clearly seen that the ring would have to be removed in any case.

The cut-off tool should bevel the end of the stock, as shown at d in C, in order to permit the starting of the box-tool on a light cut, until the back rests have a good support; the bevel also locates the hollow-mill and equalizes the cutting pressure on the teeth. The previous examples apply to the making of screws, but the principles involved are also, of course, applicable to the forming of other parts. It is obvious that, as the conditions under which the work is done and the limits allowed on same vary widely, it would be impracticable to lay down hard and fast rules in regard to the application of circular tools, but the following suggestions will be found ap-

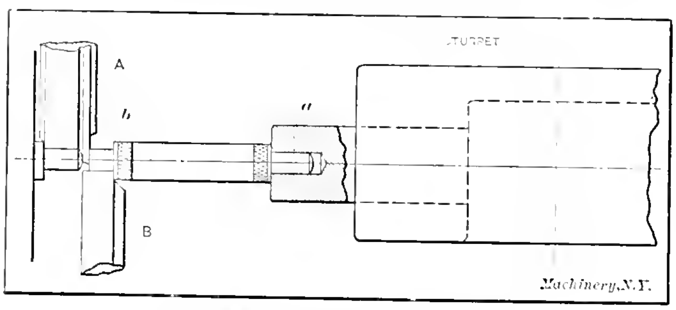


Fig. 5. Method of Supporting Long Work

plicable to general conditions. At D, Fig. 3, is shown a method sometimes used to advantage in making shouldered screws or other pieces of a similar character. This forming operation is not recommended when the piece to be made is required to be very accurate, as a slight eccentricity in the spring collet would cause the part f to be out of true with the part g. In cases where accuracy is required, the part g could be roughed down with the cut-off tool and a light finishing cut taken off with a box-tool. At D_1 is shown an improved method of forming the same piece, as the form tool here removes the burr from the head.

In applying circular tools, the question of gaging the pieces must be carefully considered, as in some cases, when difficult shapes are to be formed, it is advisable, if possible, to use the forming tool for this purpose, thus obviating the making of expensive gages, which is usually necessary when more than one tool is used. The piece shown at E, Fig. 3, will require a box-tool, forming tool and cut-off tool; if made as shown, it will be seen that no gaging will be necessary, except for diameters and over-all length, the latter not requiring great accuracy. At F, a piece of the same shape is shown; three tools are used as before, but the cut-off tool is used to finish part h to the required length and the box-tool to finish the shoulder k to correct length. It will readily be seen that a more expensive gage will be required for gaging the parts h and k; considerable time will be lost in setting up the tools, after grinding, in their correct relation to each other, insuring that part h be formed the correct length.

It is generally necessary that means should be provided to remove the objectionable burrs thrown up by the forming tools, as shown at G, Fig. 3. The burrs are caused by the tools becoming dull and by the rubbing of the forming tools on the sides of the cut due to lack of side clearance on the side of the forming tools. By adding a bevel edge to the tools as shown at G_1, the burrs are removed; this adds slightly to the expense of the tools, but in the majority of cases the results produced warrant the extra expense.

Holding Circular Form and Cut-off Tools

The method by which circular tools are held should be carefully considered; otherwise satisfactory results will not be obtained. If, for instance, the tool-holder is light and improperly supported, chattering will result when long work is

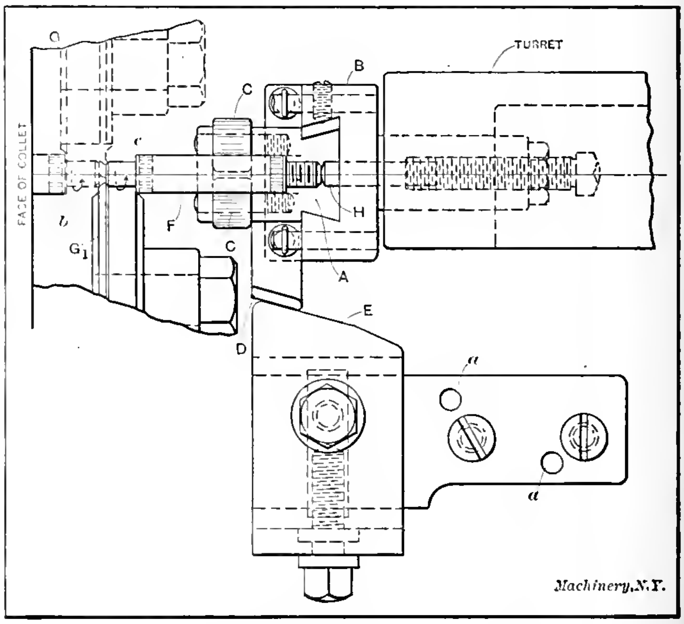


Fig. 6. Improved Method of Supporting Long Work

formed. To prevent this, the tool-holder should be well proportioned and held rigidly upon the cross-slide. The halftones A and B, Fig. 4, illustrate a suitable holder for general work, which is supplied by the Brown & Sharpe Mfg. Co. with their various types of automatic screw machines. This holder embodies all the essential features requisite for obtaining good results, *viz.:* rigidity, means to prevent the tool from rotating while cutting, suitable adjustment, provision for periphery clearance, means for adjusting the tool at right angles to the work, and means for the securing of the holder to the cross-slide.

The form tool is firmly clamped against the face of the holder by means of cap-screw a and clamping bolt b; the latter is used to keep the tool from turning while cutting. Care should be taken when designing the circular tools, so that the clamping bolt b, gets an ample bearing on the side of the tool as otherwise the clamping bolt will in time become bent, as shown by the dotted lines in the half-tone B, which would impair its efficiency as a clamping device. Plate d and eccentric bolt e are provided for obtaining a slight adjustment when setting the cutting edge of the tool in the correct relation to the center of the work, as shown at A. The block f is used for raising the tool when the cutting edge is cut below the cen-

ter. At g are two grub screws, not shown in the half-tone, by means of which the tool can be set at right angles to the work. The holder is clamped to the cross-slide by the bolt h and nut k. Numerous types of holders for holding circular tools have been designed, the principles involved being in most cases similar to those of the one described.

Supporting Long Work while Forming

It is sometimes found necessary to support long work while forming, especially when the piece being formed is turned down on both ends. The work is generally supported by a support held in the turret, which, in the majority of cases, can also be used as a stop. In Fig. 5 is shown a piece which is being supported in this manner. The part a is formed by the tool A and the stock is then fed out into the support

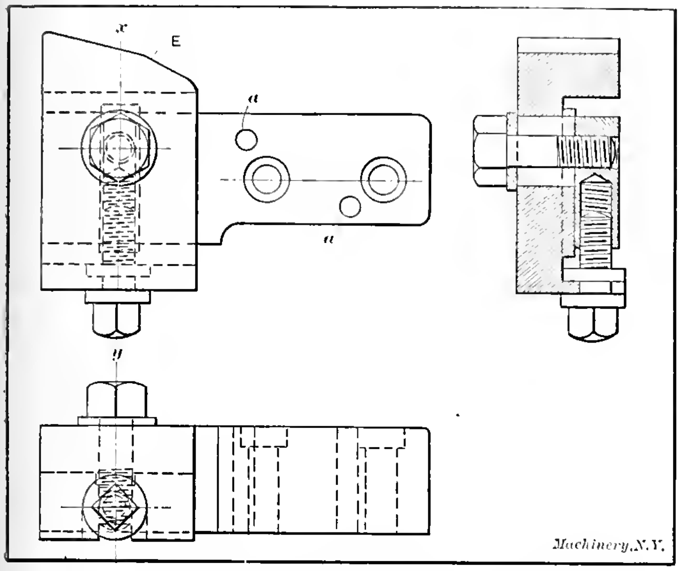


Fig. 7. Cam Attachment used in Connection with the Arrangement for Supporting Long Work shown in Fig. 6

which in this case also acts as a stop; the tool B then forms the part b. This kind of a support works satisfactorily on work which is not required to be very accurate and which is left plain, *i. e.*, not threaded on part a. In some cases both ends would require to be knurled, and then a support of this description could not be used to advantage.

In Fig. 6 is shown a method which will work satisfactorily when the piece is threaded or knurled. The work operated on is shown in position, supported by a movable slide A held in a holder B; slide A carries two hardened and ground supporting rollers C. It is forced up against the work by cam D

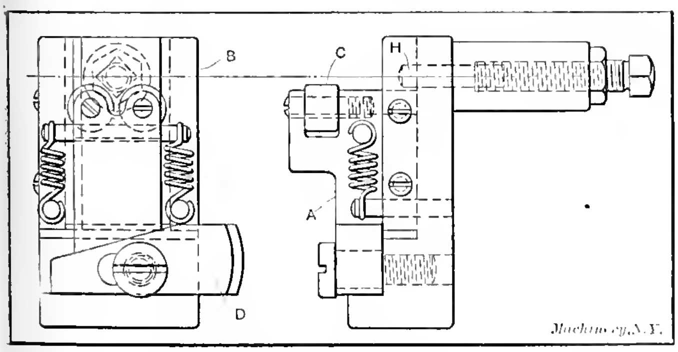


Fig. 8. Combination Stop and Support used in Arrangement for Supporting Long Work shown in Fig. 6

which in turn is operated by the cam attachment E. To fasten the cam attachment to the machine, as shown in Fig. 6, the stop which is used for locating the slotting arm when it is in position to travel onto the work, is removed, and the cam attachment is screwed down in its place. Two dowel pins a have been added to the cam attachment to hold it rigid.

A detailed sketch of the cam attachment is shown in Fig. 7, from which the operating parts can be clearly understood; the combination stop and support is shown in Fig. 8. The operations to produce the piece F, Fig. 6, would be as follows: The part b is left to project out of the chuck far enough so as to allow it to be threaded. To start the operations, the part b is formed and threaded; then, after the die leaves the work, the turret is revolved, the support is brought into position and the stock is fed out and gaged to length by the stop H. The spindle is left running backwards and the tool G_1 forms the part c. After the form tool G_1 has finished its work, a knurl-holder, not shown in the illustration, travels over the work and knurls the ends. The cut-off tool G severs the finished piece from the bar, at the same time forming the part b of the next piece. The support can be withdrawn after knurling, or left in position till the piece is cut off, when the turret is revolved and the piece drops out.

Arrangement of Circular Tools

When applying circular tools to the Brown & Sharpe automatic screw machines, the arrangement of the tools has an important bearing on the results obtained. The various ways of arranging the circular tools, with relation to the rotation of the spindle, are shown at A, B, C, and D, Fig. 9. These are to be considered as being viewed looking from the turret towards the face of the chuck. The arrangement at A gives good results when long forming is to be performed on brass, steel or gun-screw iron, for the reason that the pressure of the cut is downward and hence the work is supported and held more rigidly than when the form tool is turned upside down on the front slide as shown at B; here the stock turning up towards the tool has a tendency to lift the cross-slide, causing chattering on the finished body of the work; therefore, the arrangement as shown at A is recommended when a high finish is desired. The arrangement at B works satisfactorily when forming short steel pieces which do not require a high finish, as it allows the cuttings to drop clear of the work, and also provides for a good supply of oil to reach the tools. This arrangement gives good results when making screws when the form and cut-off tools operate after the die, as no time is lost in reversing the spindle. The arrangement

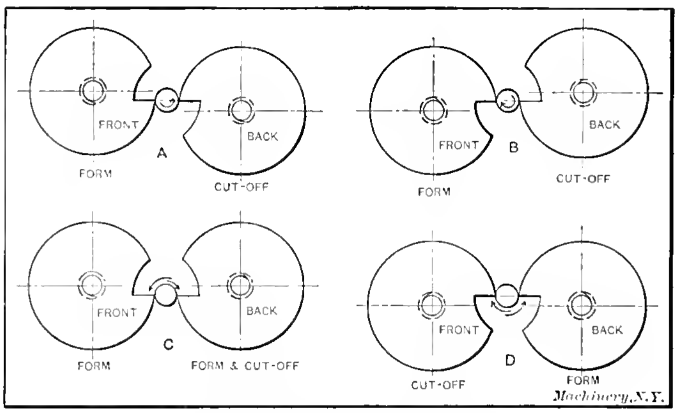


Fig. 9. Different Arrangements of Circular Tools

at C is recommended for heavy cutting on large work, when both tools are used for forming the piece; a rigid support is then necessary for both tools and a good supply of oil is also required. The arrangement at D is objectionable, and should be avoided, being used only when a left-hand thread is cut on the piece, and when the cut-off tool is used on the front slide, leaving the heavy cutting to be performed from the rear slide. In all "cross-forming" work, it is essential that the spindle should be kept in good condition, and the collet or chuck have a parallel contact upon the bar which is being formed.

Forming Spherical Work

In the making of spherical head screws or other spherical work, the circular form tool is generally used for forming part of the head, leaving the part attached to the bar to be finished by the cut-off tool. This method has become general practice on the Brown & Sharpe automatic screw machines and has proved, without a doubt, to be the most economical and efficient method of performing operations of this description. In order to produce the best results by the above method, the radius of the cut-off tool should be struck off in advance of the edge of the tool, as will be described later; otherwise a result will be produced as shown at a, Fig. 12, a ridge being formed on the head. The circular form tool should be de-

signed first, and should be made so that the circular cut-off tool will have as little as possible to form when cutting the piece from the bar. The amount that the form tool reduces the bar, as shown at b, Fig. 12, is governed by the operations following the forming cut. If heavy cuts are taken, the part b should be strong enough to resist the twisting action produced; therefore, it is not always advisable to cut a thread (especially if it be of coarse pitch) after the piece has been considerably reduced by the form tool.

In designing the form tool, there are certain dimensions which must be derived by calculation. Referring to Fig. 10.

Let r = radius of stock $= \frac{D}{2}$,

R = radius of head of screw or piece,

D_1 = distance from axis of head to point of tool.

D = diameter of head of piece,

T = thickness of head,

r_1 = radius of body of screw or piece,

O = the dimension required to be found by calculation.

Then $O = \sqrt{R^2 - D_1^2} - (R - T)$.

For example, let r = 0.175 inch, R = 0.178 inch, D_1 = 0.062 inch, T = 0.156 inch.

Then $O = \sqrt{0.178^2 - 0.062^2} - (0.178 - 0.156) = 0.145$ inch.

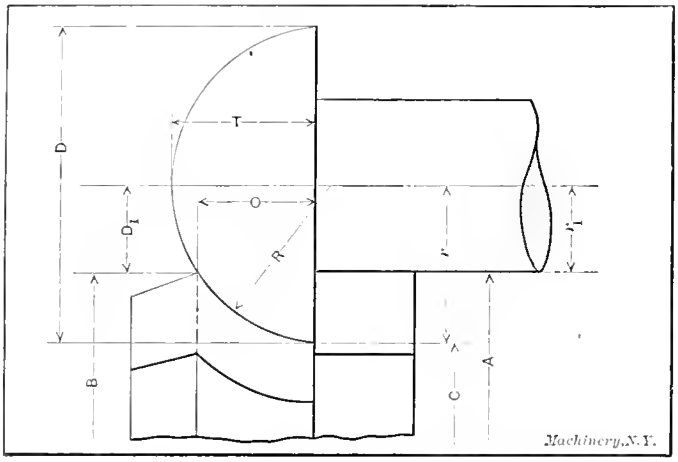


Fig. 10. Diagram for Calculating Dimensions of Circular Tools forming Spherical Screw Heads

Assume further that a form tool is to be made to form a piece as shown at Fig. 10; $r = 0.175$ inch; $r_1 = 0.043$ inch; then assume the largest diameter A to be 1.750 inch, the diameter B will be:

$A - 2(D_1 - r_1) = 1.750 - 2(0.062 - 0.043) = 1.172$ inch,

and the diameter C will be:

$A - 2(r - r_1) = 1.750 - 2(0.175 - 0.043) = 1.486$ inch.

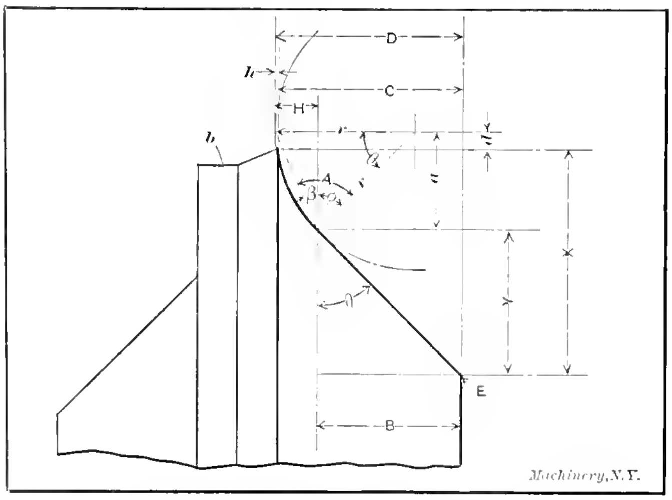


Fig. 11. Diagram for Determining Dimensions of Circular Cut-off Tool which forms Part of a Spherical Screw Head

In the above calculations the "cut-down" below the horizontal center line is not taken into consideration when finding the various diameters, but if the forms produced require to be accurate, the differences should be calculated. This question will be treated in a future issue of MACHINERY.

The feed of the circular cut-off tool should be decreased at the end of the cut, so as to leave as small a teat as possible on the work. The teat varies according to the radius formed, the size of the piece and the nature of the material. It is, therefore, impossible to specify any exact size of teat for a certain piece, but the results of a few experiments would not be out

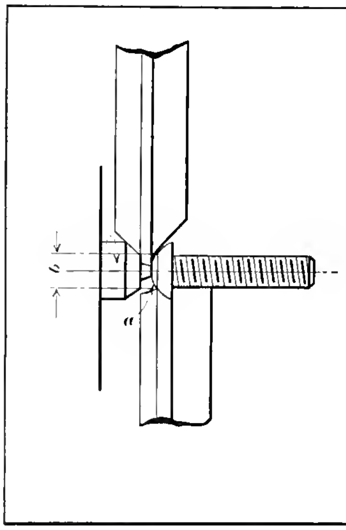


Fig. 12. Spherical Screw Head formed by Combination of Forming and Cut-off Tools

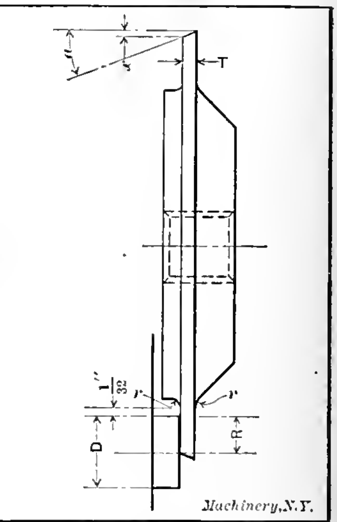


Fig. 13. Diagram showing Dimensions of Circular Cut-off Tools

of place here, as they will give a fair idea of the sizes of teats left on various classes of work. The teat left on small brass screws varies from 0.010 inch to 0.025 inch in diameter; on small screws made from gun-screw iron from 0.012 inch to 0.030 inch; on small steel screws from 0.015 inch to 0.035 inch. A good method of overcoming great variation in the size of the teat, is to make the angle of the cut-off tool similar to the enlarged view shown at b, Fig. 11, where the flat portion should be half the thickness of the cut-off tool blade. This method tends to decrease the pressure on the piece, thus preventing it from breaking off too soon.

As previously stated, the radius on the cut-off tool, if not struck off in "advance" of the edge of the tool, will give a result as shown at a, Fig. 12. There will always be a mark left on the head where the form tool finishes cutting, because the screw breaks off from the bar before the point of the tool has reached the center, and consequently the radius on the piece has not been completed. It is therefore necessary (especially for small radii) to lay off the radius in advance of the cutting edge of the tool. This method is clearly shown in Fig. 11, where d is the distance the center is in advance of the point of the tool. Then, to determine the dimensions of the tool, take any approximate dimension D as required, and also take any angle which will suit the radius of the tool, and cut away that portion of the tool which is not required for forming. In order to determine the dimension X (see Fig. 11) it will be necessary to make the following calculations:

$$A = \frac{180 \text{ deg.} - \theta}{2}$$

$$\phi = 90 \text{ deg.} - \theta$$

$$\beta = A - \phi$$

Then $a = \cos \phi \times r$; $H = \tan \beta \times a$; $B = D - H$;
$Y = B \times \cot \theta$; $X = Y + a - d$; $C = D - h$;
$h = r - \sqrt{r^2 - d^2}$.

Where h works out to less than 0.002 inch, it can be disregarded for all practical purposes.

For example, let D = 0.2343 inch; r = 0.175 inch; θ = 45 deg.; d = 0.021 inch;

Then $A = \frac{180° - 45°}{2} = 67° \; 30'$.

$\phi = 90° - \theta = 45°$.

$\beta = 67° \; 30' - 45° = 22° \; 30'$.

$a = \cos 45° \times 0.175 = 0.1237$.

$H = \tan 22° \; 30' \times a = 0.0512$.

$B = 0.2343 - 0.0512 = 0.1831$.

$Y = 0.1831 \times \cot 45 = 0.1831.$

$X = 0.1831 + 0.1237 - 0.021 = 0.2858.$

$h = r - \sqrt{r^2 - d^2} = 0.175 - 0.1737 = 0.0013.$

Therefore, in this case for all practical purposes, the dimension C would equal the dimension D. When the largest diameter of the circular tool is 2.250 inch, the diameter of the tool at point E will be $2.250 - (0.2858 \times 2) = 1.6784$ inch.

Angle on Blade for Cutting Off Various Materials

The function which the angle on the edge of the tool performs is to reduce the teat on the end of the work by minimizing the cutting pressure which becomes greater as the angle that the tool makes with the work decreases. Therefore, as the material becomes harder, the angle on the tool may decrease, since the material will stand more pressure before breaking. It is obvious, therefore, that certain angles are better suited for the various kinds of material than others. The values given in Table I have been found to give good results on the materials specified.

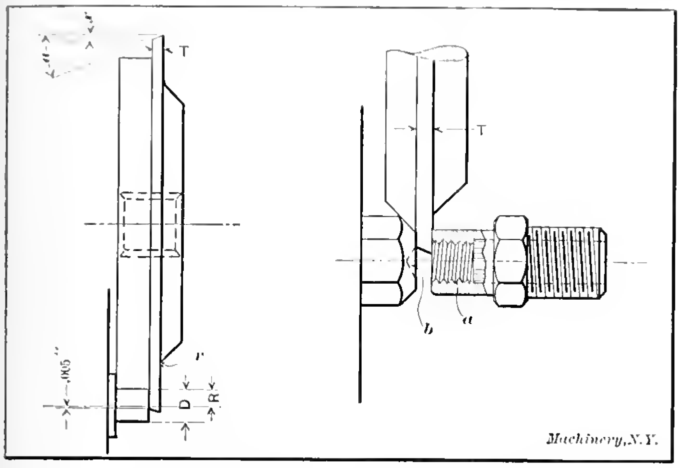


Fig. 14. Diagram showing Dimensions of Circular Cut-off Tool when it is used both for cutting off and forming part of the Work

Fig. 15. Illustration showing a Case where a Cut-off Tool with Increased Thickness of Blade is required

TABLE I. DIMENSIONS FOR CIRCULAR CUT-OFF TOOLS (For Notation See Fig 13)

Diameter of Stock	Soft Brass and Copper			Hard Brass			Gun Screw Iron			Norway Iron and Mach. Steel			Drill Rod and Tool Steel		
	Angle a = 23 Deg.			Angle a = 20 Deg.			Angle a = 16 Deg.			Angle a = 15 Deg.			Angle a = 10 Deg.		
	T	x	2x	T	x	2x	T	x	2x	T	x	2x	T	x	2x
1/16	0.031	0.013	0.026	0.033	0.012	0.024	0.035	0.011	0.023	0.039	0.010	0.021	0.043	0.009	0.018
1/8	0.044	0.019	0.038	0.047	0.017	0.034	0.050	0.016	0.032	0.055	0.015	0.030	0.062	0.013	0.026
3/16	0.052	0.022	0.044	0.058	0.021	0.042	0.061	0.020	0.040	0.068	0.018	0.036	0.076	0.016	0.032
1/4	0.062	0.026	0.053	0.067	0.024	0.049	0.071	0.023	0.046	0.078	0.021	0.042	0.088	0.019	0.038
5/16	0.069	0.029	0.059	0.075	0.027	0.055	0.079	0.026	0.052	0.087	0.023	0.047	0.098	0.021	0.042
3/8	0.076	0.032	0.065	0.082	0.030	0.060	0.087	0.028	0.057	0.095	0.025	0.051	0.107	0.023	0.046
7/16	0.082	0.035	0.070	0.088	0.032	0.064	0.094	0.031	0.062	0.103	0.028	0.056	0.116	0.025	0.050
1/2	0.088	0.037	0.075	0.095	0.035	0.070	0.100	0.033	0.066	0.110	0.029	0.059	0.124	0.026	0.052
9/16	0.093	0.039	0.079	0.100	0.036	0.073	0.106	0.034	0.069	0.117	0.031	0.063	0.131	0.028	0.056
5/8	0.098	0.042	0.084	0.105	0.038	0.076	0.112	0.036	0.073	0.123	0.033	0.066	0.137	0.029	0.058
11/16	0.103	0.044	0.088	0.111	0.040	0.081	0.118	0.038	0.077	0.129	0.035	0.070	0.145	0.031	0.062
3/4	0.107	0.045	0.091	0.116	0.042	0.084	0.123	0.040	0.080	0.134	0.036	0.072	0.152	0.032	0.064
13/16	0.112	0.047	0.095	0.121	0.044	0.088	0.127	0.041	0.082	0.141	0.038	0.076	0.158	0.033	0.067
7/8	0.116	0.049	0.098	0.125	0.046	0.092	0.133	0.043	0.086	0.146	0.039	0.078	0.164	0.035	0.070
15/16	0.120	0.051	0.102	0.130	0.047	0.095	0.137	0.045	0.090	0.151	0.040	0.081	0.170	0.036	0.072
1	0.124	0.053	0.106	0.135	0.049	0.098	0.141	0.046	0.092	0.156	0.042	0.084	0.175	0.037	0.074

Thickness of Blade on Cut-off Tools

The thickness of the blade is an important point in the design of circular cut-off tools. It is governed by the angle on the edge of the tool and also the diameter and hardness of the material being operated on. It is obvious that a circular tool with an acute angle (about 23 degrees) and a narrow blade would not work satisfactorily on hard material, as the blade would not stand the cutting pressure and would bend, producing a concave surface on one end of the piece and a convex surface on the other. This has been thoroughly experimented with by the writer and an empirical formula has been derived which has given good results. For standard circular cut-off tools, as shown in Fig. 13, where the tool is not required to form part of the work, the formula is as follows:

$$T = \sqrt{\frac{D \times \cot a}{3}} \times 0.14,$$

where T = thickness of blade in inches,

D = the diameter of the stock in inches,

a = the angle on the edge of cut off blade.

The value of r (the radius to obviate cracking in hardening) for standard circular cut-off tools for cutting off various diameters of stock is as follows:

From 1/8 to 3/8 inch diameter = 1/32 inch,
From 3/8 to 3/4 inch diameter = 1/16 inch,
From 3/4 to 1 inch diameter = 3/32 inch.

The actual length of the blade on cut-off tools is found by the formula:

$$L = R + x + r + 1/32,$$

where L = actual length of blade in inches,

R = radius of stock in inches,

x = dimension as shown in Fig. 13,

r = radius to obviate cracking while hardening, as shown in Fig. 13.

For example let $D = 3/8$ inch; $a = 20$ degrees.

Then $T = \sqrt{\frac{D \times \cot a}{3}} \times 0.14 = \sqrt{\frac{0.375 \times 2.747}{3}} \times 0.14 =$ 0.082 inch.

$L = R + x + r + 1/32$, where $R = 0.1875$; $x = \tan 20° \times 0.082 = 0.364 \times 0.082 = 0.0298$; $r = 1/32$ inch.

Therefore, $L = 0.1875 + 0.0298 + 0.0312 + 0.0312 = 0.2797$ inch.

The thickness of the cut-off tool blade, and the value of x and $2x$ are tabulated in Table I. The above formula is applicable where the cut-off tool does not form down the stock. It will be necessary to change the formula somewhat when calculating the thickness of blade when the tool is used for partly forming the work, as shown in Fig. 14.

When Cut-off Tool Forms Stock

When the cut-off tool is used to form down end of stock, as shown at Fig. 14, the following formula is used for finding the thickness of blade:

$$T = \sqrt{\frac{D \times \cot a}{5}} \times 0.17,$$

where T = thickness of blade on cut-off tool in inches,

D = diameter of end of piece in inches,

a = angle on edge of tool blade (see Fig. 14).

The actual length of the cut-off tool blade $= R + x + 0.005$ inch,

Where R = radius on end of piece in inches,

x = dimension as shown in Fig. 14.

The dimension 0.005 inch is the clearance to pass the center. To find the value of x multiply T by $\tan a$ as before.

For example, let $D = 0.250$ inch, $a = 20$ degrees.

$$\text{Then } T = \sqrt{\frac{0.250'' \times \cot 20}{5}} \times 0.17 = \sqrt{0.13737} \times 0.17 = 0.063$$

$L = R + x + 0.005$, where $R = 0.125$ inch; $x = 0.063 \times \tan 20^\circ = 0.023$ inch.

Then $L = 0.125 + 0.023 + 0.005 = 0.153$ iuch.

In cases where pieces are being manufactured similar to that shown in Fig. 15, where the tapped hole *a* is not bottomed but passes through the piece (it being necessary to have a chamfer on the tap to facilitate tapping), the blade on the cut-off tool would have to be of sufficient width to remove the portion taken up by the chamfer on the tap. Otherwise, if the blade is too narrow, the hole *b* will extend part way into the next piece to be made. Then, if the drill had a tendency to run eccentric, the centering tool would not remove the eccentric hole thus formed by the drill, which would result in the drill running out and finally in the breaking of the tap before many pieces would be completed.

The amount of chamfer required on taps for various pitches is as follows:

	Lead
From 14 to 24 threads................	2½ threads.
From 26 to 32 threads................	3 threads.
From 36 to 48 threads................	4 threads.
From 56 to 80 threads................	5 threads.

When the thickness of the blade as derived by the formulas is not equal to the amount required for the lead on the tap, the thickness of the blade must be increased to at least the amount specified as lead on tap.

* * *

COST OF POWER FOR VARIOUS INDUSTRIES

In a paper entitled "Cost of Power for Various Industries Under Ordinary Conditions," which was presented before the Boston Society of Civil Engineers, by Messrs. Charles T. Main and F. M. Gunby, the following general summary of the cost of electrical power for various purposes and under varying conditions, was given. The prices quoted are approximately those found in the vicinity of Boston.

Power in small amounts and with a varying demand, can be purchased for from about 10 cents per kilowatt hour, in five kilowatt lots, down to about 6 cents a kilowatt for 100 kilowatt lots, where the power is used for about 50 hours a month.

The rate for a permanent or steady power of 100 kilowatts for 300 hours a month would be about $2.68 per kilowatt hour, and for 500 hours a month about $1.84 per kilowatt hour. The two conditions mentioned are only used as illustrations to show normal cases as in a city like Boston.

Assuming a plant of 2,000 kilowatts capacity, the approximate costs and prices for power are given in the following table:

Kind of Plant and General Use	Hours per Year	Cost per Year			Cost per K.W. Hour
		K. W.	E. H. P.	I. H. P.	
Textile (engine)....	3,000	$32.00	$23.80	$20.80	1.065c.
Textile (turbine)...	3,000	29.00	21.60		0.965c.
Paper mill (engine).	7,200	57.00	42.50	37.00	0.792c.
Paper mill (turbine)	7,200	52.00	38.80		0.734c.

The above figures are for cases where uo waste products are used for manufacturing.

For electric lighting or railway work with a load factor of 30 per cent the cost would be about $1.55 per kilowatt hour, or $40 per kilowatt year. This is $29.80 per engine horsepower year or an equivalent of $26.00 per indicated horsepower year.

For paper mill work, 24 hours a day, 6 days a week, power only, $57.00 per kilowatt year, or 0.792 cents per kilowatt hour for engine plant, or about 8 per cent less for a turbine plant. If the waste products were used for manufacturing, these costs might be reduced by about one-third.

For industrial plants, 10 hours a day, 300 days a year, straight power would cost $32.00 per kilowatt year. If heating is done, by exhaust steam, these figures may be reduced by about $1.20 per kilowatt or to say, $30.60 per kilowatt year. This would be about $23.00 per engine horsepower and $20.00 per indicated horsepower year.

For colored textile mills, making use of exhaust steam and water of condensation, the original cost of straight power would be the same as that given in the preceding paragraph. This may be reduced by using the exhaust steam and waste products by from $2.00 to $12.00 per kilowatt year, depending upon the amount of steam and waste products used.

The common price for hydro-electric power, 24 hours a day, 6 days a week, is from $30.00 to $40.00 per electrical horsepower or $40.00 to $53.50 per kilowatt.

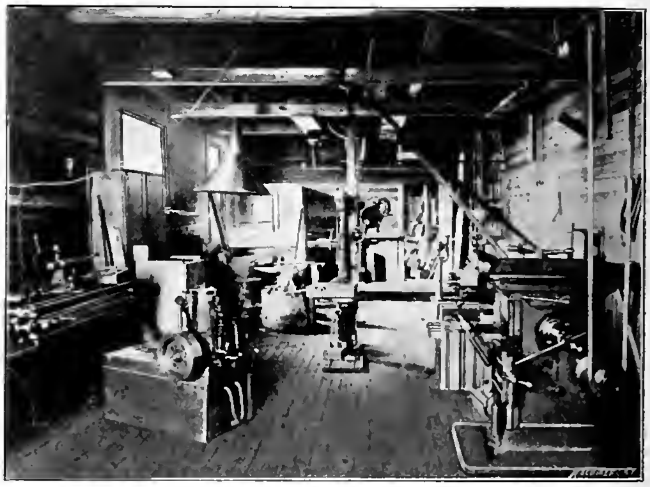
The common price for hydro-electric power, 10 hours a day, 3,000 hours a year, is from $20.00 to $25 per electrical horsepower, or from $27.00 to $33.50 per kilowatt.

* * *

A MACHINE SHOP IN ALASKA

By C. S. BROWN*

The readers of MACHINERY may be somewhat interested in a thriving little machine shop in the far north near Valdez, Alaska. The proprietor is Mr. Charles Crawford, who is considered one of the best all-around machinists on the Pacific coast, having left behind in Seattle a reputation for mechanical skill of which any man might well be proud. The various shops cover about three acres of ground and employ a dozen men most all the time. The machine shop is equipped with milling machines, lathes, drills, etc., and stands ready to build anything from a stove to a ship. For example, it has built two wharves, and an 80-foot launch which was sold to the United States government for $21,000. While doing a general machine business, its principal work is the manufacturing and installation of mining machinery such as hoisting machinery, pumps, drills, etc. One of its most important branches of work is the building and repairing of motor boats,



View of a Machine Shop at Valdez, Alaska

of which there are a few hundred in Valdez Bay. Beside wharf building, the manufacture of freight sleds is work that tends to make up a lucrative business. In connection with the machine business there is a tin shop which is always kept busy. Notwithstanding the fair wages paid to machinists—62½ cents per hour—Mr. Crawford experiences considerable difficulty in obtaining men, as most machinists, like the majority of workmen in Alaska, feel strongly the call of the north and go into the hills to seek the illusive pot of gold that is so well secreted in the frozen earth. A few are successful, but the most return with empty pockets. One machinist who has been smiled upon by Dame Fortune is Jack Carroll, who was one of Dr. Cook's guides on the Mt. McKinley trip.

Valdez is situated near the head of a beautiful land-locked bay on Prince William sound in the Gulf of Alaska. It is open to navigation the year round, and has water deep enough to float the world's navies. Six Seattle steamers call monthly with mail and merchandise, and the trip between the two ports is often made in four days. It takes nine days for a letter to reach Boston from there. Valdez is the farthest north open-all-the-year port in America.

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HANDLING AND STORING COMMERCIAL IRON AND STEEL PRODUCTS

By ETHAN VIALL*

There is a vast difference between the handling and storing of pig iron and that of the product that comes from the mills. The former may be loaded into cars with magnets—or just dumped in—and it may be unloaded on the same plan; but for handling sheets of metal, bars, tubes or beams, dumping is out of the question and magnets are impracticable and dangerous; that being the verdict of the firm of Joseph T. Ryerson & Son, Chicago, who probably handle more structural iron, sheet metal, bars and material of that sort than any other firm in the world.

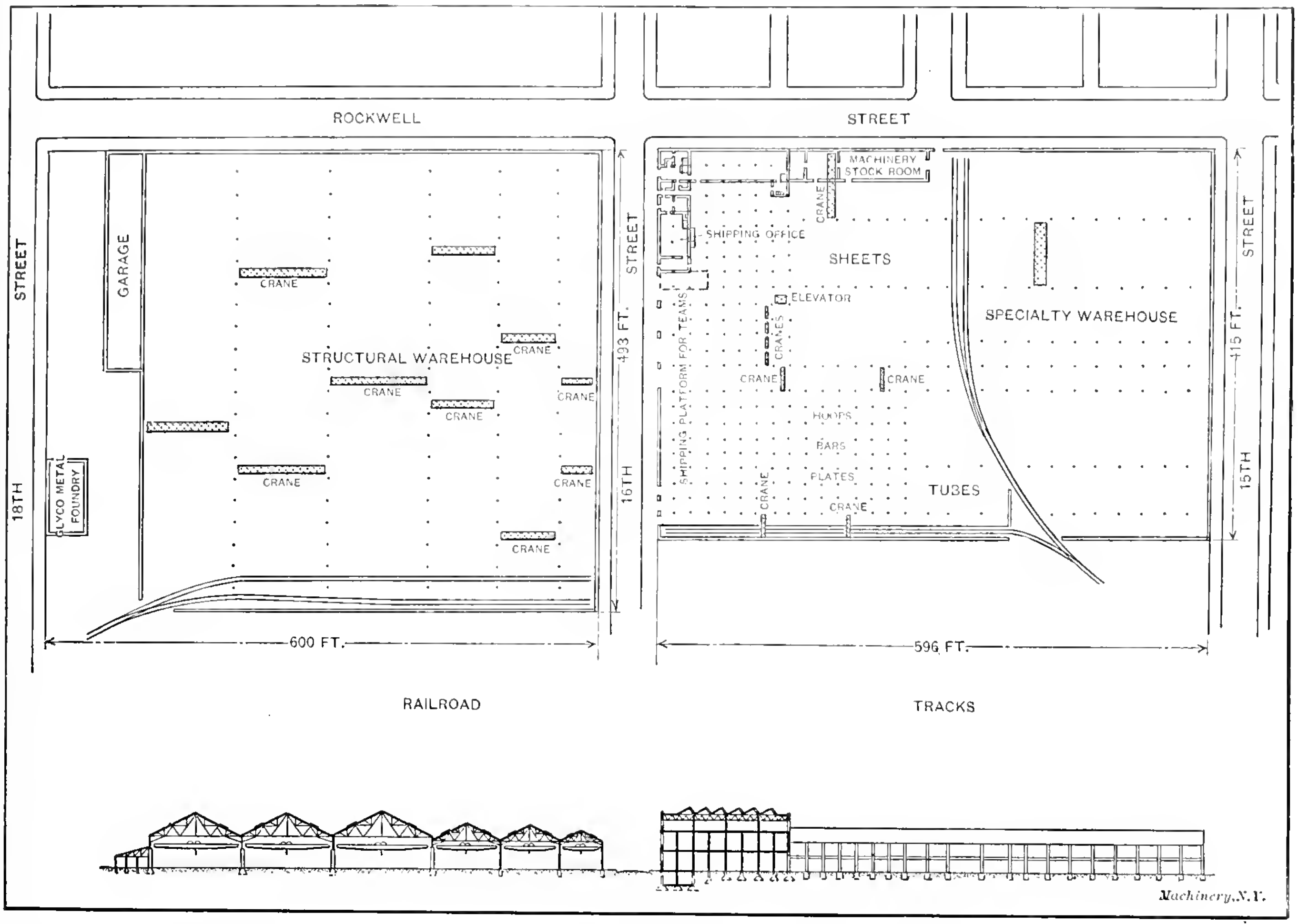

Fig. 1. Ground Plan of the Warehouse of Joseph T. Ryerson & Son, Chicago, Ill.

Fig. 2. View in the Structural Warehouse showing Cranes and Method of Storing Stock

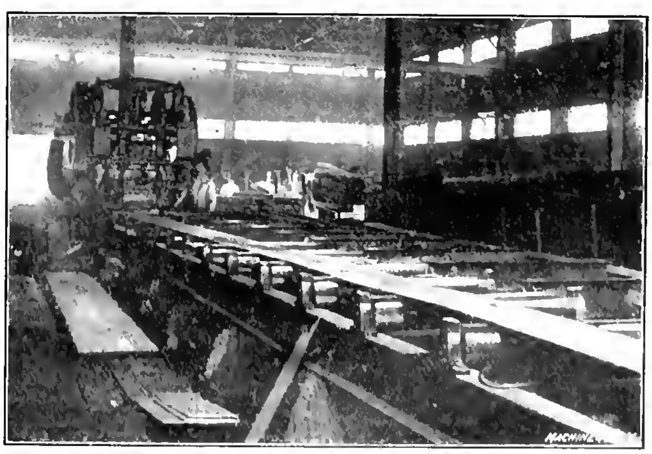

Fig. 3. Roller Table used to feed Stock to Big Shears

The general layout of the great Ryerson system of warehouses, the floor plan of which is shown in Fig. 1, is the best for the purpose that modern engineering skill could plan. These warehouses have 750,000 square feet of floor space, affording storage and handling facilities for 150,000 tons of material. The structural warehouse alone covers over eight acres. It is divided into bays, each being about five hundred feet long and varying in width from forty-five to one hundred and ten feet. All buildings are of steel construction throughout, with roofs of corrugated iron and glass. Three railroad switch tracks enter the structural buildings and extend along the entire east end, furnishing, under roof, accommodations for forty-nine cars at one time. The crane service operating in each bay over and at right angles to the railroad tracks, affords loading and unloading facilities which cannot be excelled. These shipping facilities of the structural warehouse, are supplemented by two wide wagon driveways, one entering the northeast portion of the plant and the other the southwest. These driveways are wide enough for a number of wagons, and like the switch tracks, are accessible to the entire warehouse crane service. The crane equipment is exceptionally extensive and complete, being composed of eight high-speed traveling bridge-cranes and two radial wall jib cranes in addition to the roller-tables and hoist systems used in connection with the various machines. Of the cranes just men-

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tioned [illegible] are of one hundred foot span and ten tons capacity and each is equipped with two trolleys and is operated from a stationary cage. These big cranes have a bridge traveling speed of 350 feet, and a trolley travel of 175 feet per minute.

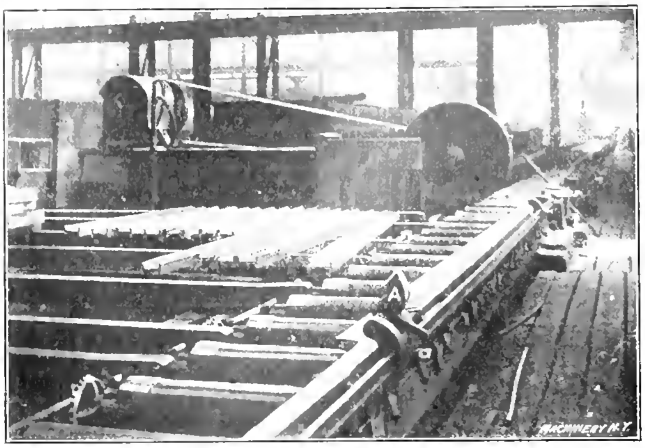

Fig 4 Roller Table for the Friction Disk-saw

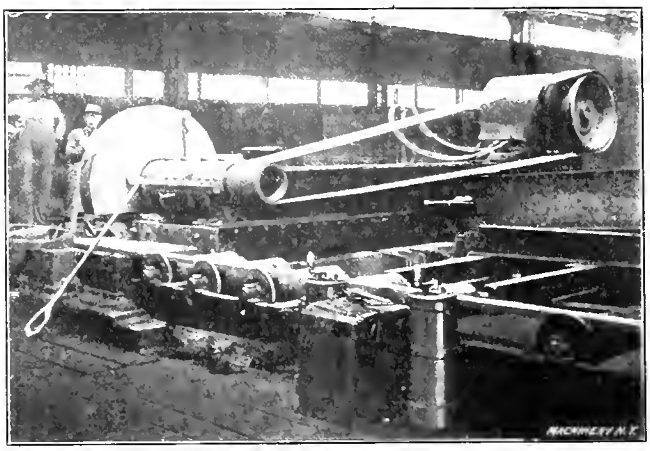

Fig. 5. Another View of the Friction Disk-saw showing Controller

A view of one of the structural warehouse bays and two of the cranes, is shown in Fig. 2. This view also shows the method of laying I-beams, etc., on structural iron "horses" so that they may be more easily picked up.

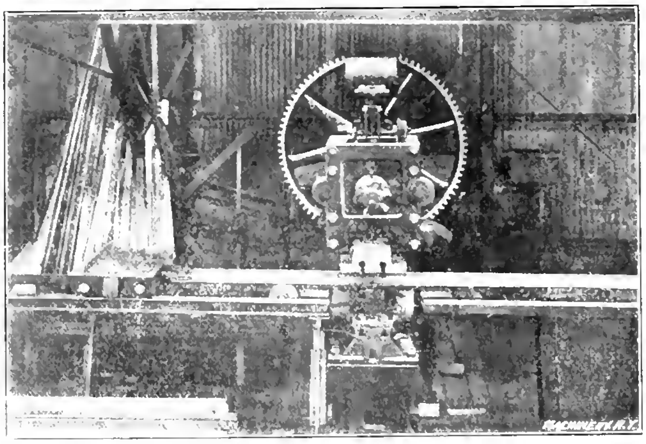

Fig 6 Punch Press and Device used to space Holes in Angle Irons

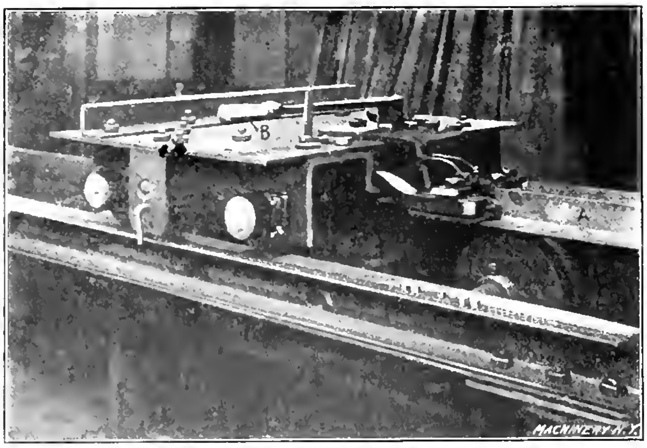

Fig 7 Detailed View of the Punch-press Spacing Mechanism

As just mentioned, the crane system is supplemented by an elaborate and carefully designed motor-driven, roller-table system, parts of which extend in three trains across the entire building and feed the high-speed friction saws and heavy shearing machinery. Fig. 3 shows one of these roller-tables that is used to carry material to one of the big shears, and in Fig. 4 is shown the roller-table of one of the big friction disk saws. The adjustable stop by which the length of the piece to be cut is gaged is shown at *A* and at the left of the rolls, may be seen the shaft and bevel gears by which the rolls are driven. Fig. 5 is a closer view of the saw from the other side, and shows the operator's seat and controlling levers in the foreground. Fig. 8 shows a view of another table with the saw in the act of tearing through an I-beam. These

Fig 8 One of the Friction Disk-saws cutting a 10-inch I-Beam

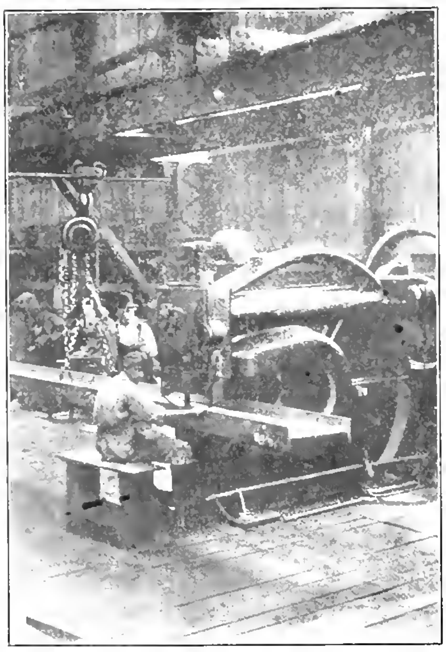
Fig 9 Traveling Hoist used to feed I-Beam under the Punch

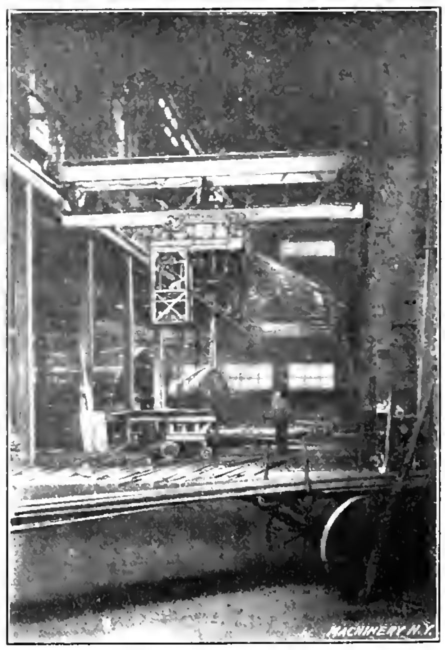

Fig 10. Cranes carrying Strap Iron to the Scales

friction disk saws have been previously described in detail in several technical journals, so only a very brief description will be given here. Each machine consists of a steel sliding

carriage, hydraulically driven forward and backward in V grooves, on a structural steel and cement foundation or bed. The saws are 52 inches in diameter, made of $\frac{5}{8}$ inch flanged steel, and run, driven by a 100 H. P. motor through a three-ply 16-inch belt, at a peripheral speed of 27,000 feet a minute.

Fig. 11. Closer View of the Portable Scales

There are no teeth on the saw, but the edge is hacked closely by using a fishtail chisel and a hammer, and instead of cutting, the disk literally melts its way through. The entire machine is 22 feet long, 5 feet 6 inches wide, and weighs

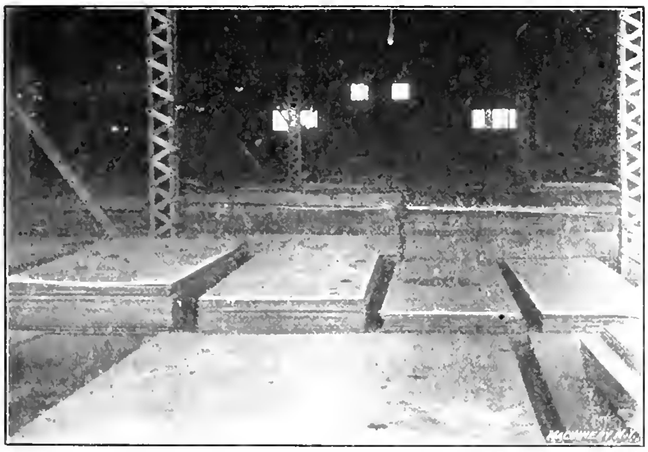

Fig. 13. The Way Flat Plates are stored

about 35,000 pounds. Some idea of the cutting capacity of these machines can be had from the fact that a 24-inch, 100-pound I-beam is cut in less than twenty seconds.

In Fig. 6 is shown a very unusual spacing device that is

Fig. 15. Grappling Claws for Plates, and Push Truck

attached to a punch press. It is designed to feed two angle irons (right and left) at once under the punches, so that the holes wanted may be punched quickly and accurately, and any number of pairs may be spaced and punched exactly alike. The device itself is shown on a larger scale in Fig. 7. It consists of a carriage mounted on wheels which run on a channel-iron track, one rail of which is drilled with three rows of holes so spaced that a stop-pin may be set every eighth of an inch; by filing a pin half away, a stop can be made within 1/16 inch of any distance, or number of distances, wanted within the length of the rail, which has been made ample for all needs. The angle irons *A* are clamped by means of the lever *B*. A dog back of the piece *C*, does the spacing

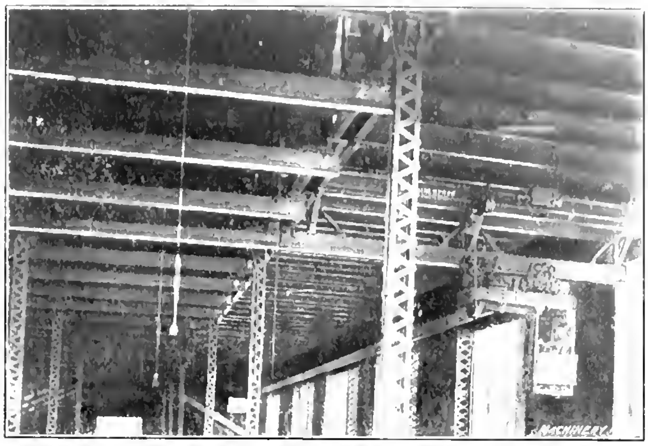

Fig. 12. System of I-Beams for Crane Trolley

for the carriage, as it drops over and is held against each pin in turn. The dog may also be lifted out of the way of the stop-pins, by using the handle just under the letter *C*, when it is desired to run the carriage out or in for any purpose.

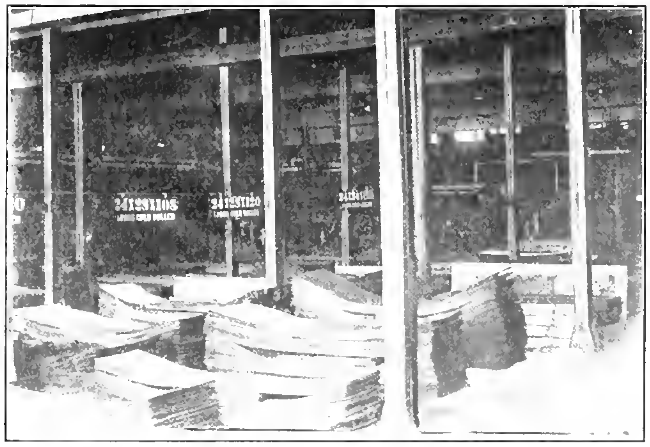

Fig 14. The Way Bundles of Sheet Metal are stored

In Fig. 9 is shown a small traveling hoist that is used to handle I-beams while punching rivet holes in them.

Fig. 10 shows a crane in the plate and bar warehouse, carrying band iron to one of the portable scales. A closer view of

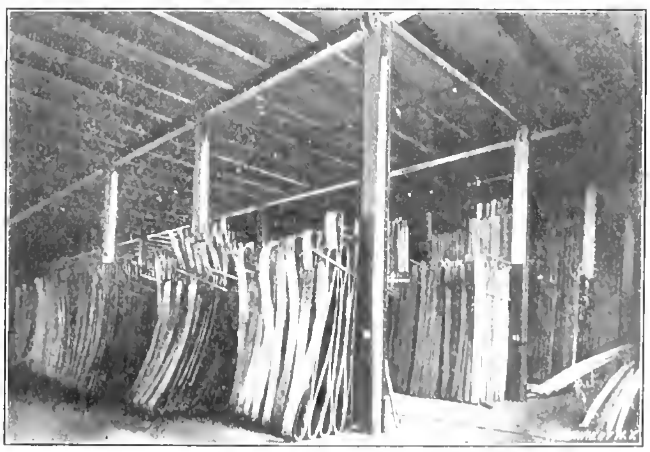

Fig 16 The Way Strap, Band or Hoop Iron is stored

the scale is given in Fig. 11. These scales are easily taken anywhere that is most convenient.

The crane system of the plate and bar warehouse, just referred to, is unusual. This building is of heavy steel, two story construction and provides 140,000 square feet of storage space. It has double crane runways, which extend the entire length of the structure, one on each side. The cranes are of ten tons capacity, and are so designed that the carriages can

be run off of the crane bridges proper onto the I-beam trolley system, illustrated in Fig. 12, which serves the entire storage floors. Beneath one of the crane runways, there is a switch track, and beneath the other, a wagon driveway, both of which extend the entire length of the building, so it will be seen that any material, such as the plates shown in Fig. 13, for example, may be taken off of a car or wagon and carried by the crane directly to and deposited on the pile designated, with but one handling. As the illustration just referred to indicates, all plate stock is laid on the floor in flat piles for convenience and to prevent distortion, each size being located in a separate pile and arranged in bays according to grade and thickness. The light sheet iron in bundles, is also stored in this way as shown in Fig. 14.

At the beginning of this article, it was stated that magnets are not used at all here as they are unsatisfactory and too dangerous for this kind of work. All crane grappling is done by means of chains or single beam-hooks or claws, two claws for plates being shown at *A*, Fig. 15, while at *B* is a short

Fig. 17. A View in the Bar Stock Storage

I-beam with an eye in the middle for the crane-hook and chains at each end, which is used for handling limber band iron, wide plates and other stock.

A rather surprising thing to most people when visiting these warehouses for the first time, is that all band and bar stock, of which there are 740 sizes carried, is stood up on end as shown in Figs. 16 and 17.

Located on the main floor of the north warehouse, and between the plate and sheet storage sections, are three heavy motor-driven, guillotine plate-shears, the largest one of which has the power and capacity to shear 12 feet of 2-inch steel plate at one stroke, and it weighs 260,000 pounds and stands 28 feet above the floor.

Boiler flues are brought in on cars as shown in Fig. 18,

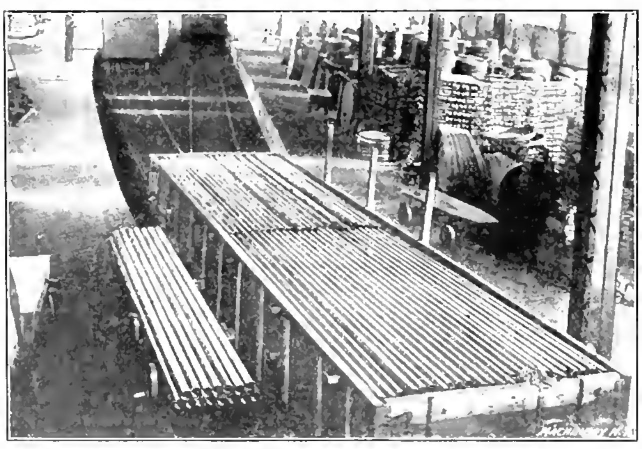

Fig. 18. Boiler Tubes loaded for Shipment

loaded onto small push trucks and then stored in structural steel racks as in Fig. 19. The various qualities of tubes such as seamless steel, lap weld steel, charcoal iron, etc., are each given different sections of the floor, while each size and length is given a separate compartment.

It must not be imagined by those not familiar with this firm, that the brief description here given covers even a small part of the immense variety of material handled and stored by the concern, for the variety of the structural and special steel and iron material, machines and specialties, is almost endless and only enough has been mentioned to give something of an

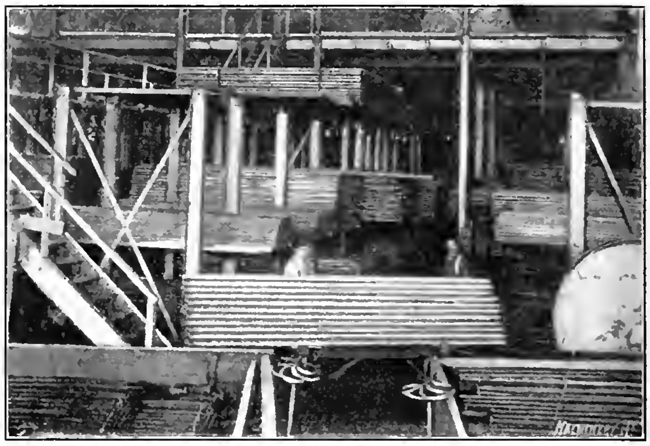

Fig. 19. Structural Iron Racks in which Boiler Tubes are stored

idea, in a general way, as to the methods used in the handling and storing of this material, in the greatest iron and steel "department store" in the world.

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THE STRENGTH OF CHANNELS AND OTHER STRUCTURAL SHAPES

Experiments on standard channels carried out by Mr. C. Bach and reported in detail in the *Zeitschrift des Vereines deutscher Ingenieure*, issue of October 30, 1909, show that the regular bending formula for beams freely supported at their ends and loaded in the center gives too high a value for the strength of structural channels. The experiments show that the amount by which the value obtained from the formula is greater than that obtained by experiments, is, for channels

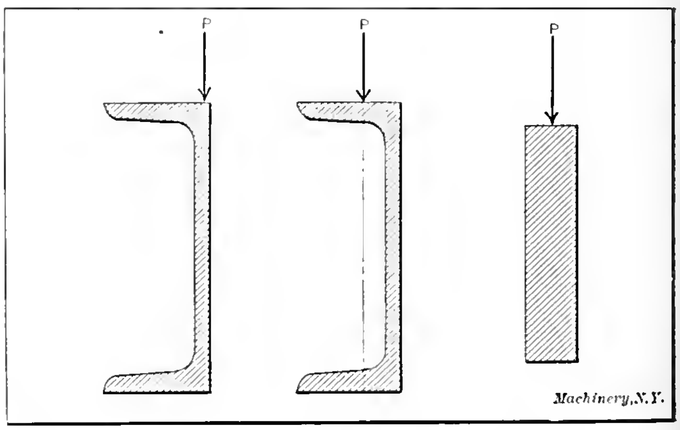

Fig. 1 Fig. 2 Fig. 3

twelve centimeters (4¾ inches) high, 7 per cent; for channels 22 centimeters (8¾ inches) high, 18 per cent; and for channels 30 centimeters (11¾ inches) high, 26 per cent. These values are those found when the load is assumed to be applied in the center line of the web of the channel as shown in Fig. 1. If the load is placed along the line of the vertical neutral axis of the channel as shown in Fig. 2, the permissible load according to the beam formula is 10, 25.5 and 34 per cent greater than that shown by the experiments. These experiments, therefore, indicate that when the usual formulas are employed in calculations, for channels or other structural shapes, a liberal factor of safety should be allowed in order to compensate for the difference of the results given by the formula and those of actual experiments. It should be noted, that apparently the formula for bending is fully correct whenever the section of the member is such that the load is fully distributed over the whole sectional area, as in a rectangular section, Fig. 3; but in the case of channels as well as many other structural shapes, the load is not, as a rule, properly distributed over the whole section, but stresses certain portions of the section in a higher degree than others.

MAKING A PRECISION DIVIDING WHEEL

There are various methods employed for making accurate indexing wheels for a definite number of divisions. One of these methods, suitable particularly for small numbers of divisions, employs a split wheel with a series of taper holes reamed through the two divisions. By shifting the two divisions from point to point and reaming and re-reaming the taper holes at each shifting, they may finally be brought very accurately into position. Another method that has been employed consists in clamping about the rim of the dividing wheel a number of precisely similar blocks, fitting close to each other and to the wheel itself. These blocks are then used for locating the wheel in each of its several positions in actual work. A third and simpler method (a modification of the one last described) consists in grinding a series of disks and clamping them around a rim of such diameter that the disks all touch each other and the rim simultaneously. The wheel we are to describe is made in this way. It is shown in Fig. 1.

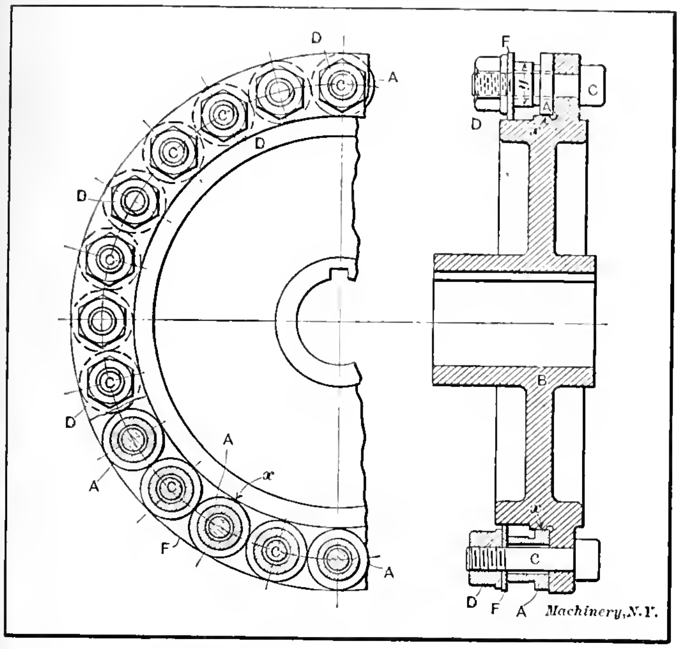

Fig. 1. An Improved Construction for Dividing Wheels of the Disk Type

In this, wheel disks *A* are clamped against an accurately ground face of the wheel *B* and are supposed to just touch each other all around, and to be each of them in contact with the ground cylindrical surface at *x*. They are held in proper position by bolts *C* and nuts *D*. The bolt fits loosely in the hole of the disk or bushing *A* so that the latter is free to be located as may be desired with reference to the bolt.

One or two improvements in the construction of this type of dividing wheel may be noted before proceeding to a description of the way in which it is made. For one thing, instead of having an indexing bolt enter the V-space between two adjoining disks, a smaller diameter *y* is ground on each of them, over which locking finger *E* (see Fig. 2) passes, holding the wheel firmly from movement in either direction. This construction has the advantage of a probable lessening of error by locating on each bushing instead of between two bushings; it gives a better holding surface and better holding angles, as well, than would be the case if this smaller diameter were not provided.

A second improvement refers to the method of clamping the bushing *A* in place. Instead of providing each bolt with a separate washer, a ring *F* is used. This ring fits closely on a seat turned to receive it on the dividing wheel *B*. When one bushing *A* has been clamped in place, the disk is locked from movement so that there is no possibility, in clamping the remaining bushings, of having their location disturbed in the slightest degree by the turning of the nuts in fastening them in place.

The bushings *A*, of which there were in this case 24, were first all ground exactly to the required diameters on their locating and locking surfaces. The important things in this operation are, first, that the large or locating diameter of the bushing should be exactly to size; and second, that this surface should be in exact alignment with the diameter in which the locking is done; and, finally, that the face of the bushing should be squared with the cylindrical surfaces. A refined exactness for the diameter of the locking surfaces is not so important, as the form of locking device provided allows slight variations at this point without impairment of accuracy. This dimension was kept within very close limits, however. The truth of the two cylindrical surfaces and the face of the bushing was assured by finishing all these surfaces in one operation on the grinding machine.

The sizing of the outer diameter of the bushing, which was 1.158 inch, must be done so accurately that it was not thought wise to trust to the ordinary micrometer caliper. An indexing device was therefore made with a calipering lever, whose long end, in the ratio of 10 to 1, actuated the plunger of a dial test indicator of the well-known type made by the Waltham Watch Tool Co. The thousandth graduations on the dial of this indicator would then read in ten-thousandths, permitting readings to be taken to one-half or one-quarter of this amount. The final measurements with this device were all taken after dipping the bushings in water of a certain temperature, long enough to give assurance that this temperature was universal in all the parts measured. It will be understood, of course, in this connection, that getting the diameter of these bushings absolutely to 1.158 inch was not so important as getting them all exactly alike, whether slightly over or slightly under this dimension; hence, the precaution taken in measurement.

Wheel *B* was next ground down nearly to size, great care being taken that it should run exactly concentric with the axis on which it is mounted for use. As soon as the diameter of the surface *x* was brought nearly to the required dimension as obtained by calculation, the disks were tried in place. The first one was put in position with its loose hole central on the bolt and clamped in place under ring *F*. The next bushing was then pressed up against it and against the surface *x* of the wheel and clamped in place. The third one was similarly clamped in contact with its neighboring bushing and the wheel, and so on, until the whole circle was completed. It was then, of course, found that the last disk would not fill the remaining space. This required the grinding off of some stock from surface *x*, and a repetition of the fitting of the bushings *A* until they exactly filled the space provided for them.

This operation required, of course, considerably more skill than a simple description of the job would indicate. One of the points that had to be carefully looked out for was the cleaning of all the surfaces in contact. A bit of dust or lint on one of the surfaces would throw the fitting entirely out. The temperature of the parts was another important consideration. As an evidence of the accuracy with which the work was done, it might be mentioned that it was found impossible to do this fitting on a bench on the southern or sunny side of the shop, the variations of temperature between morning and noon, and between bright sunshine and passing clouds, being such that the disks would not fit uniformly. The variation from these minute temperature changes resulted from the different coefficients of expansion of the iron wheel and the steel bushings. The obvious thing to do would be to build a room for this work kept at a constant temperature (preferably that of the body), so that the animal heat of the operator would make no difference in the results. It was found sufficient in this case, however, to do the work on the northern side of the shop where the temperature was more nearly constant, not being affected by variations in sunshine.

The dividing wheel, whose construction has just been described, was made by the Fellows Gear Shaper Co., of Springfield, Vt. It is used for indexing the Fellows gear cutters in the machine in which the teeth are ground. The indexing mechanism of this machine is shown in Fig. 2. The handle *G*, by which it is operated, is pinned to rock-shaft *H*, to which is keyed arm *J*. Pivoted to *J* is a pawl *K* engaging the teeth of ratchet *L*, which revolves loosely on shaft *H*. This ratchet *L* controls the movement of locking finger *E*. The

parts are shown in their normal or locked position in the engraving.

As the handle G at the right of the engraving is pulled toward the observer, arm J at the left of the engraving is raised, carrying the ratchet wheel around in the direction of the arrow shown. This allows flat spring M to drop over the ratchet tooth, permitting helical spring O to raise latch E and thus leave the wheel free. The continued movement of the hand-lever and of rock-shaft H, by means of gear N, intermediate pinion P and gear Q, causes the indexing pawl R, pivoted to the latter and acting on the head of the bolt C, to index the wheel one step. Just before reaching its new location the new tooth of ratchet wheel L coming up, bears down on the top of spring M, pressing latch E into place against the tension of coil spring O. By this means the wheel is locked in position.

When the operator pushes the handle G back again to its position of rest, the pawl R is retracted into position to act on the next bolt head for the next indexing. Star-wheel L remains stationary on this backward movement, being prevented from revolving by the notch on the top of the tooth into which spring M fits. Pawl K on its return engages with the next tooth of this wheel, ready for the next indexing operation.

A slight rotary adjustment of dividing wheel B, independent of this indexing mechanism, is required for the feeding of the machine. This is accomplished by the end movement of latch E, which is pivoted in slide S. This latter is pressed to the right by spring plunger T, and is adjusted positively in the other direction by feed-screw U, which is finely graduated to permit accurate adjustment. The accuracy in indexing obtained by the use of a wheel thus made was required to bring the finished cutters within the very narrow limits allowed for them in the final inspection.

R. E. F.

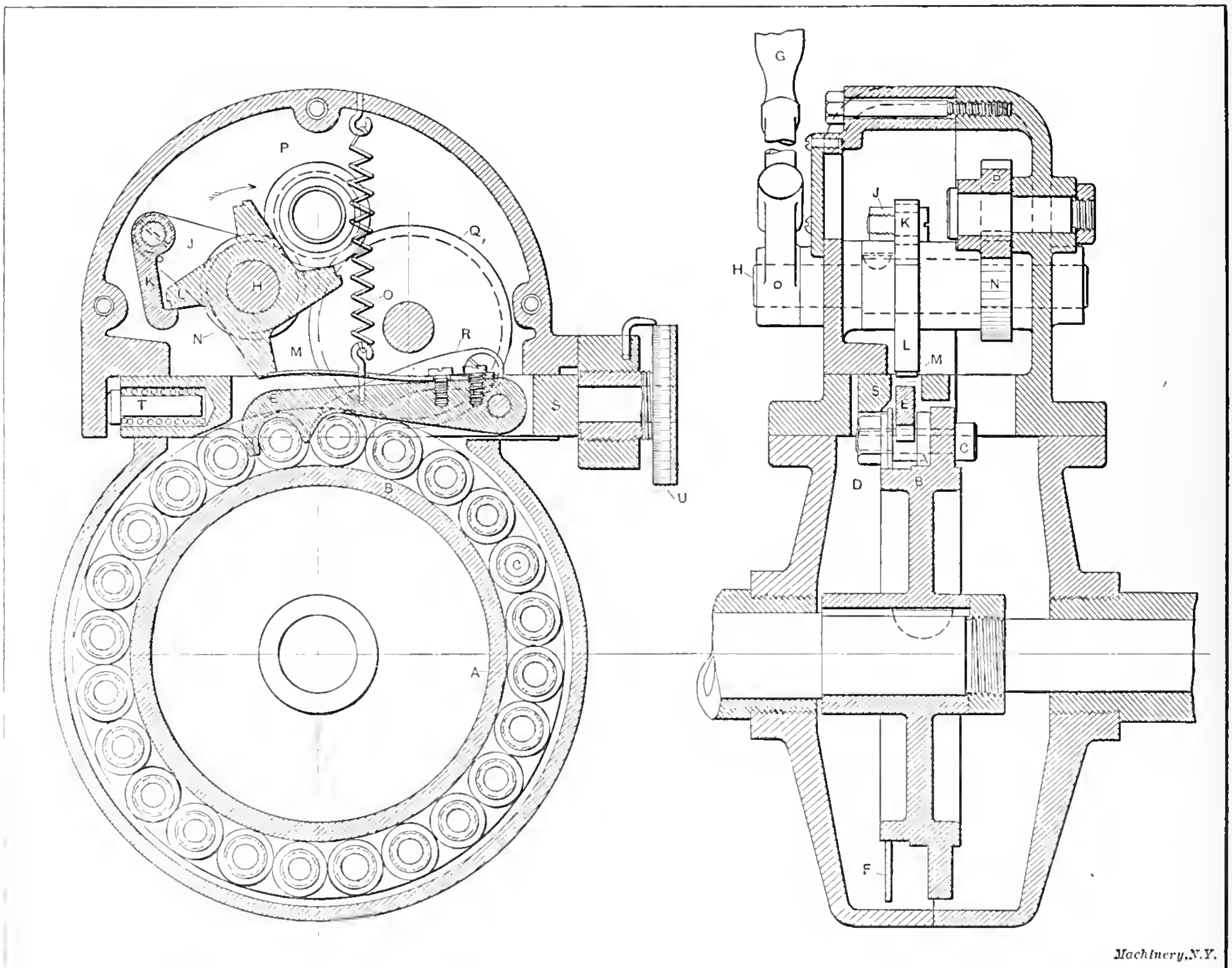

Fig. 2. The Indexing and Feeding Mechanism of the Fellows Gear Cutter Grinding Machine, in which the Dividing Wheel is used

EXPLOSION GAS TURBINES

In the March, 1907, and July, 1908, issues of MACHINERY, engineering edition, articles were published on practical results obtained with actual operative gas turbines in France. These articles consisted of abstracts from accounts published in *Cassier's Magazine*. The same magazine some time ago published additional information relating to recent developments in this field.

During the past year there has been built in Paris, by Mr. Karavodine, an explosion gas turbine developing about two horsepower; the machine has been operating with regularity, and recent tests have been undertaken from which the following data are obtained. In the Karavodine explosion gas turbine there are four explosion chambers, the products of the explosions being directed through four nozzles upon a single turbine wheel. The wheel is of the De Laval type, about six inches in diameter. This wheel makes 10,000 revolutions per minute, corresponding to a peripheral velocity of about 260 feet per second. The gasoline consumed per horsepower-hour amounted to 4.93 pounds. The machine gave 1.6 brake-horsepower, and the frictional losses were determined by the experiments to be 0.5 horsepower, so that the actual indicated horsepower was 2.1. In considering the availability of a machine of this type, there are some considerations other than fuel consumption. The continuous turning effort is often desirable, and considering the small size of the machine, the results were not unfavorable. The absence of a compressor and the corresponding reduction in weight and size are some of the advantages of the machine over previous types. Of course, the gas turbine is not yet a practical machine, but it is interesting to note the progress being made.

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Don't dry freshly applied blue vitrol by brushing the piece of work against your overalls or apron; it destroys the fabric.

CUTTING SMALL SPUR GEARS IN SPECIAL SEMI-AUTOMATIC MACHINE

By E. H. WEISS*

When it is necessary to cut a large quantity of small gears of say 80 millimeters (3 5/32 inch) diameter, it is a job of some delicacy if it is necessary to do the work accurately and economically. This condition is met with periodically in our factory, particularly in the manufacture of small gears for the magnetic calls for telephone service. These gears are first turned on the outside in gangs while they are held between two clamping plates, thus making the periphery true with the bore which is sometimes slightly eccentric. As we possessed but one small and unsuitable sawing machine, it was decided to cut the gears and pinions (the latter also being of brass but only about 20 millimeters in diameter) by mounting them in gangs of eight or ten between the dividing heads of an old milling machine.

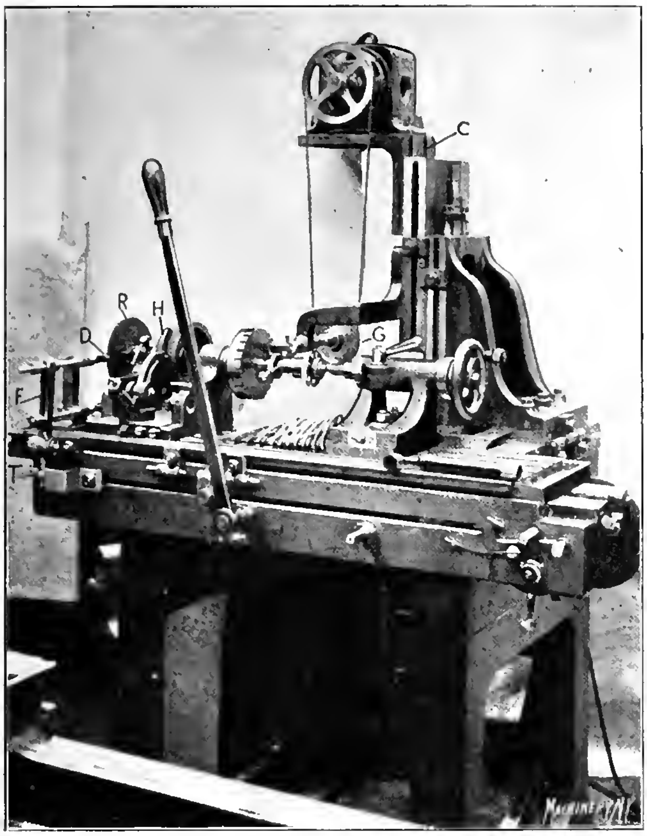

Fig. 1. Machine for Cutting Small Spur Gears, with Automatic Indexing Mechanism and Hand Lever Feed

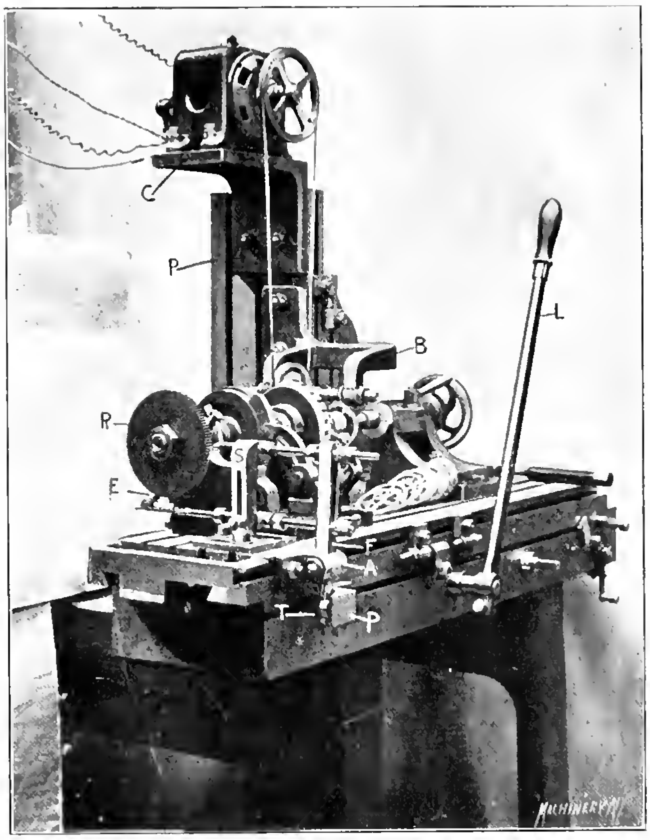

Fig 2. Another View of the Spur Gear Cutting Machine

Two difficulties presented themselves: First, the maximum speed of the cutters was 1,800 revolutions per minute, which was not sufficient to finish the surface of the teeth properly without reducing the feed of the table, which would have increased the cost of the work; furthermore, as the platen was fed by hand, naturally it was difficult to feed it uniformly and with the required feed reduction. Second, the pressure necessary to hold the gear blanks together produced a slight curvature at the center which, in conjunction with the distortion due to the pressure of the cutter, caused the depth of the teeth in different gears to vary. It was then decided to mount the cutter on a special arbor which could be run at the required speed, and furthermore, to render the indexing automatic (the dividing was intended to be controlled by the to-and-fro movement of the lever *L*). The cutter-head was removed and on the vertical platen *P*, as shown in the accompanying illustrations, there was bolted a bracket *B* having two arms to support the cutter arbor. The latter, which revolved between centers, could, without difficulty, be driven at a speed of 3,500 revolutions per minute. Besides the cutter, this arbor carried a pulley *G* having a V-shaped groove. It was out of the question to drive this pulley from the driving shaft of the machine, for that shaft revolved only 150 revolutions per minute, therefore, it would have been necessary to have had a series of belts and pulleys which would probably have become heated on account of the high speed. It was decided then to drive the cutter arbor by means of a small motor. In order to avoid having a tightener on the driving belt, a large bracket *C* was fixed to the upper part of the slide *P*, and this bracket supported a shunt motor, on the armature shaft of which was fastened a grooved driving pulley. Since the cutter arbor is adjusted up and down with the slide *P*, the distance between the centers of the two pulleys, of course, is always the same.

The method employed to automatically effect the indexing of the dividing wheel is as follows: On the back of the dividing head a bronze wheel *R* is keyed, which is provided with either the same number of teeth, or a multiple of the number of teeth in the gear to be cut. The indexing of wheel *R* is effected by a dog *E* which has an adjustable movement, permitting the indexing of one or several teeth. After wheel *R*, and with it the work, has been indexed, the finger *D* which moves with *E*, enters a tooth space in wheel *R* thus locking it in position. The stems of parts *E* and *D* both slide in the same support *S*, and their backward movement against the pressure of coiled springs bearing against an abutment, is effected by a slotted lever *F*, which is pivoted at *A* and carries at its lower end a roller *T*. The base of the machine is provided with a wedge-shaped dog *P*, which is fixed in place. At the end of the movement of the table, that is to say, when a tooth has been finished, the roller *T* is displaced by the wedge-shaped surface on *P* thus effecting the movement of lever *F*, and through it that of stems *E* and *D*.

After experimenting, it was found that the work spindle needed to be braked more or less (depending on the number of holes being indexed) to check the table at the end of its movement. To effect this, a fiber brake *H* was provided, which supplied more or less pressure on a disk keyed to the spindle by means of an arm held down by spring pressure.

After the wheels are once placed on the arbor, the workman, who under the circumstances may be a common laborer, has only to move lever *L* back and forth and he does not need to occupy himself with the details of the cutting action. The work is finished when it has made a complete revolution. The movement of lever *L* can be very rapid, as the cutter, because of its speed, does not rough up the work.

As previously stated, this gear cutting operation is only re-

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quired periodically, though several thousand gears are cut at a time. When the milling machine is not required for this work it is only necessary to remove the two heads, the bracket C and the arm B, when the machine may be used as an ordinary milling machine after the vertical or horizontal head has been replaced on the platen P.

* * *

"COST OF POWER" DEFINED

"Twenty-five years ago, the expression 'cost of power' was fairly well defined as meaning the yearly cost per indicated horsepower, if produced by steam; or power on the wheel shaft, if produced by water, for ten hours a day and about 308 days a year, or for 24 hours for the same number of days. This was fairly well understood by those who had to deal with these matters and who gave the matter any thought." This was the statement made by Charles T. Main and F. M. Gunby in their paper entitled "Cost of Power for Various Industries Under Ordinary Conditions." Continuing, this paper, which was recently read before the Boston Society of Civil Engineers, the authors go on to say:

"Since that time when mechanical transmission of power by shafting, belting, ropes, etc., were about the only methods in use, there has been developed the electrical transmission of power now so commonly in use, with new units of power as electrical horsepower, and the kilowatt, which is equal to 1.34 electrical horsepower. There also has now come into common use the steam turbine, for which there is no indicated horsepower, the measurements of power being either in brake horsepower, electrical horsepower, or kilowatts. There is the power produced by water wheels, which is gross horsepower, net horsepower at the wheel shaft, and when changed into electrical power, electrical horsepower and kilowatts.

"To-day the statement, 'cost of power,' unless clearly defined, may mean one of many things, and the men who are used to thinking in indicated horsepower are sometimes at a loss to know what is meant when the cost is stated as so much per kilowatt, delivered. It must be translated back into indicated horsepower or its equivalent, before there is any definite impression made on their minds.

"There is another source of great confusion because, during this period of time, there have been developed industries like electric lighting and street railway plants, in which the load is extremely fluctuating, in which, therefore, the cost per horsepower of unit of product is more and cost of plant more than for steady loads. Now that electrical transmission has been developed so that the current can be transmitted and used at a distance, it must be sold as electric current, delivered, and if a price is quoted to a mill manager at 32 dollars per kilowatt, delivered, he says: 'How much is this a horsepower?' and you answer, '24 dollars.' He then says: 'I can beat that in my engine,' and when he says it he is thinking of indicated horsepower at about 20 dollars a year per horsepower, with no allowance for friction loss in the engine or transmission to the same point where the electric current is delivered.

"If lighting current is offered to him at 3 dollars and 20 cents per kilowatt hour he says: 'How much is that a year?' 'For 3,000 hours it is 96 dollars a kilowatt, or 72 dollars a horsepower.' 'Well,' he says, 'that is outrageous when we produce at 20 dollars a year per horsepower.'

"It may be possible that he can beat the figures presented to him, but there is a reason for the discrepancy between his conception of what prices ought to be, and what they are.

"The cost of power and the value of steam and water power to the various industries varies between very wide ranges. Steam power costs the most per unit of power when produced in small amounts, and the cost is increased for fluctuating loads and when used for purposes where the load factor is small. By 'load factor' we mean, in this particular instance, at least, the average output in per cent to the full load capacity of the plant. Loads with a small load factor are obtained in electric lighting and street railway plants, in which cases there is generally no use for the 'by-products of power.'

"Steam power costs the least per unit of power for comparatively steady loads, and the cost is still further reduced where there is use for exhaust steam or the overflow water from the condenser. Such conditions as these are found in colored textile mills. Another example of the low net cost of power is in steel mills where the waste gases of the furnaces are used, either for the production of steam or directly in gas engines. Between these extremes there are various industries for which the cost of power will vary greatly."

* * *

ROOTS BLOWER PISTON PROFILES*

The design of the profile of the pistons of a Roots blower presents great difficulties to the novice who attempts to arrive at a correct form by the process of "trial and error," or the complicated method of making tracings of the pistons in twenty or thirty different positions on one piece of paper. The matter is very simple, however, when analyzed, and the writer believes the method of drawing the profiles, given herewith, to be original. It was at any rate discovered by him recently, when the design of some Root's blowers came into his hands, and the results appear to be excellent. A favorable point is that all the curves are parts of circles, which greatly facilitates the machining of the faces by making it possible to rotate the work on centers when planing.

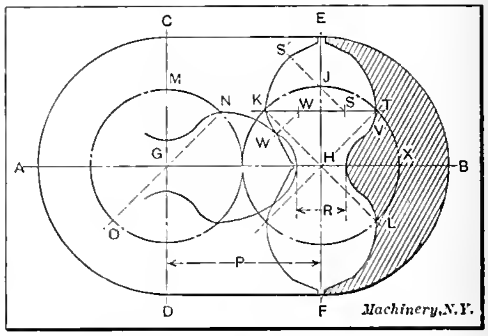

Diagram Illustrating Method of Laying out Root Blower Pistons

In a blower of this design the air space available is about 60 per cent of the area swept out in one revolution of the pistons; *i. e.*, the area X, Fig. 1, equals 60 per cent of the area of the half circle EF. In calculating the output, an efficiency of 70 per cent can be allowed, so that $L = 4 \times A \times R \times 0.7$, when L = length of piston in feet, A = area of one air space X in square feet, R = revolutions per minute. The diameter of the pistons is, of course, made sufficient to give a proportionate length of, say, 2 diameters. The distance P between the centers (see illustration), equals 0.6 times the diameter of the piston plus 1/8 to 1/4 inch for clearance. This makes the width at the narrowest part R = 1/5 of the diameter EF, and it may not be less.

To lay out the profiles, set down the horizontal and vertical center lines AB, CD and EF; and from the centers G and H strike the pitch circles JKL and MNO with radius $= \frac{1}{2} P$.

It will be seen that at the points K and N the profiles of pistons cut the pitch circles. These points are found by drawing a line at 45 degrees from the centers H and G. Through the point K draw a line KT parallel to AB. From center S with radius SK = radius of pitch circle, describe the arc KS', placing center S on the line KT. From center W with the same radius describe the arc TE. From center S describe arc TV, and from the center W describe the arc KW'.

This produces one pair of faces, and the opposite pair is produced in a similar way. A radius must now be found such that with the center on the line AB an arc may be struck connecting the inner part of the faces and the outside of the center boss. The useful part of the curving faces thus produced lies within the angles formed by the lines SS' and WW', and the line KT. These lines SS' and WW' are struck at 45 degrees from the centers S and W. The useful part is all of the faces that need be machined, though in practice it is as well to extend it 1/2 to 3/4 inch beyond.

The outer part of the pistons should be formed into a rib which may project 1/4 to 3/8 inch, and the base of this rib may be joined by a straight line to the point on the face at which the machining finishes. It may be stated that this construction does not produce perfect contact at all times between the faces, but the error is negligible. Allowance must, of course, be made for clearance between the pistons.

* R. Hampton, in the *Mechanical World*, December 24, 1909.

DON'TS FOR MACHINISTS*

By H. E. WOOD†

Don't run an emery wheel that is on a shaky machine.

Don't use a hand reamer for power reaming.

Don't run cutters backward in a milling machine.

Don't finish a milling machine job with dull cutters.

Don't put up pulleys unless they are properly balanced.

Don't leave set-screws sticking out of shafting collars.

Don't use one emery wheel for all kinds of grinding work.

Don't set the stroke on a shaper longer than is necessary.

Don't put on a belt with the flesh side next to the pulley.

Don't file holes oblong to let a bracket up to its place.

Don't force an emery wheel on an arbor; it should be an easy fit.

Don't let your milling machine cutters slip around on the arbor.

Don't work on any machine if the countershaft hangers are loose.

Don't believe that emery wheels are the only abrasive wheels made.

Don't put wooden wedges under the hanger feet without nailing them.

Don't make a new piece just like the old piece when making repairs.

Don't screw the clamping nut too tight against an emery wheel; it is dangerous.

Don't work under a cracked pulley; it should be patched or scrapped.

Don't leave anything loose lying overhead where machinery is running.

Don't bear on an emery wheel too hard; it will only cut so fast anyway.

Don't fail to have all oil cans marked so that the kind of oil in them is known.

Don't try to put in lag-screws without first boring pilot holes for them.

Don't put lag-screws into hardwood timber without a good heavy grease on them.

Don't forget that fast speed is better than slow speed for slotting saws.

Don't run a milling cutter against the table or vise jaws and then deny it.

Don't forget that very high speed should be used to make brass cut nicely.

Don't think that locomotive work is altogether like stationary engine work.

Don't get your shirt or frock sleeve close enough to touch a running drill.

Don't forget that sheet steel has an end grain, similar to a piece of board.

Don't make center punch marks to work to, when you can see your scratch lines.

Don't try to make a straight hole in a spongy piece of cast iron with a drill.

Don't forget that large flat castings will bend with their own weight.

Don't run an emery wheel any faster than one mile a minute at its cutting surface.

Don't forget that a taper reamer makes a good backing-off tool in punch and die work.

Don't forget that it is an impolite question to ask the new man where he worked last.

Don't fail to make allowances for the sag of your shafting when putting up a line shaft.

Don't neglect an emery wheel until the face is entirely clogged full of metal and dirt.

Don't put up a chain hoist and use it without making sure that it will hold more than the load.

Don't put up overhead shafting without making provision to catch or absorb the surplus oil.

Don't use flanges or washers on the emery-wheel arbor without a slight concave to their face.

Don't allow work to rattle loose on the lathe centers, except when filing or polishing.

Don't put lag-screws through a board, plank, or timber, without washers under the heads.

Don't set the outer support for a milling machine arbor up tight to the nut, but leave a little end play.

Don't mount an emery wheel without first tapping it lightly, to see if it is sound or cracked.

Don't start up a milling machine unless you have the arbor in tight enough so that it will not slip.

Don't forget that canvas or leviathan belt works better in some places than leather or rubber.

Don't use too much belt dressing as too much is worse than none at all; besides it is expensive.

Don't use a large emery wheel on a small machine, or a small one on a large machine; it does not pay.

Don't try to start a milling cutter into a piece of steel that has the rolling mill scale still on it.

Don't cross your belt laces on the side next to the pulley, for that makes them cut themselves in two.

Don't forget that a power-transmitting belt will almost invariably go to the tightest point it can find.

Don't let the full weight of a power hacksaw be on a square or flat piece of work when the saw is started.

Don't forget that you can cut flat, square and round pieces of stock in a power hacksaw at the same time.

Don't try to get along with only one center-punch, or scratch awl, but have two or three; you'll need them.

Don't forget that there is a difference in letting a bracket "up to its place" and "back to its place."

Don't put a large washer on one side of an emery wheel and a small one on the other side; it is dangerous.

Don't bolt a rough casting down on a milling machine table or planer bed; it is better to put brass shims between them.

Don't saw a piece of steel nearly through from one side only, and then break it the rest of the way.

Don't start to do a drilling job unless the drill is tight enough in the chuck so that it can't slip around.

Don't forget that a shaft bearing will only take so much oil; any more than that amount will be useless.

Don't fail to leave a liberal allowance for expansion and contraction (or end play) in a line, or jack shaft.

Don't screw the bolts up too tight on one side of a pulley; both sides should be tightened together.

Don't blow dust from a hole or a corner unless you expect it to float back and get into your eyes.

Don't put a countershaft overhead without first putting it together on the floor, to see that it goes all right.

Don't use machine lubricating oil on taps, drills, or any cutting tools, and lard oil to lubricate a machine with.

Don't think that it is absolutely necessary to be just as precise and neat in repair work as you should be in new work.

Don't let a cone pulley get gummed up with belt grease; in fact, it is better not to use belt grease on cone belts.

Don't believe that it is economical to save emery wheels by neglecting to keep them trimmed and sharp.

Don't fail to get a little originality into your head, and try to reason out the why and wherefore.

Don't spit on the floor, because there is not a sufficient amount of iron on the floor to kill the tuberculosis germ.

Don't be reluctant to use the emery wheel dresser, as it has much the same effect as a file has to a carpenter's hand saw.

Don't mount an emery wheel carelessly, because ninety per cent of the emery wheel accidents come from this carelessness.

Don't think that a shaft must be absolutely level to run correctly, for the alignment of the centers is the most important.

Don't hesitate about asking your foreman questions; it is better to make him mad that way than by spoiling a piece of work.

Don't place pulleys so close together that there is not room enough for the full width of their belts to go down between them.

Don't forget that you may resort to many tricks in repair work that would not be tolerated for a minute in manufacturing work.

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* For Don'ts previously published in MACHINERY, see "Don'ts for Pattern-makers," January, 1910, "Don'ts for Screw Machine Operators," November, 1909, and "Don'ts for Draftsmen," with accompanying references, August, 1909.

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MARCH, 1910

PAID CIRCULATION FOR FEBRUARY, 1910, 25,687 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition $2.00 per year—coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages additional reading matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

A POWERFUL COMBINATION

Considerable space has recently been used by some trade journal publishers to deny the existence of a trust or combination of their properties. This was followed by a statement signed by Messrs. Charles G. Phillips, I. A. Mekeel, John A. Hill, James H. McGraw, W. H. Taylor, E. A. Simmons and Robert Tinsman, as owners and managers of eighteen important trade journals in the iron, steel, hardware, metal, machinery, mining, power, steam and street railway, electrical, boot and shoe, and dry goods industries, explaining the purpose of a combination of the above interests "to conduct complete campaigns for advertisers in every important line in the trade or technical press or the general publications. . . . The power of this organization for the general improvement of advertising effort is immense in its possibilities."

The power of this organization is beyond question. It is a combination of five powerful organizations in the trade paper field, comprising most of the leading journals in the industries represented; and it is idle to deny that the power referred to will be exercised to secure advantages for the publications in the combination to the exclusion of their competitors. That is what the organization is for.

Without seeking to make capital out of this situation or to exaggerate its importance, we may say that such a combination is a menace to trade journalism, because its object is to weaken if not to kill the independent journals in those fields. Aggressive competition is fully as desirable between trade journals as in any other line of business.

* * *

THE FUTURE OF THE AUTOMOBILE INDUSTRY

A good many manufacturers of machine tools and supplies who are selling from fifty per cent to one hundred per cent of their product to the automobile trade are asking themselves how long the demand will continue, and if it will drop off as suddenly as the bicycle trade did. We think not.

Bicycle riding was a craze that went through a family like the measles. There were five members of the writer's family and we had five wheels. That was ten years ago, and since then a new generation of children has grown up, but they don't ride wheels. The industry is now reduced to a commercial basis, and not one rider in a hundred uses his wheel for pleasure.

Bicycling as a fad began to expire when it became commercialized, and all sorts of people took to wheeling. The future of the automobile industry, as we all agree, lies in the adaptation or development of cars to commercial uses—not accomplished yet because manufacturers so far have been unable to supply the demand for pleasure cars, and also doubtless because of the smaller margin of profit between a luxury and a strictly commercial proposition.

After the existing and projected automobile works are equipped, we shall have some let-up in the demand for machine tools for that purpose, but the skill of our mechanics probably will develop the automobile industry gradually and conservatively until it becomes as safe and permanent as any other.

* * *

SIGNS ON FACTORIES

There are many forms of advertising a manufacturing business, and not the least valuable is by means of harmonious signs on the buildings, especially when they are located within sight of a railroad. Some large and prosperous concerns neglect signs and consequently lose an opportunity of making their business known to the traveling public. An Industrial Department circular issued by the Erie R. R. places the subject in another light which is worth considering by the public-spirited manufacturer: "Signs make business. . . . Apart from all business interests, a sign on a factory is an ethical courtesy to the traveling public."

An ethical courtesy in this respect is equivalent to the answer to a stranger's civil inquiry on the street. The railway traveler is prompted to ask what the industry is that he sees housed in some fine large buildings, and the plant should answer his question with a sign. Not only is a sign an ethical courtesy, but it often is a great time-saver. A traveling man or a customer visits a place new to him, with but little time to spare between trains, and loses many valuable minutes in locating the concern he desires to visit, which might be saved if he saw its sign from the approaching train.

Manufacturing concerns should display their name and business, when practicable, prominently on their factory buildings for the reasons just given; and, finally, a plain but artistic sign is not only a good advertisement, but it gives an air of prosperity to a plant, especially if the buildings and grounds are well-kept.

* * *

THE VALUE OF THE TECHNICAL WRITER

If it were possible to follow in detail the evolution of our highly-developed mechanism and to trace to their origin the superior methods employed in the modern shop, the credit given to the technical writer, and his status in the industrial world would probably be much greater than is apparent on the surface. In the advancement which is constantly taking place throughout the entire realm of mechanics, there is reflected to a considerable extent the work of men who have given publicity, through the printed page, to valuable knowledge they have acquired in the school of experience. And while all that is published is not valuable, it should be remembered that a large part of the technical matter which appears in the columns of this and other publications, as well as that which is presented in book form, has a value often far in excess of its apparent merit. The description, for instance, of a certain method or mechanism may suggest an idea which results in the adaptation of the same principle in other ways for other purposes; and if it were possible to trace some of the most valuable pieces of mechanism or inventions back to their origin in many instances we should find that the technical writer was largely responsible for their development. If all technical literature were to be suddenly blotted out of existence and no more contributions were made to it, say, in a generation, the resulting retrogression would reveal, as nothing else could, the value of the technical writer. So the man who records the knowledge that he gathers through the years and transmits it by publication to thousands of readers should be treated as a member of that class to which is largely due the advancement of industrial knowledge.

HOPE AS A NATIONAL ASSET

It has been a matter of perennial comment that the American workman has characteristics which are all his own. He stands preeminent among all the great industrial peoples in alertness, originality, conscientiousness and ambition; and in consequence he leads the world in value of product per individual. This does not mean that he is molded of finer clay than his European brother, for every incoming ship-load of immigrants shows that the contrary is true. A few months in this country, or a few years at the most, often work wonders in the stolid, unimaginative foreigner; and the ability to thus inspire the stranger within our gates is due to our industrial development in the past, and the hope that it maintains for the future.

One basis of the efficiency of the American workman is *hope*, and that hope springs from the opportunity the individual is offered in this country. So long as he sees that faithfulness and intelligence command living wages—that exceptional ability is appropriately rewarded, and so long as he feels that no congenital social barriers exist between himself and his employer—so long is our industrial position secure.

There are, unfortunately, evidences of danger ahead in this direction. Successful employers have sometimes forgotten that they or their fathers were themselves workmen but a few years ago. The growth of monopoly and privilege has often robbed master and man alike of the just rewards of their labor; and sometimes this growth has borne its evil fruit of suspicion, recrimination and deadly warfare. Fortunately, these conditions are still sporadic. It is the duty and privilege of employer and employe alike to join hands in rooting them from the soil of our national life. It is, in fact, more than a duty and privilege—it is a necessity.

* * *

FORMULAS FOR COMBINED BENDING AND TORSION

Several formulas have been given by various authorities to be used for obtaining what is called the ideal moment of combined bending and twisting moments. Some of these formulas vary widely, and there does not appear to have been any sound practical basis for the adoption of many of them. Rankine gives a formula:

$$M_I = \frac{1}{2} M_B + \frac{1}{2} \sqrt{M_B^2 + M_T^2}$$

in which M_I = ideal or combined moment,
M_B = bending moment,
M_T = twisting moment.

St. Venant gives the following formula:

$$M_I = \frac{3}{8} M_B + \frac{5}{8} \sqrt{M_B^2 + M_T^2}$$

This formula is also given in a slightly modified form in Hütte's "Des Ingenieurs Taschenbuch." In 1900 Mr. J. J. Guest published the results of some experiments made by him, on the strength of which he gave the following formula as expressing the relation of combined twisting and bending:

$$M_I = \sqrt{M_B^2 + M_T^2}$$

It will be seen that this formula differs very considerably from that of Rankine and St. Venant, especially for increasing twisting moments. For bending moments alone, the three formulas give equal results, but as the twisting moment increases, the Rankine formula allows a steadily increasing twist to take place, so that at the point where the stress is entirely a twisting stress the permissible torque by the Rankine formula becomes twice as great as that obtained by the Guest formula. It seems evident that the Rankine formula gives too high values for very large twisting moments. The St. Venant formula is a mean between the Guest and the Rankine formulas.

Experiments have recently been carried out by Mr. C. A. M. Smith and also by Mr. W. Mason, reports of which have been read before the Institution of Mechanical Engineers, Great Britain. The experiments made by Mr. Smith confirm the soundness of the Guest formula so far as mild steel is concerned and this formula may, therefore, be assumed to agree with practical experience. Mr. Smith also undertook experiments on self-hardening steels and nickel steels, but these experiments were unsatisfactory and no definite conclusions could be drawn from them because the material gave exceedingly variable results. Specimens cut from the same bar, even, did not give the same results in two consecutive tests. The formula is applicable to machine steel, however, with which material the machine designer is almost exclusively concerned when questions of combined bending and twisting stresses demand his attention, and the fact that the other materials mentioned do not give uniform results when tested indicates that it is not possible to obtain a universal formula for them.

* * *

IMITATION OF MACHINE TOOLS

American machine tool builders frequently complain of the imitation of their machines by European manufacturers. In a few instances it appears that American machine tools have been copied outright, but in most cases the copying consists of using the principal ideas embodied in the American design, adapting them in minor details to European requirements, and introducing such improvements as appeal particularly to European users. It is evident, however, that even in such cases, where the imitation embodies certain changes and improvements, the American manufacturer who has spent a great deal of time and thought in developing the original design cannot look with equanimity upon the practice of the European builders who thus make use of his ideas; but whenever no patent rights are involved, it is not possible for the American manufacturer to interfere.

A most interesting point in this situation is that while American manufacturers often complain about their machines being copied by European manufacturers, there is but comparatively little complaint against exactly the same practice in this country, although the cases in which American manufacturers copy the designs of their competitors are far more numerous than those in which European manufacturers are the imitators. A study of representative machine tools will show that of each class there are but a few original types differing radically from other machines of their kind, these types having been developed by a dozen or so progressive American machine tool builders. Improvements on such machines have been then introduced by various other manufacturers in adapting them to special conditions, exactly as has been done in many cases by the European manufacturers who are stigmatized as imitators.

While we are not undertaking a defense of imitators, the practice of incorporating the principal points of advantage in another design and adding to them a manufacturer's individual ideas, does not necessarily deserve unqualified condemnation, for without this custom the progress of civilization would have been impeded. The whole progress of the world is based upon the imitation and adaptation of the best in previous developments, and in adding to it new features of increased utility. In the manufacture of machines, this feature has been highly important in the evolution of the art of machine construction, and it is necessary to consider these points, not from the narrow standpoint of the individual, but from the larger one of general progress.

If we prefer, however, to look upon this question from a more limited point of view, we must still recognize that the superiority of one machine over another does not lie solely in the embodied features of design; it depends also largely upon the workmanship, material and processes of manufacture. The machine builder who can make the best machine at the lowest price, due to superior organization and management, will always take the lead of his competitors, no matter if they do imitate his designs. The fact that his machines are being imitated is one of the surest indications of his success. Fear of imitation is often an indication that there are defects in the organization and management which would make successful competition possible unless a trade secret, patent, or other partial monopoly were involved. The man who can afford to let others imitate him has built his organization on the firmest foundation. He may regret to see competitors take advantage of his inventive ability, but their competition will only prompt him to still greater effort—to prove that he has not yet reached his limitations.

LAYING-OUT AND ALIGNING OPERATIONS ON MACHINE TOOLS—2

By ALFRED SPANGENBERG*

In the previous installment of this article a number of special tools and devices used in the laying out and aligning of work were illustrated and described. The use of templets and gages in this class of work was indicated by several examples. In the present installment operations of this kind performed without special tools will be dealt with.

Laying-out and Aligning Operations without the Use of Special Tools and Appliances

In the absence of special tools and appliances for laying-out and aligning operations, the principal points to be observed are the selection of a proper starting point from which to lay out all dimensions, the employment of efficient means to compensate for the deflection in horizontal aligning arbors when the bracket seats lie in a vertical plane, *i. e.*, when it is impracticable to place the bed of a machine in such a position that the bracket seats will lie in a horizonal plane and thus carry the bracket members unsupported; and the avoidance of assembling all the correlated members together for the laying-out operations.

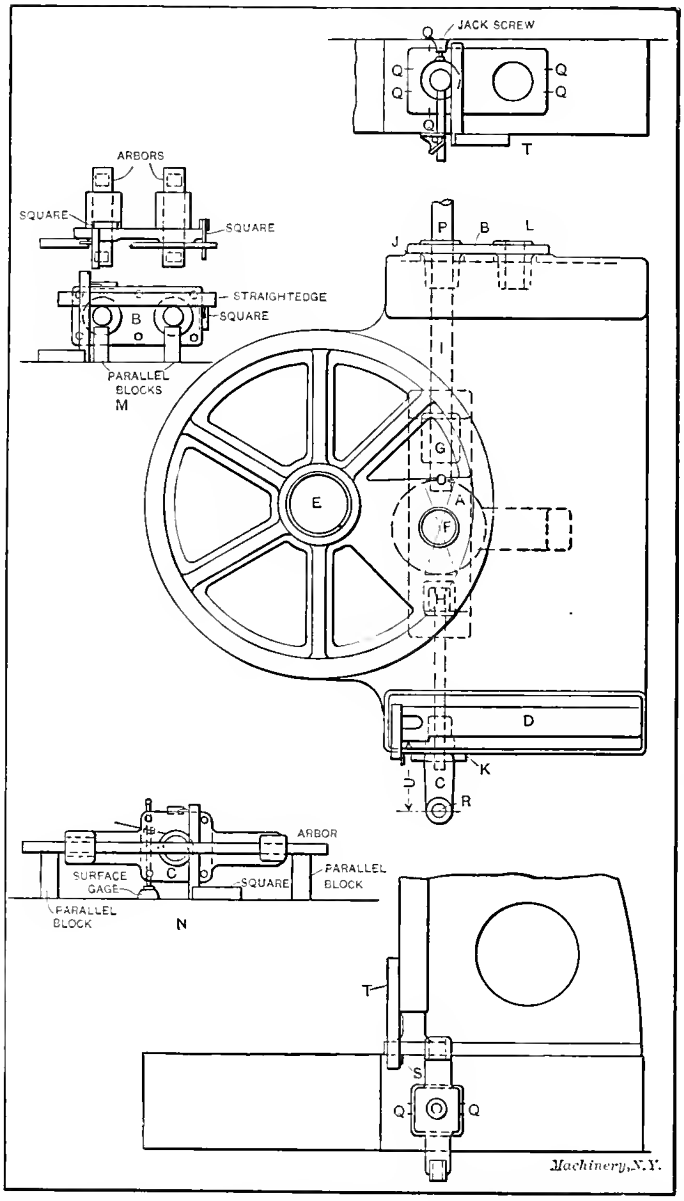

Fig. 8. Laying-out and Aligning Operations on a Vertical Boring Mill of the Spur Gear Driven Type. By the Methods shown, no Special Gages or Tools are required

The first two points brought out above are exemplified in the aligning operations on a vertical boring mill of the spur pinion driven type, which is illustrated in Fig. 8. The operations involved are the alignment of the driving pinion bracket *A*, the driving shaft bracket *B*, the feed shaft bracket *C*, and the housings; only one housing *D* is shown. The hubs on the brackets have clearance in cored holes in the bed. It is the general practice to bore out the table spindle hole *E*, and table gear pinion hole *F*, by means of a boring jig, previous to aligning the brackets; hole *F* in the bed is then used as a starting point for the aligning operations.

For convenience in setting bracket *A*, which forms the lower bearing for the table driving pinion, and also carries inner bearings *G* and *H* for the driving and feed shafts, the bed casting is turned bottom side up, the process being as follows: The table pinion is placed in position in its hole *F* for the purpose of centering the bracket; next the driving shaft *I* is put in place in its bearing *G*, and then the bracket is squared with seat *J* by means of a square held against the seat and the shaft. This setting is for marking off the bolt holes in the bed, and after the drilling and tapping is accomplished, the bracket is reset in the same manner as before and clamped by its bolts; then the dowel pin holes are drilled, reamed, and the pins fitted.

The next logical step is to turn the bed right side up and place reference lines on seats *J* and *K* respectively. A separate operation involves placing reference lines on the bracket members *B* and *C*. The reference lines represent, on each separate member, the outside diameter of the shaft used in aligning; then, in assembling the bracket members on the bed for the aligning operations, it is simply necessary to match the lines on the brackets with those corresponding on the bed. During this operation the brackets are supported on screw-jacks. This method of setting brackets illustrates the second point stated above, the employment of efficient means to compensate for the deflection in aligning arbors when the bracket seats lie in a vertical plane; another point of advantage, however, is that this method insures proper alignment of the shafts, any inaccuracy in the machining of the seats being immediately apparent when the members are assembled. For instance, another method of setting the driving shaft bracket would simply be to place the bracket in position on its shaft, support it on screw-jacks, and then shift the bracket around until a feeler indicated that all sides of the bracket were tight against its seat on the bed, attention being paid, of course, to the location of back-gear hole *L* with reference to the top of the bed. With this method it would be possible to have all sides of the bracket tight against the bed as just explained, but in the event of the bracket seat not being perfectly square with the hole, the shaft would be thrown out of proper alignment with reference to the planing on the bed and also to hole *G*.

Turning back now to the question of reference lines, the method of placing these lines on the driving shaft bracket is clearly illustrated at *M* in Fig. 8, while at *N* is shown the same operation on the feed shaft bracket; both cases are essentially the same. To place lines on the bed seat *J*, a surface gage is first set to the driving shaft at *O*; next the gage is moved to position *P* and the shaft jacked up until the surface gage indicates parallelism with the top of the bed; and then, after testing the shaft with a square on seat *J* to insure that the screw-jack is not holding the shaft out of alignment sideways, a combination square and an ordinary square are used as shown at *T*. Similar operations are involved on seat *K*. Permanence is given all reference lines by driving a thin chisel into the casting directly on the line. These lines are indicated in the engraving by the letter *Q*.

The housings are located on the bed with reference to hole *R* for the vertical feed shaft. Previous to placing the housings on the bed, however, lines are drawn at *S* on each housing and on the bed casting, which lines are in the same plane as the front face of the housings. This is accomplished in the former case by means of a straight-edge *T*, and in the latter case by laying off on the bed the correct distance from the center line of brackets *A* and *C*. In placing the housings on the bed the corresponding lines on each member are matched, and then the housings are moved so that measurement *U* is correct; this measurement is taken with a straight-edge and combination square. The housings are set for the pinning operations in the same manner. It may be of interest to state that the housings are first set on a large surface plate for the purpose

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of bolting on the arch casting and fitting the top-works, thus enabling the accomplishment of several operations simultaneously, as the cross-rail gibs also can be laid out at this time.

By observing the third principle laid down above, the avoidance of assembling all the correlated members for the laying-out operations, it is often possible to advance work that otherwise could not be accomplished. This point is illustrated in Fig. 9, which shows an oil pumping arrangement attached to an engine lathe carriage and driven by a shaft carried in bearings on the back of the bed. This outfit is special in its nature and is furnished as an attachment; considering this fact it will be apparent that the bed member is likely to reach the assemblers last, and therefore the work can be greatly advanced by laying out and fitting up the carriage members independently of the bed.

After bolting the oil tank *A* to carriage *B*, its bolts fitting T-slots in the carriage, the oil tank is set and then dowel-pinned, the operations being so simple as to need no explanation. As bracket *C* is already bored out on a boring mill, the first laying-out operation involves the location of stud hole *D* in the oil tank. Since this hole must be laid out with reference to surfaces *E* and *F* on the bed (surface *G* on the carriage is merely planed for clearance) very effective use can be made of a jig consisting of a short bed section; but if this is not available, a gage block *H* similar to that used in planing the carriage, can be substituted. A graduated try square is used first on surface *E* and then on surface *F*; the measurements are read directly from the graduations. Next, the hole is drilled and tapped using a pneumatic drill, and then bracket *C* is clamped in place by the intermediate gear *I*.

The next operation involves the alignment of hole *J* with reference to surface *E*, the object being to provide standardization for the planing of shaft bearing *K* and its seat on the bed. This is accomplished by swiveling bracket *C* around, using stud *I* as a pivot, until a combination square and scale indicate that the measurement is correct. The slide of the combination square rests against surface *E*, while its base is held in contact with surface *F*; the scale is then used to measure from the combination square slide to the center in the hole. After the bolt holes *L* and *M* are located, drilled and tapped, bolts are entered and the bracket is reset for pinning; the clearance in the bolt holes permits of adjustment.

To set the oil pump *N* it is merely necessary to bring gears *O* and *P* into proper mesh. The driving shaft brackets on the bed, one of which is shown at *K*, are located as follows: A short arbor representing the driving shaft is inserted in the bearing hole, and then the measurement is taken from surface *F* on the bed. These brackets are located and drilled on the bed while it is under a radial drill for other drilling operations, and the bed is turned over on its side at this time for convenience. The dowel pin holes in the driving shaft brackets are not drilled until all the parts are assembled on the bed; then the final alignment is accomplished by moving the carriage close to each bracket alternately and slackening off the bolts, thus allowing the adjacent bracket to be self-aligned, after which the bolts are tightened for the pinning operations.

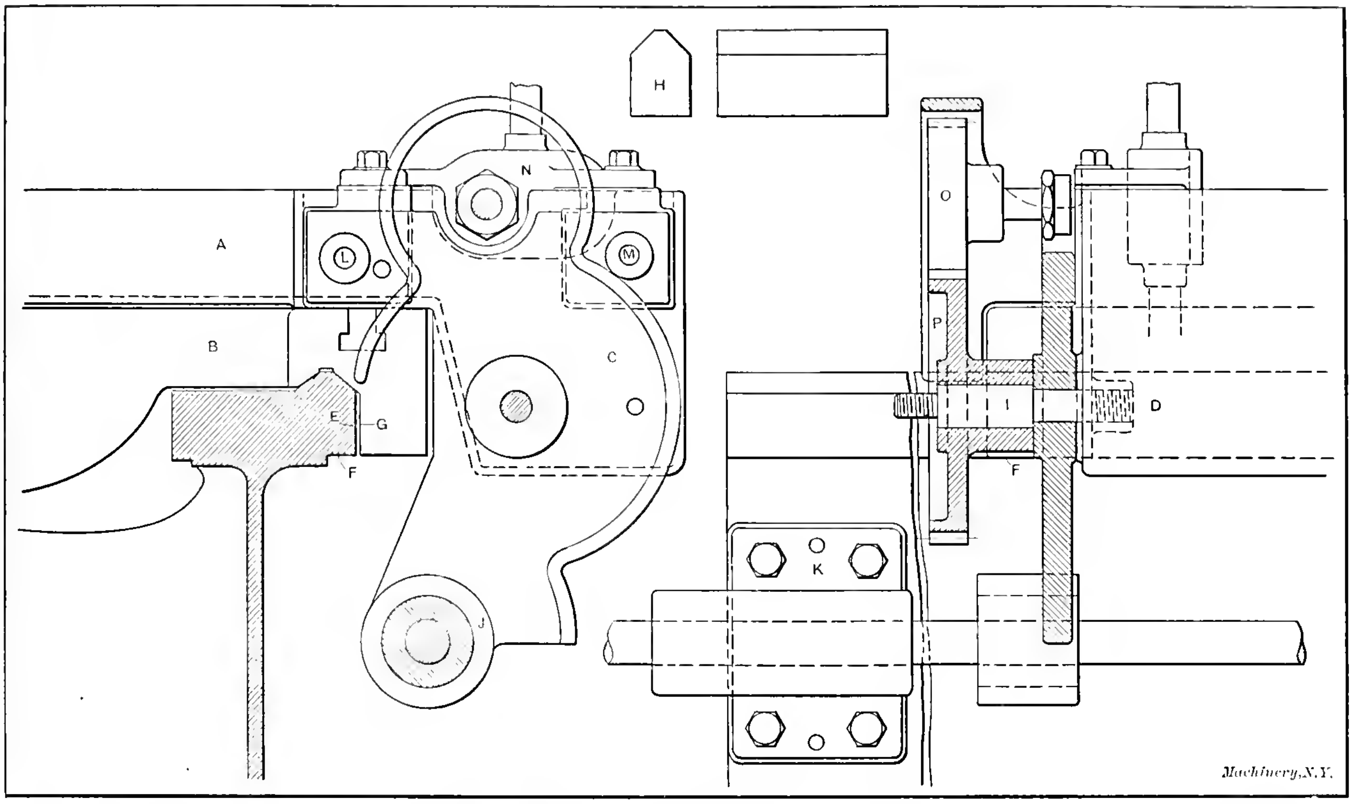

Fig. 9. Method of Laying Out and Aligning an Oil Pump Attachment on an Engine Lathe. Illustrating the Principle of Avoidance of Assembling all the Members together for the Laying out Operations

Laying Out Angles

In machine tool work it frequently becomes necessary to lay out angles, and as a general rule it may be stated that a much greater degree of accuracy can be obtained by the following methods than is possible by laying off angles with the ordinary bevel protractor made for machine shop work. The correctness with which an angle can thus be produced, however, naturally depends on the skill of the workman in working to the scribed lines and on the accuracy with which

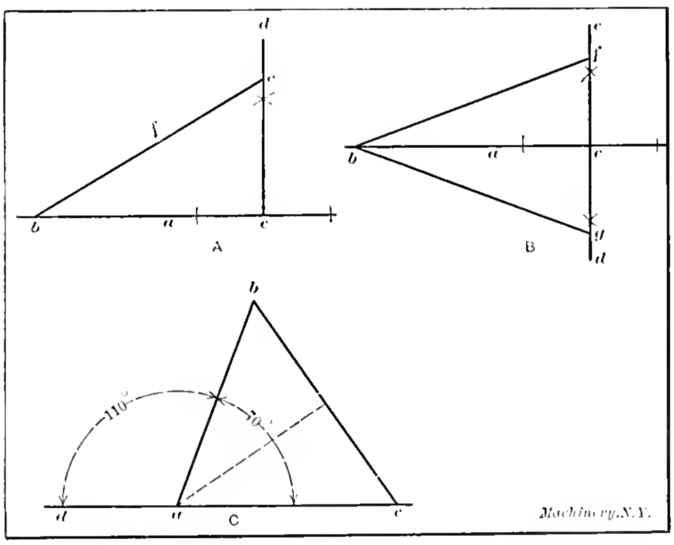

Fig. 10. Graphical Method of Laying Out Angles

they have been located. If it is not convenient to lay off the lines directly on the work, the given angle or taper may be laid off on a piece of sheet steel, which is then carefully filed to the lines scribed thereon.

Scribe a straight line *a*, as at *A* in Fig. 10; then make two very fine center punch marks, as *b* and *c*, on this line, as far apart as circumstances will permit. At *c* erect a perpendicular, as *cd*. The distance *bc* being laid off to some convenient dimension, take the tangent of the required angle and multiply the distance *bc* by this tangent, using a table of natural tangents. Then, on *cd* lay off as accurately as possible the product of *bc* and the tangent, marking it by a fine center punch mark as at *e* on the line *cd*. Scribe a line through *b* and *e*; the angle *ebc* will then be the required angle.

When the required angle is greater than 45 degrees, it is more convenient to use the method shown at *B*. Scribe the line *a* and on it lay off *bc* as long as convenient. At *c* erect the perpendicular line *de*. From a table of natural tangents, take the tangent corresponding to one-half the required angle; multiply the distance *bc* by this tangent and lay off the distance thus found on both sides of *c*, marking it at *f* and *g*. Join *f* and *g* to *b* by straight lines. The angle *fbg* is the required angle.

When the required angle is greater than 90 degrees, instead of laying off that angle, its supplement is laid off. Subtract the required angle from 180 degrees and lay off the angle thus formed. Thus, if the required angle is 110 degrees, lay off the angle *bac*, as at *C*, Fig. 10, equal to 180 degrees — 110 degrees = 70 degrees by the method illustrated at *B*. The angle *dab* is then 110 degrees. All other factors remaining as before, the accuracy attainable will be greater as the base line, as *bc*, at *A* and *B*, or *ac*, at *C*, is made longer.

The laying-out and aligning operations on machine tools require, as we have seen, a thorough understanding of the purpose of the various parts making up the machine, and the accuracy required in their alignment. Besides this, a general knowledge of elementary geometry is not only helpful but in many cases almost indispensable. The examples of aligning operations given in the present articles are, of course, intended to be primarily of suggestive value. Individual judgment will have to be used in each particular case, and definite rules cannot be laid down that would be applicable under all conditions. The general outlines presented above, however, and the simple methods given for the laying out of angles will be found useful in operations of this kind not only on machine tools but on all classes of machinery where the accuracy of the alignment of interdependent parts is necessary for the successful working of the machines.

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At the meeting of the New York Electrical Society at the Engineering Societies Building, 29 West 39th Street, January 27, Prof. W. S. Franklin of Lehigh University lectured on "The Practical Applications of the Gyrostat." The lecture was made exceptionally clear by means of lantern slides and was illustrated by experiments. A working model of the Brennan monorail car was also exhibited in action. The points discussed by Prof. Franklin were, in particular, the physical action of the gyroscope exemplified by illustrations of the gyrostatic action of the fly-wheel of automobiles; gyrostatic action on board ship, and the Schlick device for preventing the rolling of ships at sea; and, finally, the application of the gyroscope to the Brennan monorail car. Prof. Franklin explained in a very clear and concise manner the principle of the gyrostat and showed how by simple means the action may be exhibited; for example, by simply rotating at a reasonably high speed a bicycle wheel having its rubber tire replaced by a lead rim and suitably mounted in a frame on a platform, it is possible for a person sitting on the platform to balance himself on but two supports or legs.

After the lecture a description of the Scherl gyroscope monorail car was read and also a communication from Mr. Frank J. Sprague relating to his own early ideas for the utilization of gyroscopic action. The general discussion was then opened by Mr. E. A. Sperry, who explained, in particular, the design and action of gyroscopic devices installed on board ship for preventing rolling.

ELECTRIC WELDING OF COPPER, BRASS AND ALUMINUM*

By A. E. BUCHENBERG†

The welding of brass, bronze and other alloys of copper is almost impossible as a forging operation. The fusing points of the several alloy metals are considerably below that of copper, and it becomes a very difficult matter to prevent the oxidization of these metals before the copper component has reached a welding temperature. While it is possible to weld copper and aluminum in the same manner as iron or steel by the forging method, the work is more or less difficult and requires a careful and skilled operator. Some of the difficulties are as follows: The welding temperature of copper is much higher than that of iron or steel; while the metal is at or near the welding heat and exposed to the air, a very rapid surface oxidization takes place, and the oxide or scale formed is extremely difficult to treat with any flux. The range of temperature between the heated plastic or welding condition and the fusing point of the material is very small. To add to the difficulties the metal becomes brittle as the temperature approaches the welding heat.

While aluminum reaches a welding heat at a temperature considerably below that of copper, it is also subject to a serious surface oxidization when exposed to the air at high temperatures. The range of temperature between the welding and fusing points of aluminum is only about 180 degrees F. If overheated it will simply spatter away under the hammer when attempt to make a weld is made.

The fundamental principle in the electric welding of metals is the same as in the forging operation, *viz.*, forcing the two welding surfaces into intimate contact while each is in a heated plastic condition. With the electric method the surfaces to be welded are butted together endwise instead of being "scarfed" and lapped. The repeated blows of a hammer are replaced by a mechanical pressure exerted in a direction forcing together the abutting ends of the work. The welding temperature is created by the heating effect of a current of large volume flowing through an electrical circuit in which nearly all the resistance is located at a single point. The abutting ends of the stock to be welded form this point of highest resistance in the electrical circuit of the welding machine, and practically all the heating effect is concentrated at this one point. A very rapid rise in temperature takes place until a welding heat has been reached. The electric current is simply the heating medium, and in itself has no effect upon the physical or chemical properties of the metal. The actual welding is due to the mechanical end pressure exerted while the material is in a plastic condition.

The electric butt-welding of wires, bars, rods, rings, etc., of the metals mentioned above requires a machine into which are incorporated the following essential parts in their proper relation to each other: 1. An alternating current transformer whose primary coils are made up of a large number of turns of insulated copper wire. The number of turns will depend upon the voltage of the supply circuit and the transformer secondary voltage required to make the weld. The size of the conductor will depend upon the kilowatt transformer capacity required to weld the largest stock the machine is designed to handle. The secondary winding of the transformer, on account of the very low voltage required, reduces to the equivalent of a single turn. This may be either in the form of a solid cast copper bar or a laminated copper structure whose cross-section is very large as compared to that of the primary conductors. The secondary voltage of the transformer will depend upon the cross-section and electrical conductivity of the stock at the point of the weld and varies from 1½ to 5 volts. The volume of current flowing in the primary and secondary conductors of the transformer will, of course, be in inverse ratio to the primary and secondary voltages. As an example, assume current at 220 volts primary voltage and that the current flowing in the primary coils of

* For additional information on the subject of electric welding, see the following articles previously published in MACHINERY: Some examples of Electric Welding, April, 1908; Electric Welding of Dissimilar Metals, July, 1908; Electric Welding of Tools, October, 1908; Electrical Welding, February, 1909.

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the transformer is 45.5 amperes. Assuming the secondary or welding voltage to be 2½, the secondary current will be (220 ÷ 2.5) × 45.5 amperes = 4,000 amperes, about.

2. A pair of copper dies or work holders in each of which is securely clamped one of the two pieces to be welded together. These dies serve to convey the secondary or heating current of the transformer through the stock to the point of weld, and are attached to the secondary terminals of the transformer in such a manner as to allow a small movement of the dies toward and away from each other. In practice one of the dies is fixed and the other movable.

3. A break-switch or circuit breaker mounted on the machine in a convenient operating position and so arranged as to be automatically opened and the primary current of the transformer broken at a certain predetermined point in the converging movement of the dies.

4. Arrangement for obtaining pressure. The pressure required to compress the stock while at the proper temperature and plasticity to make a weld is obtained by means of a compression lever, and a weight or springs acting upon the dies to force together the abutting ends of the pieces to be welded. This pressure follows up the compression of the stock to a point where it is no longer sufficient to displace the cooler metal, and the weld is made. The surplus heated metal is forced outward all around the stock in the form of a thin upset or fin which can, when necessary, be easily removed by grinding. The pressure required varies with the material and size of stock to be welded and must be adjusted to a point where compression takes place the instant the stock has reached the proper welding temperature. This adjustment, when once made, remains the same for all welds of the same material and cross-sectional area.

The time required to electrically weld copper, aluminum and copper alloys depends to a very great extent upon the cross-section of the stock, and varies from one second or less on very small stock to a minute or more on the larger sizes. The time limits between which stock of any given cross-section can be successfully welded are comparatively wide and governed in both directions by the volume of the heating current through the point of weld. If the current is low, the temperature rises more slowly at the point of the weld, and the heat travels back a considerable distance on each piece by conduction before the surfaces to be welded reach the required temperature. Under these conditions the fin or upset becomes quite large and entails too much expense in grinding to remove it. In the extreme case of insufficient current the heat is carried away from the point of the weld by conduction to the copper dies and by direct radiation to the air so rapidly that a welding temperature cannot be attained. If the volume of current is too great a very rapid heating of the stock takes place and trouble is experienced due to the fusing and oxidization at the point of weld which occurs more rapidly than the pressure can follow up the softening of the metal, and the excessively heated stock "spatters." Although the heating current is automatically cut off at the instant the forward motion of the die begins, the oxide coating on the end surfaces prevents a molecular union and a perfect weld. In other words, the stock is burned.

The heating current must be adjusted between the two extremes given above to a point where it is intense enough to bring the stock to a welding temperature, yet not so great as to cause an excessive heating and a "blowing out" of the weld. The correct adjustment is not a difficult matter, and is attained by varying the voltage impressed upon the primary coils of the transformer in one of two ways.

If the electric welder is operated by an alternator carrying this machine only, the voltage of the alternator (which in this case is the same as the primary voltage of the transformer) can be varied by a manipulation of the alternator rheostats.

When the electric welder is being operated from a circuit whose voltage must be maintained at a constant value, such as a power circuit from which other welders or motors are being operated, an inductive regulator is used as an auxiliary apparatus to the welding machine. The action of such a regulator is simply that of a variable choke coil, and any desired voltage can be obtained across the primary terminals of each welding transformer by a proper adjustment of the regulator.

A skilled or experienced man is not required for operating an electric welding machine as the only duties of the operator consist in clamping the work in the dies of the machine and closing the switch. For this reason it is customary to use boys on this work. Many machines for light work are now made automatic in their operation, requiring no attention beyond feeding in the stock to be welded.

Uniform and perfect molecular union is obtained with this process, since the heating of the stock is from within outward and the entire areas of the welding surfaces are at the same temperature. The strength of the weld is practically equivalent to the strength of any other section of the stock of equal area and will withstand any subsequent bending, rolling, hammering, or drawing process to which it may be subjected.

The difficulties encountered in the forging process due to the oxide surface films formed at high temperatures are not present in the electric process. During the extremely short heating period the welding surfaces are in contact and practically excluded from the air. Furthermore, the heating action ceases the instant the welding temperature has been reached, and the heat extends to but a very small distance on each side of the weld. It is obvious that with a continuously applied pressure which instantly compresses the stock to form a weld when the proper temperature has been reached, the difficulty experienced in other processes due to the small range of temperature from the plastic to the fused state of the metals is overcome.

The electric welding of copper, brass and aluminum is a very rapid operation and entirely free from noise, dirt and smoke. The machine can be located in any convenient position in the shop and is free from danger of electrical shocks to the operator. The motion of the movable die can be adjusted for both the forward and backward travel so that all welds are to gage. This is an important consideration when, for example, many thousands of rings must each be welded to an exact diameter.

The cost of electric welding is low as compared to other methods. Below is given a table for copper showing the kilowatts and time required to make a weld from the time of closing the switch. Also the cost per 1,000 welds at a unit basis of current cost of one cent per kilowatt-hour. To arrive at the actual cost of the current per 1,000 welds it is only necessary to multiply the cost given in the table by the price for current per kilowatt-hour in any given locality.

TIME, CURRENT CONSUMPTION AND UNIT PRICE FOR ELECTRIC WELDING OF COPPER

Area in sq. inch	Approx. Equiv. diameter, inch	Kilowatts	Time in Seconds to make Weld	Cost per 1000 Welds at 1 cent per K. W. hour Dollars
0.05	$\frac{1}{4}$	5	4	0.055
0.10	$\frac{3}{8}$	7	5	0.097
0.20	$\frac{1}{2}$	14	7	0.272
0.30	$\frac{5}{8}$	19.5	9	0.487
0.40	$\frac{11}{16}$	26	12	0.866
0.50	$\frac{13}{16}$	32	14	1.240
0.75	1	46	17	2.170
1.00	$1\frac{1}{8}$	62	21	3.610

* * *

It has been found during the Zeppelin aerial tours that it is difficult for the crew to determine the exact location when sailing over the earth in a dirigible balloon. It has, therefore, been proposed to place wireless signal stations in a number of leading cities and towns from which signals can be sent which would keep the aerial navigators constantly informed of their location. The sphere of influence of each station would be small enough so as not to interfere with that of the next. In this way it would be possible to always determine within certain limits the location of the airship. It is likely, however, that except for military purposes, such expensive arrangements to aid aerial navigators will not be necessary for some years to come. Should, however, some day aerial navigation become commercially possible, it is likely that wireless stations will act as the "light houses" of the aerial sailor.

CASTING PIPE FITTINGS IN PERMANENT MOLDS

In the September, 1908, issue of MACHINERY, engineering edition, an article was published on "Casting Pipes in Permanent Molds," which described the methods in use at the Tacony Iron Co., Philadelphia, Pa. The molds used for the casting of pipes were made of cast iron, but the cores used were of the regular type, made of sand. Improvements have now been made with this process. The casting of fittings in permanent molds was experimented with, after success had followed the use of these molds in casting pipes, but sand cores were found

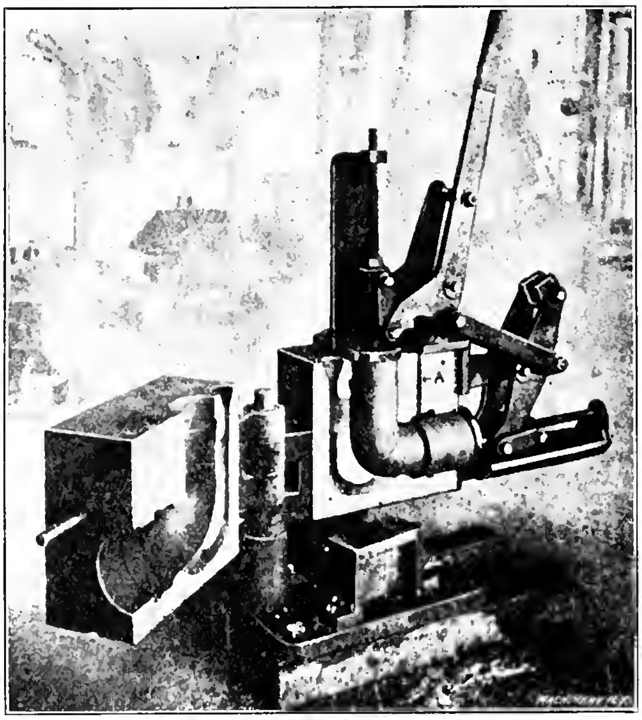

Fig. 1. Permanent Mold for 5-inch Quarter Bend showing the Cores in Position for Casting

impossible to use successfully, owing to their irregularity of form, and it was practically decided to discontinue further experiments along this line when, as a last resort, cast iron cores were suggested and tried. These experiments proved successful from the start.

This departure upsets one of the fundamental traditions in the art of founding, and may prove to have tremendous possibilities. In an article in a recent issue of *The Foundry*, the

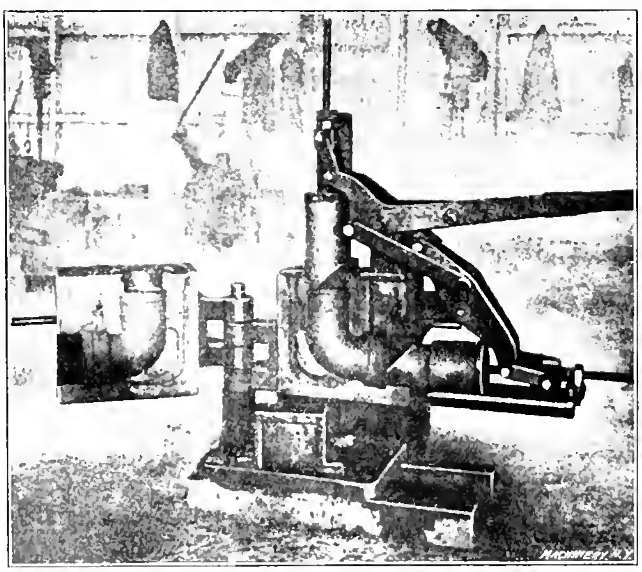

Fig. 2. Casting poured, Cores withdrawn and Mold opened, showing the Pipe Fitting

methods used are described in detail and the accompanying illustrations are reproduced from that description. It is stated that the castings made vary from 4 to 28 pounds in weight, and the average labor cost is approximately 2 cents per casting, as compared with an average molding cost of 6 cents when the fitting is cast in sand. In addition to the saving in labor cost the expense of sand and flasks is entirely eliminated, and while against this must be charged the cost of molds and the machines, this cost amounts to only a fraction of a cent per casting.

On an average each mold has an output of 1,000 pounds of castings daily. The output per day of small fittings is greater in number than that of the heavier fittings, because they can be cast more rapidly, as they do not heat the molds so quickly. If the molds are raised to a red heat they deteriorate more rapidly than when the temperature is not high enough to color them. The success of casting in permanent molds depends on a swift chilling of the molten iron to the point at which it is set, at which time it must be immediately removed from the chilling effect and permitted to cool normally. If the cast-iron cores are not removed immediately after the iron is set, the shrinkage of the iron holds the cores so that they cannot be withdrawn. However, even in such a case the mold can be opened and the casting broken with a hammer to release the cores, and the only loss incurred is the labor required in producing the casting, because the mold and core remain uninjured.

The permanent molds in the machines used for different classes of fittings and other castings are all similar in that half of the mold is fixed while the other half swings on a hinge. A machine for molding five-inch quarter bends is shown in Fig. 1. This illustration shows the mold open with the cores in position for casting. As soon as the two halves are closed up the metal may be poured. At *A* in the illustration is shown a vent which is provided to permit the air

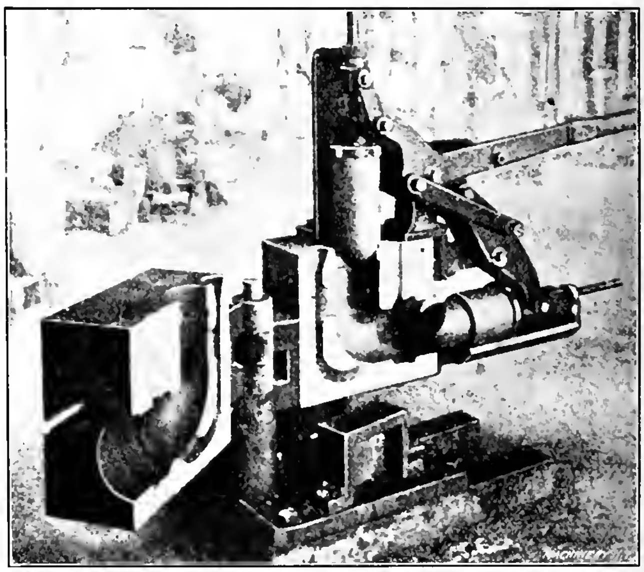

Fig. 3. Casting Removed from Mold; Cores not yet in Position for Next Casting

in the mold to escape. The cores are also drilled to permit the passage of air into the mold when the cores are removed.

In Fig. 2 the casting has just been poured and the two halves of the core have been withdrawn by depressing the operating lever. Immediately after the withdrawal of the cores the movable half of the permanent mold is swung out as shown in the illustration, permitting the removal of the casting. In Fig. 3 the casting has been removed, but the cores have not been replaced in position for casting. When this is done the appearance is as shown in Fig. 1, and the cycle of operations is repeated.

No especial care need be exercised to prevent the castings from sticking in the molds, but the mold, as well as the cores, is occasionally coated with a mixture of thin oil and graphite. The molds and the cores are cast from ordinary gray iron, such as is used for the soil pipe and fittings made, and in one mold more than 6,000 pieces have been cast without there being any signs of deterioration. Very small castings can be produced very rapidly. Plow points, for example, can be cast at the rate of four per minute, while larger fittings cannot be cast faster than one every two minutes, and in the case of pipe, it was found that but one casting could be made every eight minutes. Outside of cast-iron fittings, molds have been designed for brake shoes, sash weights and various kinds of hardware.

THE OPERATION AND CARE OF SMALL ELECTRICAL MACHINERY*

By HENRY B. BIXLER†

As the majority of users of small electrical machinery are not familiar with tho best methods employed to keep the machines in good running order and repair, tho author aims to give in this article a few practical suggestions, to be of some help in the making of necessary repairs, locating troubles, and removing the causes.

The dynamo or motor should be installed in a dry place, and under no circumstances should water be allowed to come in contact with the machine. Excessive dampness always causes trouble, and this point should be guarded against. The machine should be well ventilated, and kept free from dust as much as possible. Before starting a new machine, see that the bearings are well filled with good oil, and that the shaft turns freely in the bearings. The oil-rings should turn with the shaft, and not stick, as the lubrication of the bearings depends upon the rings working right. This is important and should be carefully watched. If the machine is belt driven, the belt should not be too tight, as this will cause undue wear on the bearing and may cause heating also. Always provide solid foundations or supports for the machine to rest on. Keep the machine cool, dry and clean, and very little trouble will result in its operation in general.

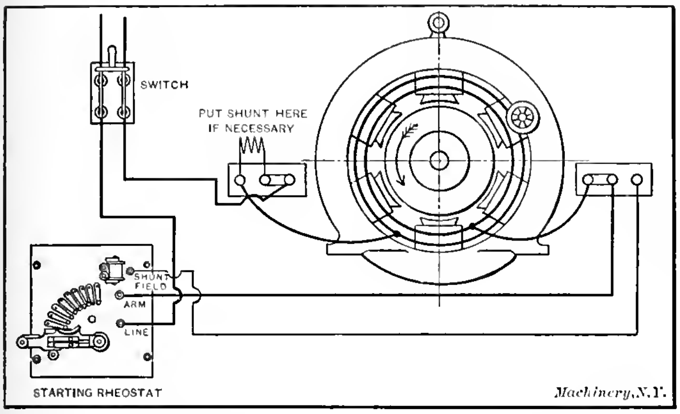

Fig. 1. Diagram showing Reduction of Over-load by means of a Shunt

When a new machine is installed and wired up, the connections should be carefully checked over, to see whether they correspond with the diagram of connections sent with the machine.‡ If this is found to be correct, and the machine refuses to act properly, the cause of the trouble should at once be located and the difficulty removed before going further.

Troubles in the Field Coils

First we will consider the troubles that may exist in the field coils, and how to proceed to correct them. If, on running a machine for some time, the field coils all become hot, the voltage may be too high and should be reduced to normal. If only a part of the coils become hot, it will usually be found that a connection exists between the coils and the frame of the machine (called "ground"), which when found should be insulated with mica or paper. Sometimes it will be found that some of the coils are cold while the remainder are excessively hot, and the cause of this is a short-circuit in the cold coils, which means that the current is not passing through the coils. Test out the coils separately with a magneto or battery, and when the defective coil is found, it should be repaired by re-insulating it.

A partial short-circuit will cause the coils to heat, and should be treated as stated above. In a compound-wound machine, *i. e.*, one having a shunt and series winding on the field coils, an over-load will cause an excessive current to flow through the series coils, causing the heat to rise above normal. The load should be reduced or a "shunt" should be connected as shown in Fig. 1. This will cause the current to divide, part of it flowing through the shunt, thereby reducing the heating of the series coils.

If a machine is run as a generator and will not generate the rated voltage, that is, if it shows too low voltage, or if the speed is too high when run as a motor, the cause may be a loose field connection, which should be carefully traced and tightened. Any extra resistance in the field will cause a motor to speed up, and the rheostat, in case one is installed, should be cut out of the circuit. The same trouble will arise from a short-circuit in one or more coils, or having the polarity reversed in one or more coils. Test this with a compass, or reverse the leads of one coil. If a generator will not hold up the normal voltage when loaded, or if the speed of a motor is too high when running under full load, the series field is either cut out of circuit or is reversed and is opposing the shunt. Disconnect the shunt coils entirely and try the machine without them. If the operation is now satisfactory, reverse the leads of the shunt field, and again connect them. If the motor refuses to start, there is no current through the shunt field, and the open-circuit should be found and repaired.

In case the motor takes an excessive starting current, the series field is opposing the shunt, and one of them should be reversed. If the motor runs the wrong way, reverse the series field or reverse the shunt field, or, in a compound-wound machine, both the series and shunt field. Never open the field circuit when the motor is running, as this would cause the machine to speed up to such an extent that the armature is liable to burst from centrifugal force. The above covers nearly everything that is due to field trouble.

Armature Troubles

When an open circuit occurs in a coil, it is shown by the broken leads, or by sparking at one or more bars of the commutator. The leads should be re-soldered into the commutator bars, or the broken wires spliced, or a new coil put in. Hot coils are caused by short-circuits at the commutator or between the separate turns of the coil, in case the winding is made up of more than one turn of wire for each coil, or from the grounding of the coil to the shaft or armature core. The leads should be separated and insulated from each other, and if this cannot be done, a new coil should be put in. Sometimes there is a short-circuit between the bars through the mica segment, or on the mica ring itself, and if this is the case, a new segment or ring should be put in, and the commutator turned off smooth in a lathe.

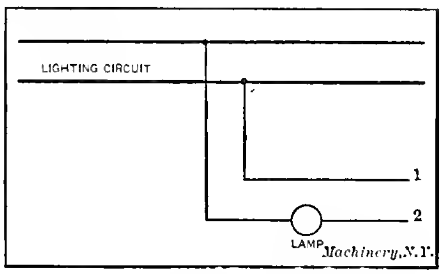

Fig. 2. Diagram of Wiring for Testing Armature Coils

When it is found that the whole armature heats up, the cause may be that the machine is pulling a greater load than it was originally designed for, in which case the load should be reduced, or else the machine exchanged for a larger one. If a machine is run at a lower rate of speed than that at which it is intended to operate, the armature often becomes quite hot, due to excessive iron losses, which will practically disappear when the speed is brought up to normal. The entire armature is sometimes heated by "cross-currents" which are set up in the windings due to the fact that the brushes are not set or spaced properly on the commutator. The only way to be sure that the brushes are spaced correctly is to count the commutator bars between each brush or set of brushes; this should be done as follows: Take for instance a commutator having 120 bars, and four sets of brushes. Set the first brush on any segment, and count thirty bars ahead of the bar on which the first brush is set, placing the next brush on this bar, and continuing thus around until all four brushes are placed in position. This will space the brushes equally apart, and when they are set properly, they can easily be kept in this position by making a gage of soft wire, just the length of the space between them.

* The following articles dealing with the care and repair of electrical machinery have previously been published in MACHINERY: Electric Repairing, December, 1904, January, 1905, and February, 1905; Winding of Direct Current Armatures, March, 1906; Tests for Faults in Armatures, May, 1906; Dynamo and Motor Troubles, September, 1906. See also MACHINERY'S Data Sheet No. 61 September, 1906; Diseases of Dynamos and Motors, and MACHINERY'S Reference Series No. 34, Care and Repair of Dynamos and Motors.

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‡ Wiring diagrams for motors of various types, will be found in the Data Sheet Supplement accompanying this issue.

To fit the brushes properly to the commutator, set them in position as nearly as possible, and place a strip of coarse sand-paper around the commutator (sand side up) and turn the armature around slowly; finish with fine sand-paper, preferably No. 00. This, of course, refers to carbon brushes only, as hardly any other kinds are now used. After the brushes have been "sanded down," the spacing should be tested again, and the brushes re-sanded if necessary. Radial type brushes should present the entire end to the commutator, and should be thus fitted. After fitting the brushes, the carbon dust should be carefully blown off the machine before starting it up. Shift the brushes to the best running position, *i. e.*, where no sparking occurs at full load, and clamp the brush holder yoke in this position, marking it in some way so that it can be set again in this position if it becomes necessary at any time to move it. Sometimes the armature becomes hot from the heat given off from a hot bearing or commutator, and as this is a purely mechanical fault, it will not be discussed here.

Heating in many cases is caused by poor ventilation, and if this is found to be the trouble, the obstruction which prevents a free circulation of air around the machine should be removed, or if this cannot be done, a small fan can be used to give artificial ventilation to the machine.

Burned-out armatures owe their destruction to one or more of the following troubles: over-load, grounded line, grounded coils, short-circuit, either on the line or in the machine itself, cross-currents in the armature as mentioned above, or from lightning discharges coming in contact with the lines leading to or from the machine, or striking the machine directly, which however is a rare thing. The only remedy for a burned-out armature is to rewind it, or to replace the defective coils.

When a break-down of insulation occurs, a "ground" is the result, owing to the fact that a part or all of the current does not complete its circuit through the coil, but passes through the armature core and frame of the machine to the earth. If the bad place in the insulation cannot be found any other way, the leads should be removed from the commutator and tested out separately. If a lighting circuit is available, an effective test can be arranged as follows: Connect up a lamp as shown in Fig. 2 and place lead No. 1 on the shaft or other bright part of the machine; then touch lead No. 2 on each coil separately. If a coil is grounded, the lamp will light up, but will remain dark on the good coils. A bell and battery may be used with the same results, the bell ringing on the defective coils only. The grounded coils should be carefully insulated with mica or good tape, and the leads soldered into position.

Bearings are sometimes allowed to wear so much that the armature rubs on the lower pole-pieces, wearing the banding wires to such an extent that they break. The bearings should be renewed, and the armature re-banded, and centered up with the pole bore. Be sure there is plenty of good insulation under the band wires, and if this insulation comes out, as is often the case in old machines, it should be renewed, and new banding wires put on the armature.

Commutator Troubles

Excessive sparking at the brushes is one of the troubles most frequently met with, and one or more of the following reasons may be assigned to its cause. In nearly every case this trouble is caused by the brushes being out of position, and care should be taken to see that they are properly spaced as mentioned above. If, after the brushes are properly spaced, sparking still occurs, look for high bars in the commutator, for if one or more of the commutator bars stands out above the others, there will be a flash every time the high bar passes under a brush. The best way to remedy this is to remove the armature from the machine and turn off the commutator smoothly in a lathe, using a sharp V-pointed tool.

A high mica segment will also cause sparking, and should be brought down with a file. If the commutator is not too rough it can easily be smoothed with sand-paper, pressing this evenly against the surface while in motion. Better results are gained by raising the brushes from the commutator while sanding it off, and this can easily be done when the machine is running as a generator, but will not be so convenient in the case of a motor, unless some other source of power is available to rotate the armature. Never use emery paper for this work, as the dust may get between the windings of the armature and cause short circuits.

Sparking often results from excessive vibration of the machine, due to poor foundations, or to the armature itself being out of balance. If this is found to be the trouble, proper steps should be taken to remedy it. A weak motor field will often cause severe sparking, and the field connections should be made secure. Test the coils for short-circuits and grounds as shown in Fig. 2. When a weak field exists in a motor, it will always be noticed that the machine takes a great deal more starting current than when operating under normal conditions. Sometimes the brushes are not of the proper material; if so, they should be exchanged for others, softer carbon being used for lower voltages—110 volts, for example—and harder carbon for higher voltages—500 volts, for example. It has often been found that a change of brushes has entirely stopped excessive sparking when all other means had been resorted to and failed.

The brushes should have just enough pressure on the commutator to make good electrical contact; if the tension of the brush-holder springs is too weak, sparking will occur, as the brushes cannot follow the inequalities of the commutator, especially when it is a little rough. Too much pressure should not be given to the brushes, as this will cause the commutator to heat more or less, and will wear the brushes and commutator away a great deal faster than necessary. Oftentimes it is found that the brushes do not cover the proper number of commutator bars, and some of different thickness should be tried. If the brushes in use are too thin, they can be made to cover more bars by beveling them at a greater angle, by tilting the brush ahead and re-fitting it to the commutator.

When sparking occurs at only one or two points on the commutator, the trouble is usually due to a short-circuited or grounded coil, and a test should be made for this as shown in Fig. 2. When the defective coil is located, it should be securely insulated with mica or other suitable material. If the sparking is allowed to continue for any length of time, it may result in "pitting" the commutator so badly that it will be necessary to turn it off in a lathe before being fit for service again.

It is often found that several commutator bars become blackened after the machine has been in service for some time, the cause arising either from grounded or partially short-circuited armature coils, defective mica ring or segments, or from cross-current in the armature, set up by the brushes not being properly spaced. Directions have already been given for the repair of these troubles. Sudden or extreme fluctuations in voltage or sudden over-load will often cause severe flashing at the brushes. As this is due entirely to operating conditions, nothing further can be said than to eliminate these conditions as much as possible.

Troubles in the machine itself which cause flashing are poor brush contact on the commutator and wrong connections of the field windings in compound-wound machines. If the series field is connected in reverse to the shunt winding, flashing at the brushes is often the result. The series leads should be reversed, or if the trouble is due to the first-mentioned cause, the tension of the brush holder springs should be increased. If it is found that the commutator heats up above normal, it may be due to an over-load on the machine. If so, the load should be reduced or a larger machine substituted. Poor brushes, rough commutator or too much brush pressure always cause excessive heating, and should be cared for.

Never allow grease or dirt to accumulate on the brushes or commutator, and be sure that the brushes are having a good contact, and are pressing evenly against the commutator surface, fitting it perfectly at every point. After running a few days, the commutator should acquire a brownish glaze on the surface and nothing further need be done except to keep it clean by wiping it with a clean cloth every day or so. Very little lubrication is necessary, and none at all is a great deal better than too much.

The prime requisite for the successful operation of electrical machinery is cleanliness, and as stated in the beginning of the article, if the machine is kept cool, dry and clean, a great many of the troubles enumerated above will be greatly reduced, if not entirely eliminated.

TESTING MANGANESE STEEL SAFES

Pretty much all steel contains manganese. Ordinarily, it is to be regarded as an impurity giving brittleness to the mass. But back in the latter part of the nineteenth century it was discovered that, if the manganese content amounted to, say, $7\frac{1}{2}$ per cent or something more, the resulting steel possessed in a high degree the valuable property of toughness. This is, it will be granted, rather a marvelous result. The ingredient which in a small percentage produces brittleness gives toughness when in fairly large proportion. The reason why this is so is not known, but the fact itself is well ascertained.

Fig. 1. Manganess Steel Safe tested by exploding Nitroglycerine in the Door Joint. Tenth Explosion—5 ounces Nitroglycerine

Some have supposed that manganese steel is very hard. It *is* hard but not excessively so. It is, no doubt, its toughness which has given it this reputation. The moderate hardness combined with the great toughness gives it such a refractory character that it is practically impossible to machine it. High carbon steel and high-speed steel are alike unable to conquer it. It is formed to shape by casting, forging, rolling and grinding. But this very character of high resistivity to tools has made it a very valuable material for burglar-proof safes. It is possible to remove the metal by a grinding wheel, and the writer lately saw a hole which had been made in the back of a manganese steel safe by grinding. But the wheel was power-driven, and it required more than a day and a half to produce its effect. It seems practically impossible, therefore, that a burglar should be able to force an entrance by means of cutting tools, whether of steel or emery. However, there is nitroglycerine. There is no material known having cohesive strength sufficient to resist this explosive. So we may expect that it will rend manganese steel, if it can be properly placed to render it effective.

Experiments along this line have lately been tried with interesting results. The manganese steel safe of the Ely-Norris Safe Co., 359 Broadway, New York City, consists essentially of two castings—the body and the door. The general form of the whole is that of a flattened orange. The door is a kind of stopper or bung fitting into its opening, with a ground joint. The inner end of the door and the corresponding part of the body are fitted with a system of interlocking lugs which are the real means of resistance to an effort to force the safe. There are bolts operated by the combination mechanism and the automatic device. But their office is mainly to prevent rotation and consequent release of the interlock of the lugs. The door, although it is a single casting, consists of a forward and rear part. These are joined by connecting lugs. There is thus left between the two parts an air space which is partly occupied by the combination mechanism. This space is the explosion chamber when subjected to attack. There are two spindles of manganese steel which occupy perforations in the forward plate. The fit is a ground one. The joint on the face of the safe between door and body is ground to make the two surfaces absolutely flush when the safe is locked. The obvious method of attack is by way of this joint or those about the spindles. In a test of a new \$1,600 safe at the company's works at Perth Amboy, N. J., January 21, a point a little to the right of the uppermost part of the joint between door and body was selected as the point of attack. Without difficulty, an indentation was made by means of sledge and cold chisel. A "cup" of putty was placed in a suitable position, and one-half ounce of nitroglycerine discharged without apparently any decided effect. A second charge of one ounce was then discharged. The explosive seemed to have

Fig. 2. Twelfth Explosion—at Night—7 ounces

Fig. 3. Condition of Safe after Nine Attacks in which Nitroglycerine was exploded within the Lock Chamber. Total Explosive used in these Nine Attacks 50 ounces

had but little effect. Applying sledge and cold chisel again, a third charge, consisting of one ounce, was exploded. It was fairly evident now that the joint was widening on each side of the wedge-like indentation of the chisel. Four more charges varying from one to two ounces were then used.

After the last or seventh discharge, it was evident that the nitroglycerine was penetrating to the explosion chamber. This was to be inferred from the fact that the front plate of the door was protruding slightly all around. Charges of three, four and five ounces were next exploded successively. The door was then observed to be protruding about 1/16 inch at the top, perhaps a little less at the right. At the bottom, the protrusion amounted to about 3/16 inch, on the left, about 5/32 inch. This displacement was to be attributed mainly, if not altogether, to a stretching of the connecting lugs, as the door itself was apparently intact. Four more charges of seven ounces each were next applied. The door was then found to be out an amount ranging from about 3/16 to about 1/2 inch. A final charge of eight ounces was then employed with no especial result.

It is to be observed that even had the outer plate of the door been forced off by stretching the lugs to the breaking point, the safe could not have been entered. There would still have been in the way a 5-inch plate or plug of manganese steel securely held in position by the interlocking lugs and the bolts of the automatic time mechanism. It does not seem apparent that a burglar would have had an advantageous opportunity for attack. No holes pierce this inner door. The only joint open to attack is the 5-inch ground taper contact between it and the body. The exterior plate may be regarded as merely the outer fortification—the main works are within.

These experiments show in a forcible way what a wonderful material manganese steel is. Hardened tool steel would probably have equal capability for resistance to machining, but this would hardly be accompanied by the great tenacity shown here. The question is how to shape it.

* * *

HARDENING SMALL BLANKING DIES

By H. J. BACHMANN*

It is manifestly an unprofitable investment to equip a manufacturing establishment with all the latest and most approved facilities for hardening, if there are only a few pieces to be treated occasionally. However, in cases of this kind, especially when blanking dies are to be hardened, it is up to the diemaker to make the best of the apparatus on hand. With this condition in mind, I will endeavor to set down specific directions which will invariably give definite and satisfactory results if followed closely.

If a blacksmith's forge is used, let the die be placed in the fire with the cutting face upward. During the period of heating, keep the fresh coal away from the die by surrounding it on all sides and on top with red hot cinder coal. When turning on the blast, be careful not to give it too much air. In fact, the more sparingly the blower is used, the better are the chances of the steel becoming evenly heated throughout. Even if the blast should be applied carelessly, the scaling and oxidizing will be more prominent on the bottom of the die where it is not so harmful. But most of all I wish to insist on an intelligent use of the blast. Turn it into the fire for about a minute, then shut it off and let the heat *soak* into the die instead of *blowing* it in. This is probably the most important point. The block of steel must be evenly saturated with heat and kept from contact with cold air until it reaches the proper hardening temperature. Remember to blow a little and then stop the air while the steel absorbs the heat. While the die is being heated, prepare a pail of clean water, taking the chill from it, that is, heating it until lukewarm. The die held in one hand with tongs, is then plunged into the water and kept moving all the time; when the die is cool enough, take hold of it with the other hand and stir the water with it until they both arrive at the same degree of heat. Now instead of taking the die out of the water and reheating it over the fire or letting it finish cooling in the air, just let the whole thing stand so that the water and steel will cool off together.

The entire method may be summed up as follows. Do not *shock* the steel by quickly heating it red hot or by plunging it suddenly into cold water. Let the change from cold steel to hot steel, and *vice versa*, be a gradual one; this will avoid all cracks and breaks due to any abrupt change in the molecular structure of the steel.

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MACHINE SHOP PRACTICE*

TOOL GRINDING—1

In the grinding of tools, whether they are to be used for turning, planing or boring, there are three things of importance that need to be considered: First, the cutting edge of the tool (as viewed from the top) needs to be given a certain shape; second, there must be a sufficient amount of clearance; and third, tools, with certain exceptions, are ground with a backward slope or a side slope, or with a combination of these two slopes on that part against which the chip bears when the tool is in use.

In Fig. 1 a few of the different types of tools which are used in connection with lathe work are illustrated. This illustration also indicates the meaning of the various terms used in tool grinding. As shown, the clearance of a tool is the angular distance α; the back slope is represented by the angle β and the side slope by the angle γ. The angle δ for a tool without side slope is known as the lip angle or the angle of keenness. When, however, the tool has both back and side slopes, this lip angle would more properly be the angle between the flank f and the top of the tool, measured

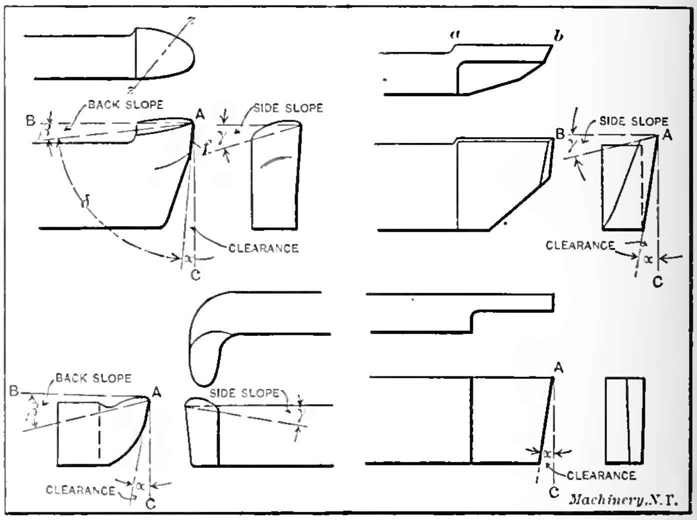

Fig. 1. Illustration showing the Meaning of Terms used in Tool Grinding, as applied to Toole of Different Types

diagonally along a line $z—z$. It will be seen that the lines $A—B$ and $A—C$ from which the angles of clearance and back slope are measured, are parallel with the top and sides of the tool shank, respectively. For lathe tools, however, these lines are not necessarily located in this way when the tool is in use, as the height of the tool point with relation to the work center determines the position of these lines so that the *effective* angles of back slope, clearance, and keenness are changed as the tool point is lowered or raised. The way the position of the tool affects these angles is illustrated on the Shop Operation Sheet accompanying this number.

Now, while tools must, of necessity, be varied considerably in shape to adapt them to various purposes, there are certain underlying principles governing their shape which apply generally; so in what follows we shall not attempt to explain in detail just what the form of each tool used in the machine shop should be, as it is more important to understand how the cutting action of the tool and its efficiency is affected when it is improperly ground. When the principle is understood, the grinding of tools of various types and shapes is comparatively easy.

In the first place we shall consider the shape or contour of the cutting edge of the tool as viewed from the top, and then take up the question of clearance and slope. Of course, when a tool is being ground it is given clearance and the required shape at the same time, but the different elements will be considered separately to avoid confusion.

The contour of the cutting edge depends primarily upon the purpose for which the tool is intended. For example, the tool A, in Fig. 2, where a plan view of a number of different lathe tools is shown, has a very different shape from that of, say, tool D, as the first tool is used for rough turning, while

* With Shop Operation Sheet Supplement.

tool D is intended for cutting grooves or severing a turned part. Similarly, tool E is V-shaped because it is used for cutting V-threads. Tools A, B and C, however, are regular turning tools, that is, they are all intended for turning plain cylindrical surfaces, but the contour of the cutting edges varies considerably, as shown. In this case it is the character of the work and of the cut that are the factors which determine the shape. To illustrate, tool A is of a shape suitable for rough turning large and rigid work, while tool B is adapted for smaller and more flexible parts. The first tool is well shaped for roughing because experiments have shown

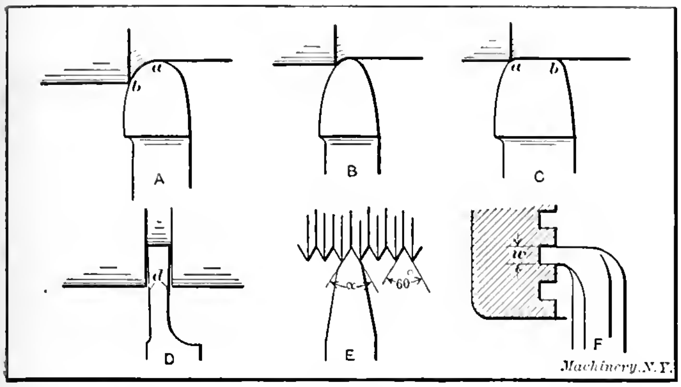

Fig. 2. Plan View of Lathe Turning and Threading Tools

that a cutting edge of a large radius is capable of higher cutting speed than could be used with a tool like B, which has a smaller point. This increase in the cutting speed is due to the fact that the tool A removes a thinner chip for a given feed than tool B. Therefore, the speed may be increased without injuring the cutting edge to the same extent. If, however, tool A were to be used for turning a long and flexible part, chattering would result. Consequently, a tool B having a point with a smaller radius would be preferable, if not absolutely necessary. The character of the work also affects the shape of finishing tools. The tool shown at C is used for taking light finishing cuts with a wide feed, and a tool similarly shaped is also used for the same purpose in connection with planer work. Obviously, if the straight or flat part of the cutting edge is in line with the travel of the

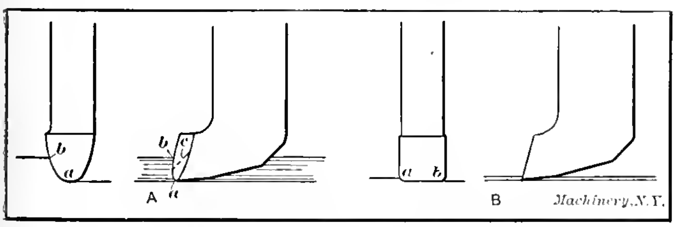

Fig. 3. Planer Tools for Roughing and Finishing Cuts

tool, the cut will be smooth and free from ridges, even though the feed is coarse. But such a tool cannot be used on work that is not rigid, as chattering would result. Therefore, a smaller cutting point and a reduced feed would have to be employed. Tools with broad flat cutting edges and coarse feeds are almost invariably used in taking finishing cuts in cast iron, as this metal offers less resistance to cutting than steel, and is less conducive to chattering.

The shape of a tool (as viewed from the top) which is intended for a more specific purpose than regular turning, can be largely determined by simply considering the tool under working conditions. This point may be illustrated by the parting tool D which, as previously stated, is used for cutting grooves, squaring corners, etc. Evidently this tool should be widest at the cutting edge; that is, the sides d should have a slight amount of clearance so that they will not bind as the tool is fed into a groove. As the tool at E is for cutting a V-thread, the angle a between its cutting edges must equal the angle between the sides of a V-thread, or 60 degrees. The tool illustrated at F is for cutting inside square threads. In this case the width w should be made equal to half the pitch of the thread, and the sides should be given a slight amount of side clearance, the same as with the parting tool D. So we see that the outline of the tool, as viewed from the top, must conform to and be governed by its use.

Aside from the question of the shape of the cutting edge as viewed from the top, there remains to be determined the amount of clearance that the tool shall have, and also the slope (and its direction) of the top of the tool. By the top is meant that surface against which the chip bears while it is being severed. It may be stated, in a general way, that the direction in which the top of the tool should slope should be away from what is to be the *working part* of the cutting edge. For example, the working edge of a roughing tool A (Fig. 2), which is used for heavy cuts, would be, practically speaking, between points a and b, or in other words, most of the work would be done by this part of the cutting edge; therefore the top should slope back from this part of the edge. Obviously, a tool ground in this way will have both a back and side slope. Similarly, the planer tool shown at A in Fig. 3, which is used for deep roughing cuts and does most of its work along the side between points a and b, should slope backward along a line c. When, however, most of the work is done on the point or nose of the tool, as for example, with the lathe finishing tool C (Fig. 2) or the planer finishing tool B (Fig. 3) which take light cuts, the slope should be back from the point or cutting edge a—b. As the side tool shown in Fig. 1 does its cutting along the edge a—b, the top is given a slope back from this edge as shown in the end view. This point should be kept in mind when grinding a tool, for when the top slopes in the right direction there is less resistance or power required for cutting. Of course, tools for certain classes of work, such as thread tools, or those for turning brass or chilled iron, are ground flat on top, that is, without either back or side slope.

The effect of too little or too much slope or clearance and some additional points of a general character on the grinding of tools, will be given in a succeeding installment.

* * *

ELECTRICAL INDUSTRIES IN GERMANY

In a paper read before the Institution of Electrical Engineers in Great Britain, the electrical industries in Germany were interestingly dealt with. The electrical manufacturing industry in Germany is at the present time almost entirely in the hands of four large companies. In the organization of these firms, we are told, an almost bureaucratic rule is in force. Each man's work is specialized in the minutest details, each branch of manufacture has an organization of its own with its own drafting-room, designing and clerical staff. Each type of motor is designed and manufactured in a separate department. Each firm has a special foreign department dealing exclusively with inquiries from abroad. All these departments are responsible only to a central authority or administration. The average technically educated employe is of high theoretical training, but salaries are kept low. As an example of the almost military rule, it may be mentioned that leave of absence of more than three days must be granted any employe by the central administration. The most striking feature of the shop system is the working day. It consists regularly of eighteen hours work in two shifts of nine hours each, with only a fifteen-minute interval during the nine hours, and half an hour between the two shifts. Thus the first shift works from 7 A. M. to 4.15 P. M., while the second works from 4.45 P. M. to 2 A. M. This system permits full advantage being taken of the machinery without working the men excessively long hours and without the necessity of paying over-time wages.

* * *

A rather peculiar safety device has recently been patented by Mr. Charles F. Pfalzgraf of Baltimore, Md., for preventing accidents to press operators. The device consists of an arrangement attached to the operator's arm, which, by means of electrical connections, makes it impossible to trip the treadle when the operator's hand is between the dies. When the device is properly adjusted, the arm must be moved back before the machine can be operated. With due esteem for all efforts that are made to prevent accidents in industrial work, it may, however, be doubted whether attachments arranged on the machine proper would not be preferable. To propose to connect up the operator directly to the machine seems like making him a part of it, even to a greater extent than he already is, and this may be neither expedient nor wise.

MILLING FIXTURES FOR AUTOMOBILE PARTS*

By E. H. PRATT†

The growth of the automobile industry has been so rapid that it has been found difficult for most factories to keep up with their orders. In order to avoid delays, a large number of companies have undertaken the manufacture of their cars complete. This necessitates the use of the most improved machinery, and also the designing and making of many special jigs and fixtures to insure the greatest possible amount of accurate work.

Among the most important fixtures are those used for the milling operations. There is a very close limit of variation allowed on most milling work, which in many cases is not more than one-half thousandth inch. This close margin is due to the introduction of the duplicate-parts system now used by the leading manufacturers. In most cases milling operations are the first ones performed; therefore the greatest difficulty is encountered in clamping the work in the fixture in such a way as to locate it properly from the uneven surface of the casting or forging without springing it.

Some of the fixtures and clamping devices used in one of the largest and best equipped automobile factories in the country, which were designed to overcome such difficulties are illustrated and described herewith. An efficient type of milling fixture for holding a number of light brass castings is shown in Fig. 1. These castings, as indicated by the dotted lines, were of a rather peculiar shape, having a heavy boss on each end and one in the center with light webs connecting them. It was necessary that the faces of the bosses *A* be milled at right angles with a hole through the central part of the casting. There was the usual difference in the shape and size of these bosses, that exists in all castings of this kind. Provision was made for machining ten at a time. The adjustable jacks *C* have swivel heads which seat themselves firmly to the uneven surfaces of the tapered end bosses. These jack heads are of machine steel and casehardened. The square bosses *D*, on one side of the fixture, each have two set-screws passing one above the other, at right angles. These screws take care of variations in the castings and securely hold the bosses in position. A hole in the center of each casting fits over a stud *E* which is provided with a slip washer *B* and a nut which aids in holding the casting securely; by using a large end mill the pieces are very quickly and accurately machined.

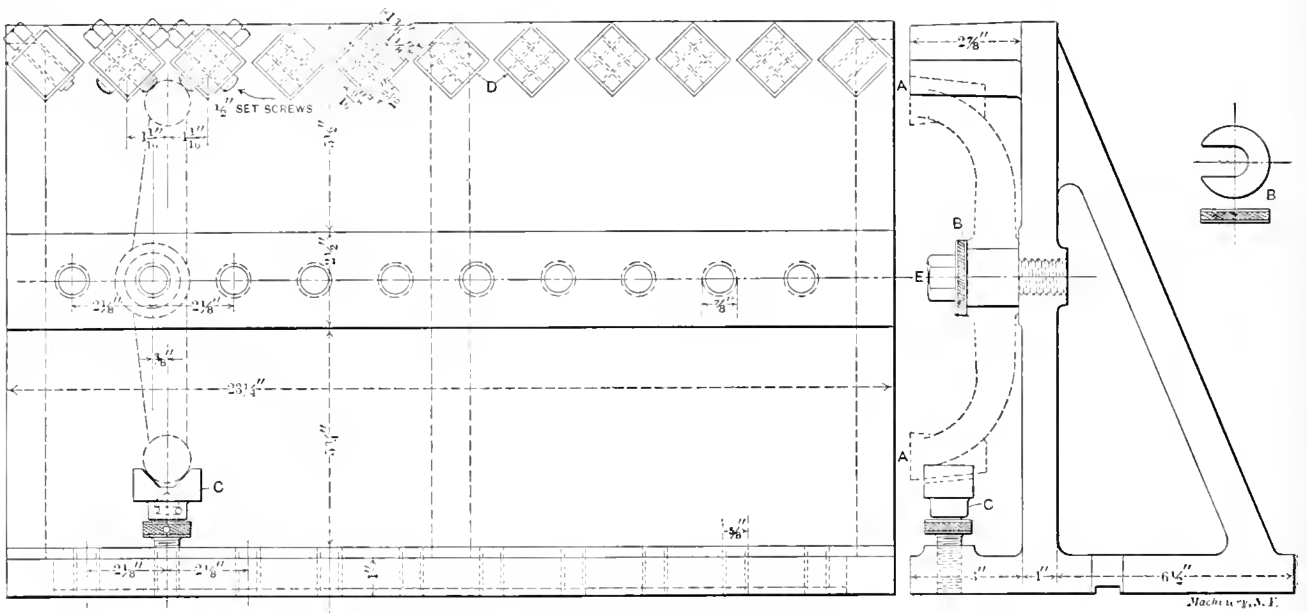

Fig. 1. Gang Milling Fixture for Castings shaped as indicated by the Dotted Outline

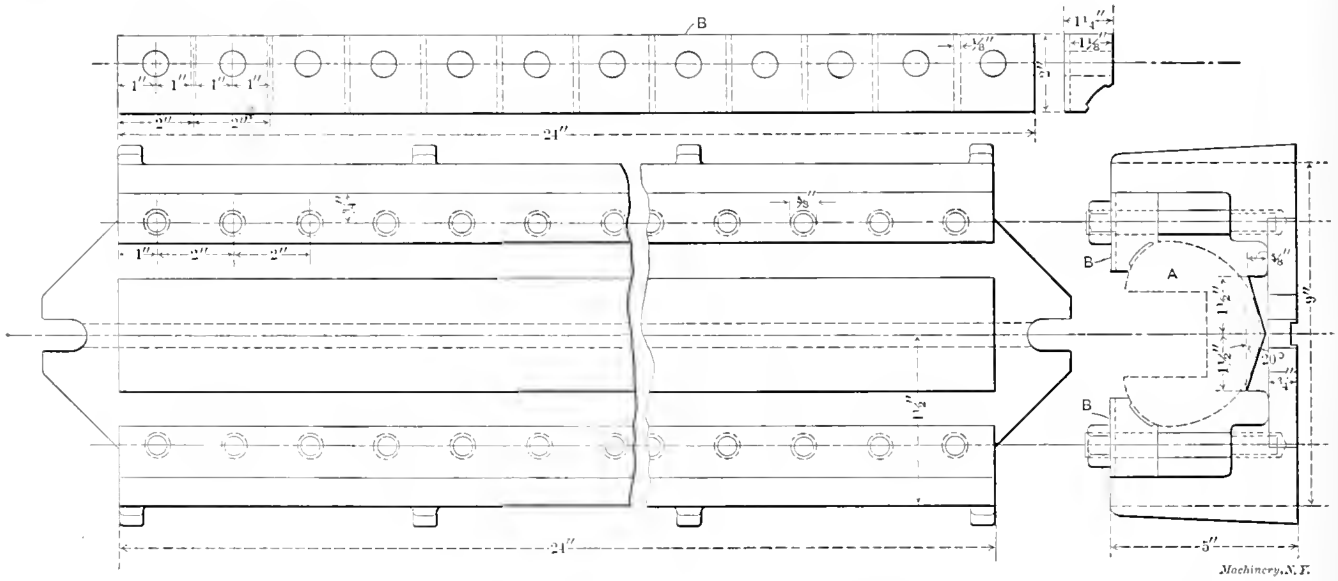

Fig. 2. Gang Milling Fixture for Engine Counterweights

A milling fixture for crankshaft counterweights and the method of clamping and locating the work in the fixture, is illustrated in Fig. 2. The counterweight *A* has circular sides and a large milled opening, as shown by the dotted lines. Twelve weights are placed in the fixture at once; these are securely held in position by one stud on either side of each counterweight, in conjunction with clamps *B*, which are machined to fit the curved surface of the counterweight. These clamps, one of which is illustrated at the top of the engraving, are machined in long strips and are sawed nearly through at

* For previous articles on this and similar subjects, see "Automobile Factory Practice" in the January, 1910, issue of MACHINERY, engineering edition, and articles there referred to.

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intervals equal to the width of the counterweight, thus allowing each section to act independently. The sides of the fixture are made very rigid to withstand the outward strain when clamping. The end view plainly shows the locating V in the bottom of the fixture, and also the studs and clamps in position on the counterweight. These counterweights are rough steel castings which makes it particularly difficult to keep them within the 0.0005 inch limit allowed in the milled groove. To get interlocking cutters of the dimension required, would and by using a large straddle mill both faces are finished simultaneously. After the ends have been faced, the hangers are sent to the drill department and the hole *E* is drilled. They are then returned to the milling department for the second milling operation which consists in finishing the flat surface *G* (Fig. 4) that fits the inside of the frame. As this is a slow operation, the fixture was designed to hold as many hangers as could be placed within the feed limit of the milling machine table. This fixture is shown in Fig. 4 and the

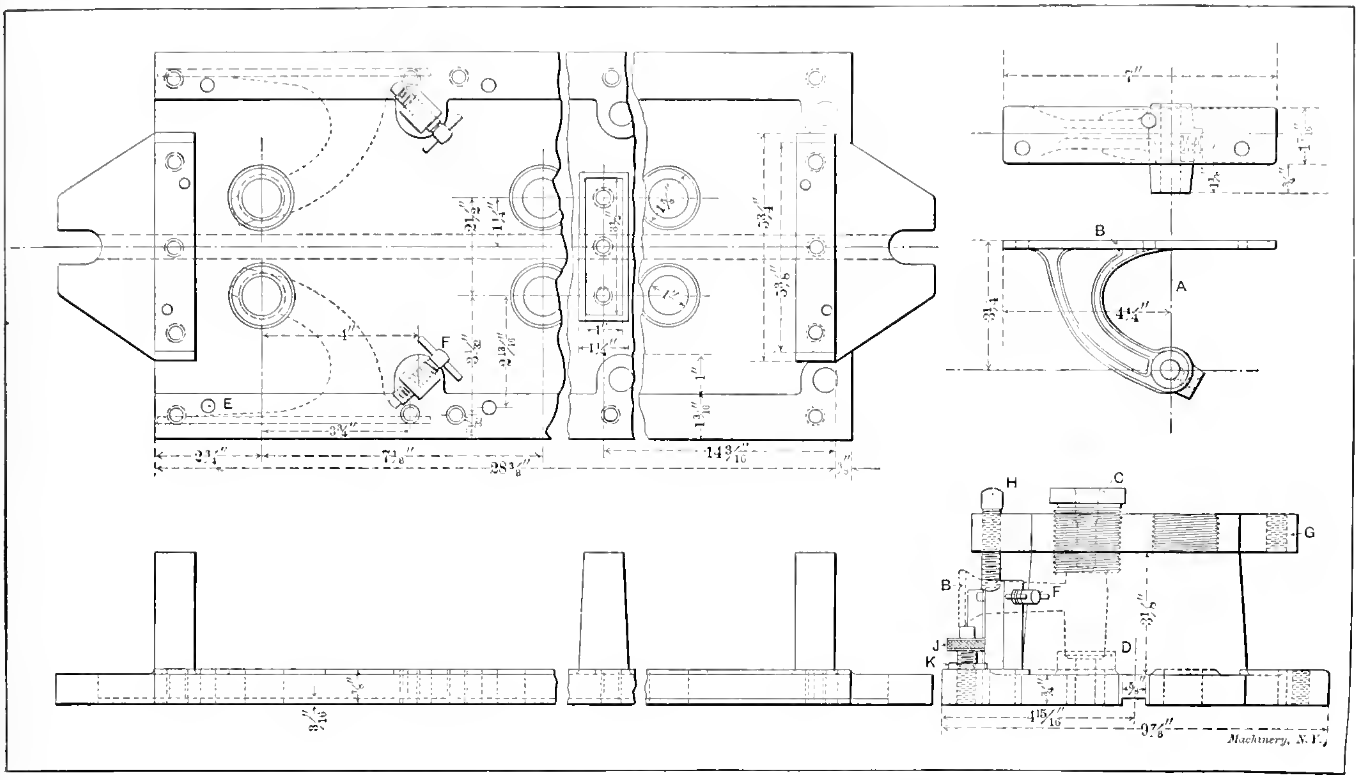

Fig. 3. Combination Milling and Drilling Fixture for Spring-hangers

take considerable time, therefore an inserted tooth cutter was made in which every alternate tooth projected ahead of the other on both sides. When the cutter becomes too narrow, it is easily adjusted by driving one tooth one way and the next one the other, and regrinding to size.

A design of spring-hanger for an automobile, and also the fixture for milling it, is illustrated in Fig. 5. This spring-hanger is a drop forging, and it is hollowed out to accommodate the width of the spring. It is not machined on the in- position of the work when set up in it is indicated by the dotted lines. The hangers are located by studs *A* that fit into the holes previously drilled, and also by the milled surface *B*. After the hangers are placed on these locating studs, they are clamped by means of the strip *C*. This strip is slotted at intervals as shown in the detail view and it is divided into as many sections as there are hangers to be clamped. As the set-screws *D* are tightened, each section acts as an independent vise jaw. The work is prevented from shifting or

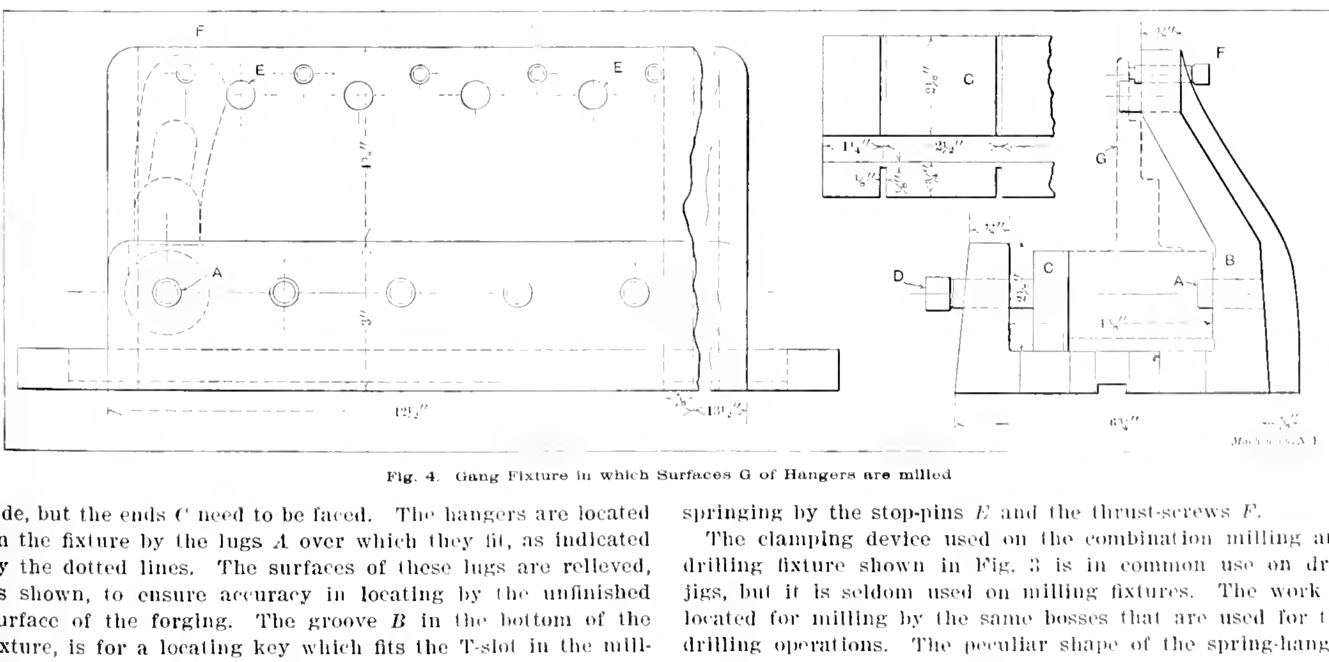

Fig. 4. Gang Fixture in which Surfaces G of Hangers are milled

side, but the ends *C* need to be faced. The hangers are located on the fixture by the lugs *A* over which they fit, as indicated by the dotted lines. The surfaces of these lugs are relieved, as shown, to ensure accuracy in locating by the unfinished surface of the forging. The groove *B* in the bottom of the fixture, is for a locating key which fits the T-slot in the milling machine table. The clamp *D*, used on this fixture, is of the type ordinarily employed on quick-acting milling devices. Both right and left hangers can be machined on this fixture, springing by the stop-pins *E* and the thrust-screws *F*.

The clamping device used on the combination milling and drilling fixture shown in Fig. 3 is in common use on drill jigs, but it is seldom used on milling fixtures. The work is located for milling by the same bosses that are used for the drilling operations. The peculiar shape of the spring-hanger forging for which this fixture is intended, is shown by the detail at *A*. This fixture is designed to mill the surfaces *B* of eight hangers at a time by using large straddle mills. Bush-

ings *C* and *D* locate the work by the hub ends as shown. The hangers are prevented from shifting by stationary stop-pins *E* against which they are forced by lock-screws *F*. The bushing plate *G* also contains clamping screws *H* which hold the hangers firmly on the adjustable studs *J*, of which two are used for each hanger. After these studs are adjusted to the work, they are held in place by lock-nuts *K*.

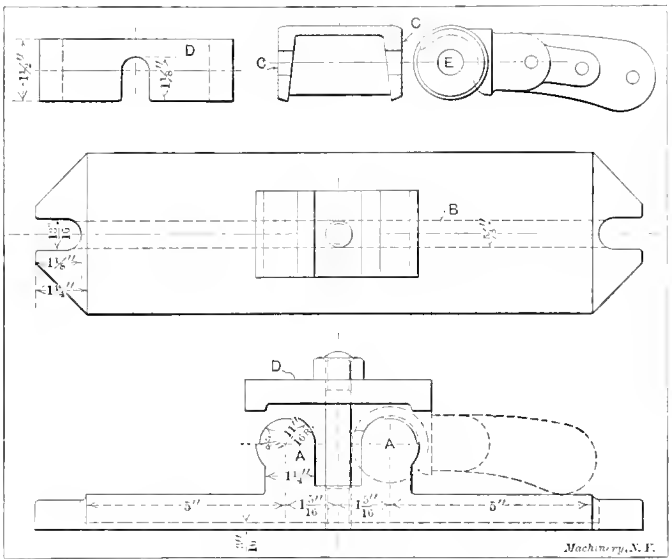

Fig. 5. Fixture for Milling Sides C of Spring-hanger

The bushings *C* and *D* are provided with holes of the same diameter as those to be drilled in the boss of the hanger, and when the fixture is not in use on the milling machine, it can be used on the multiple spindle drill press, thereby forming a combination milling and drilling fixture.

* * *

BALL POINT VERSUS ANVIL TYPE THREAD MICROMETERS

Two forms of measuring points are employed in practice for comparing the pitch diameters of threaded work. The first and oldest of these, shown in Fig. 1, is the method employed on the Brown & Sharpe thread micrometer. This may be used for positive measurements, as well as for comparisons. Figs. 2 and 3 illustrate another principle of measuring, using in the one case a ball point micrometer and in the other case wires of suitable diameter measured with the regular microm-

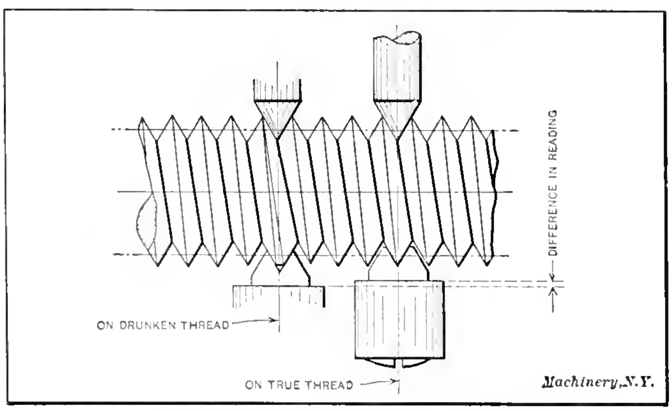

Fig. 1. The Anvil Type of Thread Micrometer gives Varying Measurements on True and Drunken Threads

eter caliper. The arrangement shown in Figs. 1 and 3 may be used for other positive measurements or comparisons with other threads. The device shown in Fig. 2, owing to the tilting of the micrometer required, should be used for comparative measurements only between two threads of supposedly the same exact form.

A recent experience of a well-known machine tool building firm shows, however, that the scheme of Fig. 2 cannot be relied on in certain cases, even for comparative measurements, and the same holds true of Fig. 3. The way in which this was discovered brings up a very interesting point in machine tool construction as well as in thread measuring.

This manufacturer bought a lathe for cutting accurate threads. It was provided with a lead-screw which proved to be satisfactory from the standpoint of the accuracy with which it was cut. A serious error developed, however, in its mounting in the machine. It was provided with a loose thrust collar between the shoulder of the lead-screw and the face of the bearing bracket which took the thrust in feeding the carriage. This thrust collar unfortunately was very poorly squared up, being some thousandths thicker on one side than on the other. Unfortunately again, the thrust surfaces on the

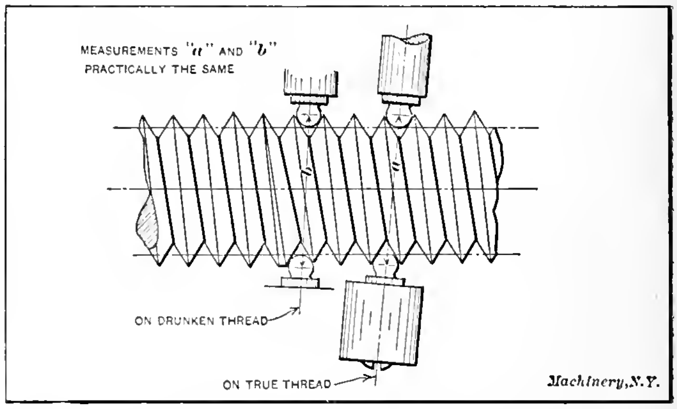

Fig. 2. The Only Difference in Measurement made by the Ball Point Micrometer is due to the very Slight Difference in Inclination—too Slight to be Appreciable

lead-screw and the bearing, between which it was placed, were also poorly faced, running out sidewise to an appreciable extent. As a result of this combination of misfortunes the lead-screw, in revolving, received an irregular endwise movement resulting from the varying position of the untrue loose washer between its untrue thrust surfaces. The machine thus cut an irregular drunken thread.

This fact was brought to the attention of the makers of the

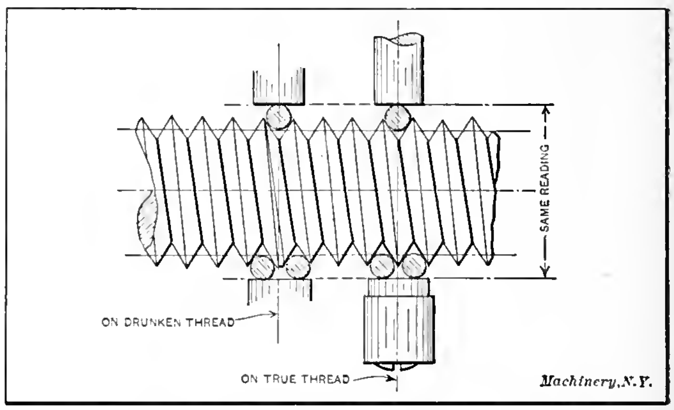

Fig. 3. The Three-wire Method of Thread Measurement makes no Distinction between True and Drunken Threads

machine, who measured with the ball point micrometers a sample screw cut by it, and pronounced it O. K. The purchaser of the machine, however, brought out a measuring tool of the type shown in Fig. 1, and this at once indicated varying diameters in different parts of the thread, giving evidence of the irregularities of which he complained.

The reason for this is evident. The ball point micrometer measures the groove cut by the thread tool, and as this is always set at the same depth and is unvarying in shape, the error was undetected. The same conditions are met with in the three-wire method, shown in Fig. 3. The lower anvil point in Fig. 1, however, since it spans the abnormal thread, instead of making contact with the sides of adjacent threads, indicates the irregularity by giving an increased reading for the pitch diameter.

This point of the accurate squaring of the thrust surfaces for precision lead-screws is a very important one; and it is one that it liable to be neglected by those who have given no thought to the matter. We have been told by a man of wide experience in accurate thread cutting, that it is fully as difficult and of fully as great importance to mount a lead-screw properly in the lathe for use, as it is to cut it accurately in the first place.

FORMULA FOR THE VOLUME OF A PART OF A SPHERICAL SEGMENT

In the December, 1908, issue a request was submitted by F. M. S. to the readers of MACHINERY for a formula for the volume of a section of a spherical segment. In the accompanying illustration the heavy lines show half of the part of the segment, the volume of which is required. The method for finding a formula for this volume involves a vast amount of mathematical work, and it is not possible to give space to the derivation, which would occupy more than four full pages in MACHINERY. The formula for the volume, however, is:

$$V = \frac{2SP\sqrt{C^2-P^2}}{3} + \frac{\pi(SC^2-4Sr^2+4r^3)}{6} - \frac{3r^2P-P^3}{3} \sin^{-1}\sqrt{\frac{C^2-P^2}{r^2-P^2}} - \frac{S(C^2-4r^2)}{3}\tan^{-1}\sqrt{\frac{C+P}{C-P}} - \frac{2r^3}{3}\left(\tan^{-1}\sqrt{\frac{(C+P)(r+C)}{(C-P)(r-C)}} + \tan^{-1}\sqrt{\frac{(C+P)(r-C)}{(C-P)(r+C)}}\right) - \frac{SC^2}{2}\sin^{-1}\frac{\sqrt{C^2-P^2}}{C}$$

in which V = the volume of the part of the spherical segment

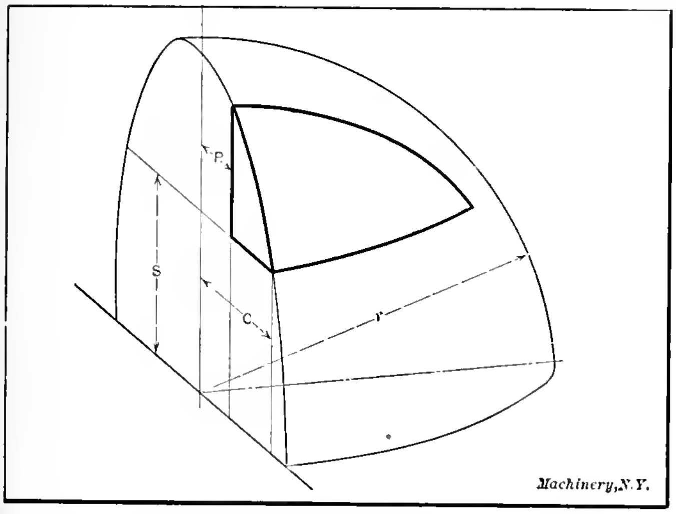

Diagram showing Notation for Formula for the Volume of a Part of a Spherical Segment

required, which is twice the volume of the section shown with heavy lines in the accompanying illustration, and S, P, C and r are dimensions as given in the illustration, r being, of course, the radius of the sphere. This formula with its derivation has been worked out by Mr. R. A. Jewett, of 35 Pinkney St., Boston, Mass., and he does not think that the formula can be simplified further. F. M. S. asked for the volume in terms of the radius of the sphere, the height of the segment, and the distance between the central plane and the plane passed through the segment, this latter distance being shown as P in the illustration. Of course, these values for the height of the segment could be substituted in the formula, but to do so would vastly complicate what is already too complicated, and the result would be an unwieldy, if not an unmanageable expression.

The formula has been checked by actual figures and been found to work out exactly. The method for checking is to assume some limiting value for certain dimensions, so that the volume can also be calculated by any of the general formulas for spherical segments. In this way, if the two values obtained by the two different formulas prove to be equal, the formula here given can be relied upon to be correct. We are reasonably sure, however, that no one will use this formula except in a case of dire necessity.

SPECIAL UNIVERSAL VISE FOR GANG PLANING

By E. H. WEISS*

When it becomes necessary to machine small, slender pieces in quantity, whether the forms are complicated or not, it is usual to use a formed cutter for milling them, the cost of which is defrayed by the economy which results from the use of such a cutter as compared with hand work. If the number of pieces is comparatively small, it is best to plane them in a gang, while they are held in the vise, by the use of a formed planer tool. This operation consists in placing a number of

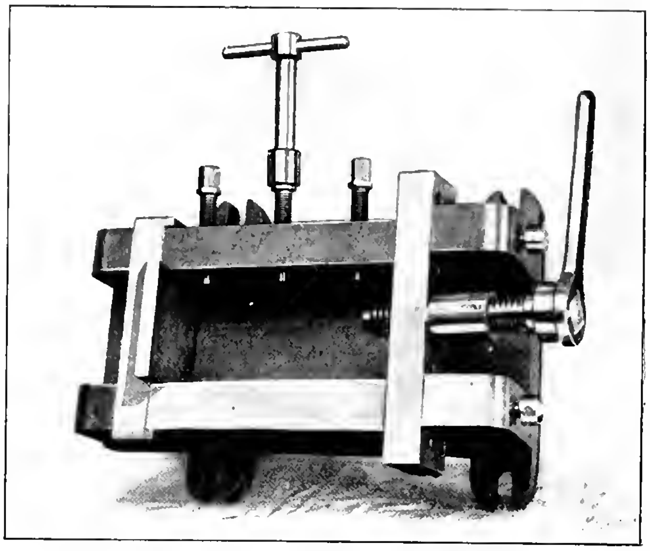

Fig. 1. Special Vise for Holding a Small Number of Duplicate Pieces on the Planer

pieces in a vise and shaping them all simultaneously. When the parts are machined by this method, it is necessary to strongly clamp them against each other, and when they are very small, it is often quite difficult to place the blocking so that it will not hinder the passage of the tool. I make use of a special chuck for this work which is of simple construction, as may be seen by referring to the accompanying illustrations, Figs. 1 and 2.

This chuck is composed of a base A of channel section, whose sides B are provided with slots in which are placed two steel rectangular cross-pieces C and D. The cross-piece D, carries a screw having a squared head which fits a wrench as shown in Fig. 1. This screw tightens the pieces together by bearing on a pad or block similar to E. It is possible to

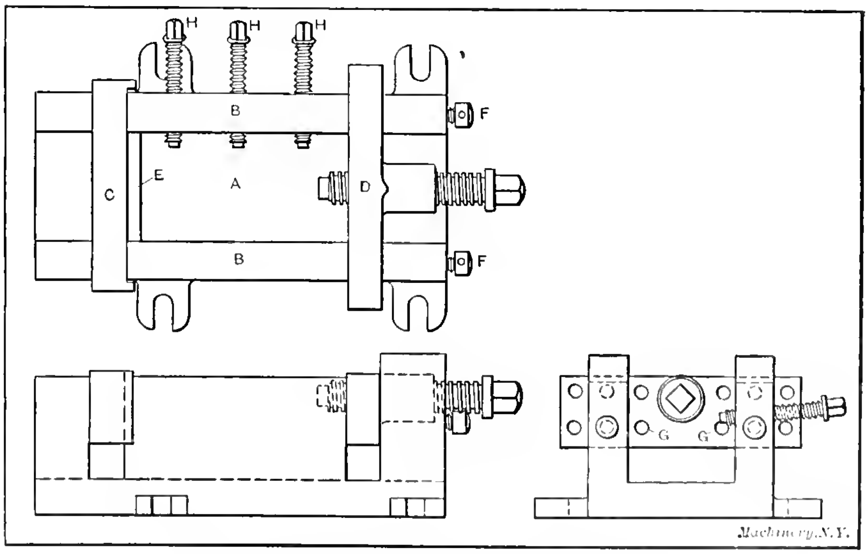

Fig. 2. Elevations and Plan of the Special Planer Vise

adjust the height of cross-piece D to agree with the height of the work, after which it may be locked in place by screws F, which fit into holes G. The location of the tightening screw can, therefore, be adjusted to any desired point on the work. To locate the row of pieces laterally, there are provided three

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screws H, in the side of the vise, which bear against a block similar to that shown at E. These screws are at a slight angle with the base of the vise, as shown, so that the pieces, when clamped, are forced into contact with the base or with such blocking as may be necessary to mount them on. The four slotted feet shown permit the vise to be securely clamped to the table of the machine by means of four bolts.

* * *

THE GROWTH OF CAST IRON

In an interesting paper entitled "The Growth of Cast Irons after repeated Heatings," read before the Iron and Steel Institute of Great Britain, September, 1909, the authors, Prof. H. F. Rugan and Prof. H. C. H. Carpenter, report the results of their investigations relating to the "growth" of cast iron.

The fact that certain types of cast iron grow after repeated heatings has long been familiar to engineers. Cast iron annealing ovens 8 feet in length, 3 feet in diameter, and 1½ inch in thickness, which are kept red hot for prolonged periods, between which they are permitted to cool off, sometimes grow to 9 feet in length in the course of their use. Cast iron furnace grates, range fittings, etc., subjected to alternate heating and cooling are also frequently distorted and sometimes broken from the same cause. It has been demonstrated that mild steel subjected to the same treatment does not grow, so that this quality is one peculiar to cast iron.

The principal investigator of the subject of the growth of cast iron after repeated heatings was, previous to the investigations of the authors of the paper referred to above, Mr. A. E. Outerbridge, Jr., of Philadelphia. His experiments were reported in the transactions of the American Institute of Mining Engineers, 1905, Vol. XXXV. In these experiments a cast iron bar of 1 by 1-inch section, 14 13/16 inches in length, was heated 27 times to about 1470 degrees F. for one hour. During this treatment it increased in size to 16½ inches length and 1⅛ x 1⅛-inch cross-section. This corresponds to an expansion of nearly 41 per cent. The enlarged bar had, it was stated, the same weight as the bar before the treatment. Twelve additional heatings increased the dimensions of the bar until the total expansion was 46 per cent.

The experiments of Messrs. Rugan and Carpenter were more extensive than those carried out by Mr. Outerbridge, but in the main, there is a close agreement in results. The following is a summary of the results of these investigators' experiments. The maximum growth of commercial cast iron takes place when the heating is continued for four hours at a time at a temperature of 1650 degrees F. In order that growth shall take place, both heating and cooling are required. The growths of the cast iron investigated varied between 35.2 and 37.5 per cent. It is interesting to note that the latter experimenters found that an increase in weight took place amounting to from 7.8 to 8.6 per cent. It is thus evident that the metal took up gases from the outside air, there being an oxidation of silicon and an oxidation of carbon. The ends of a cast iron bar grew more rapidly than the middle parts, which is readily explained by the fact that they expose more surface to the penetrating gases. The investigators, therefore, came to the conclusion that the influence of gases on the growth of cast iron is very important, and one test piece which grew very decidedly in a muffle furnace not only did not grow when heated in a vacuum, but it actually contracted 0.04 per cent. This would partly explain why Mr. Outerbridge's experiments did not show an increase in weight, as he enclosed his samples in an iron pipe closed at the ends with clay in order to prevent scaling; consequently there were practically no gases to be absorbed by the heated iron. On the other hand, this does not seem to explain satisfactorily the fact that his samples increased in size nevertheless.

In constructions where the growth of cast iron is objectionable, white irons should be used instead of gray; the most suitable composition appears to be an iron with about three per cent of carbon that has as few impurities as possible. As to the impurities, silicon is the most objectionable and it should not exceed 0.2 to 0.3 per cent. The only objection to using white iron for such purposes as annealing ovens, etc., would be that it might crack when heated, but this difficulty might be obviated by modifying the design.

MOMENT OF INERTIA OF BUILT-UP SECTIONS

By JAMES A. BROWN*

The usual method of calculating the moment of inertia of a built-up section involves the calculations of the moment of inertia for each element of the section about its own neutral axis, and the transferring of this moment of inertia to the previously found neutral axis of the whole built-up section. A much simpler method which can be used in the case of any section which can be divided into rectangular elements bounded by lines parallel and perpendicular to the neutral axis, is the so-called tabular method based upon the formula:

$$I = \frac{b\,(h_1^3 - h^3)}{3}$$

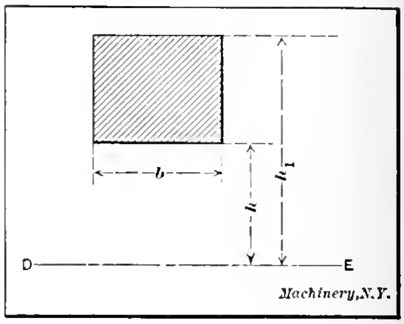


Fig. 1

in which I = the moment of inertia about axis DE, Fig. 1, and b, h and h_1 are dimensions as given in the same illustration. This method is given in Alexander and Thompson's "Elementary Applied Mechanics."

The method may be illustrated by applying it to the section shown in an article in the January issue of MACHINERY, entitled "To Calculate the Deflection of a Special Steel Section." This section is reproduced in Fig. 2, and for simplicity of calculation shown "massed" in Fig. 3.

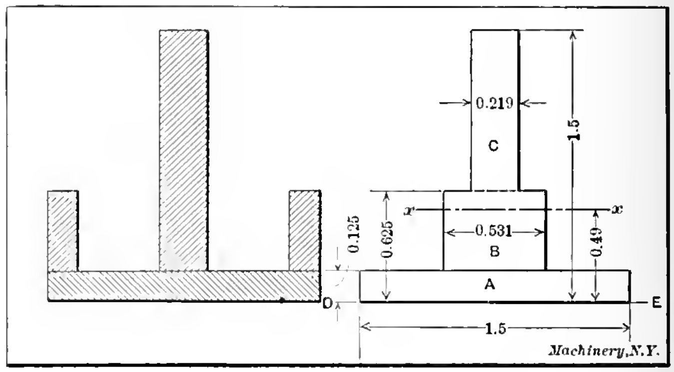


Fig. 2 Fig. 3

The calculation may then be tabulated as shown in the accompanying table. The distance from the axis DE to the neutral axis xx (which will be designated as d) is found by dividing the sum of the geometrical moments by the area. The moment of inertia about the neutral axis is then found in the usual way by subtracting the area multiplied by d^2 from the moment of inertia about the axis DE. The slight differences in the results from those given in the article in the January issue previously referred to are due to the use of a 5-inch slide rule in the present calculations.

TABULATED CALCULATION OF MOMENT OF INERTIA

Section	Breadth b	Height h	Area $b(h_1 - h)$	h^2	Moment $\frac{b(h_1^2 - h^2)}{2}$	h^3	I about axis DE $\frac{b(h_1^3 - h^3)}{3}$
A	1.500	0.125	0.187	0.016	0.012	0.002	0.001
B	0.531	0.625	0.266	0.391	0.100	0.244	0.043
C	0.219	1.500	0.191	2.250	0.203	3.375	0.228
			$A = 0.644$		$M = 0.315$		$I_{DE} = 0.272$

$$\text{Distance } d \text{ from } DE \text{ to } xx = \frac{M}{A} = \frac{0.315}{0.644} = 0.49.$$

Moment of inertia of whole section with reference to its neutral axis:

$$I_n = I_{DE} - Ad^2 = 0.272 - 0.644 \times 0.49^2 = 0.117.$$

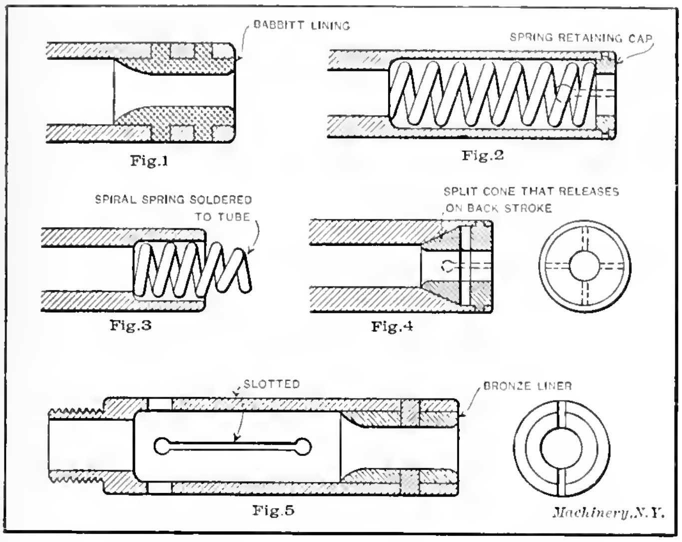
* Address: Holmesburg, Philadelphia, Pa.

LETTERS ON PRACTICAL SUBJECTS

Articles contributed to MACHINERY, with the expectation of payment must be submitted exclusively

EXPERIMENTS WITH AUTOMATIC SCREW MACHINE FEED-FINGERS

When reading my November MACHINERY I was most interested in the "Dont's for Screw Machine Operators" by Mr. Paul W. Abbott, and the one that attracted my attention the most was "Don't let the first few pieces go by without looking to see if the feed-finger is scratching the work." Now I wonder if the writers of "Dont's" ever realize what it means to attempt to follow out their suggestions and then not altogether succeed in attaining the object in view.



Figs. 1 to 5. Various Types of Feed-fingers designed to prevent Scratching the Stock

The superintendent of a large factory once decided on the particular don't mentioned. He argued that to get closely-rolled bright stock and then mark or scratch it on the unturned parts was foolishness, so we had to get busy. To begin with, there was no thought of discarding the feed-finger and feed-tube for any other manner of feeding, as this method has many decided advantages peculiar to itself, not the least being that there is always a full chuck length of material left in the chuck when the feed-finger has parted with the last part of the bar, and there is also a minimum length of scrap.

When various makers were approached, they could suggest nothing that did not decrease the machine's capacity, such as making a 1-inch machine into a ¾-inch machine, etc., and

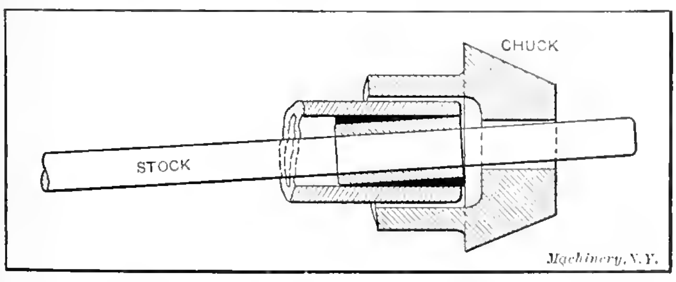


Fig. 6 Illustration showing on an Exaggerated Scale the Relative Positions of Stock and Chuck when Feed-finger Bushings are out of Line

indeed, the lack of space often cripples many of the devices which one immediately thinks of for this special operation.

We tried hardening and lapping the fingers and nicely rounding the backs of them, but while the results were better, they were far from satisfactory. The tinning of the fingers was then tried but this method was also unsatisfactory. Babbitted fingers, such as shown in Fig. 1, were then used, but these were constantly being enlarged by the new bars and relining was frequent.

Fingers such as shown in Figs. 2 and 3 were next tried, but the faults were numerous and the up-keep large, so these designs were also discarded. The design of Fig. 4 was then made and while it proved to be a useful type of finger, it had the disadvantage that when feeding up to a stop with a slight overfeed, it locked itself and caused the heating of the feed-tube; where it can be applied, however, for open feeding, it is very useful.

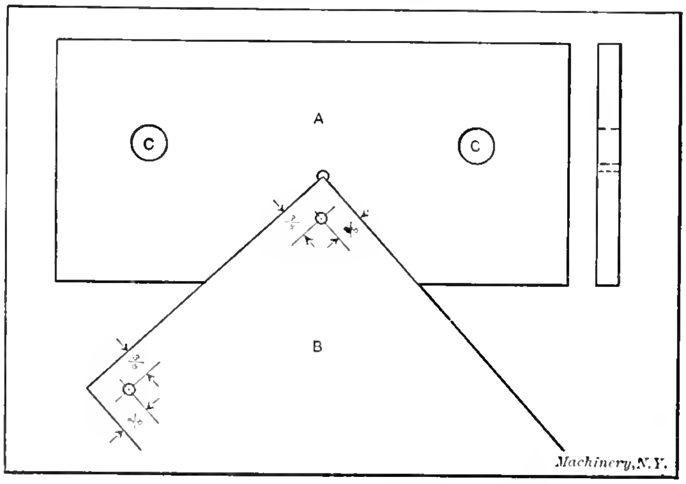
Solid bronze fingers were tried but these were rejected on the score of expense and also because they have little spring tension. Bronze bushings were next used and they, if anything, proved the best, but they left a lot to contend with. These fingers were made as shown in Fig. 5. The bushing was soldered in solid and then pinned in position so that introducing new bars would not knock it out. When the bushing was soldered in position it was placed in a little fixture and drilled to a suitable size; it was found necessary to do this as the bushings were sometimes placed in the tubes out of line, consequently the bar was fed forward out of line with the machine, as illustrated on an exaggerated scale in Fig. 6, thus putting extra work on the chuck and quickly undermining its accuracy.

As can be seen, this Don't caused considerable trouble and I should like to know if anyone else has had any particular experience with this special Don't. No doubt Mr. Abbott has some ready means of overcoming this trouble, inasmuch as he makes special refereuce to it in his interesting article.

J. S.

PLATE LOCATING FIXTURE FOR DRILL PRESS

A useful fixture for the drill press, that is used for locating steel plates, etc., that are to be drilled, is illustrated by the accompanying sketch. This fixture does away with the operation



Fixture for Locating Plates on the Drill Press

of laying out each hole preparatory to drilling. If a number of plates are to be drilled in the manner illustrated, the corner of one plate is first laid out and the hole drilled; the drill is not removed from the hole until the fixture *A*, which has been previously notched as shown, is brought against the plate *B* and is fastened to the table of the drill press by two bolts which pass through the holes *C*. The fixture is then ready for use, and it will locate the plates for the rest of the holes by simply inserting them in the locating notch.

I do not claim that this fixture will enable all the holes to be drilled with extreme accuracy as to distance, etc.; it is, however, a useful and time-saving fixture that I have often seen used with good results upon many ordinary jobs for which extreme accuracy was not essential.

C. F. EMERSON

DIAGRAM FOR GOTHIC LETTERS AND FIGURES

A diagram giving the proportions of Gothic letters and figures, is shown in the accompanying engraving. The system is so simple that the diagram is self-explanatory. By its aid Gothic letters and figures of any size may be rapidly drawn by means of ordinary instruments. In some cases,

appearance has been sacrificed to ease of construction, but the dominant consideration throughout has been absolute legibility. Many such systems of lettering have been prepared, some of which possess considerable artistic elegance, but none state with clearness the actual dimensions employed and, consequently, the construction of the letters is difficult. It was, therefore, decided to evolve a perfectly definite system of proportions. This system has been used for 5/16-inch letters on a drawing requiring unusual care, and also for painters' stencils fifty inches high. In both these extreme cases, and for many intermediate cases, the system has been found satisfactory to all concerned. CARINGTON C. CARISS

London, Ontario.

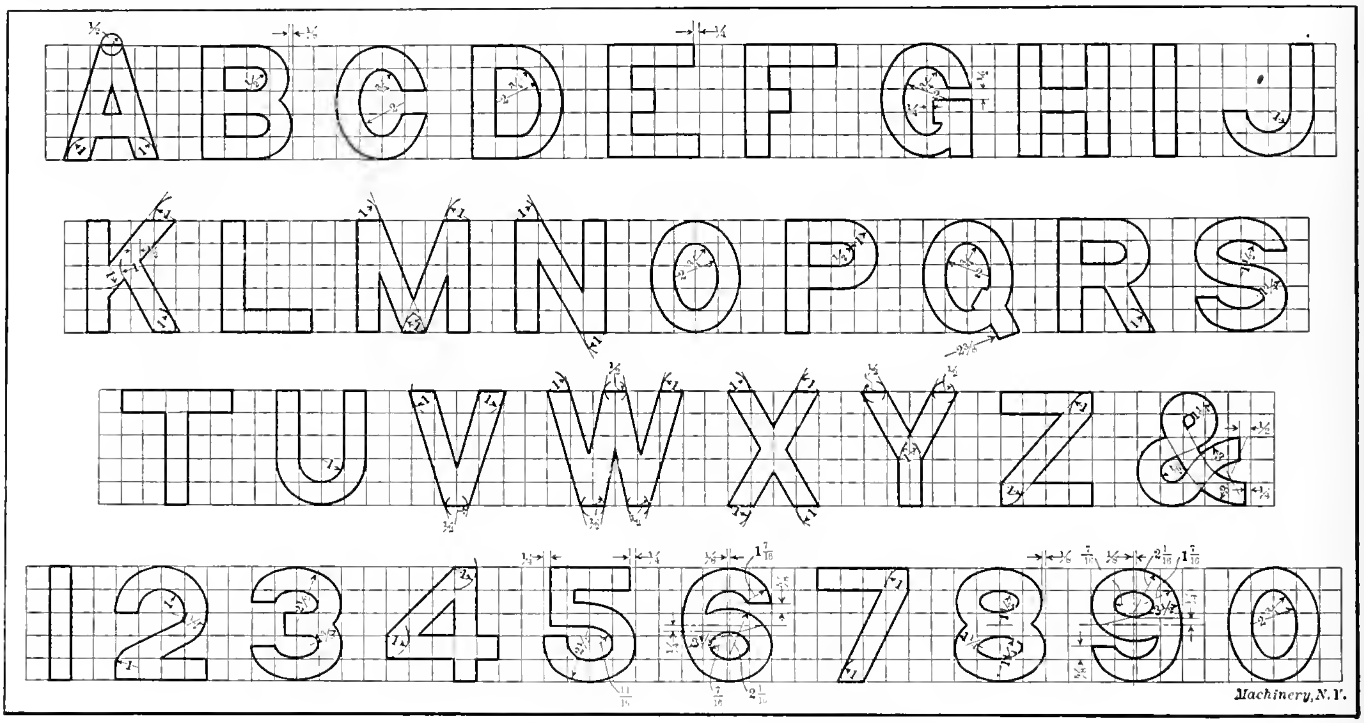


Diagram giving Proportions for Gothic Letters or Figures of Any Size

CLAMPING LONG AND SLENDER WORK

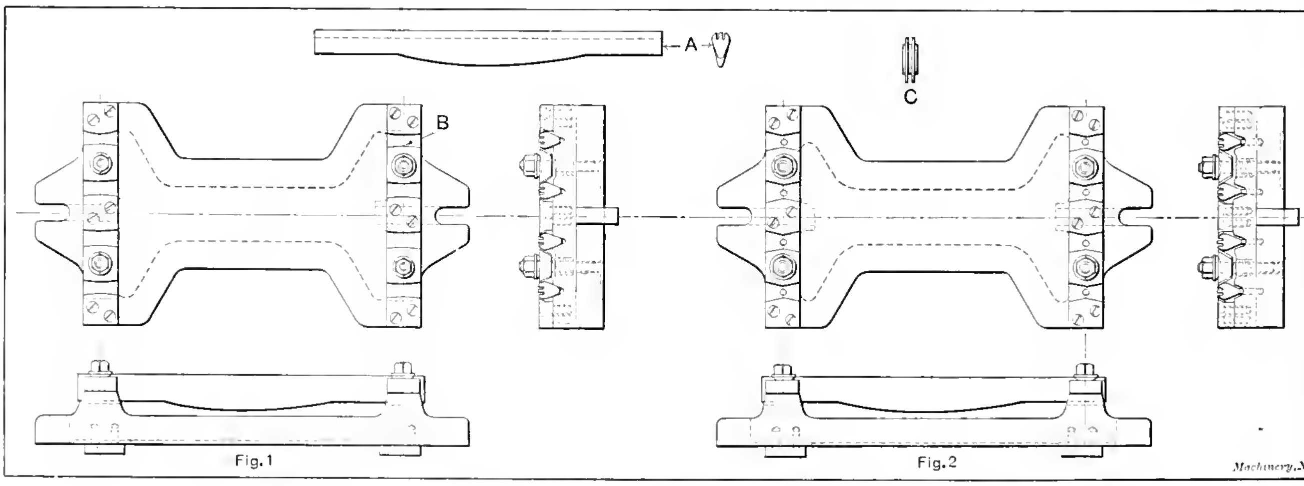
Good examples of both correct and incorrect methods of clamping a long, slender and rough casting are illustrated in the two fixture designs shown in the accompanying illustration. The piece to be milled, which is made of cast iron, is shown at *A* in the drawing. It requires a flat surface on top and two slots that must be milled straight, with only 0.0015 inch limit sideways. This is done in one cut with a gang cutter *C*. Four of the pieces are milled at the same time, but there is no reason why more than four could not be done at once, providing the milling machine table is wide enough.

In Fig. 1 is illustrated a design of fixture for holding the work that is faulty. It will be seen that the clamps are rounded at *B* and that the work rests in V's, but although the clamps are rounded, the bearing that the work has in the V's will result in bending it. In Fig. 2 an improved design is shown. The clamps are pointed instead of rounded, and the work rests on points instead of V's, and for this reason it is not distorted by clamping.

It is obvious (but often ignored), that if a rough casting is clamped onto a flat surface it will be bent.

The vital difference, therefore, in the two designs, is that one clamps on surfaces and the other on points. When the job is clamped as shown in Fig. 1, it is held at each end by four points, that is, between two clamps and the two sides of the V, while in Fig. 2 it is in contact with only three points. One other important feature is that the points are all in line with each other, making it impossible to bend the work. O. R. BARRETT

Luton, Bedfordshire, England.



Figs. 1 and 2. Two Fixture Designs Illustrating Incorrect and Correct Methods of Clamping Slender Work

DESIGN OF TOOL CHESTS AND CASES

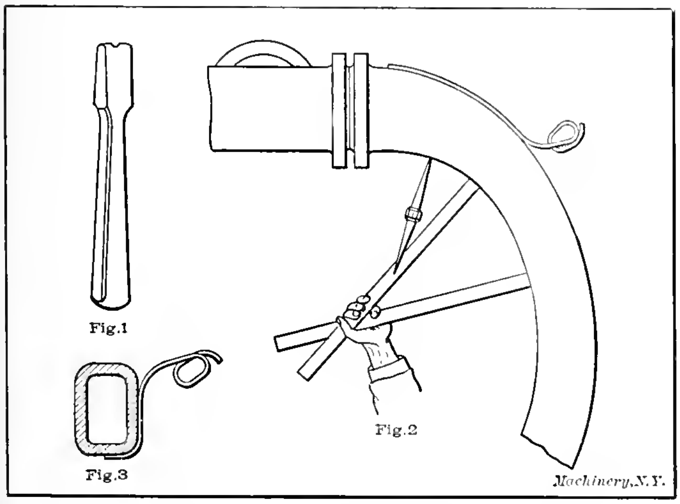
In the December number of MACHINERY there appears a suggestion by Mr. J. F. Winchester on the design of cases for small tools. As I am constantly on the road erecting textile machinery for a large English concern, I have had an excellent opportunity of finding out what is most needed in this direction. I obtained from one of your advertisers (Lyon Metallic Mfg. Co.) a steel machinist's tool-box, the weight of which is much less than that of a wooden one of the same size. When all the cases for micrometers, etc., were replaced by thin leather ones, which in my opinion answer the purpose much

better than the morocco cases that usually come with such tools, there was lots of room in the steel box and a great reduction in weight, which was important as I had continually to pay for the weight. I have been trying for some time to get a steel box for the heavier erecting tools, as wooden boxes, even when heavily banded, are constantly being split, to say nothing of the extra charges for weight. J. A. Caless

Providence, R. I.

FINDING THE RADIUS OR SHAPE OF IRREGULAR PARTS

Mechanics in the various trades often find it necessary to obtain the radius or shape of irregular parts of machinery or patterns, thus making the use of templets necessary. Making templets, even when they are made from wood or cardboard, takes a great deal of time, and in many instances it is inconvenient to get at the work. For tool, punch or die work, metal templets are, of course, necessary. When great accuracy is not required, I have a method of obtaining irregular shapes which has proved satisfactory, and which will, doubtless, be of interest to many readers of Machinery. The shape of irregular parts may be easily obtained by the use of a piece of 1/8 inch soft solder wire. This wire is bent to conform to the shape of the work, but before this is done, it should be straightened and all small kinks that may be in it from previous use, removed. The wire is then formed to the shape of the work with the end of a stick, such as shown in Fig. 1. When it is well formed and lies evenly it should be removed and laid on a flat board; then, by adjusting a pair of dividers until one point follows that part of the wire which was in contact with the work, the radius may be ascertained. Fig. 2 illustrates the application of the wire to a locomotive steam pipe which has many different radii, and irregular shapes that would be difficult to measure, especially with the pipe in place. This illustration also shows a very convenient way to get the inner radii. Two pieces of wood are held with one hand, as shown, and the dividers are held with the other, one point resting on the wooden support, while the other is adjusted to the correct radius. Fig. 3 shows the method of using the wire to get the radius on the cross-section of the steam pipe, which usually varies from end to end.



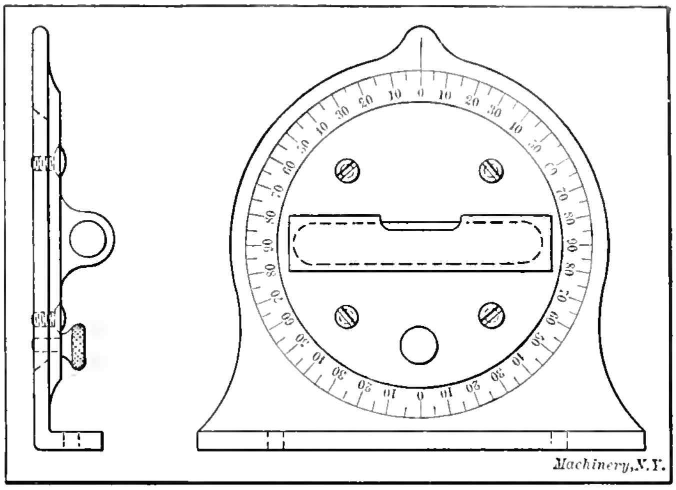
Illustrations showing the use of Soft Solder Wire for obtaining Radii on Locomotive Steam Pipe

Chicago, Ill. C. V. Frisk

NEED OF A LEVEL ON THE MOTOR DRILL

It is time that a level was applied to the motor drill; at least, one similar to the kind used on a combination square which would not cost the maker much and would be appreciated when drilling horizontal or angular holes. The level shown in the illustration would be a convenient form, and it would enable the drilling of holes to any angle by setting the protractor to the angle required and then holding the level horizontal while drilling. The hole would then be at a corresponding angle and it would not be necessary to have someone to help keep the drill straight. I have used a loose level for this work, but such a level can only be applied when drilling a horizontal hole, without special arrangements, and even when the drill is in a horizontal position, the use of such a level is often impossible as some motors do not have a surface that is parallel to the drill, for leveling. In addition, when the motor is in action, both hands are required for holding the motor and feeding the drill. Therefore the level must be dispensed with and the position of the drill guessed at.

The level should be furnished by the maker of the motor, and the latter should have a face on the body parallel to the drill center line, and two thumbscrews for holding the level so that it may be easily put on or removed.



Level and Protractor for the Motor Drill

I hope that this article will be read by both the makers and users of motor drills. It is, of course, very important to hold the motor as straight as possible when drilling, as side movements cause friction which not only requires more energy, but endangers the motor and temper of the drill, besides making the hole large or elliptical. Many broken drills are the result of this lateral movement when drilling, which could be avoided by the level attachment. A. Nielsen

Cleveland, Ohio.

REPAIR JOB ON AN ALTERNATOR

The burning of a collector ring on three-phase rotary field alternator supplying current to individual motors, forced a tie-up in a factory putting out a food product which was highly perishable. Owing to the nature of the output and the inability of the engineer to temporarily repair the alternator until a new ring could be cast, or one secured from the makers, a highly developed case of uneasiness attacked the management that was not relieved until a smart machinist made a suggestion, which he was allowed to carry out. His scheme, as simple as it was successful, is shown by the accompanying engraving.

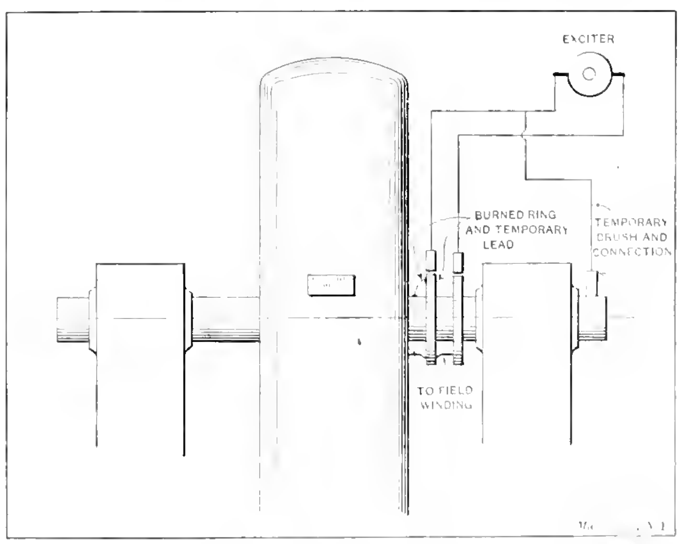


Diagram showing Temporary Repair of an Alternator with a Burned Ring

The brush was first removed from contact with the burned ring. Then by setting the brush in a temporary holder, so that it was in contact with the shaft to which a lead from the burned ring had been soldered, the exciter circuit was closed. This completed the job, and in less than two hours the machine was again running, which it continued to do until the arrival of a new ring from the factory. So, what at first seemed to be a serious breakdown and loss, resulted simply in a slight delay. DONALD A. HAMPSON

Middletown, N. Y.

ADDING, SUBTRACTING AND DIVIDING FRACTIONS

In making half-size drawings, it is often necessary to divide odd fractions by 2. I make use of the following method: Divide the whole number by 2; discard the ½; add the numerator and denominator together and double the denominator.

Example: Divide 15 7/8 by 2. The half of the whole number is 7½, and discarding the ½ we have 7; the numerator added to the denominator = 15; and the denominator doubled equals 16, giving a total of 7 15/16. By this method it is very easy to do this mentally.

Here is another method for adding and subtracting fractions:

Example: Add 9 13/16 and 6 7/16. Subtract the difference between 13/16 and 1 = 3/16; subtract the 3/16 from 7/16 which is ¼. 13/16 and 7/16 added together gives more than 1 so carry the 1 and add the units which makes 16¼. This can also be changed by subtracting 7/16 from 1 = 9/16 and then subtracting that from 13/16 = ¼.

For subtraction, this method is reversed.

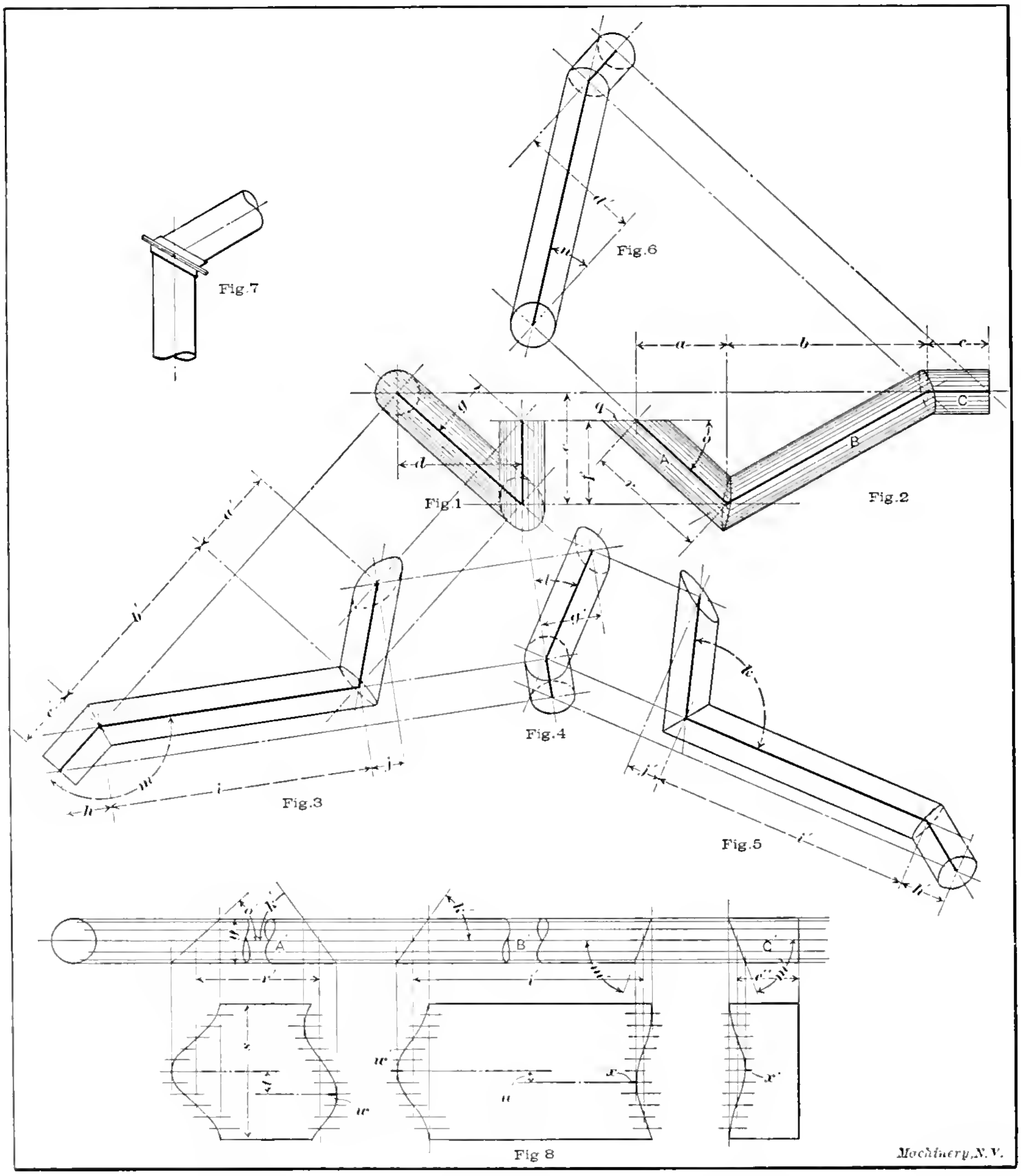
Example: Subtract 6 13/16 from 9 7/16. Add the difference between 13/16 and 1 to 7/16 = 5/8; carry the 1, and add 6 = 7; 7 from 9 = 2, and 2 plus 5/8 = the difference between the two numbers.

I have never seen the foregoing methods published; nor have I come across anyone who has used them, but I find them to be a great help to me. FRANK W. HOLCOMB

Cincinnati, Ohio.

LAYING-OUT AND DEVELOPING THE SHEETS FOR STEEL SPOUTS

It might perplex one, who had not done similar work, to lay out and develop the sheets for a steel spout such as is shown in Figs. 1 and 2 of the accompanying engraving (in which a, b, c, d, e, and f are the given dimensions)) on account of the fact that the true lengths of and the true angles between the various parts have to be obtained before the sheets can be developed. However, the task is not as complicated as it might at first appear, as it is only necessary to work with the center lines. In the illustrations, the center lines are shown heavy and the spout parts are drawn in around them merely to better illustrate the principles involved.



Method of Laying-out and Developing the Sheets of an Angular Spout

Having drawn the views shown in Figs. 1 and 2, draw Fig. 3 making $c' = c$, $b' = b$, and $a' = a$; then m will be the true angle between the pieces B and C, and i will be the true length of piece B. Next draw the view, Fig. 4, making $g' = g$; then l will be the angle made by the center lines of pieces A and C when looking directly along the center line of piece B. Draw the view Fig. 5, making $j' = j$, $i' = i$, and $h' = h$; then k will be the true angle between the pieces A and B. Draw the view Fig. 6, making $d' = d$, and n will be the angle made by the major axis of face q and the center line of piece B when looking directly along the center line of piece A.

To determine the shapes of the flat sheets at the different joints, draw A', B' and C', making $r' = r$, $i'' = i$ and $c'' = c$. Make angle $o' = o$, $k' = \frac{k}{2}$ and $m' = \frac{m}{2}$. Develop the sheets in the ordinary way, as shown, making $s = y\,\pi$, $t = s\,\frac{n}{360}$ and $u = s\,\frac{l}{360}$.

If a lap joint is to be used, allowance must, of course, be

made for it. The sheets as shown should have their edges rolled up from the plane of the paper. When assembling the spouts, points *w*, and *w'*, and *x* and *x'*, should be brought together. The connections may be made with flanges as shown in Fig. 7.
CHAS. E. EVANS

Aurora, Ill.

TEST INDICATOR

The test indicator shown in the line engravings, Figs. 1 and 2, was originally designed for very accurate bench-lathe work, but it has since proved to be a handy tool for all

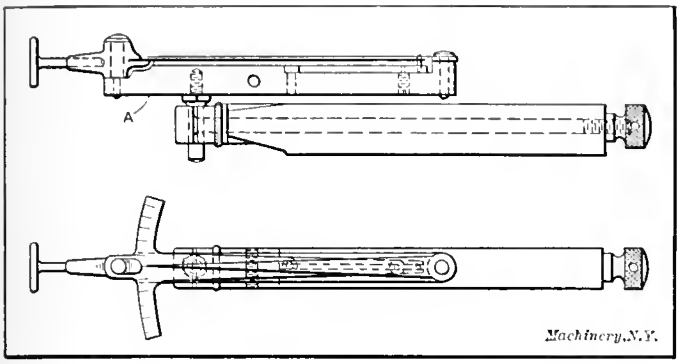


Fig. 1. Test Indicator for Accurate Work

kinds of work requiring accuracy. It is made so that it multiplies the errors in the work 120 times, or in other words, an error of 0.001 inch will show about 1/8 inch on the graduated scale. It will be noticed that the graduations extend from the zero at the center towards each side, so that both positive and negative errers are thus indicated. The design of the indicator can be easily seen by a study of Figs. 1 and 2. It consists principally of a body *A* made of tool steel and two levers and studs. The former is provided with two tapped holes, one on the under side and one on the front side. These holes are intended for studs by means of which the test indicator proper may be held to holders of different types. Examples of two kinds of holders are shown in the illustrations. The indicating device itself consists practically of only two thin levers, one of which is provided with a pointer indicating on a graduated scale as shown. The scale, of course, is graduated after the device is made, so that the graduations are exactly true. The points are made in disk form as shown in Figs. 1 and 2, but points of other shapes can, of course, be used

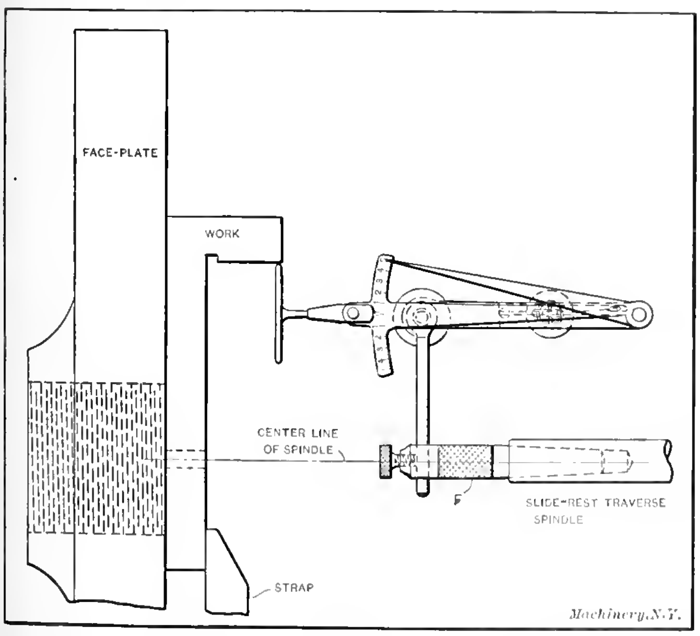


Fig. 2. Test Indicator in use for Setting up Work on the Faceplate

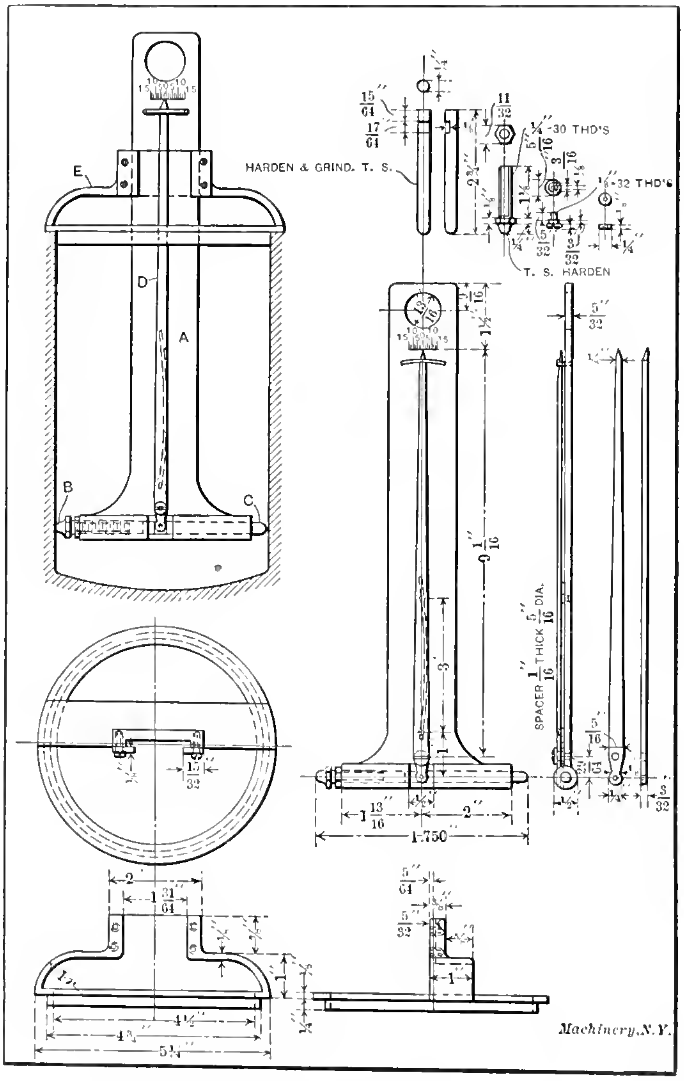
if preferred. Fig. 2 illustrates the use of the indicator in lining up work on the faceplate of a lathe. A number of different attachments may be made and used for special purposes, and holders of different kinds can be adopted. By means of these accessories the indicator may be used on nearly all classes of work requiring a high degree of accuracy.

The uses of the tool will easily suggest themselves. A few jobs on which the writer has used it are for testing the lead of an engine lathe lead-screw, comparing it with a master thread plug; locating buttons in making drill jigs on the milling machine; truing up work held on the faceplate of the lathe, indicating either by a hole already bored, a center, or the outside of the work.
A. L. MONRAD

East Hartford, Conn.

DEEP HOLE CALIPERS

There has been considerable written of late on the subject of deep-hole calipers, and after studying the ones described in these columns, I have concluded that the type used at the Olds Motor Works is far more sensitive and accurate. These calipers indicate measurements within 0.001 of an inch, and



Assembled and Detailed Views of a Deep Hole Caliper for Testing Gas Engine Cylinders

they are used in our factory to test the size and alignment of the bore of gas-engine cylinders. As the variation allowed is but 0.001 it is essential that the calipers be well made to insure a long life and unimpaired accuracy. This, of course, makes the first cost considerable, but when the calipers are once finished they will last a lifetime.

These calipers consist principally of a body *A*, a fixed anvil *B*, and a movable anvil *C* which is connected with pointer *D*. The movement of this pointer along the graduated scale shown, indicates the variations in the cylinder diameters. To insure accuracy when the calipers are used by inexperienced hands, a guide *E* is used which fits the bore of the cylinder, as shown, and through which the outer end of the caliper passes. This guide so locates the calipers that the axes of the anvils intersect the axis of the cylinder and are at

right angles to it. Care is taken to have that part of the guide which enters the cylinder a very accurate fit. The ways into which the caliper body slide are carefully scraped to a perfect bearing.

The body of this caliper is a steel forging that is proportioned, of course, according to the size of the caliper. The anvil C is a sliding fit in a reamed hole in the cylindrical boss shown. The oposite anvil B is provided with a fine thread so that it may be adjusted when the calipers are being set to the size for which they were designed. A hexagon lock-nut holds this anvil securely in place after it is set in the desired position. Of course the caliper and guide are made for a specified size of hole.

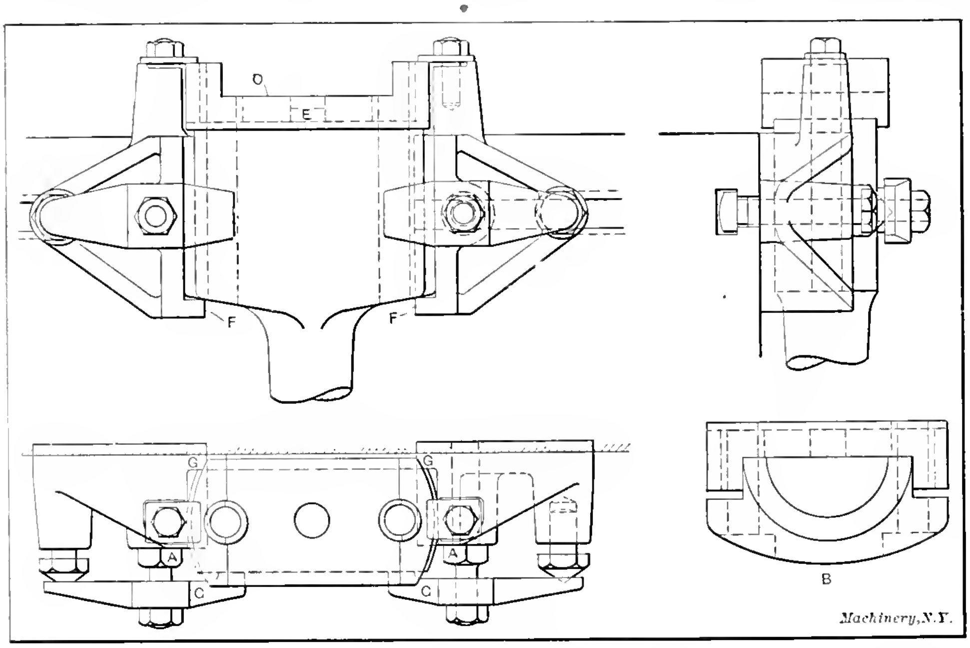
To determine the spacing of the graduation lines, an outside micrometer was set to the required dimension, and was made to bear heavily enough upon the movable anvil to bring the indicator hand to the center line. The threaded anvil was then screwed in or out until it came into proper contact with the anvil of the outside micrometer. It was then found that the point of the indicator hand had a movement of 1/50 inch, for a movement of 0.001 inch of the anvil. The caliper body was then securely fastened to an angle-plate and the graduation lines were put on with a height gage. The large hole at the upper end of the caliper body affords a hand hole that makes it more convenient to use the calipers.

This makes a very substantial tool, and it is giving perfect satisfaction in our inspection department. E. H. Pratt

Lansing, Mich.

DRILLING BOLT HOLES IN CONNECTING-ROD ENDS

A pair of special clamps for holding and aligning gas engine connecting-rods while the bolt holes are being drilled, and also the jig used for locating the drill are shown in the accompanying illustration. The end of the finished rod is held between the two clamps or special angle-plates. These clamps each have a rib or tongue on the back that fits a T-slot of the machine table. In this way they are set parallel to each other and in line with the drill spindle. By tightening the nuts A, these plates are fastened to the machine. The same bolts that hold the plates to the table are also used for tightening the clamps C. One end of these clamps rests on adjustable screws with conical casehardened heads, which may be set to different heights to correspond with work of different thicknesses. On the top of each angle-plate there is a boss in which is tapped a small stud that is used in conjunction with the clamps shown to hold the drill jig D. This jig is used for drilling the outer half of the bearing brass, as well as the connecting-rod bolt holes. A channel is planed in one side of the jig, so that it is a snug fit over the end of the rod, while on the other side it is planed out at right angles to the first side as shown. The projections thus formed on either end, fit over the bearing brass as shown at B. The jig is further located for drilling the bolt holes in the rod end, by a central hole which fits the projection E on the rod.

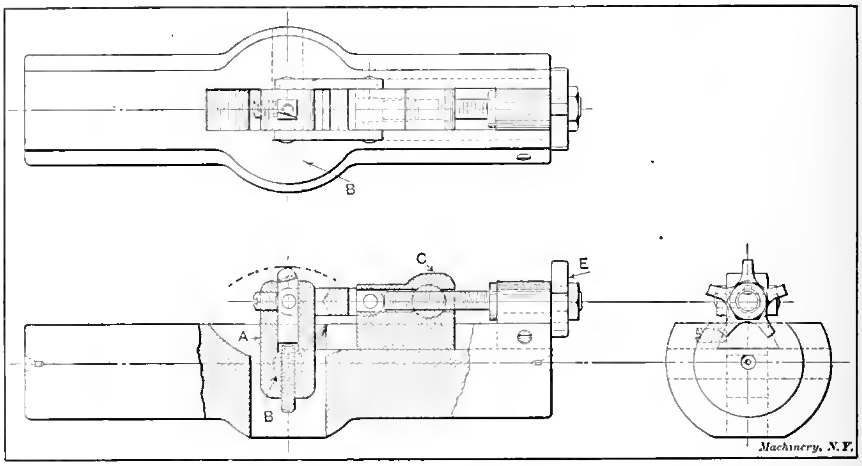


Special Clamps and Jig for Drilling Connecting-rod Ends

After the connecting-rod is turned and planed, and is ready to be drilled, it is placed between the two plates which are movable sideways. The work rests on the lugs F and the plates are fastened, as before stated, by tightening nuts A. The rod is then clamped against the faces G. The drill jig is then placed on the end of the rod and lightly clamped against it. The drilling is then done by the usual method. When drilling the holes in the outer half of the crankpin brass, with the jig in the position shown at B, the tool steel bushings not only locate the drill properly, but take the side thrust while the drill is cutting on one side only, through part of the hole.

P. A.

SPHERICAL BORING ATTACHMENT



Compact Design of Spherical Boring Attachment for the Lathe

The design of spherical boring attachment illustrated herewith, is in use in one of the largest automobile concerns in the country. This attachment is used on the lathe in connection with a fixture that is fastened to the carriage for holding the work. It is held between the lathe centers and is driven by a dog. The boring tool is clamped in a tool-holder A that is attached to a pin B, which is free to turn in the bar. The upper end of the tool-holder is connected with a slide C by two links. Through this slide the feed-screw of the tool passes. As the bar revolves, the star-wheel E is actuated by a dog which is clamped to the tailstock spindle, thus giving the tool a circular movement about the axis of the pin B, as indicated by the dotted line. This movement combined with the regular rotary movement of the tool produces the spherical surface. G. R. Richards

Brooklyn, N. Y.

* * *

TO GET THE FOURTH DIMENSION OF SPACE

Take a hecatonicocehedridgon and multiply by four,
A sexicocehedrigon plus half as many more;
Put in some polyhedrigons where gaps suggest a minus
And you will have a polyhedral-perpendodicahedrinus.

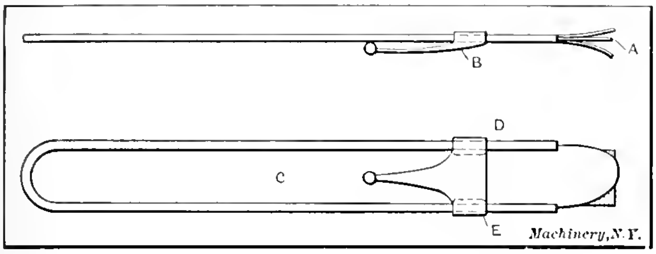
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

TO PREVENT LOSS OF POCKET SCALE AND CASE

Nearly every man in the machine shop carries a six-inch steel scale, and often loses it because it so easily slips from his pocket. The device shown in the accompanying sketch has overcome this difficulty for the writer, and it is so simple and easily made that others may provide themselves with it

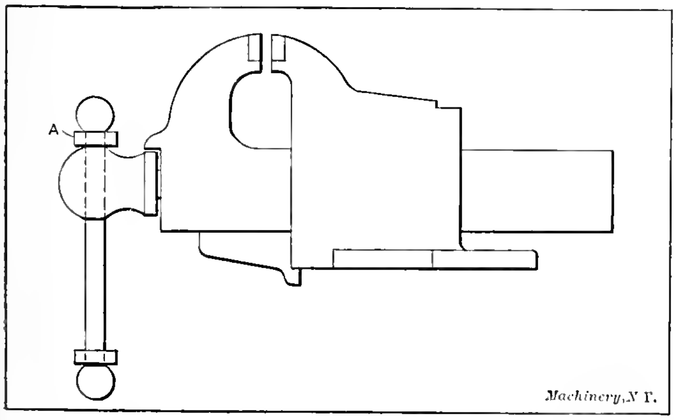


with very little trouble or expense. *A* is a 6-inch steel scale; *C* is a leather case which was purchased with the scale; *B* is a fountain pen "clip" which has been bent to fit the case and fastened in place with a little solder at *D* and *E*.

The clip should be so placed that it may grip the upper edge of the vest pocket, before the lower end of the case reaches the bottom of the pocket. W. H. K.

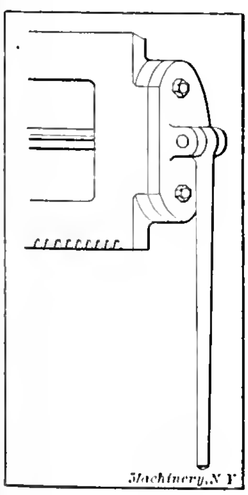
HAND PROTECTOR FOR VISE HANDLE

An excellent device for protecting the hand from a falling vise handle consists of a rubber ring *A* with a section about



⅜ inch thick by ½ inch wide, and having a hole a little larger than the handle. This ring can be stretched into place and when the handle drops it will not catch the skin and pinch it black and blue. A. G. Johnson

Two Harbors, Minn.



HANDLE FOR RADIAL DRILL ARM

Any one working on a large radial drill knows how difficult it is to move radially the arm when the head is raised. We have overcome this difficulty to a large extent by bolting a cast bracket to the end of the arm, to which is attached a handle as shown in the accompanying illustration. This handle, which is 24 inches long, is closely fitted to the bracket so that there is sufficient friction between it and the lugs to hold it in any position.

W. F. Oliver

Plainfield, N. J.

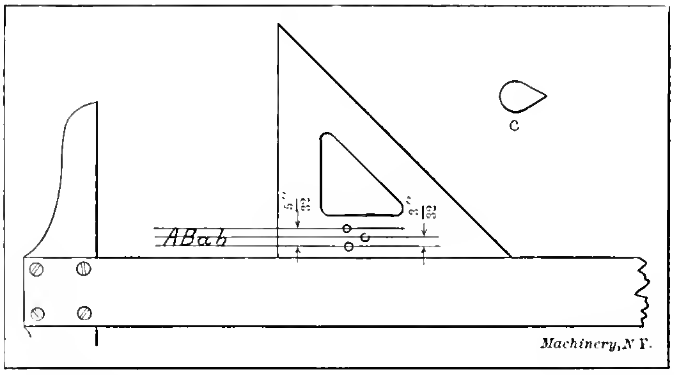
METHOD OF TESTING CANS FOR LEAKS

When searching for a leak in an automobile or bicycle tire, it is wet or placed in water so that the bubbles caused by the air will indicate the leaks. This same method is used by manufacturers of tin cans to find out if they leak before filling; but instead of putting an air pressure in the cans they are placed in a sort of conveyor, which after automatically putting a rubber cover on them, immerses them in hot water. The heated air in the cans expands, which causes bubbles to follow those which have leaks as they are carried along under the water; the defective cans are then picked out by an operator. Herman Jonson

New York City.

DRAWING GUIDE LINES FOR LETTERS

As many firms require a uniform height for the letters on drawings, the following scheme may be appreciated by those who draw guide lines for lettering in the usual way: Drill two or more 1/16-inch holes in a triangle, one above the other a distance equal to the height of the letters desired, as shown in the illustration. In this case the small letters are 3/32-inch high, and the capitals 5/32 inch. These holes are used

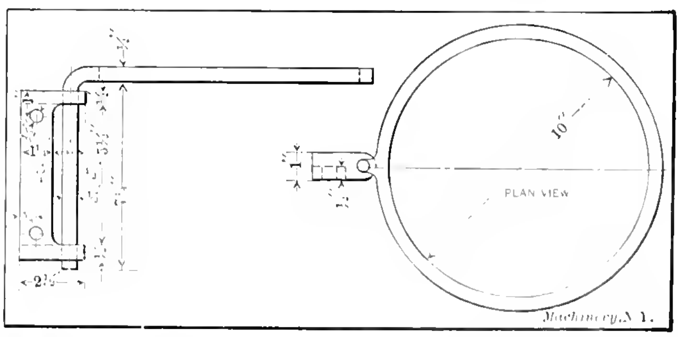


as a guide for the pencil, while sliding the triangle along the edge of the T-square. C. R.

[With round holes there will doubtless be some difficulty in drawing all lines to the same height, as the pencil point will not always be located in the same place. By making one side of the hole V-shaped, as shown enlarged at *C*, the pencil will be centered in the bottom of the V as the triangle is moved along.—Editor.]

BRACKET FOR WASH BUCKET

Many factories are without a wash room, the washing being done in buckets which are filled by a boy and set around the room in the most convenient place. By this method much water is spilled on the floor and spattered on the work. A good bracket for wash buckets is made as follows: Take a flat piece of machine steel of the dimensions shown in the accompanying sketch, and bend it at right angles at each end;



then drill one-half inch holes through the lugs thus formed. With a piece of one-half inch round iron, form a hoop to fit around the bucket, and also make a right-angle bend to fit the holes previously drilled through the lugs in the bracket. The holder is then ready to fasten to the bench, under which the bucket is swung out of the way when not in use.

E. H. Pratt

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

FORMULA FOR AREA OF LOCOMOTIVE EXHAUST NOZZLES

J. W. H.—Will you give me the formula for finding the size of the exhaust nozzles for coal-burning and wood-burning locomotives?

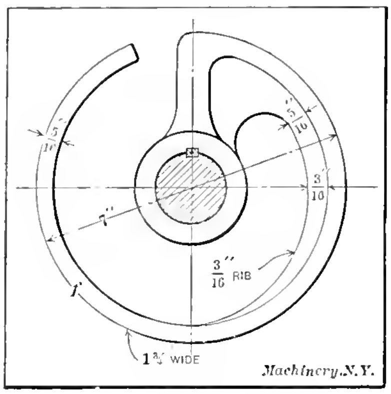
A.—The formula used by Mr. C. J. Mellin, consulting engineer of the American Locomotive Co., Schenectady, N. Y., for coal-burning locomotives is:

$$d = 0.156\sqrt{\frac{S \times R}{S + 0.3\,R}}$$

in which d = diameter of the exhaust nozzle, R = area through tubes, S = grate area. All dimensions are in inches. For wood-burning locomotives, the coefficient 0.156 is changed to 0.140. The practice varies with different railway companies, however.

DESIGN OF EXPANSION BRAKE RING

J. D. R.—The expansion brake ring shown in the sketch is closed in 3/8 inch measured on the periphery, and turned to 7 inches diameter and placed in a case bored to fit. What is the radial pressure against the case when the ring is made of Parsons cast manganese bronze? The situation is similar to that of a piston ring in a cylinder except that one end of the ring is fixed on a central shaft instead of its having both ends floating as in the case of the piston ring.



A.—The question is submitted to our readers. It may be assumed that cast manganese bronze has a modulus of elasticity of 14,000,000. A treatment of concentric and eccentric piston rings can be found in Unwin's "Machine Design," Part II.

INVENTOR OF THE SENSITIVE DRILL

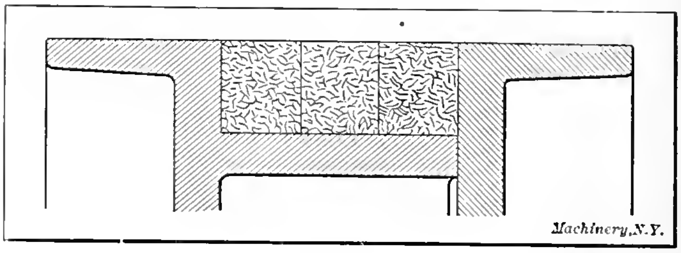
A. L. D.—Who invented the so-called "sensitive" drill, that is, the type in which the drill spindle is driven directly by a thin, narrow belt, and fed to the work by a directly connected hand lever?

A.—The invention of the sensitive drill, which was primarily made to prevent heavy breakage of small drills, is commonly credited to Dwight Slate, one time head of the well-known Dwight Slate Machine Tool Co., Hartford, Conn., who died in 1906. See MACHINERY, July and September, 1906. Mr. Slate's claim to the invention was not supported by the facts, however, and he failed to obtain a patent. In a letter by Mr. Frank H. Pierce, published in the *Hartford Courant*, August 11, 1906, shortly after Mr. Slate's death the following statement was made: "During the term of the late Hon. Ezra Clark as president of the National Screw Co., Mr. Slate was engaged as draftsman and he found there the sensitive drill set up and running as it had been for a long time before he went to work for the screw company. This drill was invented by Elijah S. Pierce, general superintendent of the National Screw Company, who also made the drawings for it and had it built and run under his personal supervision. Mr. Slate was quick to see the excellent mechanical points of the drill, and when he started a shop of his own the commercial value of it appealed to him. He began manufacturing the drill and sold a great many. He tried to get it patented but was unsuccessful."

PACKING FOR VACUUM PISTONS

E. A.—We have a vacuum pump of the vertical type that is equipped with water-packed pistons, and we have had considerable trouble keeping the vacuum pistons in good working condition. Will bronze rings work all right on a brass liner, and be an improvement on a solid piston?

A.—We would advise you to discard the water-packed pistons and replace them with ones having square fibrous packing. A packing of this kind which has been used for many years by a firm which manufactures a high grade of vacuum pumps, may be obtained from the Revere Rubber Co., 59 Reade Street, New York. The pistons should have a single groove, as shown in the engraving, that is wide enough for three of the fibrous rings. For pistons larger than eight or ten inches in diameter, a cast iron eccentric spring-ring should be inserted beneath the fibrous rings, to set them out against the cylinder wall. This spring-ring, while not absolutely necessary, should, preferably, be employed in connection with comparatively large pistons when a high vacuum has to be maintained. The groove in which the fibrous rings are placed should be somewhat wider than three times the width of the packing, as the latter is expanded considerably by the moisture which it absorbs. For the same reason the depth of the groove, when the spring-ring is not used, should be slightly in excess of the thickness of the packing. These fibrous rings should also be cut a little less in length than the piston circumference to allow for elongation. When the rings are finally inserted, the joints should, of course, be separated to prevent leakage. The amount of expansion may be determined by soaking the rings in water until they are completely saturated. If the packing swells to such an extent as to cause the piston to stick, the trouble may be overcome by removing one or more of the thin strips or layers which form the packing, from the side of one of the rings. For pistons in the neighborhood of ten inches in diameter, the size of the packing should be about 1/2 inch square. For larger pistons up to 18 or 20 inches, the packing should be from 3/4 to 1 inch square. This fibrous packing will be found more satisfactory for a vacuum pump than metallic rings, though babbitt rings, which are also set out by a cast-iron spring-ring, have been used with considerable success.



* * *

PROCESS FOR COATING STEEL WITH COPPER

Copper-coated steel has been on the market for several years and is much used where strength is required with ability to resist corrosion and erosion, as in the case of steam turbine blades. A process has recently been made public for coating steel with copper that is of interest. A steel billet that has been given a preliminary treatment is immersed in a bath of copper at a temperature so high that the surface of the billet is partially dissolved; the steel unites with the copper and forms a steel-copper alloy coating on the billet that firmly adheres when withdrawn from the bath. The billet is next placed in a mold, great care being exercised to prevent the destruction of the alloy film by oxidation, and a final coating of pure copper, which readily welds to the previously alloyed surface, is cast around it. In this way the two metals are so firmly united as to withstand sudden temperature changes, drawing, cutting and mechanical manipulation generally. When drawn through dies the reduction of cross-section areas of copper and steel is almost exactly proportional to their original areas in the billet.

* * *

A large German electrical concern uses its erecting shop for advertising purposes in a very effective way. On each large casting is painted in white letters the name of the customer of the machine for which the casting is intended, together with the size and capacity of the complete machine. Visitors and prospective customers are taken freely through the shops so as to be duly impressed in favor of the firm, as they find that their friends or competitors have already placed orders.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

MILLED SCREW AND MACHINE CO.'S UNIVERSAL THREAD MILLING MACHINE

The machine illustrated in Figs. 1 to 4 inclusive, is a universal thread milling machine, made by the Milled Screw & Machine Co., of Sayre, Pa. The points of interest in the design relate particularly to the simplicity of the mechanism, the avoidance of delicate or rapidly revolving members, and the support and driving of the work in a way which insures freedom from all avoidable strains arising from cutting or driving.

The machine consists essentially, as will be seen in Figs. 1 and 2, of a bed of the lathe type, carrying at one end a headstock mechanism by which the lead-screw is fed forward and rotated; and at the other a spindle-driving mechanism by means of which the cutter is driven, while set in any angular position required by the thread being cut. It will be seen that the work and the lead-screw are mounted on the same axis, so that the strains are taken in a straight line, with no possibility of bending or overhang. The lead-screw is of unusually large diameter to resist torsional stresses, and is mounted over the center of the bed. The blank to be threaded is gripped in a chuck connected directly with the end of the lead-screw. The screw at this end is carried by a sliding carriage, which gives it the necessary support. The blank is gripped from the outside and no centers are used or required.

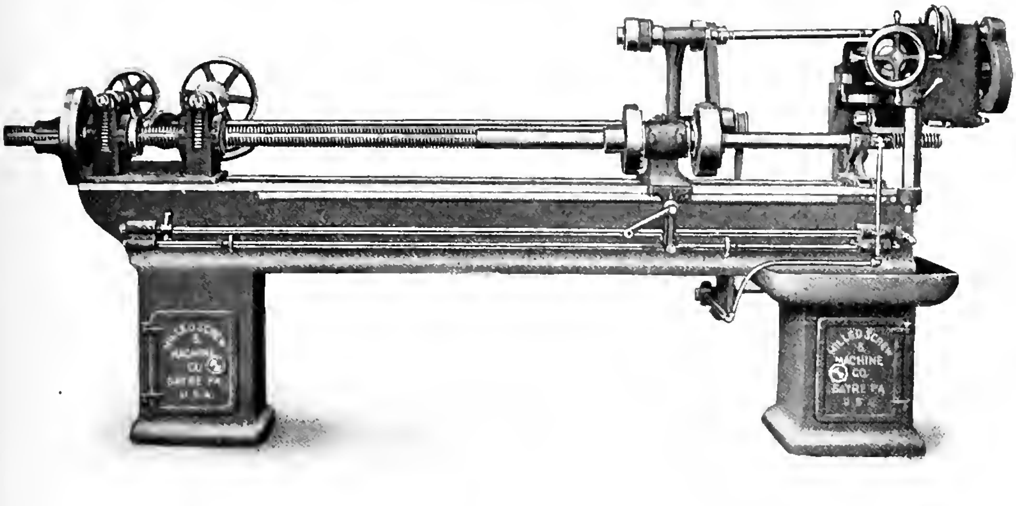


Fig. 1. Universal Thread Milling Machine, of Direct and Simple Design

The Cutter Head

Details of the cutter end of the machine are shown in Fig. 3. Power is received from the countershaft on the grooved pulley *A* at the top of the head. This is connected by suitable gearing with the cutter spindle, the whole being mounted on a swiveling bracket provided with graduations as shown at *B*, which permit it to be set to the calculated helix angle. The cutter head is supported at both the front and the back of the bed. The work is held directly beneath the cutter by a bushing in rest *C*, which is cut away at the top to allow access to the work. The adjustment for depth of cut is made by handwheel *D*, which is provided with a large diameter dial reading to thousandths of an inch.

The feed and revolving motion for the screw to be cut is obtained from driving pulley *A* through shaft *E*, with which it is connected by universal joints. The joint at the right is placed directly over the axis of angular adjustment of the cutter head, so as to make a minimum of change in the end position of the shafts. The bracket *F* supports a countershaft arrangement which, by means of the two sets of cone pulleys shown, gives nine rates of feed to the work for each cutter speed. From here the motion is conducted through shaft *G* to the feeding head at the rear of the machine, which is more clearly shown at Fig. 4.

The Lead-screw Controlling Mechanism

The lead-screw *H* of the machine is solid, of large diameter and carefully made. It passes through the hub of worm-wheel *J*, to which it is keyed and from which it receives its rotary motion. It is free, however, to slide through it axially. Worm-wheel *K* has mounted on its outer hub a disk *L*, which carries jaws *M*, bored to form a nut for engaging the thread of lead-screw *H*. By a construction very similar to that of the ordinary two-jawed chuck, these half nuts *M* may be closed down on the lead-screw or withdrawn from it, permitting the screw and the work connected with it to be freely moved in an axial direction. Worm-wheels *K* and *J* are driven from shaft *G* through worm-gearing at *N*. The worms driving *J* and *K* are connected by change gears *O* and *P* and idler *Q* as shown.

Setting the Change Gears for Various Pitches

The relation between the rotating and threading movements in the head shown in Fig. 4 will best be understood by first considering the simplest case—that of cutting a screw of the same pitch and hand as the lead-screw. For this case idler *Q* will be thrown out of engagement, so that worm-wheel *K* and half nuts *M* remain stationary. Under these conditions, as lead-screw *H* and the worm connected with it is rotated by worm-wheel *J*, it will advance through the stationary nuts *M* in the exact proportion to its lead, giving the same pitch to the work. To cut a finer pitch of the same hand as the lead-screw (which is left-hand as shown in the engraving), the disk *L* with the half nuts would be so connected with *J* through change gears *P* and *O* that it would revolve in the same direction as the lead-screw but at a somewhat slower feed. For left-hand pitches coarser than the lead-screw, the nut *M* is evidently revolved in the opposite

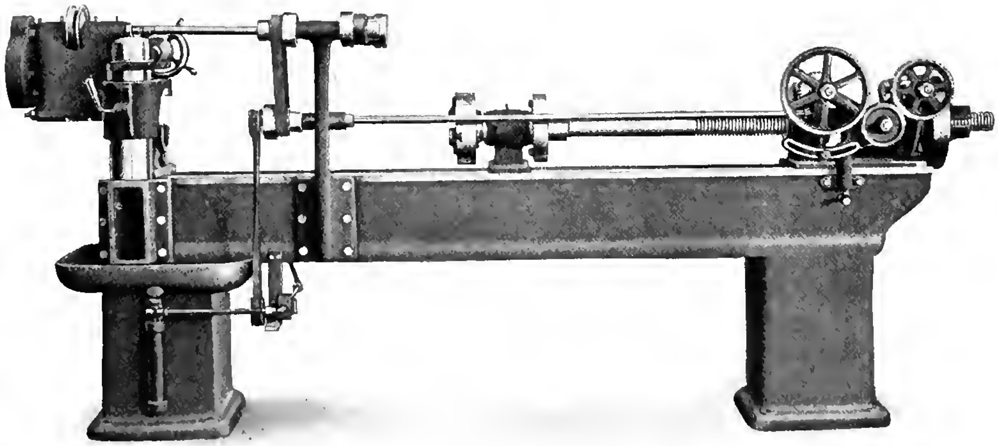


Fig. 2. Rear View of Thread Milling Machine, showing Feed Connections

direction to the lead-screw so as to give it a more rapid travel, and consequently produce a coarser pitch.

For cutting right-hand threads the work and lead-screw will evidently revolve in the opposite direction from that required for left-hand threads, if it is to feed in the regular way from left to right in Figs. 1, 3 and 4. If nuts *M* were stationary and the lead-screw were revolving in this direction, it would evidently feed to the left. In order to make it feed to the right, we must revolve nuts *M* in the same direction as the lead-screw, but at a faster rate. The faster the nut is revolved, the coarser will be the pitch.

The requirements may thus be summarized as follows: For right-hand pitches, gear *O* revolves faster than gear *P* and in the same direction. For left-hand pitches finer than that of the lead-screw, *O* revolves in the same direction as gear *P*, but at a slower rate. For left-hand threads of the same pitch as the lead-screw, gear *P* is stopped altogether. For left-hand threads of a coarser pitch than the lead-screw, gears *O* and *P* are connected so as to revolve in opposite directions. This would evidently require the introduction of another idler in addition to *Q*.

The Sliding Head and Provision for Multiple Threads

The forward end of the lead-screw is supported in sliding head *S*, where connection is made with the short spindle carrying the chuck *T*, through the medium of the flanged coupling *R*. The work is grasped by chuck *T* and supported in bushing *C* as has been previously mentioned. When nuts *M M* are released from the screw, head *S* may be rapidly adjusted to any point on the bed by means of the crank and rack and pinion movement shown. An automatic feed stop is also provided for limiting the length of thread cut. This operates a clutch which forms the connection between shaft *G* and the feed driving worm-wheel *N*, and is manually controlled by lever *U*.

The purpose of the coupling *R* is to permit the cutting of multiple threads. When the bolts in this coupling are loosened, the work may be revolved with respect to the lead-screw, making provision for double, triple, quadruple threads or worms, etc., as may be desired. The index is accurately

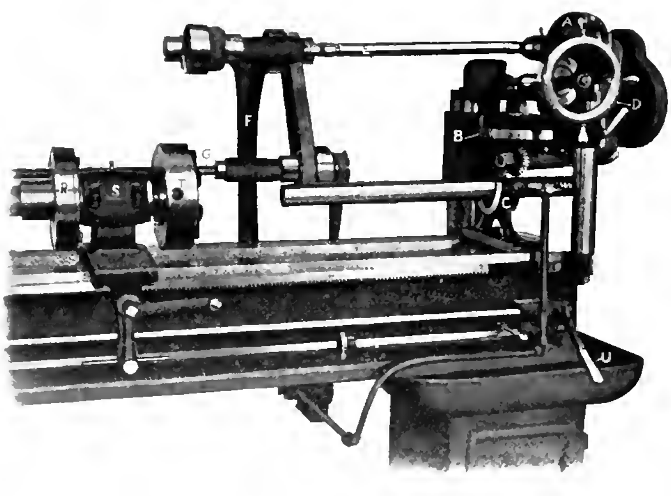


Fig. 3. The Cutter Drive and Work Support

made, and permits great accuracy in the division of the threads.

For any except complicated decimal pitches, the nuts *M* may be released and the head run back by the rack and pinion movement after the cutting of each thread of a multiple screw. In order to engage properly again, the same precautions would have to be taken as when running the carriage back by hand for threading in the lathe—namely, for odd pitches the lead-screw should be stopped and the carriage run back an exact number of inches; for even pitches, an exact number of inches or half inches, etc.

General Features of the Design

The simplicity and directness of action of this machine is one of its chief characteristics. Its simplicity enables it to be sold at a moderate price, makes it easy of operation, and reduces expense for maintenance and repair. In the matter of directness the salient point is the provision of a lead-screw of large and stiff proportions, directly over the center of the bed, with the blank to be threaded gripped in a chuck directly at the end of the lead-screw. The work is supported of the bed, with the blank to be threaded gripped in a chuck lar bushing of the exact size of the blank. All the threaded portion is therefore free from strain after passing the cutter. This arrangement avoids any bending of the blank due to the side pressure of the tool or cutter, and obviates the buckling due to the heating of the blank that would be met if it were held between rigid centers.

The simplicity of the mechanism for revolving and feeding the screw should also be noted. The double worm drive gives a smooth, direct and powerful motion to the screw, and to the work which is directly connected with it. This permits a full depth of thread to be machined at each operation with a

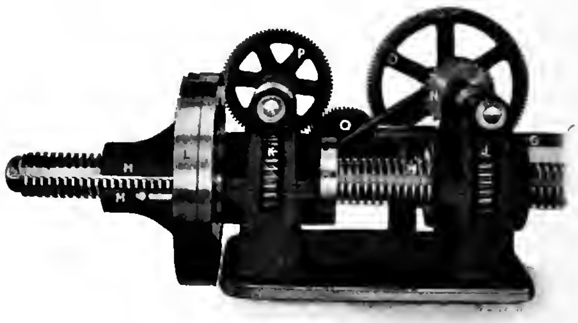


Fig. 4. The Lead-screw Revolving and Feed Mechanism

minimum of chatter. The reducing ratio of the worm drive varies from 60 to 1 on the large machine, up to 100 to 1 on the lightest size. This avoids the use of large and complicated gear trains, auxiliary shafts, movable carriage and bearings, and numerous small details, all subject to wear and strain.

This machine is built in three sizes, each having a capacity for work of maximum diameter of 6 inches, and ranging from 2 to 21 feet in length. The machine will be furnished with motor drive if required. The safety of the belt drive should be noted, however, as the failure of any or all the belts will not damage either the machine or the work under any condition.

An extra attachment will be provided if required for cutting keyways. A variation of the style of machine here illustrated provides for a vertical spindle, using a formed end mill in accordance with the method pursued in cutting the worms for some makes of Sellers drive planers.

AVERBECK 17-INCH SHAPER

In the November, 1906, number of MACHINERY, in the department of New Machinery and Tools, we illustrated a 21-inch shaper made by the H. J. Averbeck Shaper Co., of Covington, Ky. The novel features which were incorporated in the design of this shaper have recently been applied to a smaller machine of the 17-inch size, which we herewith illustrate and describe.

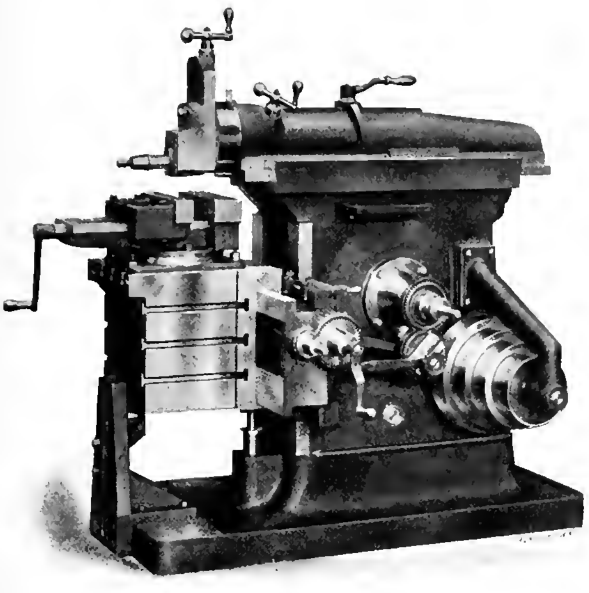
The design, of course, includes the features which have been found necessary for machine tools in the past few years in the matters of providing increased rigidity of the structural members (the column, ram, table, etc.) together with ample driving power for using high-speed steels to the limit of their capacity. The machine is back-geared. For direct connection the ratio between the gear and the ram is 5 to 1, and with the back-gears 18 to 1.

The cross-rail is of unusual construction. It is deeply ribbed and very heavy. The power cross-feed has the advantage of being provided with an automatic stop, controlled by two dogs, which may be set for use when cutting in either direction. Two stationary dogs are also provided which cut out the feed at the extreme travel of the table, avoiding any possibility of breakage at these points. The lever shown just above the gearing at the end of the rail, engages, disconnects or reverses the feed. The operation of the cross-feed screw by 2 to 1 gears provides for a slow or quick hand movement as

may be desired, as both shafts are squared for the wrench. The cross-feed screw has a graduated collar reading to 0.001 inch, and has 16 feed changes ranging from 0.008 to 0.125 inch per stroke.

The table is slotted on both top and sides. It is of such construction that, in combination with the form of rail used, bolts may be entered from the back as well as from the front. It has four T-slots on the top. These provisions facilitate the clamping of work. The vise has a graduated swivel base, and can be clamped on either side or the top of the table. When the table is removed, either the vise or the work itself can be clamped directly to the front of the apron, T-slots being provided at this point as well.

Attention should be called to the table support, which is bolted to the front of the base. The roller slide can be conveniently set to the vertical travel of the table in any position. It is evidently dirt proof, as contact with the roller is made on an inverted horizontal surface. This table support is always



Averbeck 17-inch Back-geared Shaper, with Automatic Cross Feed Stop

directly beneath the cutting tool, and so is adapted to take up the strains in the most effective way.

The down-feed screw of the tool block is provided with a double collar, one keyed to the screw and the other provided with a friction slip, and graduated to 0.001 inch. The provision of the keyed collar prevents any possible accidental change of the graduated collar from the position for which it is set. The head swivels to any angle and is graduated.

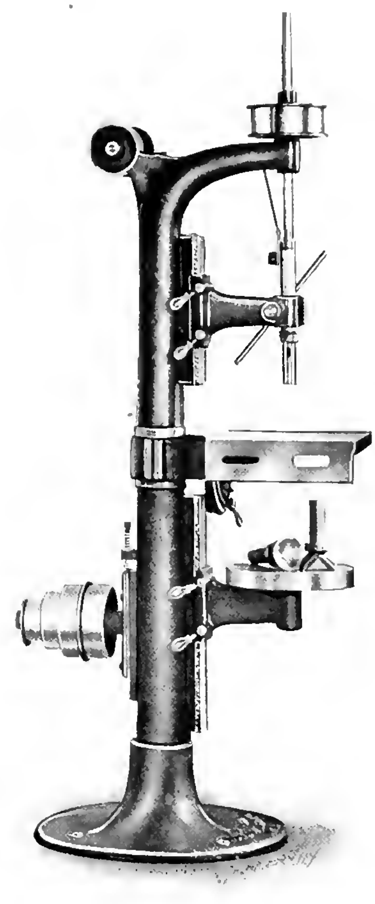
Great care has been taken in the general design and workmanship of this machine. All the shaft bearings in the column are well braced and of ample length, and are provided with suitable oil channels, fitted with dustproof plugs. All the T-slots are cut from the solid and (as may be seen from those shown on the apron in the engraving) are cut deeper than usual to prevent breaking out. All the bearings, such as those of the ram, rail, tool-block, crank-wheel slides, etc., are provided with taper gibs, so as to permit the maintenance of the accurate fit originally given these parts.

BARR NO. 7 TOOLMAKER'S DRILLING MACHINE

The No. 4 drilling machine made by H. G. Barr, 21 Hermon St., Worcester, Mass., was found so convenient for toolmakers that a heavier machine was demanded for this use. The resulting design is shown in the accompanying engraving, where it will be seen that a very stiff frame and drive has been provided, together with all the various attachments and adjustments needed in a machine which is to meet the varied requirements of the toolmaker's work.

This drill is provided with a sliding spindle head, a vertically adjustable round table, and a square table mounted on a swinging bracket. The square table can be tilted about a horizontal axis as well as swung about a vertical axis, so that it may be used for drilling holes at any angle. It is located in the horizontal position by a tapered dowel pin. One side of the table is provided with an extended bearing surface, with T-slot holes for clamping, adding greatly to its convenience in the holding of certain classes of work. It has a working surface of 13 by 14 inches. The round table is 12 inches in diameter, and can be removed from its supporting bracket to permit the use of the cup and V-centers provided. Binding handles are provided for locking the vertical adjustment, as well as for the various adjustments of the square table, and of the sliding spindle head.

The spindle is turned from a steel forging and is carefully ground to size and hand draw-polished. It is 1 inch in diameter, 35 inches long, and provided with a No. 2 Morse taper hole. The feed movement is 5½ inches, through a steel rack and pinion and a self-fastening feed lever, which does away with set- and thumb-screws. Ball bearing thrust collars are provided at the lower end of the quill and a fiber washer with a splined collar and spanner nut at the top. The cone and driving pulley on the rear of the machine is provided with a screw belt tightening adjustment as shown. All the pulleys are turned inside to give correct balance. All sliding surfaces are carefully scraped to their bearings and given a frosted finish. All the machines in this builder's line are tested to 0.00075 inch in 10 inches as the maximum allowable amount of error in lining up the spindle with the surface of the work-table.



Universal Sensitive Drill for Toolmaker's Use

The No. 7 size here shown weighs 515 pounds with the countershaft. It will handle any drill up to ¾ inch in diameter.

DUDGEON "UNIVERSAL" HYDRAULIC JACK

The hydraulic jack is so old and so simple a piece of mechanism that there would seem at first thought to be little chance for the display of ingenuity in improving its construction. The original inventor, however, Richard Dudgeon, Broome and Columbia Sts., New York City, has succeeded in developing a new construction which is of enough interest to warrant the description and illustration here given.

An example of one of the various styles of this new "universal" jack, as the maker calls it, is shown in Fig. 1. It is similar to older designs in its external appearance with the exception of the small valve handle in the head of the ram. This handle operates the lowering mechanism, and also controls a system of valves which, through the action of a double piston, gives two rates of pumping for the jack, permitting it to be used for the maximum load at regular speed, or for one-half the load at twice the speed. This double-pump arrangement is also useful, of course, in rapidly bringing the ram to any desired height before the load is applied. The functions controlled by this handle operate through an extremely simple construction, and this simplicity and directness of construction, in combination with the double pump

and the improved lowering connections, constitute the main points of interest in the new design.

The Universal System of Pistons and Valves

In describing the action, attention is first called to the diagram shown in Fig. 2, where is shown the pump as set for the rapid movement under one-half the normal load. The cistern or water supply is located at A, while the ram B is lifted by the water in cylinder C. The pump plunger is shown at D. This has two diameters, as shown, the full diameter working in chamber E, and the reduced diameter in the lower chamber F. The larger diameter is so proportioned to the smaller that it gives twice the area. The effective area of the pump plunger in chamber E, however, is the same as in chamber F, the area of the smaller diameter being subtracted from it.

Fig. 1. Dudgeon Double-pump Plain Hydraulic Jack

A continuous passage extends from cistern A to cylinder C. In this passage three valve seats are provided as shown, closed by valves G, H and J, which may be simply held upward in their seats by water pressure as shown, or by springs. With the usual construction, the lower valve J is the only one provided with a spring. By the operation of plunger K, as will be described later, one, two or three of these valves may be forced from their seats.

Fig. 2, as stated, shows the arrangement of the parts when the pump is working at its highest speed under one-half the normal load. As plunger D is pressed downward, the liquid is forced out of the chamber E, past the valves H and J into C; and out of chamber F, past valve J alone into C. When plunger D is raised, the pressure in C seats valve J firmly, while valves G and H drop from their seats, allowing a new supply from the cistern A to flow into chambers E and F. The repetition of the up and down strokes evidently forces the water from A into C, and raises the ram. It will be noted that under these conditions valve H is open on both up and down strokes, being thus inoperative when the jack is working as a double-plunger pump.

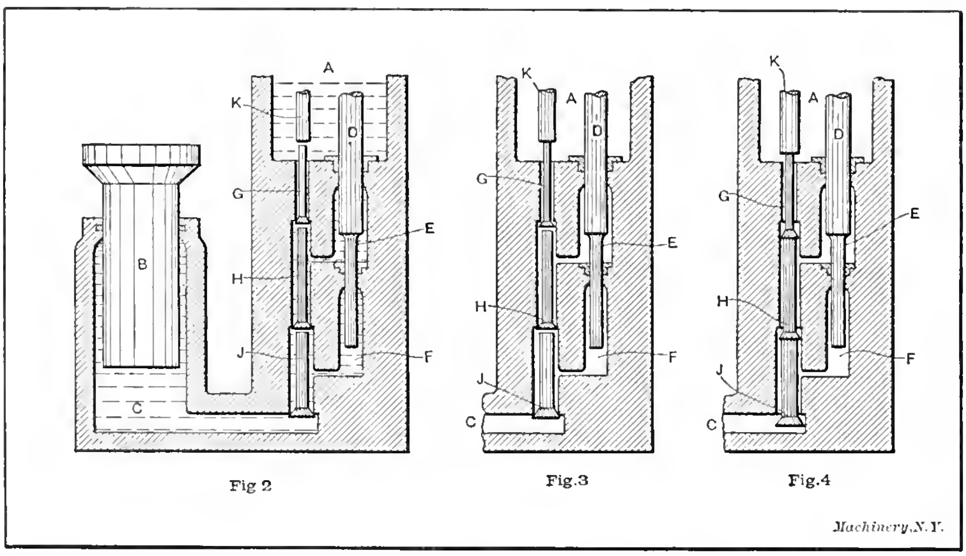
Fig. 3 shows the pin K pushed down far enough to hold valve G open permanently. Under these conditions it will be seen that when the ram is forced down, the water in chamber E is pushed back past valve G into the cistern again, instead of into the cylinder, while that in chamber F passes valve J into C as before. In this way, valve H is seated during the downward stroke and thus becomes operative. On the upward stroke, the pressure in C seats valve J as in the previous case, to close communication with the cylinder, while water is drawn into E and F through G and H, the latter of which drops from its seat to permit the flow. Under these conditions the continued up and down movement of the ram forces water from chamber F only into cylinder C, thus giving one-half the rate of movement of Fig. 2 and twice the available pressure. The higher pressure is due, of course, to the fact that the same pressure on the ram is applied to only the smaller area at the lower end in chamber F, instead of in both E and F as before. The water in chamber E, it will be seen, is merely churned in and out of cistern A without going to the cylinder.

For lowering the jack under the load, pin K is pressed still further downward as shown in Fig. 4 until it has unseated all three of valves G, H and J, permitting the liquid to flow directly back from C into A. The raising of K again far enough to permit the seating of valve J at once checks the lowering of the ram and holds the load at any desired position.

Application of the Principle to the Jack

The mechanism whose principles have thus been illustrated is practically applied to the jack in a way seen best in Fig. 5, where a vertical cross-section is shown. The cistern or reservoir is located in the head and barrel of the ram. The piston is operated as usual from a rockshaft and an outside lever, pivoted in the head. The chambers for the large and small diameters of the pistons are formed in a pump cylinder bored out in the lower end of the ram. In this ram is also formed the passage in which the three valves are mounted. The pressure valve, which is the last of these, is provided with a removable seat and a spring for holding it in the closed position.

Instead of using a pin K, as in Figs. 2, 3 and 4, for forcing down the valves for the various conditions of operation, a sleeve is used. This is forced down to the double stroke, single stroke, or lowering positions by the operation of the valve handle, which carries a cam on its inner end, operating on the upper edge of the sleeve. The latter is held up against this



Figs. 2, 3 and 4. Diagrams showing Double Pump and Valve Mechanism as set (Fig. 2) for High-speed Pumping using Both Pistons; (Fig. 3) for Slow Speed and Maximum Capacity, using Lower Piston only; (Fig. 4) with all Valves held open for Lowering the Load

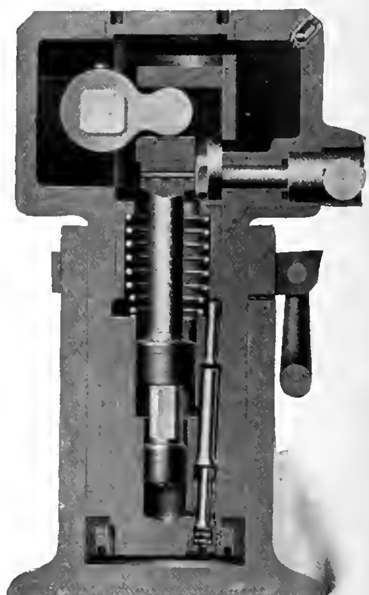


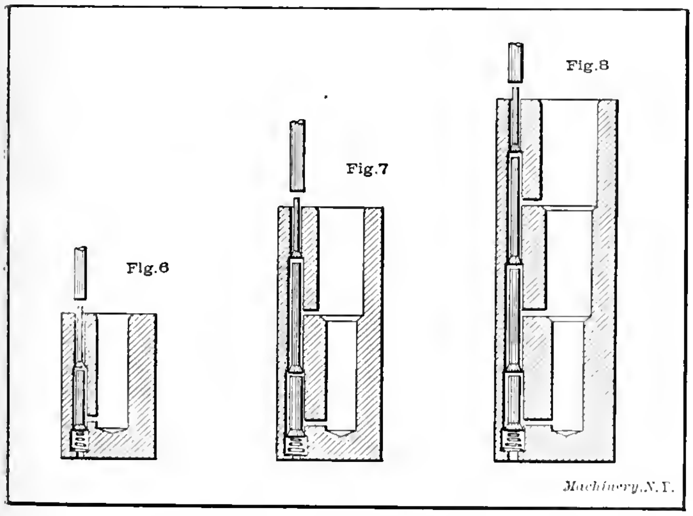
Fig. 5. Ram with Pump and Valve Mechanism operating on the Principle Illustrated in Figs. 2, 3 and 4

cam by a spring under its lower end, as shown. The lower edge of the sleeve bears on the top of the valve stem, which is thus operated in a manner identical with that shown in the diagrams. The sleeve may also be depressed for lowering by throwing the pump-lever to the extreme lower position. When this is done a pin on the crosshead strikes the top of the sleeve, opening all the valves and bringing about the conditions shown in Fig. 4. To permit the lever to take this extreme downward position, it is reversed in the socket as with the ordinary construction of jack, so that the lug is upward. This lug in the operating position stops the movement before the lowering position is reached. The exterior construction is plainly shown in Fig. 1.

The Adjustability of the Jack

The reason for having a sleeve instead of a rod, *K*, as shown in Fig. 2, for operating valves *G*, *H* and *J*, is to permit the head to be turned on the ram, or the cylinder to be turned in the same member, and still have the controlling mechanism for the valves operative. Whatever the positions of either, the cam on the valve handle and lowering pin *P* are always in line with the upper edge of the sleeve; and the stem of the valve is always in line with the lower edge. This is necessary, because the joint between the head and the ram is a threaded one, so that no assurance can be given that it will be re-assembled in exactly the position it had when originally put together.

The same thing applies, in other styles, to the cylinder ram. The ram in such cases is provided with a pin which may be entered in any one of four holes in the cylinder flange, which may thus be given four positions. This construction is of especial advantage when using the ram horizontally. As the tool is regularly assembled, the ram when used horizontally has the lever projecting straight up, while the three valves are on the lower side of the ram. This permits the use of sufficient water from the cistern to permit the use of the full stroke of the ram. In some places, however, it would be more convenient to have the pump lever project to one side or the other, or even (in special cases) vertically downward, in order to give room for easy manipulation. To meet



Figs. 6, 7 and 8. Diagrams showing the Application of the "Universal" Plunger and Valve Construction to Single-, Double- and Triple-action Pumps

these exigencies this provision of four positions has been made. To change the position it is only necessary to withdraw the ram from the pump, unscrew the pump retaining ring, and shift the position of the dowel pin in the flange of the cylinder. The ability to use the ram for the full stroke any side up in the horizontal position, is an important advantage of this new design.

It should be noted that the particular ram shown in Fig. 5 is designed for car inspectors' work and always used in a vertical position, so does not clearly show the nature of the adjustment when applied to jacks of other styles.

The Points of Improvement

The points of novelty in this universal jack may be summarized as follows: It provides a double-pumping mechanism giving two rates of lift, applicable to a general purpose hydraulic jack. When the load is light, the double pump will raise it with twice the rate of speed for a single pump. When the load is heavy, one-quarter turn of the handle will throw out the action of one pump, and will give the action of a single pump jack.

It provides for this double-pump action and the control of the lowering by the simplest valve construction imaginable. The valves are assembled in one chamber and only three are needed (two suction and one pressure valve) of which only two are ever in use at one time. Other double-pump jacks require at the least five valves, and three passages between the pressure chamber and the reservoir, and each closed by a separate valve, and the failure of any one of these valves or

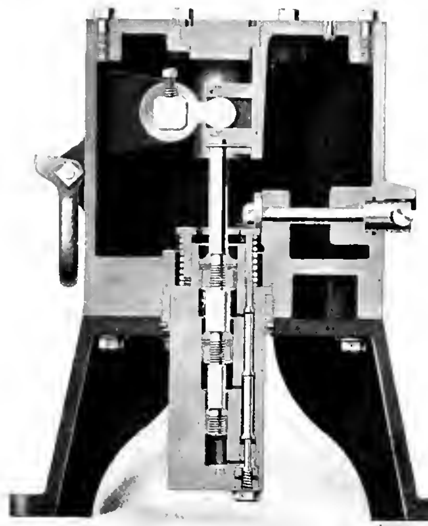


Fig. 9. Hand-operated Cistern Pressure Pump, embodying the Triple Plunger Principle shown in Fig. 8

of either cylinder packing renders the pump inoperative. It will be seen by referring to Figs. 2 to 5 inclusive, that two cylinder packings or three valves would have to be thrown out of commission before the load would be released with this type of jack. The advantage of the construction from the point of safety and the prevention of serious accidents is undeniable.

It can be lowered by either the lever or the valve handle. As the valves can be operated by the handle independently of the pumping mechanism, they may be opened and cleared of any obstruction which prevents their proper seating by the working of the pump. This often obviates the necessity for dismantling the mechanism.

Ease of dismantling the pumps, valves, etc., for this jack is another advantage of its construction. This will be best appreciated from Fig. 5. Access to all the valves is provided by the removal of but one bonnet. When the ram is removed from the cylinder, the unscrewing of this bonnet permits the three valves, and the removable seat, to drop from the passage in which they are confined. Furthermore, to remove the piston for the examination of the packings of the plungers, it is only necessary to unscrew the cap in the top of the ram, when it may be freely withdrawn.

The instant and absolute control of the lowering mechanism by the handle should also be included as one of the advantages of this jack. This control of the lowering is, in fact, one of the prime advantages that the hydraulic form possesses over the mechanical types of jacks. With the latter the lowering is hardly less laborious than the raising. No additional valves are required for this releasing movement. The position of the valve lever indicates at all times whether the lowering valve is open or closed.

The general design of this tool has been carefully looked out for, to preserve the qualities of lightness, portability, simplicity and reliability. It will stand rough usage, and not get out of order. It has the minimum number of parts. These are so assembled as to be easily replaceable when necessary. The whole device can be easily taken apart and put togther without special tools.

Triple-action Pumps built on the "Universal" Principle

That the new design of plunger and valve mechanism used in this jack is, as its name indicates, "universal" will be appreciated after a study of Figs. 6, 7 and 8. Fig. 6 shows the single plunger, single chamber and double valve arrangement. Here, evidently, the plunger is single-acting and the ram has but one rate of speed. The depression of the two valves under the action of the lowering pin would permit the release of the load. In Fig. 7 is shown diagrammatically the arrangement shown more elaborately in Figs. 3 and 4. Here we have two chambers, two rates of pumping speed, and provision for lowering.

In Fig. 8 the construction is carried still further, and provision is made, as shown, for three chambers and four valves arranged as before. With all the valves free to act, all three chambers would be forcing water into the cylinder. By depressing the uppermost valve, two chambers only would be in operation. By depressing still further the two upper valves, but one chamber would be in operation. And finally, by depressing all four valves, the load would be lowered. It would be possible, but perhaps not practicable, to carry this multiplicity of valves and pistons to any extent, giving three, four or any number of rates of pumping speed. Two, however, is sufficient for all the practical purposes for which a portable jack is used.

Fig. 9 illustrates a pressure pump for hydraulic work in which the triple piston arrangement shown diagrammatically in Fig. 8 has been used. There are thus, in this case, four working positions to the handle, giving three different rates of pumping, in addition to the lowering position. This cistern pump may be used for a great variety of purposes, such as for making tests, or on the operation of variable pressure hydraulic presses, etc. It may be connected to any piece of hydraulic apparatus by means of flexible copper tubing. It will be furnished to give any combination of pressure required—such as, for instance, 1,000 pounds to the square inch with three pumps in operation, 2,000 pounds with two pumps, and 6,000 pounds with one pump.

Other Hydraulic Machinery

A wide variety of other hydraulic apparatus has been designed by the makers of these jacks, incorporating the principles of the mechanism we have described. Horizontal jacks, jacks for bridge builders, car inspectors, etc., hand hydraulic pumps, power hydraulic pumps, jack cylinders for hydraulic presses, etc., are some of the various styles. In the last case, the ram is provided with a rack and pinion adjustment which permits the rapid bringing down of the platen against the material to be pressed, without requiring the tedious operation of the pump for this idle movement.

All these pieces of apparatus are composed of parts which are simple in themselves and which may be replaced when necessary at a low cost. The parts are interchangeable, being made by automatic machinery, and are easily dismembered without the use of special tools.

IMPROVED DESIGN OF BINSSE BORING MACHINE

The boring machine built by the Binsse Machine Co., Newark, N. J., is of the standard type in which the spindle is mounted in fixed bearings on a column or headstock, while the work is clamped to a table adjustable by both longitudinal and cross motions on a knee, which latter member is itself adjustable vertically by means of two connected elevating

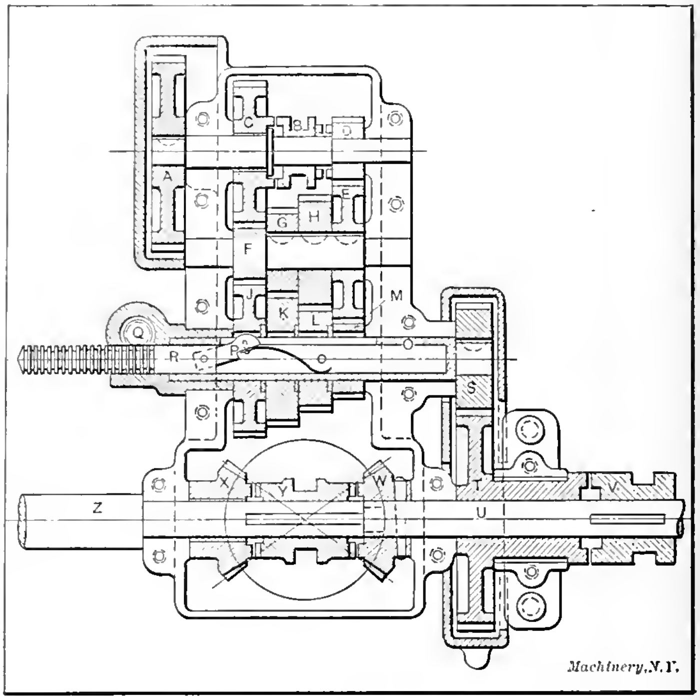


Fig. 2. Arrangement of Gears in Quick Feed Change Mechanism

screws. The type will be readily recognized from Fig. 1. The makers of this machine have recently made important improvements in the design, which should add to its convenience and productiveness.

One of these improvements consists simply in lengthening the arms of the pilot wheel at the extreme left of the machine, by which the boring-bar is advanced toward or withdrawn from the work. This improvement, simple as it would appear to be, is yet of great advantage, as it permits the workman to shift the bar without moving from his position of observation at the working end of the spindle. He is thus enabled to center the spindle to a punch mark, and do similar work accurately to dimensions, without the inconvenience of stepping back and forth between the pilot wheel and the working point.

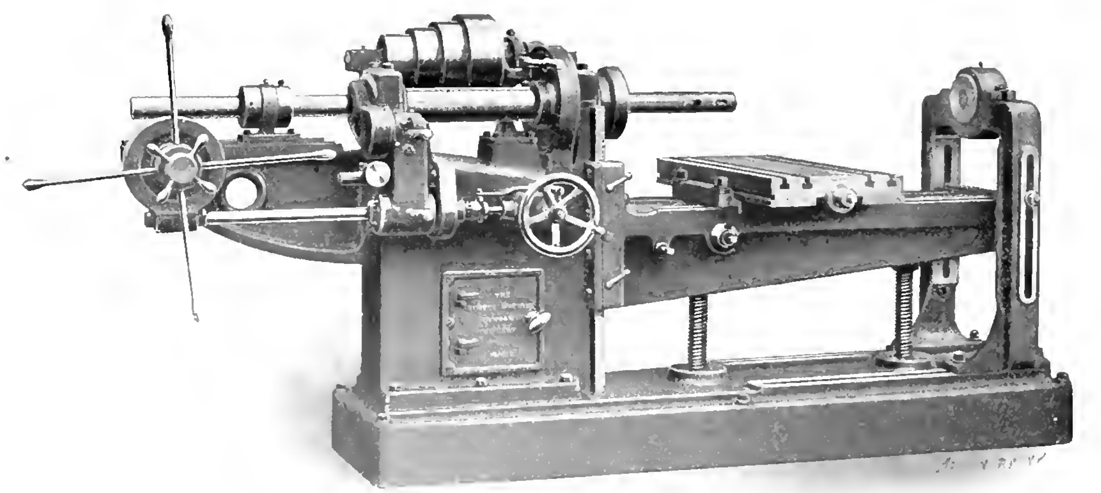


Fig. 1. Binsse Boring Machine with Improved Feed Gearing and Other Details

A second improvement relates to the means provided for clamping the work-table to the saddle and the saddle to the knee. This provision consists of four bolts, one passing through each corner of the saddle. The lower end of each is provided with heads fitting in T-slots on top of the knee, while the nut on the upper end tightens down on a clamp, which enters the gib slot in the edge of the work-table. When the nuts are screwed up, it will be seen that with this arrangement the table is clamped to the saddle and the saddle to the knee simultaneously, the strain being taken directly down from the table to the knee, giving the most rigid possible construction. This is similar in principle and effective-

ness to the method which has always been provided on this machine for clamping the outer end of the knee and outboard support together. This consists, as may be seen, simply of a through bolt laid on the top of the knee, and passing from side to side of the outboard support through slots formed to receive it. When the nut on the outer end of this bolt is tightened up, the sides of the support are drawn against the knee and the whole structure is clamped together. It will be noticed that square locked gibbed surfaces are used throughout the machine. This is the construction that gives the greatest rigidity and the best fitting sliding bearings.

A third and the most important improvement is the provision of a geared feed drive of the quick change variety. This change gear mechanism has been worked out in very attractive form. As may be seen in Fig. 1, it is compact and designed in harmony with the rest of the machine. It is also very easily manipulated. It provides for a reverse motion and for eight feeds, any one of which may be instantly obtained. These changes are effected by the operation of two levers and a knurled knob.

Fig. 2 shows details of the construction of this change gear device. Gear *A* is driven by intermediate gears from the spindle of the machine. On the shaft to which it is keyed is also keyed sliding clutch member *B*, which may be set to engage with clutch teeth in either of gears *C* and *D*. The clutch is operated by the upper of the two short levers shown on the feed box in Fig. 1. Gears *D* and *C* mesh respectively with gear *E*, and an integral pinion on the shaft *F* to which it is keyed. *F* may thus be given two speeds depending on whether *B* is engaged with *C* or *D*. *F* also carries two other gears *G* and *H*. *F*, *G*, *H* and *E* mesh respectively with gears *J*, *K*, *L* and *M*, which revolve loosely on the hollow shaft *O*. Either of these four gears may be connected with *O* by means of the diving key *P*, which may be moved from one to the other of its four positions by means of a pinion *Q*, meshing with circular rack teeth turned in the outer end of the plunger *R*, in which *P* is pivoted. *R* is operated by the knurled knob shown at the side of the feed box in Fig. 1, and thus controls four changes, which, in combination with the upper crank, give the eight for which the mechanism provides.

Gear *S*, keyed to shaft *O*, meshes with gear *T* running loosely on shaft *U*; the latter is connected by bevel gears with the handwheel at the right of the column. To connect or disconnect *T* with *U*, and thus start and stop the feed, clutch *V* is provided. Bevel gears *W* and *X* and clutch *Y* control the direction of the feed. Gear *W* is pinned, as shown, to shaft *U*, and *X* is connected with *W* by an idler bevel gear so that it revolves in the opposite direction. Clutch *Y* is keyed to shaft *Z*, which extends backward to drive the worm on the pilot wheel shaft. It will be noted that shafts *Z* and *U* are separate, the former having a pivot bearing in the latter at their junction.

It would be very difficult to effect the same number of changes, with a smaller number of gears than that used by the combination shown in Fig. 2. Ten gears only, as may be seen, are required for giving the eight changes of speed. All the mechanism is enclosed in a dust and grit proof casing, with ample provision for lubrication.

The means provided for clamping and centering the boring-bar in this machine is original and effective. A split and tapered bushing surrounds the bar in the nose of the spindle. A steel collar, threaded on the outside and tapered to fit on the inside, surrounds this bushing. When the collar is screwed into the spindle, its taper presses in on the bushing, forcing it together and tightly gripping and centering the bar.

This tool retains all the features which have become well known in the boring machine made by this firm. The base is of unusual depth and rigidity, as may be seen. This gives stiffness to the whole machine. The driving cone is mounted on a shaft, separate and to the rear of the spindle, and is provided with internal back-gears. The arrangement gives a drive particularly suited to heavy facing cuts and other hard service, and relieves the spindle of the belt pull.

The makers have found that it is possible with this type of boring machine to maintain a high degree of accuracy in the alignment of the spindle with the top of the table. The maximum error in parallelism between them allowed is 0.0005 inch per foot, and most of the machines turned out come considerably within this limit.

The machine illustrated in Fig. 1 is the No. 2B size. The boring bar of this machine is 2¾ inches in diameter and is made of high carbon steel with a No. 5 Morse taper hole. The direct gearing ratio between the cone and the spindle is 1 to 4½; and through the triple gearing, 1 to 18. The eight feeds range from 0.001 to 0.100 inch per revolution. The bar is held by friction at any point and can always be given the full length of feed at one setting.

PAWLING & HARNISCHFEGER HORIZONTAL DRILLING AND MILLING MACHINES

The firm of Pawling & Harnischfeger, of Milwaukee, Wis., has developed a line of horizontal boring and drilling machines comprising three different sizes and two different designs. Examples of each of the designs are illustrated herewith: Fig. 1 shows the largest or No. 7 size with the solid box casting column, while Fig. 2 shows the No. 5 machine with a column built up of cylindrical members. The feed and driving mechanism on the spindle saddle is similar for the two machines, although in Fig. 1 the motor is mounted on the saddle while in Fig. 2, it is placed on the top of the column. The two designs are also similar in that the column is bolted in place on the floor, while the work is mounted on a table which rolls on a track, thus giving the required longitudinal adjustment.

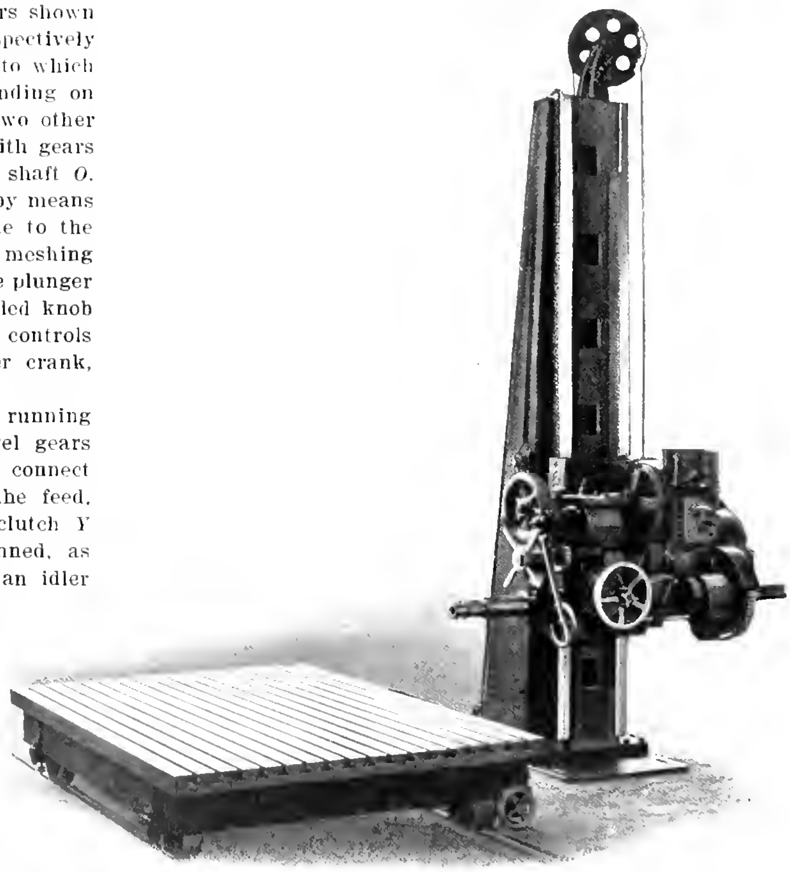


Fig. 1. No. 7 Horizontal Drilling and Milling Machine, with Box Type of Column

The No. 7 machine, shown in Fig. 1, will cover a working surface area of 65 square feet, for drilling and tapping holes up to 3 inches in diameter. The saddle has a vertical movement of 7 feet 8 inches on the column. The speed and feed control is arranged conveniently with relation to the operator's position. A positive clutch engages the motor pinion and is operated by a lever at the front of the saddle. This also controls the reverse as well. The feed is locked or unlocked and the spindle advanced or withdrawn by one hand-

wheel. The spindle is of high carbon forged steel with extended bearings which assure alignment at the extremes of travel. The end thrust is taken up by dust-proof ball bearing. The saddle is balanced by a counterweight inside the column.

The table has a length of 8 feet, and a width of 6 feet. It is adjusted by barring the capstan heads provided for the purpose on the axles. The table is fitted with improved roller bearings, large diameter axles and chilled wheels. A clamping brake on one axle, operated by the handwheel shown, provides for locking in position when desired. For boring with long bars, an adjustable outboard bearing is used, clamped to the table and lined with the work and the spindle.

The machine is easily adapted to portable use, as it may be unbolted from its base and swung by the crane into any desired position for operating on large castings. A three-horse-power motor is required for the No. 7 machine. Eight changes of spindle speed are furnished, ranging from 7 to 200 revolutions per minute. The spindle is 2 7/16 inches in diameter, has a No. 5 Morse taper hole and a feed of either 24 or 30 inches as may be ordered. Four feed changes are provided for each spindle speed. The weight of the machine itself is 8,300 pounds; the weight of the table is 9,250 pounds.

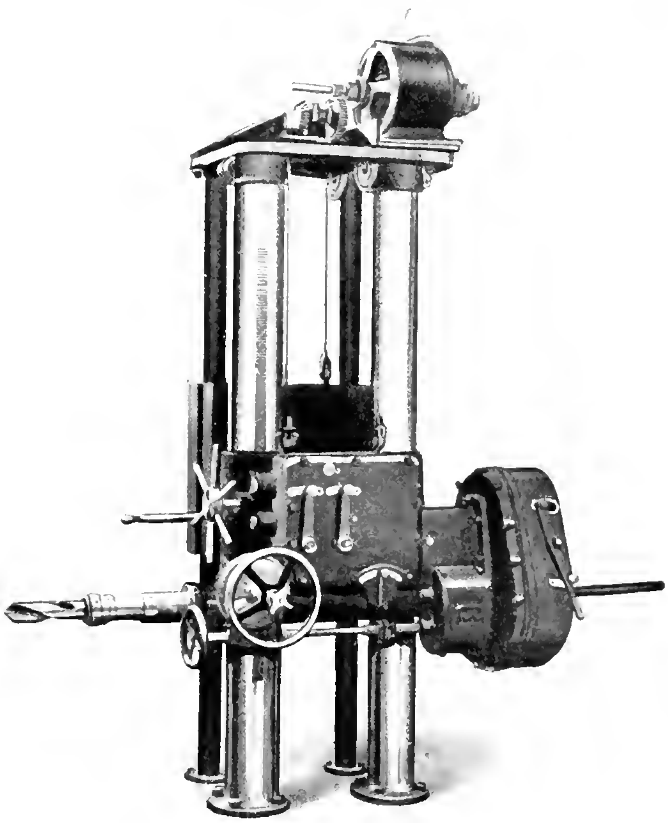


Fig. 2. No. 5 Machine, with Frame built up of Cylindrical Members

The No. 5 machine, shown in Fig. 2, has about the same capacity as the No. 7 machine so far as size of spindle and maximum diameter of drilling is concerned. The work-table, not shown in the engraving, is 8 feet long and the vertical adjustment of the spindle carriage is 5 feet, giving approximately 40 square feet of area available for a working surface. The columns of which the frame is formed are held in position by top and bottom plates, the latter of which is bolted to I-beams embedded in the floor. These are extended to support the two rails on which the work-table travels. The counterweight for the saddle is guided by two pipes that are also retained in the top and bottom plates, making the machine practically self-contained.

As in the previous case, the machine is driven by a three horse-power motor through mechanism which gives a similar range of speeds. The rotation is reversible for tapping and for back counterboring, by the operation of a lever within convenient reach of the operator.

The weight of machine, counterweight and table combined is 12,841 pounds. It will be noted that no overhead support or pit under the floor is required. The machine may be belt-driven, if desired, by the substitution of a driving pulley for the motor.

WESTMACOTT GAS FURNACES

The accompanying engravings show three new members of the line of furnaces made by the Westmacott Gas Furnace Co., of Providence, R. I. Fig. 1 shows an oven furnace which has been redesigned throughout. The burners have been improved in efficiency and the furnace has a new and more effective form of lining. The door is 12 inches wide and 6 high. The heating space is 18 inches long. It may be employed for hardening or case-hardening tools, die blocks or other pieces of carbon or machinery steel, and may be advantageously used as well for annealing metals of any kind.

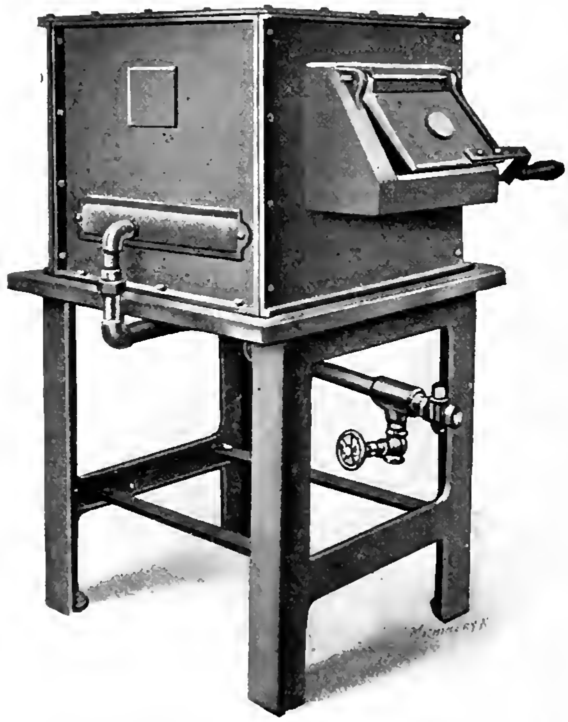


Fig. 1. Westmacott Oven Furnace for General Heating, Hardening, etc.

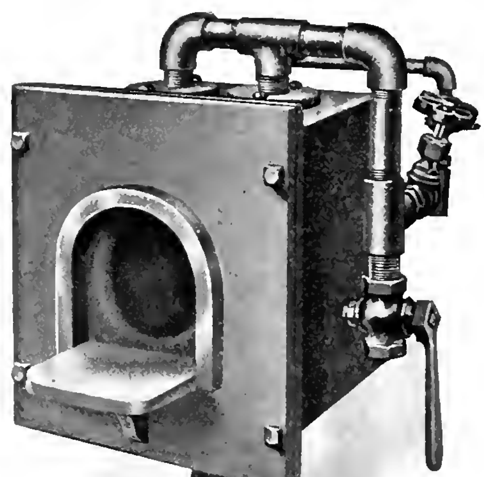


Fig. 2. A Bench Forge for Small Work

Fig. 2 shows a small forge of new construction. It is intended to be placed on a work-bench, where it occupies very little space. The heating space, front and back, has a diameter of 3 inches and a length of 6 inches. It is equipped with a pilot light, which may be left constantly burning at a negligible expense, making it unnecessary to relight the furnace every time it is used. This forge is adapted to hardening

small pieces, heating bars of stock and pipe, light forging, brazing, etc.

The brazing table shown in Fig. 3 is equipped with two blast blow pipes. These have a universal adjustment, allowing them to be placed in any position. This, in combination with the movable bricks, allows the flame to be directed and confined on the work in the most efficient manner. The variety of sizes of the bricks furnished is a convenience in "walling in" the work. The top of the slab stands up 30 inches from the floor. This table is adapted to a wide variety of operations, though intended primarily for brazing. It can be used for hardening or annealing small pieces, heating bars of stock and pipe for bending, and other light work of a similar nature.

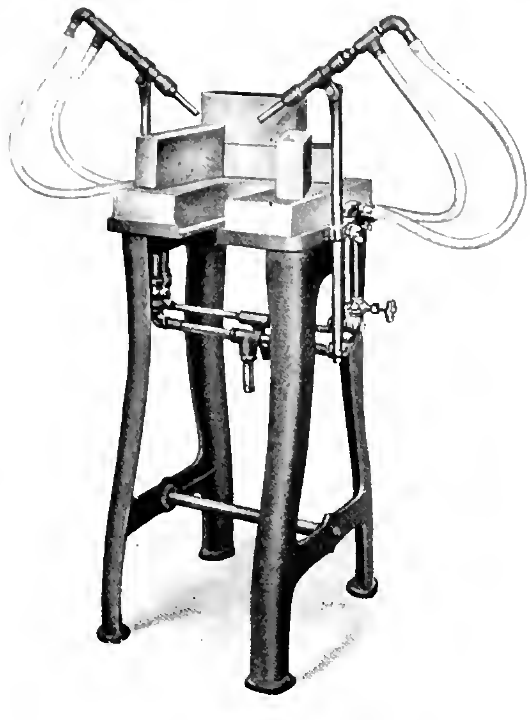


Fig. 3. Brazing Table with Adjustable Blow Pipes

SELLS ROLLER BEARING

The Sells roller bearing herewith illustrated and described is being sold by the Royersford Foundry & Machine Co., of Royersford, Pa. It is the design of Mr. John D. Sells, for many years identified with the "Standard" roller bearing, and is therefore the product of a long experience in this line of work. This bearing is universally adaptable, can be applied to any hanger or pillow-block of corresponding size either for new installations or for substituting in a plant previously equipped with the old style of plain or oil bearings; and it also possesses the advantage, as may be seen from the engraving, Fig. 2, of being applicable without requiring to be pushed on over the length of the shaft from one end to the other.

The construction will, perhaps, best be understood by reference to Fig. 2, which shows the successive operations of putting the bearing in place. First the split sleeve is put on the shaft. This is formed in two parts, with the split running diagonally, as shown, so that the rolls may pass over the joint without shock or irregularity of motion. Next this sleeve is clamped in place onto the shaft by two collars, see *B*, which are provided with counterbores fitting the edges of the sleeve so that they are thus themselves truly located. Next, as shown at *C*, the two halves of the split cage are placed around the sleeve between the collars. Then, as shown at *D*, the box itself is put over the whole and fastened. The application of the bearing will thus be seen to be as simple as the application of a split sleeve or wood pulley.

The bushing is of hardened steel, and absolutely protects the shaft from being cut or scored by the case-hardened steel rollers. Injury from this cause is of common occurrence in other designs. These bushings are so constructed as to vary in thickness, allowing the same size of bearing to be fitted to different diameters of shafts. Each roller cage structure is adapted to three such changes of bushings. This makes it unnecessary for the dealer to carry a large stock of these bearings, as odd-sized bushings will take care of the intermediate sizes.

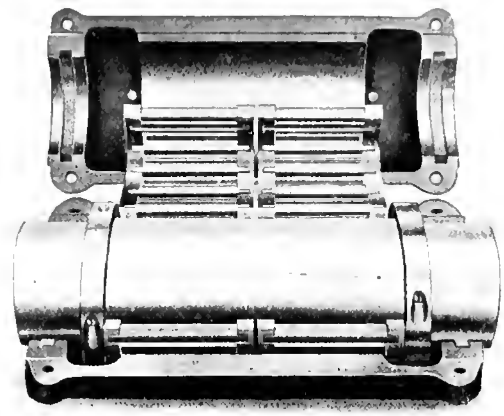


Fig. 1 The Selle Roller Bearing, of the Double Cage Type

The rolls, as plainly shown in Fig. 2, are contained within a roller structure or cage. This separates them from each other, and eliminates the friction caused by the rolls running in contact. It also holds them parallel to each other so that it is impossible for them to get cramped diagonally in the boxes.

This bearing, as may be seen, is of the full floating type, so that none of the customary trouble from end-thrust friction in roller bearings is met with. The two halves of the case are fitted together with milled joints to make them dust-proof, and to give further assurance in this matter a heavy felt wiper is used at each end of the box, which at the same time

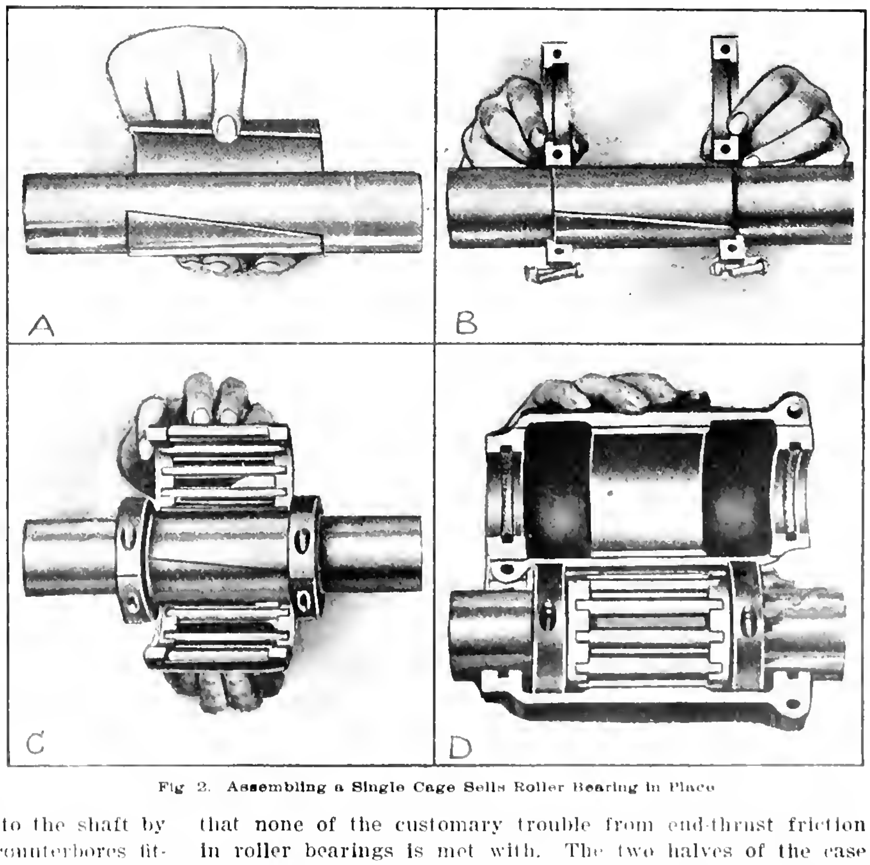


Fig. 2. Assembling a Single Cage Sells Roller Bearing in Place

prevents the loss of oil. Drain holes are also provided so that the case can be flushed with kerosene or other cleansing fluid when the oil gums. Holes are tapped in the top of the box to provide for oil cups. For head- or jack-shaft use, on shafts 3 11/16 inches in diameter or larger, this bearing is provided with a double roller structure as shown in Fig. 1. This gives a greater bearing area for heavily loaded shafts. All parts are made interchangeable. In case any part of the bearing becomes mislaid or broken by accident, it can be easily replaced, avoiding the expense of a new complete bearing.

For the present, at least, the manufacturers intend to sell this form of bearing for fifty per cent less than the price asked for any other similar device on the market.

FERRACUTE TOGGLE PRESS OF UNUSUAL SIZE

The "largest ever built" in the way of various forms of power presses have come along very rapidly in the past two or three years. We are beginning to get familiar with the application of these machines to larger and larger work, and the picture of a new press of unusual size does not, perhaps, excite the same interest that it would have a few years ago. The accompanying illustrations, however, show a double-action drawing press of such enormous size and capacity that the builder, the Ferracute Machine Co., of Bridgeton, N. J., has good reason to call attention to it. This press was built particularly for seamless burial caskets of the largest size, drawn from sheet steel 1/16 inch thick. It is equally well adapted, however, for forming other large drawn work, such as automobile bodies, bath tubs, metallic boats, etc.

The bed is a massive, internally ribbed and trussed casting weighing 18 tons. The width of the bed, right to left, be-

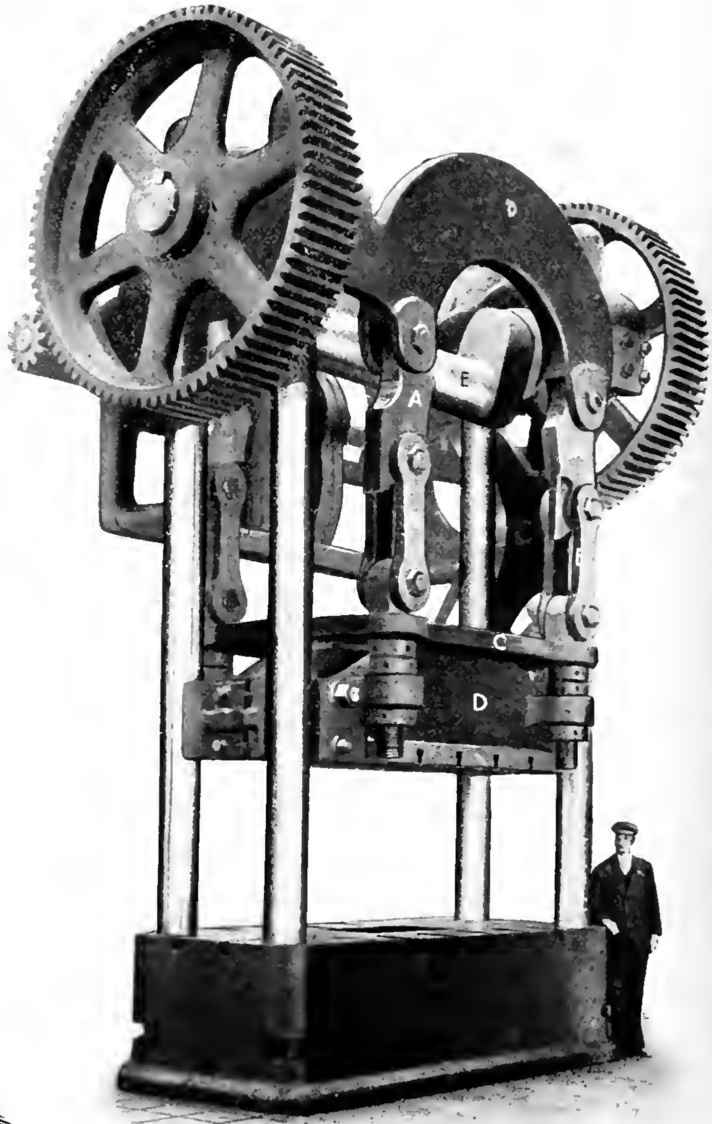


Fig. 2. The Press Partially Erected, showing Cam and Toggle Mechanism for Operating Blank Holder

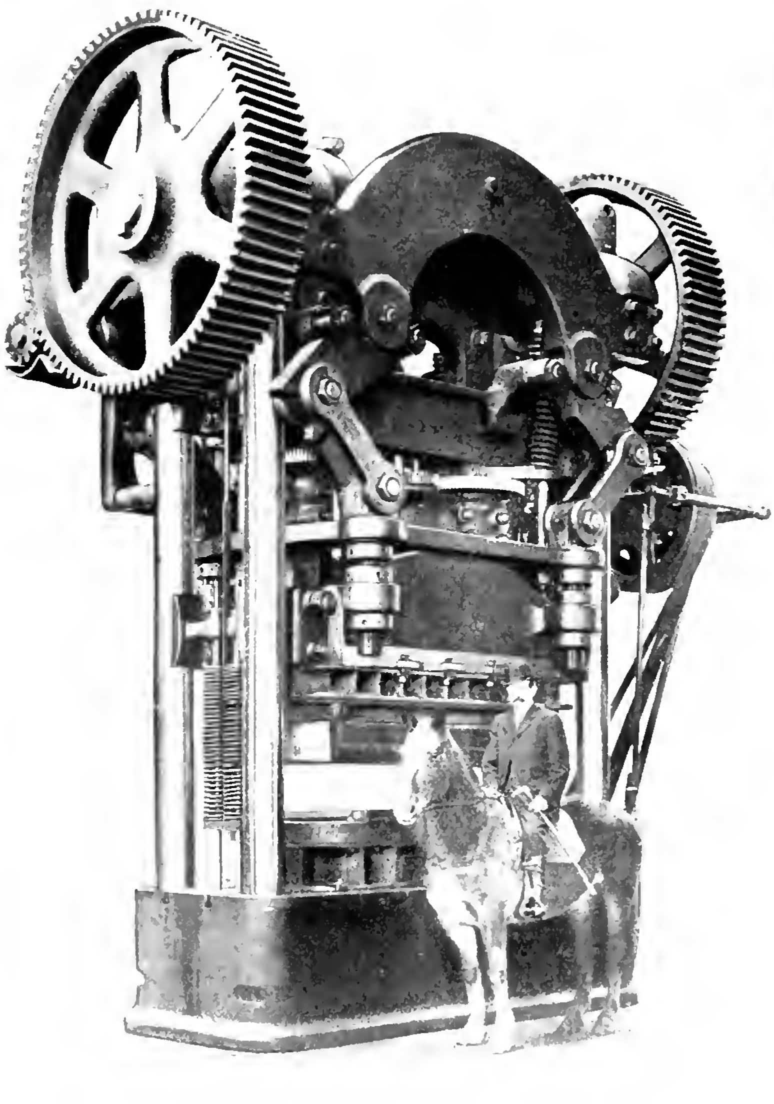


Fig 1. An Enormous Double-action Drawing Press

tween columns is 9 feet 4 inches and extreme depth of bed front to back, 4 feet 6 inches. Projecting upward from the corners of the bed are round steel columns, 10 inches in diameter, supporting the upper framework, taking the tensile stresses, and also serving as slide-bearings for the outer ram. These columns are connected at the top by heavy stays, the crank-shaft (see *E*, Fig. 2) being journaled in the end stays. The crank-shaft is composed of forged steel, is 15 inches in diameter and weighs 5 tons. Twin gears, each 7 feet 2 inches diameter by 1 foot 6 inches face, are keyed to the ends of the crank-shaft. These gears are steel castings, the teeth being cut. The weight of each gear is 4¼ tons. The back-shaft is driven by a gear at the middle of the shaft instead of at the end, the torsional strains thereby being balanced and the pressures at the end of the shaft equalized.

The upper toggles *A* are pivoted to the front and back frame trusses, the lower toggles *B* being connected to the outer ram or blank-holder *C*. There are four sets of these toggles, giving pressure to the outer ram at four points. The crank-shaft is connected to the inner ram or plunger by pitman strap and pitman, as usual, there being two bearing points in the plunger.

Rollers on studs projecting from the plunger bear against the upper toggles *A*, causing them to straighten out when the plunger descends, forcing the outer ram down. As the main ram or plunger

rises, after a stroke has been made, similar rollers on the other side of the toggles strike projections at the "knee-joints" of the toggles, causing them to resume their angular position, the outer ram being lifted by steel springs as soon as the toggles are tripped. This is shown in Figs. 1 and 2. The plunger has 32 inches stroke. As the ram has a stroke of 16 inches, it is possible to draw work of very nearly that depth. The adjustment of both ram and plunger is 8 inches.

The fly-wheel is 50 inches diameter and 12 inches face. The press is driven by a 125 H. P. motor through a powerful friction clutch, by means of which the operator has perfect control at all times, being able to start and stop the machine at any part of the stroke. The ratio of gearing is 1 to 300. The press makes about one and a half strokes per minute, giving it a great advantage in speed over hydraulic presses in which heavy work of this character is usually done. A positive knockout is connected to the ram by rods running up through the bed.

The press is 20 feet 2 inches high. It occupies a floor space of 18 feet 9 inches by 9 feet 3 inches. It weighs 100 tons, and gives a ram pressure of 1,500 tons. It was designed by Mr. Oberlin Smith, the president and mechanical engineer of the Ferracute Machine Company.

GARVIN NO. 11 2 GEARED FEED MILLING MACHINE

The milling machine herewith illustrated and described is made by the Garvin Machine Co., Spring & Varick Sts., New York City. The principal features of the design are the box construction of the knee, the arrangement of the knee bearing surfaces and those of the saddle and table, and the compact geared feed mechanism employed. These improvements have been incorporated in a machine which otherwise retains the good points of the older line of millers built by the same firm.

Improvements in the Structural Design

In regard to the general structure of this miller, it may be said that the column is built on the standard lines which have previously given good results in the matter of strength and rigidity, and consequent output of work. The first point of interest in the structural design relates to the knee, which is illustrated in Fig. 1. This is of the solid top, extended type, which has been patented by the builders. As may be seen, the top is entirely closed except for one very small hole, which does not interfere with strength and stiffness. The back of the knee, where it joins on the column, is also closed, as are the sides and end, while the lower opening is well ribbed. A stiff internal rib is also provided. The bearing on the column is extended upward, and two binders for clamping the vertical adjustment are furnished, with an extra gib screw placed close to each binder.

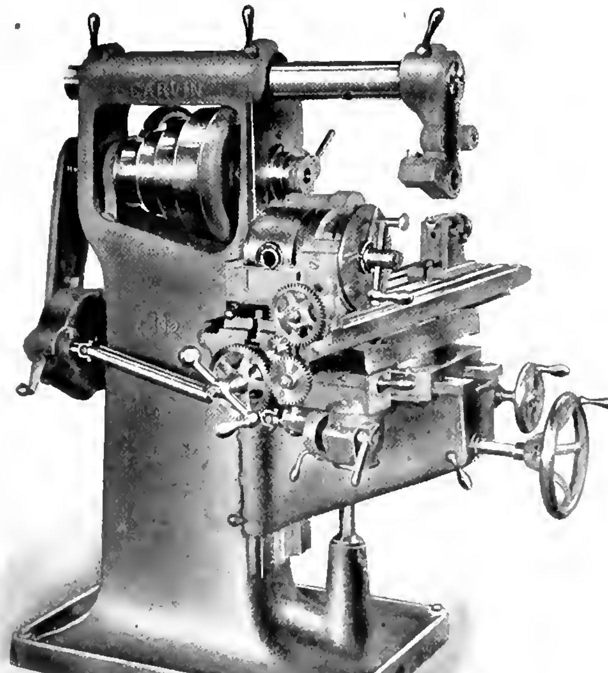


Fig. 1. Garvin No. 11 2 Geared Feed Milling Machine

This solid top construction furnishes the necessary stiffness for resisting the side pressure from heavy cuts, and checks the vibration induced by coarse tooth cutters. These troubles, and a certain amount of distortion due to overhanging work and table, are liable to be met with in designs which employ an opening in the top of the knee. The opening tends to spring together under stress, permitting the undesirable conditions noted above.

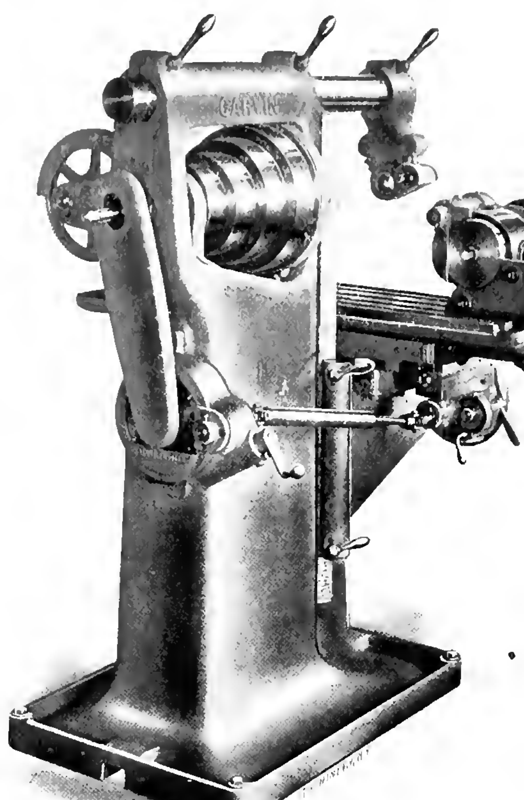


Fig. 2. Rear View of Milling Machine, showing Feed Gear-box and Connections

The solid-top design is made possible by placing the cross-feed screw just under the edge bearing on the right-hand side of the knee. Any objection which might be offered to this offset control for the in and out movement of the saddle, is answered by the design of bearing employed. This is of a type which has been generally used on gear cutting machines. The saddle is lined up by the narrow bearing on the right-hand side, to which it is confined by a strap gib beneath, which holds it down, and by a tapered gib on the edge. As this narrow guiding surface is practically central with the cross-feed screw, no canting or twisting action is possible, even should the gibs be adjusted very loosely. The resulting conditions are probably better than would be obtained by the usual method of guiding the slide across the full width of the knee, even with the cross-feed nut in the center of this wide guiding surface.

The extended bearing on the face of the column adds greatly to its rigidity, gives a larger and more durable bearing surface, and prevents a tendency to sag; and this, together with the box construction, affords a firmer and more unyielding support to the arm and arbor braces. It also permits giving more clearance between the arm brace and the face of the column without sacrificing the rigidity and accuracy of the structure.

Another interesting point in the design is shown in Fig. 3, which is a view looking down on the top of the saddle, the latter being removed. Particular attention is called to the use for the table bearing of two gibs, tapered in opposite directions. This gives assurance of a good fit at this point, and

consequently of freedom from vibration which would result from the use of a single taper gib worn at one end.

Construction of the Quick-change Feed Mechanism

The new feed-box (shown in detail in Fig. 5, and applied to the millers in Figs. 1 and 2) is unusually compact in construction, when the range and number of feeds it provides is considered. It will give 12 feed changes, varying from 0.002 to 0.080 inch per revolution of the spindle. The construction is best seen in Fig. 5.

A series of gears of different diameters, meshing with each other, is mounted on pivots extending around the periphery of a double-walled circular cage as shown. This train of gears is driven from a central gear mounted on a shaft, which receives its motion from the spindle as seen in Figs. 1 and 2. The cage in which these gears are mounted is provided with worm-wheel teeth on its periphery, meshing with a steep pitch worm mounted on a crankshaft as shown. Each revolution of this crankshaft, therefore, turns the cage to a new position; and in each of these positions a new one of the series of gears provided is brought into mesh with a pinion set in a recess in the front of the gear casing. This pinion is connected by the usual telescopic shaft with the feed gearing on the saddle.

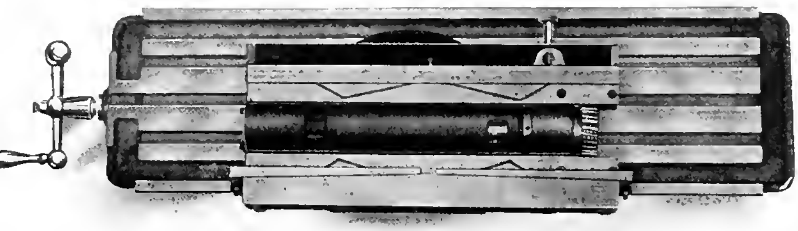


Fig. 3. Top View of Saddle (on Table) showing Double Taper Gibs

Two or three points in the construction of this mechanism should be noted. For one thing, the teeth of the gears about the periphery of the cage, and the teeth of the pinion driving the telescopic shaft, have been given special shapes. This permits them to be turned into and out of engagement freely while running at full speed, without any possible danger of interference and consequent injury. Another point that will perhaps occur to the reader as requiring consideration relates to the direction of the rotation of the feeds. The gears in the periphery of the cage, which are brought successively into mesh with the pinion on the telescopic shaft, evidently revolve in different directions. Every other one turns to the right hand, while the remaining ones turn to the left. This means that with every successive feed change, the direction of rotation is altered. This change is rectified by the feed reverse motion in the gear-box on the saddle, to which the telescopic shaft is connected. The small lever shown on this gear-box effects this reversal through a tumbler gear mechanism, similar to that commonly employed in the headstock of the engine lathe.

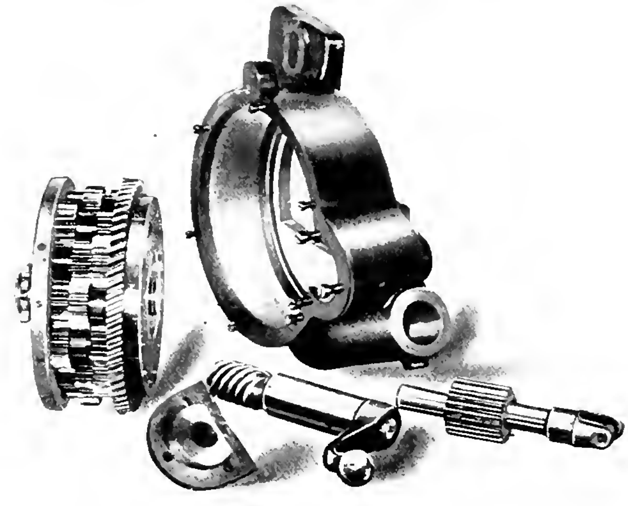


Fig. 5. Feed Gear-box Dismantled to show the Construction

The compactness of this feed change mechanism is its most salient characteristic. The ease of making the change is another as the crank, for the reasons described, can be turned rapidly and easily without meeting any perceptible resistance, until the desired feed position has been reached. Suitable graduations in connection with an index give direct readings for the rate of feed obtained.

General Features and Dimensions

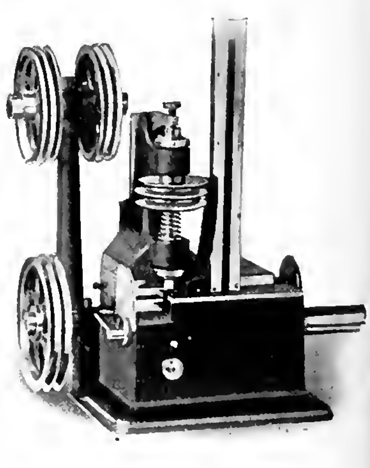
In its general construction, the remaining features of the machine come up to the standard of requirements in milling machine design. The arm is of solid steel, and overhead braces are provided. The cross, longitudinal and elevating screws are controlled by attached cranks and handwheels which give plenty of room for movement without interference with each other. The main spindle bearing is tapered, and the thrust is taken in either direction by hardened and ground washers on each side of the spindle collar. A soft packing washer is provided which may be taken out and faced off in the lathe to let the spindle in further to take up wear whenever this is necessary. A large cap holds the spindle back to its seat, and thoroughly protects the bearing from oil. The machine has a longitudinal feed of 20 inches, a cross-feed of 7 inches, and a vertical adjustment of 18 inches. The weight packed for domestic shipment is 2,300 pounds.

Fig. 4. Solid Top Extended Knee with Confined Guide Bearing for Saddle

WALTHAM AUTOMATIC VERTICAL RECESSING MACHINE

The automatic precision machine herewith illustrated is made by the Waltham Machine Works, Newton & Cutter Sts., Waltham, Mass. It was originally intended for recessing watch parts, such as bridges, etc., having a simple recess that can be roughed or finished by a revolving cutter, with the work stationary. It may be used, however, for any similar work on small flat blanks.

The blanks are placed by hand in the vertical magazine, and all the subsequent operations are automatic. The blanks are taken from the magazine by a slide, operated by compressed air, that carries them, one at a time, to a position underneath the vertical spindle carrying the cutter, where they are securely clamped, also by compressed air. The cutter spindle is then fed to the required depth by a cam attached to a shaft at the rear of the machine.



An Automatic Precision Recessing Machine

Upon the return of the cutter spindle, the slide is withdrawn, releasing the recessed blank, but leaving it directly beneath the cutter spindle. From this position it is ejected

by a blast of air with all the chips made by the operation, thus cleaning the clamp for the insertion of a fresh blank. The air valves controlling the operation of the slide, clamp and blast are operated by cams on the same shaft which carries the cam for feeding, recessing and ejecting the blank.

This machine is best adapted for brass work. A production from 12 to 20 per minute can be obtained, according to the size of the recess. The weight of the machine is 80 pounds.

WELLS SPEED LATHE FOR MANUAL TRAINING AND GENERAL SHOP USE

The firm of F. E. Wells & Son Co., of Greenfield, Mass., has developed a line of speed lathes primarily for manual training school use, but which has been found well adapted also to the general run of hand lathe work found in the ordinary machine shop. They are built either as cone pulley or motor-driven machines, and provided either with bench legs or with regular legs for mounting on the floor. The engravings shown herewith illustrate the floor type of machine.

In Fig. 1 is shown the new design of electrically-driven lathe with the motor enclosed in a special headstock. This motor is designed expressly for this lathe, with an extended spindle which is bored out with a No. 2 Morse taper, and threaded on the outside for holding chucks. A ½-inch hole is provided through the spindle for knocking out centers, holding bar stock, etc. The motor has a variable speed control by means of the starting box shown on the front of the lathe.

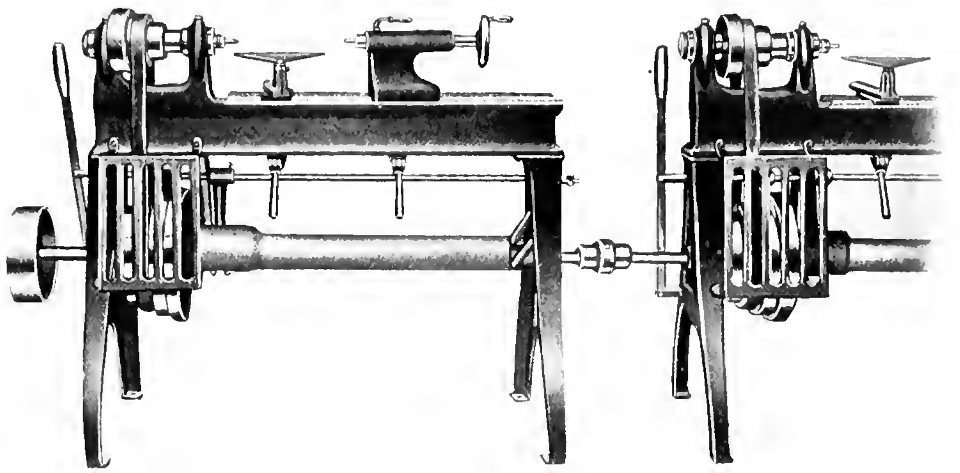


Fig. 2. Under Drive for Speed Lathes, which avoids the Use of Countershafts

One of the important new features of this line is the improved spindle bearing furnished. The box is of phosphor-bronze, split, tapered on the outside and provided with nuts at each end for adjustment in the taper seat in the headstock. This allows taking up wear without disturbing the fit on the spindle. An oil chamber in the headstock bearing furnishes a constant supply of lubricant to the spindle by means of a ring oiling device of standard construction.

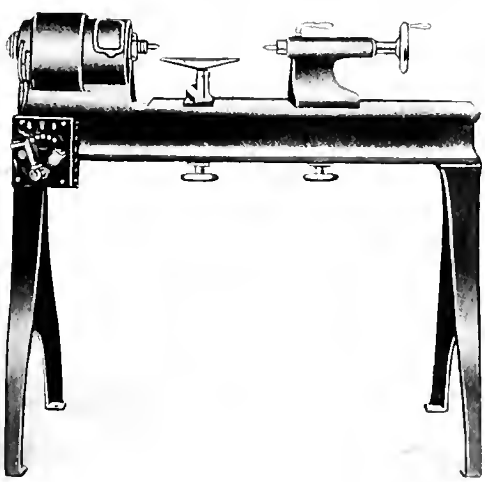


Fig. 1. Speed Lathe with Motor built into Headstock

A cone pulley type of this lathe having a novel form of belt drive is shown in Fig. 2. A lineshaft is provided, extending under as many of these lathes as it may be desired to set in a row. On this lineshaft, under each headstock, is mounted a large cone pulley which may be connected with the shaft by means of a friction clutch operated by the hand-lever shown at the end of each lathe. This lever is also connected with a brake, which goes into action when the clutch is thrown off, stopping the spindle instantly and saving considerable time. Suitable guards are provided for both shaft and pulley, obviating any danger of catching the clothing and causing consequent injury to the operator. A flexible coupling is used for connecting the lathes, so that they will run properly even though not set exactly in line. The clutch is made noiseless by hard wood bushings set in the flanges of the coupling. This makes it possible to engage or disengage them without noise while running at any speed.

On these under drive lathes the makers furnish everything except the pulley for driving the shaft, and that will be furnished if desired. Floor hangers may also be provided to extend the shaft for belting to other tools or machines.

Another method of doing away with a countershaft, and the extra belting which it requires, consists in mounting the cone pulley and friction clutch on a lineshaft directly over the lathe. The same friction is used in this case as for the under drive. By thus simplifying the overhead work and doing away with belts, countershafts, etc., complication of mechanism is avoided, the time and money spent on maintenance are greatly lessened, and the shop is made much lighter and has a more satisfactory appearance.

The engraving shows the lathe with plain screw feed tailstock, but it will be furnished with combination screw and lever feed if desired. The lathe will also, as stated, be furnished as a bench machine with short legs if preferred by the purchaser.

THE PARKER SPEED-CHANGING DEVICE

The accompanying illustrations shown the application and design of the Parker transmission and speed-changing device. This device is patented by Mr. Clark W. Parker and manufactured by the Parker Transmission and Appliance Co., Springfield, Mass. The transmission can be used for all kinds and sizes of machines that require change of speeds and is particularly applicable to machine tools and automobiles. The speed changing device is of the non-sliding gear type with positive drive, and can be operated either as a "progressive" or "selective" speed-changing device. It may be made as an integral part of the machine to which it is applied or to take the place of a countershaft, and can be placed in any convenient position. It may be made for any required number of speed changes and any ratio, and of any combination for forward and reverse speeds. In Fig. 1 the device is shown applied to a 16-inch Reed engine lathe. In this case the head-cone of the lathe has been removed and a single pulley drive supplied. The transmission takes the place of the discarded countershaft.

The principal parts of which the Parker transmission consists are two cones of gears that are in constant mesh and mounted idly on parallel shafts, the shafts being properly slotted for the sliding keys, and the shock absorber that is applied at the driven end.

The line engraving Fig. 3 shows in the lower part of the illustration a horizontal section in detail and an end view at the driven end. The upper part of Fig. 3 is the plan, and shows the transmission assembled. The lower view shows

the five gears C_1, four for the forward speeds and one for the reverse, which are mounted idly on shaft B_1, and also the sliding key E_1, which is hinged in the sliding sleeve D_1. The key E_1 is shown in its extreme right-hand position, locked in the reverse gear. The reverse is obtained by using an intermediate gear indicated in the end view. The collars between the gears are fastened tightly on the shafts and prevent any tendency that the shafts may have to spread at the slots. They also act as a device to release that portion of the key

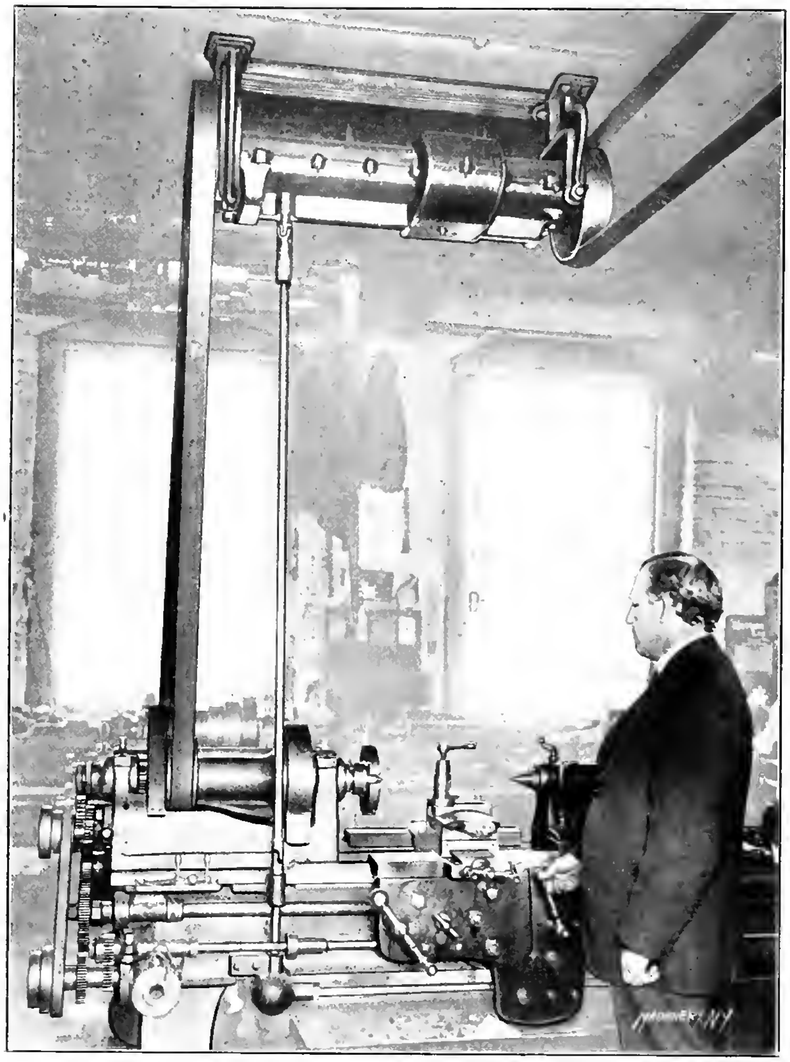


Fig. 1. The Parker Speed-changing Device applied to an Engine Lathe

that is locked in the gear slots when changing the positions of the keys of gears C and C_1 for obtaining the change of speed. The keys are moved by sliding the sleeves D and D_1 on the shafts B and B_1.

In the upper view in Fig. 3 are shown assembled both sets of cone gears C and C_1 mounted on their shafts B and B_1, the collars between the gears, the sliding sleeves D and D_1 on each shaft, the yoke F which moves both sleeves D and D_1 and the attached keys. These latter move at the same time when making a change. To the yoke F is attached a rack G which, in this case, is moved by the gear H, that is mounted at the end of the vertical rod passing up from the machine in Fig. 1.

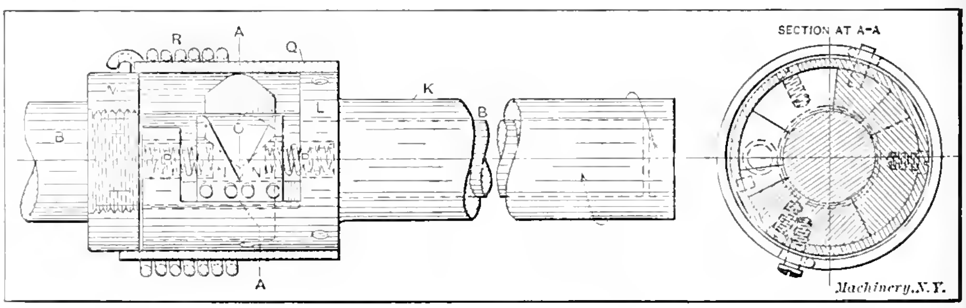


Fig. 2. The Shock Absorbing Mechanism

At the right in Fig. 3 is shown the pulley I by which power is delivered to the transmission. This pulley, through the shock absorber J, delivers the power to shaft B, and thence through the gearing and pulley W to the machine to be driven. The gears not locked by the keys are running loose only on their shafts.

The shock absorber is shown in detail in Fig. 2. This is one of the main features of the Parker transmission. It prevents any undue wear and breakage from sudden engagement. The pulley I is fastened to a sleeve K that is a running fit on shaft B. The sleeve K is enlarged at L at which place it is partly cut away. A piece M similar to L is fastened to shaft B. The pieces L and M overlap each other in a clutch-like manner and in the box-like space between them are two wedged-shaped blocks N and a V-shaped block O. The blocks N are forced together by the springs P, and the power is transmitted by block O being wedged in between blocks N. This mechanism is covered by the shell Q that is fastened to the sleeve head L. The helical spring R is at the proper tension to carry the idle load, one end of this spring being fastened to shell Q, and the other end to M. As the springs P force the blocks N together, these in turn hold the block O against its seat in M.

In operation, the shock absorber revolves shaft B only, until the key in this shaft enters the slot in one of the gears C, into which it is forced by small springs indicated in Fig. 3. Now a single pair of gears is revolved until the slot in the meshing gear C_1 comes opposite key E_1, at which time the key is forced into position in C_1 and now, when both keys are engaged, the working load is transferred to spring R which, not being strong enough to take the whole load, shifts it onto the blocks N and O, the block O forcing the blocks N apart until springs P offer resistance enough to permit the carrying of the load. The mechanism is thus engaged without shock or blow.

In Fig. 1 is shown the method of operating the Parker transmission at the lathe carriage. Changing the position of the crank-handle at the lathe carriage revolves the horizontal rod shown, and through bevel gears actuates the vertical rod from the machine to the transmission. At the top of this rod is fastened gear H, Fig. 3, which, in turn, moves the key-shifting mechanism, as mentioned. A pointer and scale near the crank-handle in the apron indicates which pair of gears is engaged. This lathe now has the same speeds that were obtained with the regular head-cone, and the belt is of the same width, but by having better belt contact on the pulleys, the lathe is capable of taking a cut more than double that possible with the cone pulley arrangement. The transmission can also as readily be operated by the ordinary shipper lever arrangement.

The transmission shown has been in constant use for two years. A transmission has also been applied to a six-cylinder Stevens-Duryea 40 H. P. automobile that has run over 16,000 miles. No repairs or adjustments have been made on either of these transmissions, and in a recent examination of the automobile transmission a wear of only 0.005 inch had taken place at the keys. This small wear, of course, in no way impairs the working or efficiency of the transmission.

One of the important features of the device is that it is very compact. The distance between the bearings for a 40-horsepower automobile is only 10 inches. When used as a machine tool drive, the size is, of course, not so important, but its other features will undoubtedly make it of interest to the machine tool trade.

GARVIN SPEED LATHE FITTED WITH AUTOMATIC CHUCK AND TWO-HOLE TURRET

The speed lathe shown herewith was built by the Garvin Machine Co., Spring and Varick Sts., New York City. The simple attachments with which this lathe is provided adapt it to the operations of drilling and tapping, in a way which should produce a surprisingly high output, considering the simple nature of the special devices employed.

As shown in Fig. 1, the headstock is provided with two loose and one tight pulley, together with a belt shifter operated by a treadle, so that the direction of rotation of the spindle can be controlled by the foot, leaving the hands free. This reversal is provided for the tapping operation.

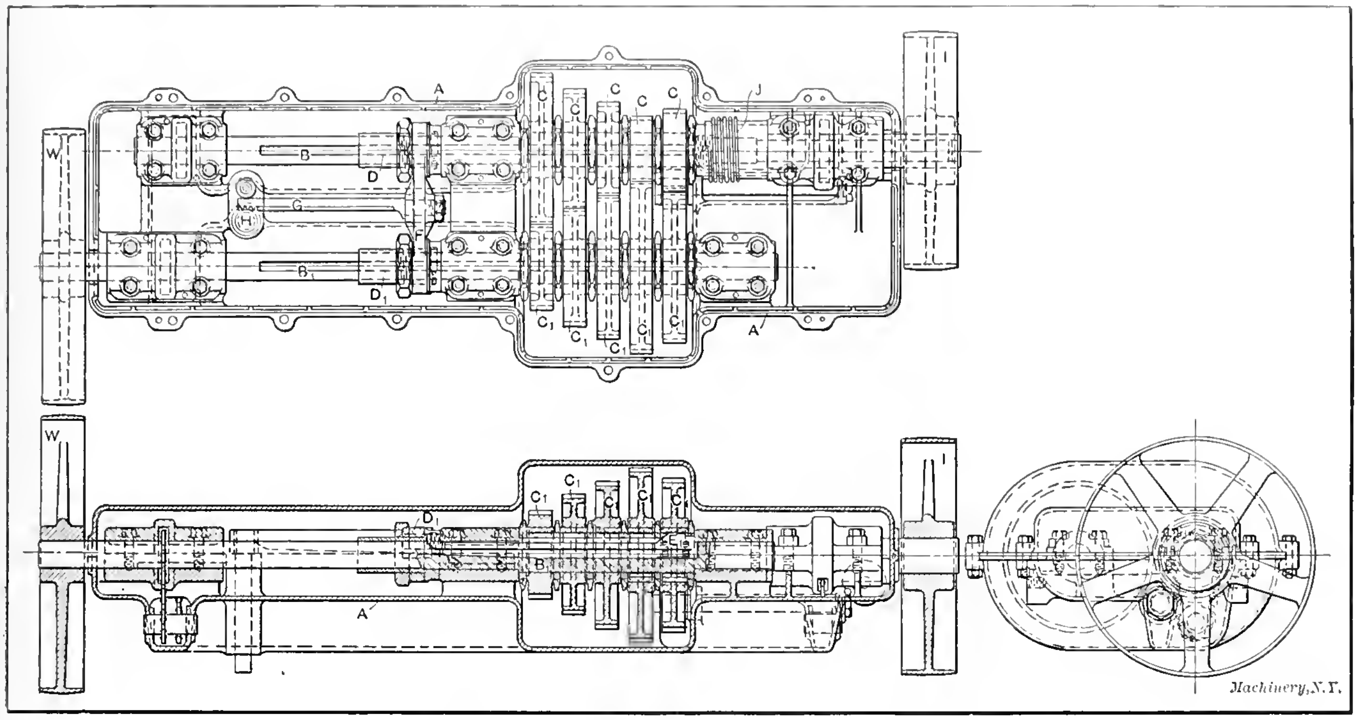


Fig. 3. Section through Speed Changing Device, showing Construction

The spindle nose is fitted with a Jacobs chuck, having a leather or canvas faced brake band around it, which can be tightened down on the knurled sleeve by the operation of the lever shown at the front of the headstock. This provision of a brake on the chuck and a reversing mechanism for the spindle, allows the chuck to be opened and closed automatically without stopping the spindle. When this is running forward and the work is inserted between the jaws of the chuck, the tightening of the brake screws these jaws down onto the work. After the spindle has been reversed to back the tap out, the tightening of the brake works in the other direction, releasing the jaws and allowing the work to drop out. This evidently facilitates to a high degree the operation of the machine. A tap holder of the pull-off type is used, so that absolute accuracy in reversal is not necessary.

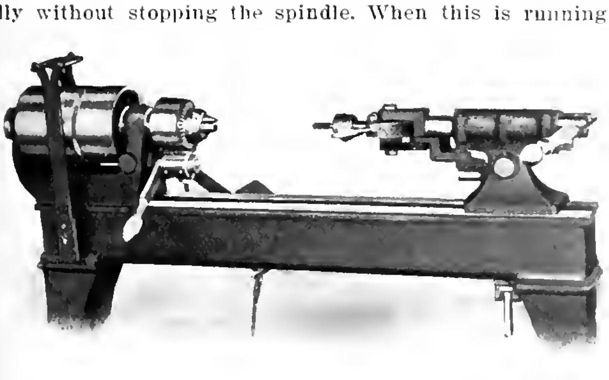


Fig. 1. Automatic Chuck Control and Two-hole Turret, applied to Speed Lathe

A very simple and ingenious mechanism, shown in detail in Fig. 2, is used for operating the two-hole turret, which carries a drill and a tap. This turret, *A*, is pivoted in the forked end *B* of the tailstock spindle. Plunger *C* in the center of this spindle is provided with a point which enters either of the two V-notches shown in the rear edge of the turret, locating it with either one of the two holes in line with the spindle of the lathe.

The turret *A* is alternately thrown from one position to the other by means of the crab-claw shaped piece shown at *D*. This has just thrown the turret to the position shown in the plan view, by the engagement of its rear prong with the kite-shaped dog *F*, which is pinned to the turret. As the tailstock spindle is moved forward, feeding the tool into the work, pin *E* on the lower side of the turret strikes inclined surface *c* of the crab claw, turning it about pivot *G* and bringing the front prong in a position to engage with the front projection of dog *F*. When the turret is again drawn back, this front prong operates on *F* to throw the turret around to bring the other hole in line with the spindle, and it is held in this position by the bearing of spring plunger *C* in the other V-notch. When the turret again moves forward, pin *E* has been shifted to engage with the inclined surface *c*, on the front prong, and the crab claw is thus thrown back again to the position shown in the engraving.

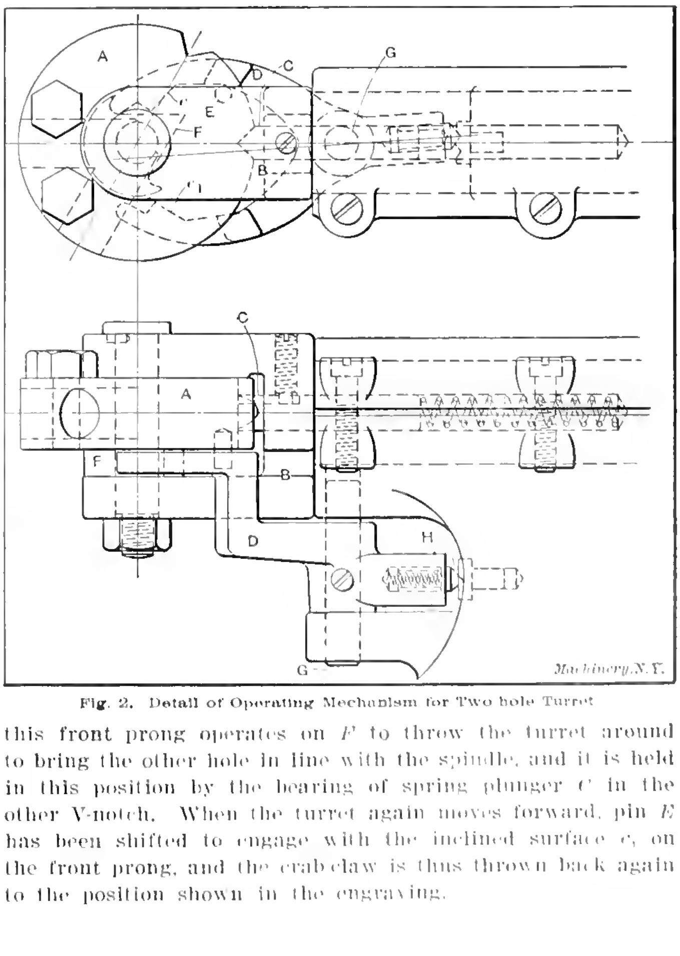


Fig. 2. Detail of Operating Mechanism for Two-hole Turret

Spring plunger *H* enters V-notches cut in the plug shown, and holds *D* in each of its two positions. It will be seen that this can be worked rapidly and without attention, other than is required to make sure that the tailstock lever is thrown clear back at each stroke. The forward movement is limited by an adjustable stop as shown in Fig. 1.

This mechanism is evidently not designed for work requiring extreme accuracy; but in the ordinary case, in which it is simply required to drill and tap a hole, a high output is made possible. The combination of foot and hand lever movements, the automatic changing of tools, and the opening and closing of the chuck, reduce the time required for idle movement to the lowest possible figure.

MIAMI PLAIN AND UNIVERSAL CUTTER AND TOOL GRINDERS

The Miami Valley Machine Tool Co., of Dayton, Ohio, has redesigned its plain and universal tool-room grinders, adding considerably to their convenience. The universal machine is shown in Fig. 1, while the plain machine with the cylindrical grinding attachments, etc., removed, is shown in Fig. 2.

On both the machines the table is traversed by a crank-handle at the front, which operates through a rack and pinion movement. This takes the place of the hand lever arrangement formerly used, gives a more even feed, and is conveniently operated by either hand. On both machines the tables swivel for grinding tapers, graduations being provided at one end for quickly setting to the proper angle. The emery wheel head also swivels, instead of having the body of the machine adjustable as formerly. This gives a quick adjustment, and permits the grinders to be placed in a more restricted space than formerly. This is an item of considerable importance where the floor space is limited. The bearings are of phosphor-bronze, compensated for wear, and protected from grit by felt washers revolving inside the dust ring caps. The machine is designed so that the only time that the vertical adjustment of the wheel spindle is required, is when backing off taper reamers. This vertical adjustment is provided by turning the adjusting nut shown under the base of the wheel-stand in Fig. 3. The universal machine shown in Fig. 1 is provided, as shown, with a live spindle headstock and a spring tailstock for cylindrical grinding. An internal attachment is also permanently mounted on the head, in the position best shown in Fig. 3. When operating the internal attachment, the drive belt on the wheel-head is run as a cross-belt, so that no change is required. The handwheel at the right of the column operates the cross feed, while that at the left gives a fine adjustment to the table movement permitting the accurate squaring up of shoulders, thrust surfaces, etc.

Among the other attachments furnished with this style of machine are, an indexing holder for grinding formed cutters, etc.; a universal holder for angular mills, end mill teeth, etc.,

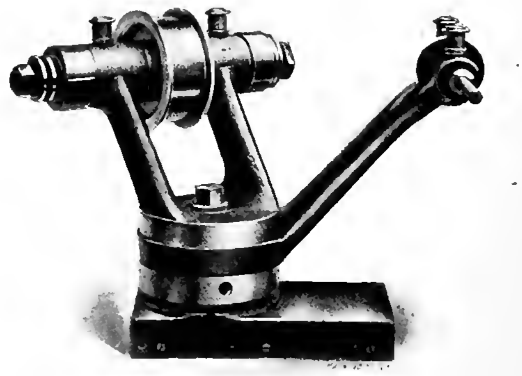


Fig. 3. Wheel Head of Universal Machine showing Vertical Adjustment and Permanently Mounted Internal Grinding Spindle

and a universal chuck, driving dogs, plain centers for reamers and similar work, vise, dead center driving pulley, tooth rests, wrenches, etc. The countershaft provided has a cone pulley driven drum, for belting to the live spindle headstock for cylindrical grinding.

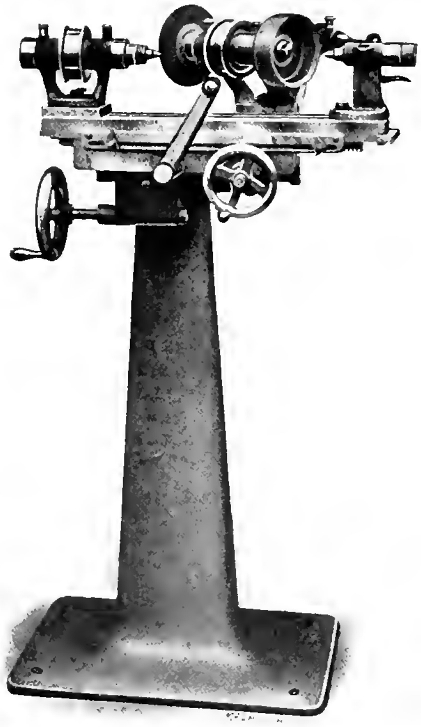


Fig. 1. Universal Cutter Tool and Cylindrical Grinder for Tool-room Use

Fig. 2. Plain Machine for Cutter and Reamer Grinding

The plain machine shown in Fig. 2 is particularly adapted to cutter and reamer grinding. For this work it is provided, as shown, with a pair of plain centers. Suitable wrenches and tooth rests are also furnished, together with a universal indexing attachment for sharpening formed cutters, end and angular mills, and similar work. In this design of machine, the double countershaft is not required, nor is the fine longitudinal adjustment for the table. In each case stops are provided at the front of the table, as shown, to limit the movement in both directions.

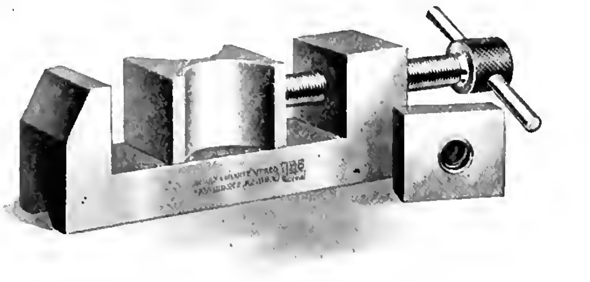
The universal machine will take work between the centers 8 inches in diameter and 16 inches long. The table swivels up to 4 inches taper per foot. Milling cutters, angular or straight, up to 16 inches in diameter can be ground. The internal attachment will operate on holes up to 6 inches in diameter and 4 inches long. The formed cutter centers will take 5 inches diameter up to 11 inches long. The vise has jaws 3 inches long, opening up 2 inches wide. The machine weighs about 500 pounds. The plain machine takes work up to 8 inches in diameter and 20 inches long, but will sharpen milling cutters, angle or straight, up to 16 inches in diameter. The table swivels the same as the universal machine, up to 4 inches taper per foot. This style weighs about 400 pounds.

BROWN & SHARPE TOOLMAKER'S VISE

The device herewith illustrated is a recent addition to the line of small tools made by the Brown & Sharpe Mfg. Co., of Providence, R. I. It is a toolmaker's vise and is intended

particularly for holding work for drilling and other light machining operations, and also for fitting and laying out on the surface plate. Many other uses will readily occur to the user of the tool.

The body is made of steel, drop forged and case-hardened. The screw is hardened to provide against wear. It has a knurled head for easy manipulation, and is provided as well with a short cross-bar through the head, by means of which a firm grip may be had upon the work. Two interchangeable jaws of different size are furnished, which readily slip on and off the end of the screw and provide for holding work of any dimensions up to 2 inches wide. While this vise is light and convenient to handle, it is still made strong



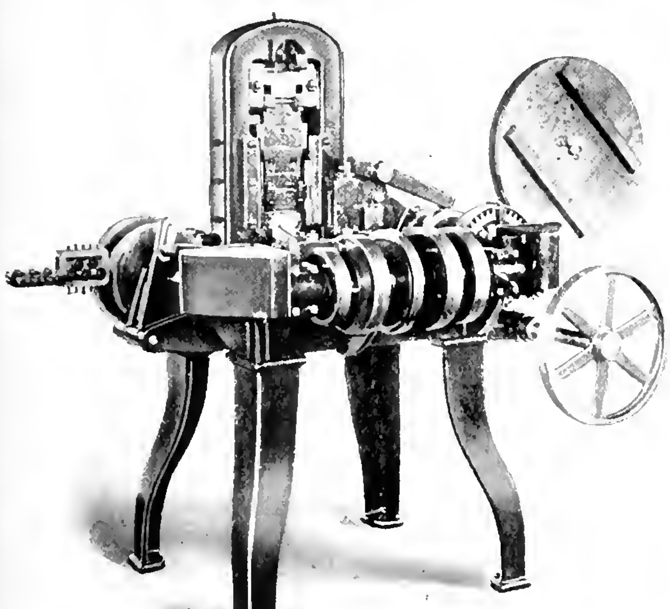
A Toolmaker's Vise for Laying-out, Drilling, etc.

enough to withstand the severest usage it is likely to be subjected to.

The V-groove cut in the under side of the body of the vise makes it useful as a V-block for centering round bars, supporting round work in the drill press, and other operations that an ordinary V-block is used for. The vise can be employed for this purpose by simply turning it over. The V-groove is machined very accurately. This is true of all the surfaces of the vise, whose usefulness is thus extended in laying out and similar careful work, where it is convenient to lay the tool on its side, stand it on end, or place it in other positions without interfering with the accuracy of the setting.

BAIRD WIRE FORMING, FERRULING AND STAMPING MACHINE

In the issue of MACHINERY for January, 1910, we illustrated a machine made by the Baird Machine Co., Oakville, Conn.,



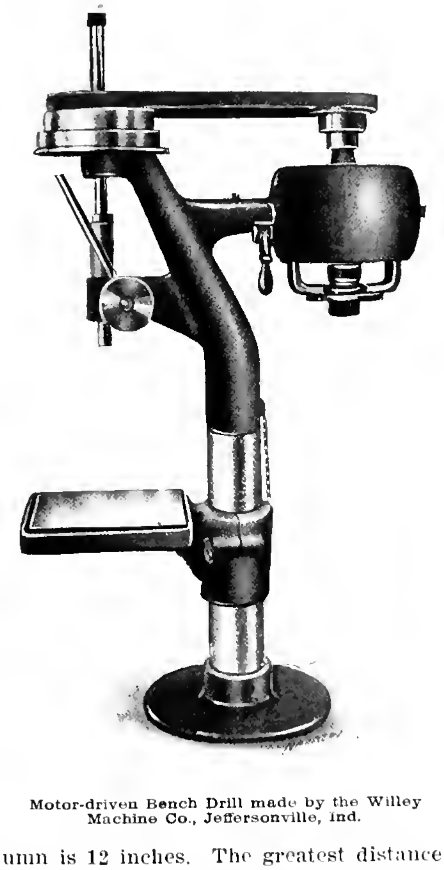
An Automatic Machine for Making Parts from Wire requiring Several Operations

for forming and stamping parts made of wire. In the February, 1910, number was illustrated and described a machine built by the same firm for forming and ferruling wire parts. The machine herewith illustrated combines the functions of the two previously described. It will take wire from the coil, straighten, feed and cut it off, form it into shape, attach to it a ferrule made from a strip of metal wound from the reel at the right of the engraving, and carry it to a press incorporated in the mechanism, where it is flattened and stamped as may be required.

While the machine was first designed to be used particularly on dry goods novelties, it has found many other uses in general manufacturing work. Such articles are made at the rate of 60 to 80 per minute according to size and shape and are dropped from the machine completely finished. It is made in several sizes to cover a wide range of work. The makers state that particular attention is given to the materials and workmanship used, with an idea of making it a serviceable and durable machine.

WILLEY MOTOR-DRIVEN BENCH DRILL

In the department New Machinery and Tools Notes, in the October, 1909, issue of MACHINERY, a brief description was given of a motor-driven sensitive drill built by the Willey Machine Co., Jeffersonville, Ind. This company has now brought out a bench drill built on the same principles as the 12-inch sensitive drill then referred to. The motor is connected to the spindle by a belt and cone pulley, three changes of speed being provided. The motor is adjustably mounted for tightening the belt, and the starting switch is placed within the motor frame, thus eliminating outside connections. Any type of motor can be used, and the motor can be easily detached and exchanged for another of different voltage if required. The table is square and its weight is counterbalanced by a weight inside of the column. When not required it can be swung out of the way. While the tool is very simple and reliable, it is adapted to a wide range of work. The most important dimensions of the machine are as follows: The distance from the center of the spindle to the column is 12 inches. The greatest distance from the spindle to the table is 14 inches. The traverse of the spindle is 3 inches. The power of the motor is 1/3 horsepower, and the weight of the machine, 180 pounds.



Motor-driven Bench Drill made by the Willey Machine Co., Jeffersonville, Ind.

KERN 25-INCH HIGH-SPEED UPRIGHT DRILL

This machine is of an entirely new design and is provided with a number of important improvements in construction. Among these may be mentioned the use of a three-step cone drive with double back-gears, and an improved construction of vertical reverse for tapping and similar operations. A power quick change feed is also provided. In its structural design, and in the proportions of its details as well, it is intended to fully meet the severe requirements imposed by the use of modern high-speed drills.

The three-step cone and double back-gears provide nine changes of spindle speed. This gives a sufficient range for all the work for which the machine should be used, and at the same time gives more power than with the ordinary construction. Wide cone steps of large diameter are possible, giving a greatly increased belt capacity. At the same time,

the belts themselves are always running at a high speed and thus transmit nearly their maximum power even when the spindle is on the slowest speed. This is particularly advantageous in the drilling of large holes where, with the ordinary low ratio single back-gears, a comparatively slow belt speed would have to be used.

The arrangement of the driving gears is best shown in Fig. 3. *A* is the three-step cone pulley, which is belted to the countershaft on the base of the machine. The shaft on which *A* is mounted is bored out to form a bearing for driving shaft *B*, which revolves loosely in it. Keyed to the cone pulley shaft *C* is a gear *D*, which, through idler *E*, is connected with gear *F* on back-gear shaft *G*. Also keyed to shaft *G* is a large gear *H*, meshing with pinion *J*, which is keyed to *B*. The hubs of gears *F* and *D* are provided with friction clutches operated by sliding collars *K* and *L*. These are connected together and operated by the lever which extends down back of the main column of the machine in Fig. 1, and is furnished with a lever in back of the spindle head as shown. This lever is so connected with the clutches that when one is thrown in the other is released.

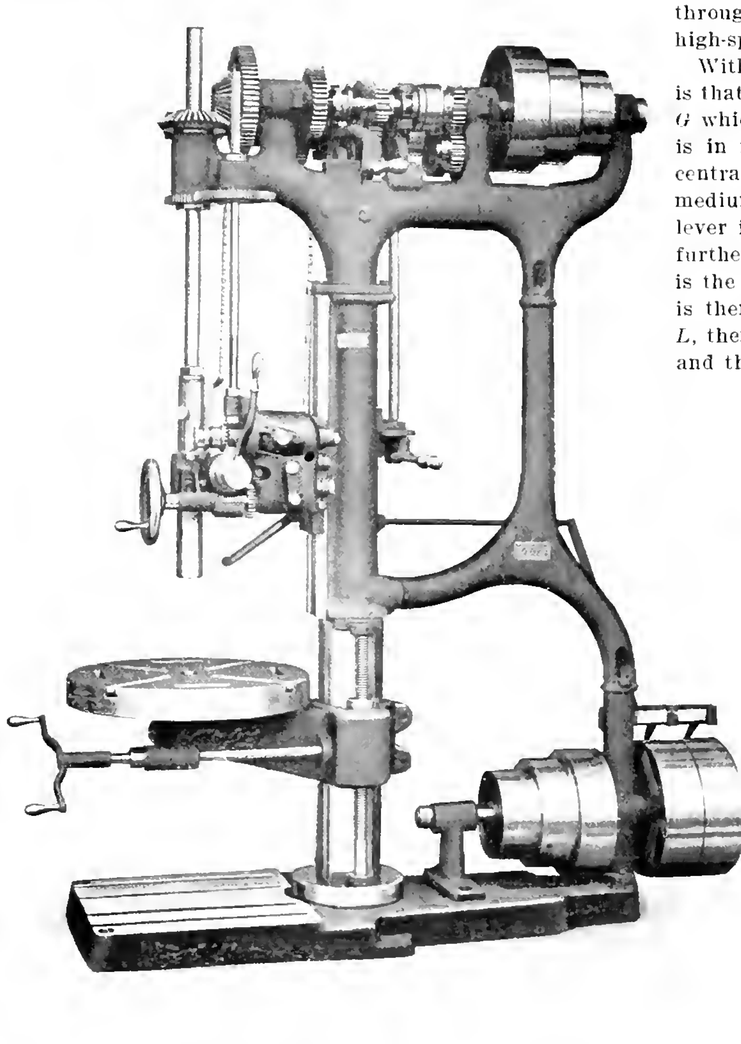


Fig. 1. High-speed Drill Press with Gear Guards Removed

The mechanism thus described is for reversing the spindle motion, and the lever just described is therefore the one used for tapping. The operation is as follows: When the clutch *L* is thrown in at gear *D*, driving shaft *B* is directly engaged with shaft *C* and runs at the same speed. When clutch *L* is thrown out and *K* is engaged, the motion is from gear *D* through *E* to *F* and then through shaft *G* to gear *H*, which drives pinion *J* at a higher speed and in the opposite direction, for backing out taps, etc. It will be seen that shaft *G*, with this construction, revolves constantly whenever *B* is revolving, but at a slower rate of speed.

The double back-gears are operated by the handle shown at the top of the main column in Fig. 1. This controls sliding gears *M* and *N* and positive clutch *O*, in such a way as to give either a direct drive from shaft *C* through to bevel gear *P*, or else one of two back-gear ratios. When the lever is thrown to the left, clutch *O* engages mating clutch teeth in the face of gear *Q*, which is keyed to the sleeve hub of gear *R*; this being keyed, in turn, to bevel gear *P*, drives the spindle. It will thus be seen that on the forward motion, with clutch *O* thrown in, the drive is direct from pulley *A* through to bevel pinion *P*, without transmitting the power through any gears whatsoever. This is the condition for high-speed work.

With the back-gears arranged in the second position, which is that shown in the engraving, clutch *O* is disengaged. Shaft *G* which, as has been pointed out, revolves constantly when *B* is in motion, has keyed to it sliding gear *M*, which in this central position is in mesh with gear *Q*. By this means a medium back-gear speed is obtained. When the back-gear lever is thrown to the extreme right, gears *M* and *N* are still further shifted until *N* is in engagement with gear *R*. This is the slowest speed, and on the forward direction the motion is then transmitted from pulley *A*, through gear *D* to clutch *L*, thence to shaft *B*, then through gears *J* and *H* to shaft *G*, and then from pinion *N* to gear *R* and bevel pinion *P*.

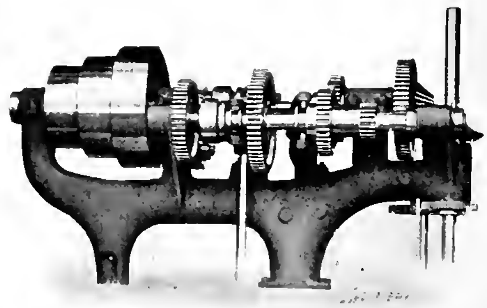


Fig. 2. View of Back and Reverse Gearing

The placing of the friction reverse mechanism between the cone pulley and the back-gears, instead of between the back-gears and the spindle, is unique on the upright drill press so far as we know, although the construction has been common for some time in radial drill press practice. There seems to be fully as much need for it on the upright drill. It gives the great advantage, of course, that on heavy tapping operations in which the highest back-gear ratio is thrown in, the torsional strain is transmitted through the friction at comparatively high speed, and with a correspondingly low torsional strain. With the usual construction, the frictions have to carry the load at low speed and under a greatly increased torsional strain. The frictions are originally designed to be of great strength and durability, and this location gives them an added advantage. The greatest gear ratio between them and the spindle is 12$\frac{1}{2}$ to 1, in which case they are required to exert less than 1/12 of the actual torque exerted on the spindle. This insures long life, as the possibility of slipping is entirely avoided.

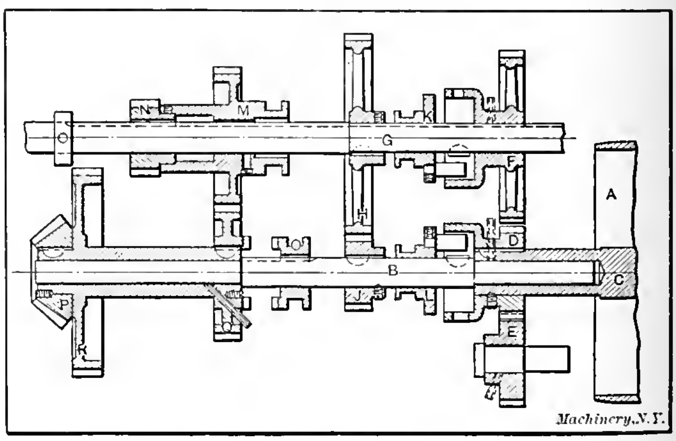


Fig. 3. Arrangement of Gears and Clutches for the Speed Control

In comparing the driving power of this drill with others of the same size, but of orthodox design, it should be noted that

with this machine the cone diameters are 9, 11 and 13 inches for a 3½-inch belt, with the driving cone running at 440 revolutions per minute. Ordinary proportions for the 4 step cone with single back-gears give cone diameters varying from 5 to 11 inches, with a 2½-inch single ply belt, seldom running over 350 revolutions per minute. Under these two conditions the belt power for the 3-step cone on high speeds will be seen to be about double that of the 4-step cone, while on slow speeds it will have nearer three times the power.

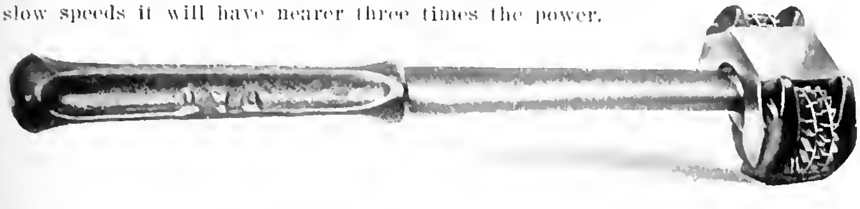
The operating lever of this reversing or tapping attachment, being mounted directly behind the sliding spindle head, is in a convenient position to be used for starting and stopping the machine, as well as for reversing. When thus stopped, only the the countershaft and the cone pulleys are in motion, thus saving unnecessary wear on the gearing and other revolving parts. On the standard machine without the tapping attachment, this lever operates a single clutch for starting and stopping only. The back-gear changes may be effected if desired while the machine is in operation, though the convenient position of the tapping attachment lever makes it easy to stop the machine for making the change.

The geared feed change mechanism is mounted on the sliding head. It gives eight variations, ranging in geometrical progression from 0.006 to 0.050 inch per revolution of the spindle. It is of simple construction, but seven gears and two levers being required for its operation. A feed plate is attached to the frame in a convenient place, indicating at a glance the correct position of the lever for any desired feed. All the gears are of steel, and have wide faces and coarse pitch. An automatic stop and depth gage for the feed is furnished. These features, in combination with the graduations on the spindle sleeve, permit tripping the feed at any desired depth from any given position within the limits of the travel of the sleeve, allowing any number of holes to be drilled within fixed dimensions. It should be noted that the feed control lever, as well as the other operating levers of the machine, are placed at the right-hand sides where they may be manipulated by the workman without change of position.

The total height of the drill is 89¾ inches. The column is 6½ inches in diameter, and the spindle 1 9/16 inch. It drills to the center of a 25½-inch circle. The greatest distance from the spindle to the baseplate is 45½ inches, and from the spindle to the table, 32 inches. The spindle has a feed of 10 inches in the head. The table has a vertical adjustment on the column of 15 inches. The spindle is bored to No. 4 Morse taper. This drill requires a floor space of 30 by 70 inches, and has a net weight of 1,900 pounds. For motor drive the cone pulleys may easily be replaced with single pulleys, permitting the speed range to be obtained through the back-gears when using a variable speed motor of commercial design. It should be mentioned that the machine is fully provided with gear guards, though these are shown removed in the illustrations. This drill is made by the Kern Machine Tool Co., Cincinnati, Ohio.

MARBACH EMERY WHEEL DRESSER

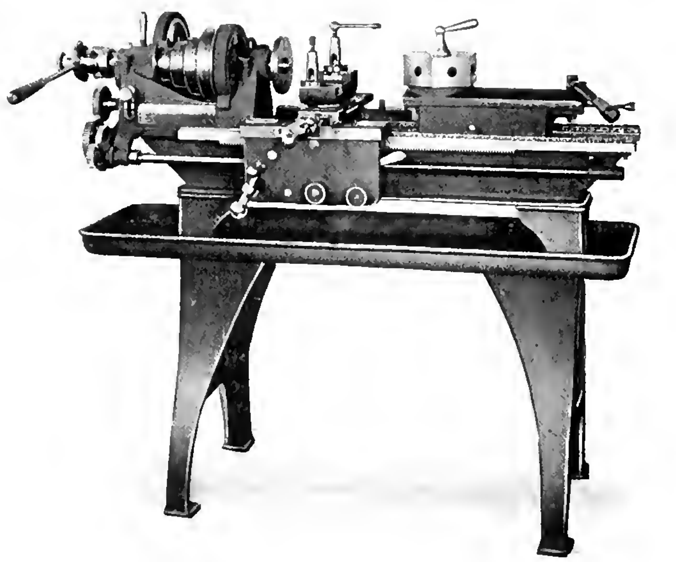
The tool herewith illustrated is designed for truing emery wheels, making use for this purpose of the well-known and effective combination of hardened steel star wheels and washers, mounted on pivots so as to revolve freely in contact with the emery surface. The improvement in the construction relates to the provision made for safeguarding the workman from injury in the operation of dressing the face of the wheel. In this operation two dangers are met with, one of which is that of grit getting into the eyes of the operator. If he wears glasses they become so pitted almost immediately that they have to be discarded, owing to the fact that he stands directly in the path of the flying particles and receives them in the face. Besides this there is the further and more serious danger of the breakage of the wheel under the strain of dressing it. This breakage is almost sure to mean injury or even death to the operator, and great expense to the manufacturer.


An Emery Wheel Dresser which safeguards the Workman

These dangers are avoided in the dresser shown, simply by providing the tool with a handle extending out to the side of the machine instead of directly in front as usual. This brings the operator out of the line of flying parts of emery or pieces of broken wheel. In order to enable him to exert the proper pressure, horns or projections are provided under the star wheel bearings, which may be hooked under the face of the wheel-rest, permitting him to get a strong leverage by twisting the handle of the tool. Two sets of rolls are provided, as shown, doubling the effective life of the tool. The metal clip spans the ends of both pivots and holds them in place. This permits the rolls to be readily assembled. This tool is made by the F. G. Marbach Co., Medina, Ohio.

ATTACHMENT FOR "STAR" LATHES

In the September, 1909, issue of MACHINERY, the "Star" lathes built by the Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., were illustrated and described. It will be remembered that these lathes have 9- and 11-inch swing. In the accompanying illustration is shown one of these lathes provided with three new attachments, lately brought out by the company, which practically convert the lathe into a hand screw machine capable of rapidly producing small duplicate pieces in large quantities. These three attachments consist of an automatic turret, a draw-in chuck and rod feed attachment, and a double tool-block or cutting-off and forming slide.


"Star" Lathe, provided with Turret Attachment, Draw-in Chuck, Rod Feed and Cutting-off and Forming Slide

The automatic turret, placed on the bed as shown, is operated by a hand lever, and the turret head automatically revolves when the lever draws the slide away from the work. An adjustable stop is provided and the sides of the hexagon turret are finished square with the ways of the bed, so that the face may be drilled and tapped for bolting on special tools, if required. A hole through the turret post permits a bar to pass through the turret head when machining long pieces.

The draw-in chuck and automatic rod feed attachment permits of the feeding and chucking of the bar stock operated upon without stopping the machine. By moving the hand lever operating this attachment to the left, the split collet or chuck is released and the feed fingers are brought back; by moving the lever to the right, the feed fingers are brought to bear on the stock and feed it forward until at the end of the movement the split collet is closed. This device is simple in its construction, but it is very effective and facilitates rapid production to a considerable extent.

The double tool-block or cutting-off and forming slide is attached to the cross slide and is interchangeable with the plain and compound rests. When this tool block is used in connection with the turret and draw-in chuck attachments, the lathe is practically transformed into a complete hand screw machine, being in addition a screw-cutting engine lathe. The machine undoubtedly will be highly appreciated in shops where the requirements do not make a special hand screw machine necessary, but where considerable work for which this machine is adapted is to be done from time to time. These attachments are somewhat of a novelty, and as far as we know, there is no other maker of similar sizes of lathes who furnishes attachments of this kind. Of course, the automatic draw-in chuck and rod feed is similar in principle to that regularly employed by some makers of small hand screw machines on their regular type of tool, but this attachment to so small a screw cutting engine lathe is unusual, and will be appreciated by the users of the machine.

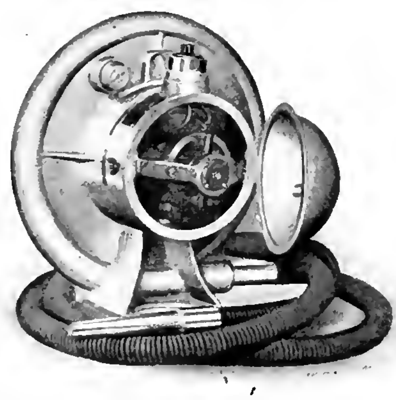


Fig. 1. Sturtevant Electric Dust Blowing Set

STURTEVANT ELECTRIC DUST-BLOWING SET

A dust-blowing set composed of a small light aluminum fan and driven by a direct-connected electric motor, built to operate from lighting circuits, has recently been brought out by the B. F. Sturtevant Co., Hyde Park, Mass. The device with a 1¼-inch diameter flexible reinforced air hose and a 10-inch long polished tapered aluminum nozzle is shown in the accompanying illustration, Fig. 1. The runner or fan-wheel is shown in Fig. 2. It is designed especially for the blowing out of dust from around motors, switchboards or other machinery, and also for the removal of chips and dust in the working of metals. While the blower does not give as high a pressure as would a regular compressed air system, the larger volume of air at the lower pressure in most cases accomplishes the same results without there being the hard severe blast necessary from such a system. The larger volume of air also enables a greater area to be covered in less time than would otherwise be the case. The device is portable, weighing only 55 pounds and provided with socket and cord for attaching it directly to a lamp socket. It can also be used as a vacuum cleaner in cases where a dust-collector is not required. All that is necessary for changing it from a blower to a vacuum cleaner is to attach one end of the hose to the inlet of the fan, and another hose can be connected to the outlet through which the fan may discharge the dust or chips removed. As there is no dust collector, however, used with this arrangement, care should be taken that no objects are picked up which would work injury to the fan.

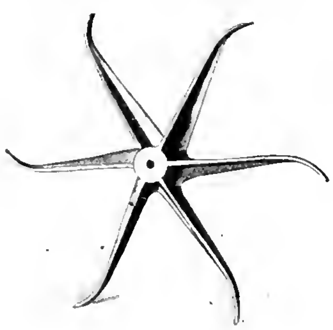
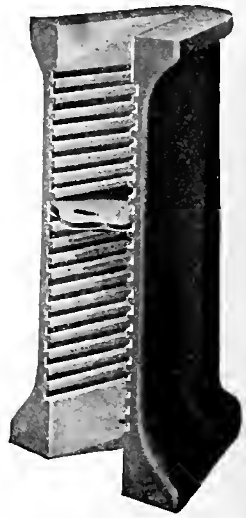


Fig. 2. Runner of Sturtevant Dust Blower

NICHOLSON DRIVING BLOCK

The device herewith illustrated shows itself on first sight to be a variation of the orthodox form of driving block, which has been in use for many years. The mechanic will readily see, however, that the makers, W. H. Nicholson & Co., Wilkes-barre, Pa., have incorporated several refinements in construction which greatly increase its usefulness.



A Driving Block with Adjustable Shelf for Retaining Arbor

The driving block is of the type provided with V-shaped center, which supports the work close up to the arbor with any size of hole. The interior of this V has formed in it, as shown, a series of cored slots, in any pair of which may be inserted a shelf for the arbor to drop onto. In driving the mandrel out of the work without the shelf to catch it, it would fall to the floor, instead of having the short drop of an inch or two allowed with this construction. The shelf is of iron, covered with leather, so that there is no danger of bruising the arbor. Of course, the hammer used for knocking out the arbor should be of leather, rawhide, wood or similar soft material. This driving block is 28 inches in height, weighs 225 pounds, and is sold for $15.00.

NORTHERN MACHINE WORKS "LITTLE GIANT" CUTTING-OFF SAW

The cutting-off saw shown herewith is intended by its builders, the Northern Machine & Repair Works of Wausau, Wis., to be simple and inexpensive enough to take the place of the power hack-saw, on work for which this latter machine is largely used—namely, the cutting off of stock. The advantage of the circular saw for this work is, of course, the fact that it cuts off the stock squarely, leaving the ends ready for accurate centering. At the same time it permits the stock to be cut to exact length without waste for truing up. A circular saw, when properly driven, also cuts very much faster than the hack-saw.

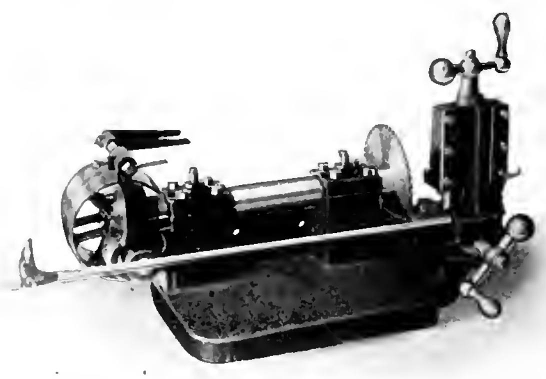


Fig. 1. A Simple and Efficient Cutting-off Saw

As may be seen, the machine has been simplified to the last degree in the point of mechanism; but at the same time, as is shown particularly in Fig. 2, the construction has been made very rigid, so that a cut up to the full capacity of the saw blade can be taken. The power feed, automatic stop, etc., have been eliminated, giving the machine a simplicity which adapts it to the requirements of smaller shops and for use on odd jobs and miscellaneous work in stock-rooms of large plants.

Its use is also suggested by the inventor in key fitting, to lessen the time required to file down and fit the battered ends resulting from driving the key in and out. The key may be made a little longer than the finished size for fitting, permitting the upset ends to be cut off before finally assembling it in the machine. This can be done in much less time than is

required to file these ends down to accuracy. The machine is provided with a vise which will grip either square or round stock, up to 2 inches in width or diameter. The worm drive provided, and the ample belt power, permits it to take a cut

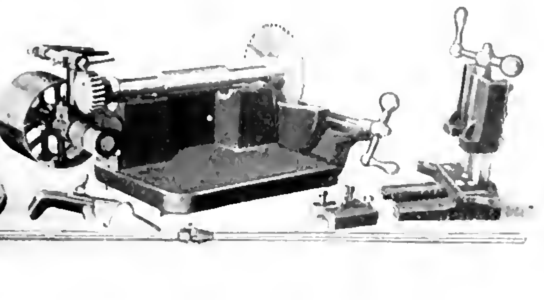


Fig. 2. Machine Dismantled to Show Construction

to its full capacity in two minutes, without crowding the saw. The machine is of simple construction and takes very little floor space. It can be bolted to a post or mounted on a bench.

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NEW MACHINERY AND TOOLS NOTES

HEATING FURNACES FOR DROP FORGINGS, ETC.: Billings & Spencer Co., Hartford, Conn. This is a strongly and durably built line of furnaces, adapted to the use of either oil or gas as fuel. They are intended to be used in heating work for drop forging or other hot working processes.

SMALL INCLINABLE POWER PRESS: T. W. G. Cook, 2 Reade St., New York City. This line of small power presses is built on the inclinable plan, so arranged that the machines may be swung from the vertical clear down to the horizontal, or to any angle in between. The change can be quickly made. The length of the slide has been increased by placing the crankshaft at the back of it, allowing the slide bearings to extend clear to the top of the frame.

HAND-OPERATED COMBINATION SHEAR AND PUNCH: Peck, Stow & Wilcox Co., Southington, Conn. This is a bench machine having separate handles for the shear and punch. The shear blades have a cutting length of 6 inches, and will cut bar iron up to ¼ by 1½ inch, or ½ inch square; it will cut sheet iron as thick as No. 8 gage for the full length of the blades. Holes can be punched to the center of a 10-inch circle, up to ⅜-inch diameter in ⅜-inch iron.

"VULCAN-BIJAW" CHAIN PIPE WRENCH: J. H. Williams & Co., Brooklyn, N. Y. The well-known chain pipe wrench made by this firm is now furnished in a double-ended, modified design, which permits the jaws to be turned end for end. This gives a new, sharp set of teeth for use when the old ones have become worn, doubling the useful life of the tool. The wrench is made in both cable and flat link chain styles, in sizes adapted to pipe and fittings from ⅛ inch to 12 inches.

"TWIN-GRIP" AUTOMOBILE WRENCH: Burkley Supply Co., 27 Old Slip, New York City. This tool is really a collection of four wrenches mounted together in a clamping holder, which permits them to be handled and kept as one tool. Closed, the measurements are 6 inches long by 1¼ inch high over all. The variety of wrenches provided takes in eight sizes of nuts, ranging from ¼ to ⅞ inch; one of the wrenches is furnished with a screw-driver end. The material used is case-hardened steel.

BENCH TAPPING MACHINE: S. A. Stewart Co., Waltham, Mass. This is a vertical machine of light but rigid construction. The spindle pulleys are made of aluminum for the sake of lightness. The reversing is effected by hand lever or treadle, either of which may be used without interfering with the other. The machine will tap to the center of a 12-inch circle, and will take in a maximum height of 7¾ inches from the chuck to the table. It may be used for any tap up to ¾ inch in diameter.

"SPARTAN" CHAIN PIPE WRENCH: Drop Forging Co., West Side Ave. & Fisk St., Jersey City, N. J. This pipe wrench is made of drop forged steel. Both handle and jaws are specially designed to give the maximum degree of strength for the amount of metal used. The teeth are milled at an angle so as to draw the jaws together when the pressure is applied, preventing excessive strain on the bolts, and giving a better gripping action on the pipe or rod to be turned. The wrench is made in five sizes, adapted to pipe from ⅛ to 12 inches diameter.

FRICTION TAPPING CHUCK: Woodstock Safety Chuck Co., Woodstock, Ill. This device employs a friction slipping mechanism, which is adjusted to give a driving power adapted to the diameter of tap being used. The adjustment is made by the turning of a knurled nut to agree with graduations provided. The driving power thus furnished is said to be nearly up to the strength of the tap a point which cannot be reached, however, without the slipping of the driving surfaces. The chuck has a round body without projections of any kind.

RADIAL POWER HAMMER: Radial Power Hammer Co., Los Angeles, Cal. This hammer is especially designed to permit one man alone to perform a wide variety of forging on work which has hitherto required the assistance of a helper. The hammer head is mounted on a swiveling bracket, so that it can be brought over a vise, an anvil or a swage-block. The latter may be rotated to bring various shapes into position beneath the hammer. The head weighs 75 pounds and has a vertical adjustment of 15 inches. It requires 3 horsepower to drive the hammer.

PORTABLE ACETYLENE WELDING APPARATUS: Oxy-Carbi Co., New Haven, Conn. The apparatus made by this firm, which was noticed in the January issue of MACHINERY, has now been put on the market in a portable form. The oxygen and acetylene generators are mounted on a truck, in combination with a reservoir and regulating apparatus for automatically controlling the supply of gases to the nozzle. This outfit is adapted to welding and cutting operations of all kinds by the oxy-acetylene process, and is said to be very economical and simple in operation.

PORTABLE STOCK RACKS: American Die & Tool Co., Reading, Pa. This stock rack resembles a type which has been used in various machine tool building firms and has been previously illustrated in the technical papers, but it is now for the first time placed on the market. The racks are formed of a solid casting with wide bases whose shape provides three backs each for lengths of bar stock to rest in. These racks will stand on any floor and do not need to be fastened. Each opening will hold fifteen round bars 2½ inches diameter. The weight of each casting is about 115 pounds.

POWER CHIPPING HAMMER: Coates Clipper Mfg. Co., Worcester, Mass. The makers of the Coates flexible shaft and mongrel gear drive (described in the November, 1909, issue of MACHINERY) have applied this drive to a new portable tool—a power-operated chipping hammer. This is of simple construction, giving 2,000 blows a minute, through the action of revolving hammers on the chisel head. It is operated by a ½ horsepower motor and, it is stated, will perform all classes of chipping work in a manner which competes with the performance of the pneumatic hammer.

CLUTCH PLANER DRIVE: American Twist Drill Co., Laconia, N. H. This firm has devised a friction clutch drive for planers, which is operated by the regular reversing dogs. It obviates the shifting of the belt, which requires considerable power and is a matter of great difficulty, particularly with wide and heavy belts. The wear of the belts due to the shifting is also obviated by the use of this clutch. It is stated to be very positive in its action, causing the platen to come to a stop at very nearly the same point at the end of each stroke. It is designed for application to standard planers.

FOUR-BELT PLANER DRIVE: Niles-Bement-Pond Co., New York City. The difficulty of shifting the wide belts required for heavy planers has led to this new design. The wide forward and reverse driving belts are each replaced by two narrow ones, which have to be shifted but one-half the distance, and which offer considerably less resistance to the movement as well. This gives a greatly increased ease of operation to the planer, and greater surety of action in the automatic reversal of the stroke. There should also be, it would seem, a gain in the reduction of wear and tear on the belts themselves.

LAMINATED LEATHER BELT: American Laminated Belt Co., New York City. This leather belting is built up of strips of leather bound side by side, and so arranged that the cut edge of the leather forms the surface in contact with the pulleys. This construction, it is claimed, gives much greater wearing qualities than when the ordinary construction is used with the fibers of the belt running parallel with the direction of movement. It at the same time brings the wearing surface on a stronger portion of the leather, and one not likely to be affected by improper tanning, or to be burned when the belt slips.

COLD CUTTING-OFF SAW: American Die & Tool Co., Reading, Pa. This is a machine of the type in which the saw is mounted on the carriage and fed in the work. It is spur-gear driven, the gears on the carriage being forged in one piece with their shafts and made of 60 carbon steel. Changes in feed are obtained from a gear box giving a range of from ⅛ to 1 inch movement per minute, all controlled by a single lever. The driving pulley is provided with a clutch, so the machine may be driven direct from the line shaft if desired. An automatic stop is furnished. This machine will take 9 inch round stock. It weighs about 2,200 pounds.

BORING MACHINE FOR LOCOMOTIVE WORK: Niles-Bement-Pond Co., New York City. This tool, made at the Bement Works of the builders, is designed for simultaneously boring and facing both ends of cylinders up to 6 inches in length. The spindle is driven by a gear of large diameter close to its outer end, giving a powerful drive. The work table is 54 inches wide, and 72 inches long in a direction at right angles to the machine. It has a cross feed of 30 inches and a longitudinal

hand traverse of 18 inches. A 20-horsepower motor is required to drive it. Power handling is provided for the raising and lowering of the table, and the rapid traverse of the bar.

Special Machine for Milling Automobile Front Axles: Beaman & Smith Co., Providence, R. I. This machine comprises a long bed on which the work is clamped, and which is also provided with ways on which slide four heads, equipped with suitable cutters for milling the faces of the spring-supporting pads and the bosses for the steering knuckles. Power quick return is applied to all the feed movements, which are so connected as to operate simultaneously. Six feed changes are provided, varying from ½ to 6 inches per minute. A cone pulley gives three speed changes for the spindle, ranging from 17 to 23½ revolutions per minute. Speeds and feeds are all gear-driven.

Swivel-joint Pneumatic Hose Coupling: Caskey Valve Co., 99 John St., New York City. This is a coupling for pneumatic hose of the quick connection type; it has the advantage of being provided with a swivel joint, so that all tendency toward kinking in the hose is avoided. The coupling is kept locked by a powerful spring, and it is impossible to open it by jarring. The joints are packed with leather and are tightened by internal air pressure entirely, it not being necessary to jam the surfaces together to insure freedom from leakage. The capacity of this coupling is equal to that of the full area of the hose to which it is attached. They are made for ¼ to 1¼-inch diameters.

Hand-Power Punching and Shearing Machines: Little Giant Punch & Shear Co., Sparta, Ill. This firm has recently completed a line of hand-power punch and shearing machines adapted both to actual use in the hand, and, in the larger sizes, for mounting on the bench or floor. They are made both as separate punches and separate shears, and also in combined form; the latter machine is of the floor type and has separate levers for the punch and shear, so that both can be operated simultaneously without interference. This machine will cut round iron up to ½ inch and bar iron up to ¼ by 2½ inches, while the punch has a capacity for 5/16-inch holes in ¼-inch material.

Punch Presses with Westinghouse Motor Drive: Toledo Machine & Tool Co., Toledo, O. This firm has recently furnished a complete motor-driven stamping press equipment for making metal boxes, requiring operations like perforating, shearing, blanking, forming, etc., on the various angles, corner braces, sides, bottoms and covers used on steel-bound, wood packing cases. These machines have been equipped throughout with electrical drive, giving a considerable advantage in ease of operation, freedom from countershafts, etc. This results in a clean, well-lighted shop, free from ceiling obstructions. It is stated that the electrical operation has also resulted in a reduction in operating costs.

Drawing Stand: Shartle Bros. Machine Co. Middletown, O. This is a table of the tripod stand variety, adjustable both for height and angle of the board. It may also be revolved at will to any position required to get a favorable light. A special feature of the construction is a tool shelf, which is so connected with the column by a link arrangement that it is kept horizontal whatever the angle to which the board itself is set. This obviates the accidental dropping of instruments, ink, etc. Special provision is also made for rapidly changing drawing boards. This is a convenience where two or three jobs are kept in hand at one time, as it is unnecessary to remove the paper from the board each time a change of work is made.

Tool-room and Vertical Grinder: Blake & Johnson Co., Waterbury, Conn. This grinding stand is provided with a table adjustable for height, and has a tilting adjustment for this table about a pivot, operated by a fine pitch screw and nut, giving an additional fine adjustment for height of 1½ inch. By this means it is possible to use the machine as a surface grinder, sliding the work on the table back and forth under the wheel. This adapts it to the grinding of blanking, stamping and piercing dies, etc. The table is 18½ inches long and 9¼ inches wide. The bracket carrying the table has a vertical adjustment of 6 inches, permitting it to be raised within 3 inches of the spindle center. The spindle boxes are dust-proof.

Kelly Sand Blast: High Pressure Sand Blast Co., New York City. The difficulty of using high pressures for sand blast work has been principally that of the erosion of the nozzle surfaces by the combined air and sand passing through it at a high velocity. In this apparatus the difficulty has been overcome by leading the sand and the air to the nozzle by separate hose, and providing the nozzle with a removable tip at the orifice. The cost of these tips is insignificant, and they may be quickly renewed as often as needed. Working with 100 pounds pressure, about 70 cubic feet of free air is used per minute. It is stated that the low pressure machines require from three to six times as much sand for the same work as when the higher pressures are used.

"Rapid" Screw Slotting Machine: Garvin Machine Co., Spring and Varick Sts., New York City. This screw cutting machine works on a different principle from the orthodox construction, in that the body of the screw is grasped in a split chuck, and fed directly in toward the wheel. The latter is guarded to protect the fingers of the operator, and is equipped with a self-contained reservoir to provide the lubricant. A lever operates the plunger, tightening the chuck when the work is fed toward the saw and loosening the chuck and ejecting the work when the plunger is drawn back again. It will slot screws from ¼ to ½ inch in diameter. Suitable supports are provided for the work-boxes, into the lower one of which the slotted screws fall without help from the operator.

Cam Grinding Attachment for Vertical Grinder: Pratt & Whitney Co., Hartford, Conn. The well-known vertical grinder made by this firm has been provided with an attachment for grinding automobile cams, particularly those of the type that are formed integrally with the shaft. The flat lower surface of the ring-wheel is used to finish the work. This preserves the constant shape of the cam as the wheel wears down; in this particular it is an improvement over the method of grinding with the periphery of a disk wheel, which gives a changing shape to the work as the diameter decreases. The attachment is easily placed on the machine or removed from it. It is provided with an indexing mechanism for timing the cams. The operating parts are carefully protected from dust and dirt.

Nut Castellating Device: Garvin Machine Co., Spring and Varick Sts., New York City. The screw slotting machine manufactured by this firm may be provided with a simple attachment for castellating nuts. When so used, it is provided with a hexagonal chuck, fitting the work and mounted in a head, which may be rotated by a convenient handle to three different positions for cutting the successive slots. The chuck is self-ejecting, and the machine is provided with all the conveniences found on the regular screw slotting machine. A device acting on similar principles is also made for use in the milling machine. This, however, carries four spindles, and is designed to be used for four saws on the cutter arbor. All four chucks are opened and closed and indexed simultaneously.

Die and Surface Grinder: Hemming Bros., New Haven, Conn. This machine is of the vertical spindle, cup-wheel type, which has lately come into extensive use for die sharpening and surface grinding. It is a hand-operated machine, and offers in this respect the particular advantage on certain work of permitting the operator to feel the cut and thus be sure of what the wheel is doing. The spindle is driven through bevel gears and a self-contained countershaft. Rubber wheel guards and a trough surrounding the work-table, keep the cooling water within bounds. The vertical feed handwheel is graduated to thousandths of an inch, on a circle of large enough diameter so that fractions of thousandths can be easily read. This tool will be furnished, if required, with magnetic chuck and automatic feed.

Slotting Machine: Pottstown Machine Co., Pottstown, Pa. This firm builds a slotting machine of improved construction, giving adjustments which should be particularly useful in tool-making, die work, etc. The slotting head can be swung to an angle and the work-table can be also tilted around to an angle of 45 degrees. This makes it possible to cut miter gears or do similar work. A hole is provided clear through the circular table, the work-slide and the knee, permitting long work to be held without interference. In its general design, the structure of the machine is similar to that of the ordinary column and knee type milling machine, with the cutter spindle replaced by the slotter ram. The distance from the column to the center of the tool is 12 inches. The circular table is 14 inches in diameter and the tilting table has a vertical adjustment of 16 inches.

"Perkins" Combined Protractor and Level: Florence Iron Works Co., Florence, Col. This instrument consists essentially of a V-block on which is mounted a disk graduated in degrees and carrying a level; the V-block also carries a prick punch in a central seat. The tool is useful in a number of ways. It is adapted particularly, for instance, to the laying out of keyways on shafting. By means of the level, the V-block may be set on the shafting so that the prick punch point will indicate the vertical center. It is thus possible to locate a line of keys along a shaft having varying diameters. By setting the protractor properly, it is also possible to locate keyways at any desired angle with the horizontal and vertical, clear around to the bottom. It should be useful among other things for quartering locomotive axles, and for laying out eccentric keyways when the angular advance is given.

New Designs of Forge Blowers: Buffalo Forge Co., Buffalo, N. Y. This firm has added two new designs to its line of forge blowers. One of these is intended for use particularly where compressed air is available, and consists simply of a tuyere and jet made on the injector principle. With this construction, a small high-pressure stream of air sets in motion a large volume of air at a low pressure, giving the required condition for the forge fire. The second design is of the rotary fan type, driven by a direct-connected motor. Great care has been taken in this set to have the efficiencies of the motor, the fan and the rotating members in their bearings

all very high, so that the air will be delivered with as little power expense as possible. These sets are made in sizes varying from 1/32 to 1/2 horsepower. They are adapted to direct connection with a lamp socket in shops where electricity is available.

Multiple Drilling and Tapping Attachment: Rockford Drilling Machine Co., Rockford, Ill. This attachment is applied directly to one of the maker's regular 14-inch drills with tapping attachment, and makes possible the drilling of six holes in a circle simultaneously. It was originally designed for drilling and tapping 54 holes, spaced equi-distantly in a circle about 6 inches in diameter. The drilling of these 54 holes required, therefore, nine indexings of the work, which was effected by the special type of jig used. For tapping, the work was spaced around by hand from one series of holes to the next. The multiple head is clamped directly to the spindle sleeve, and is lined up by guides on the jig base clamped to the table. A spring support is provided which, with the spindle counterbalance, permits the head to return freely after each drilling operation. By the use of this attachment 54 holes, 1/4-inch in diameter are tapped at an average rate of 50 seconds for the set. The drilling operation is, of course, much more quickly performed.

Axle Cutting-off and Centering Lathe: Fawcus Machine Co., 2820 Smallman St., Pittsburg, Pa. This machine is, of course, a specialized lathe, following the general lines of the machines previously used for this purpose. It has a number of advantages incorporated in its design, particularly in the strength and rigidity of the structure, the power of the drive and the convenience of manipulation provided. Complication of the driving mechanism is avoided by the use of separate motors for the main drive, and for each of the two centering spindles. Each carriage has a centering spindle and a cutting-off tool, and is provided with a quick operating lever for bringing either one or the other into position. The double driving heads are adjustable for length to suit different lengths of axles, although, of course, in ordinary work where the standard gage is employed, this adjustment is not altered. Two rates of driving are provided through friction clutches and simple geared connections, and controlled by a hand lever operated from the front of the bed. These machines were originally designed and furnished for the new axle mill of the Indiana Steel Co., at Gary, Ind.

Steam Turbine Driven Centrifugal Boiler Feed Pump: De Laval Steam Turbine Co., Trenton, N. J. The development of the centrifugal pump has reached a point which makes it practicable to apply it to boiler feeding. The latest pump designed by the above makers will overcome a head of 700 feet with two stages only, and will give efficiency of over 60 per per cent when working at 1,600 gallons a minute. It can be governed to generate any desired constant pressure, or any desired fixed excess pressure, and it will maintain these conditions without vibration, hammer or shock in the feed line. The advantages of such a pump are numerous. The inflow of water can be regulated at the boiler without reference to the pump. There are no valves and only two packings of small diameter to be kept tight against the hot water. The high efficiency of the design of the propeller has made unnecessary the use of guide vanes, with their mechanical and theoretical disadvantages. Simplicity of construction and accessibility for inspection have been carefully looked out for. The steam turbine driving it can be modified to operate on exhaust or live steam or both as may be required. The pump is, of course, as well adapted to motor drive as to direct connection to steam turbine.

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The famous mine fire in the Greenwood Colliery near the village of Summit Hill in northeastern Pennsylvania, which had been burning for almost exactly fifty-one years has finally been checked. This subterranean fire had resisted all efforts to smother or drown it out and thousands of dollars have been expended in vain efforts to stop its spread (see Machinery, October, 1904). It is estimated that $25,000,000 worth of coal has been burned and probably if the last effort had not succeeded, many millions more would have been destroyed. The spread of the fire was checked by building a clay barrier across the basin extending down to the water level. The barrier was approximately 900 feet long and it extended down to a depth of about 220 feet. The work was conducted under great difficulties, the fire being so close at places that the heat and bad ventilation made the work exceedingly arduous. For part of the time the men had to work on half-hour shifts, and work was only possible because of elaborate ventilating apparatus which was installed at heavy cost. Canvas flues were let down into the shaft, which being flexible, could be shifted so as to supply fresh air in the exact spot needed. Fifty thousand cubic yards of clay were required to make the barrier and 8,000 cubic yards of concrete.

ELECTRICAL HEAT STORAGE

A scheme for storing heat generated electrically has been devised by Mr. C. G. Bell, member of the British Institute of Electrical Engineers that may be useful to electric lighting companies in supplying a daylight load. The futility of electric storage batteries for large power stations is generally recognized—Mr. Edison's excepted, of course and Mr. Bell has tried to solve the problem by converting electricity into heat and storing it for domestic use. Electric heating at regular commercial rates is too costly for all but certain special uses but if a large market for heat could be found in the daylight hours only, a very favorable price could be made by the lighting companies with profit to themselves and satisfaction to customers.

The apparatus in the present form consists of an iron block about eighteen inches high and a foot in diameter. This block is incased in a thick magnesia jacket to prevent radiation. In the center of the block is placed a removable heating unit of several sections. When the current is turned into the heating unit the iron block is raised to a temperature of 600 or 700 degrees F. in a few hours, and will remain heated almost indefinitely, except for what is used. In its original form it was designed for hot water alone. Its present development not only does away with tanks and kettles, but provides hot air, steam, or hot water for heating, with great saving of space, and provides unlimited heat for cooking. Boiling water is instantaneously on tap day or night, even though all the current may be in use at the time for lighting. The system does away with storage of hot water. Instead, an iron coil is cast inside the metal block. As the block is at a normal temperature of 600 degrees, this coil is full of superheated steam. The steam is regulated so that a small or great quantity may be introduced into the water pipe, giving, instantaneously, water at any desired temperature.

The system is to be used with a house feeding device that makes each customer a consumer of a constant quantity of electricity throughout the twenty-four hours of the day. When the current is being used for lighting, fans, or other purposes, it is switched off the heating unit perhaps entirely, and as soon as ordinary uses stop, the current is switched back again into the heater. The advantage of a constant load thus made possible is obvious. It is claimed that it would more than quadruple the efficiency of the machinery in the average lighting power house by making it produce useful current all the time instead of having a large amount of equipment idle save during four or five hours a day.

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EDISON STORAGE BATTERY

The new storage battery which Mr. Thomas A. Edison has been experimenting with for a number of years has recently been subjected to a series of tests to determine its efficiency. In order that the tests might be made under actual working conditions, a special car suitable for street railway service was constructed and in this car the batteries were installed. Two 7 1/2-horsepower motors were used for driving, and a maximum speed of 20 miles an hour was attained. It is stated that this car, which weighs about 5 tons, will run 150 miles at an average speed before the batteries need to be recharged. In outer appearance the cells of this battery do not differ, except in minor details, from the original cell which was brought out in 1901. The structure of the positive plate, however, has been radically modified, and other improvements embodied, to increase the capacity and durability. These batteries are made at present in two sizes. The smaller size gives about 14 watt-hours per pound of cell and the larger size 16 watt-hours. The weight of such a battery for a car requiring an average of 12,000 watts (it being assumed that the battery is to be in service for even five hours without recharging) would be 3,750 pounds. When the additional power required for hauling this dead weight is considered, it is evident that the present system of imparting the electrical energy from the power station to the motors of the street car is not likely to be changed by the present form of this new storage battery.

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CINCINNATI AUTOMOBILE SHOW

The First Annual Automobile Show given under the auspices of the Cincinnati Automobile Club, opened Monday

morning, February 21, with two hundred cars on display representing sixty exhibitors; the floor space given to the machines was 30,400 square feet. Of the cars on exhibition, fifteen were of Cincinnati manufacture, and were made by the Enger Motor Car Co., Haberer & Co., and the Schact Mfg. Co.

Besides automobiles, there were motor-cycles, motor boats, accessories, balloons and aeroplanes. The aero exhibit was strictly local, being furnished entirely by the Holz Balloon Co. of Cincinnati, and consisted of small aeroplane models, a large glider without a motor, and a large, complete, air-inflated balloon model, showing basket, ballast bags, anchor and drag ropes.

Much credit is to be accorded General Manager Ruthford H. Cox, Charles L. Bonifield, Wm. M. Perin and the various committees for placing this show in a class well up towards those of New York and Chicago.

The show closed Saturday, February 26, after a week of continuous success.

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MEMORIAL OF DR. ROBERT H. THURSTON

A beautiful bronze memorial tablet in high relief of Dr. Robbert H. Thurston, one-time head of Sibley College of Engineering, Cornell University, one of the founders of the American Society of Mechanical Engineers and the society's first president, was dedicated in the reception hall of the society at 29 West 39th St., New York, Tuesday evening, February 8. It is a replica of the tablet by Herman H. McNeil, presented to Sibley College by the students and alumni. The tablet bears the inscription:

1839—ROBERT HENRY THURSTON—1903
FIRST PRESIDENT
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Dr. Thurston was an international authority on the steam engine, thermodynamics, friction and lubrication, materials of construction, etc. He was a voluminous writer, being a frequent contributor to the technical press, the society's proceedings and the author of several standard works. He died October 25, 1903. See MACHINERY, November, 1903, for an account of his life.

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WORCESTER ANNUAL EXHIBITION

The second annual exposition of the mechanical, electrical and textile industries of New England was held in Mechanics Hall, Worcester, Mass., during the week beginning February 7. Two large floors were completely filled with exhibits representing improvements in machinery and appliances in these industries, and the attendance from all over New England was large. It was generally conceded that the exposition was much better than the first one, held last year. Many new machines were shown. It is proposed to continue the exposition as an annual event.

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PERSONALS

Edward Schwartz has been made superintendent of the Toledo Electric Welder Co., Cincinnati, Ohio.

C. G. Heiby, machine shop foreman for the H. Mueller Mfg. Co., Decatur, Ill., has been promoted to the position of tool-room foreman.

R. K. LeBlond, president of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has gone to the West Indies for two months' vacation.

Fred A. Bigelow, formerly New England representative of the Carpenter Steel Co., has been made manager of the company's Cleveland branch.

P. C. Benedict has been made district salesmanager for the Bessemer Gas Engine Co. of Grove City, Pa., with headquarters at 719-721 First National Bank Building, Cincinnati, Ohio.

E. R. Johnson, until recently master mechanic of the Rock Island shops at Horton, Kansas, has been made general foreman of the Illinois Traction System's shop at Decatur, Illinois.

Henry Morris, manager and treasurer of the Western Tool & Mfg. Co., Springfield, Ohio, will sail early in March for a ten weeks' trip to Italy, Germany, France and Great Britain for business and pleasure.

H. E. Obenshain, who has been secretary and treasurer of the Screw Cutting Company of America, Philadelphia, Pa., for some time, resigned February 1 to become president of the Roanoke Iron Works, Inc., Roanoke, Va.

Roy V. Wright, for several years editor-in-chief of the *American Engineer and Railroad Journal*, has joined the editorial staff of the *Railway Age Gazette*. Mr. Wright will supervise the mechanical department of the journal.

E. G. Matter, connected with the office of the National Acme Mfg. Co., Cleveland, Ohio, on Indiana territory, for several years, has been transferred to the Detroit and eastern Michigan territory formerly covered by Mr. W. C. Lang.

James Brown, formerly department foreman for the Cincinnati Milling Machine Co., Cincinnati, Ohio, and later superintendent of the Oesterlein Machine Tool Co., of the same city, has taken the position of superintendent for M. L. Andrew & Co., Cincinnati.

Fr. W. Sebelin, general foreman of the mechanical department of the Cleveland Twist Drill Co., Cleveland, Ohio, has resigned the position to become superintendent of the P. A. Geier Co., Cleveland, general jobbers and manufacturers of automobile parts.

Eph. Smith, who has been the New England sales manager of the Colonial Steel Co. since its organization in 1901, has resigned on account of long continued ill-health. E. P. Fitzgerald, who has represented the Boston office with headquarters at Springfield, Mass., for the past five years, has been appointed successor, the appointment taking effect March 1.

Following the consolidation of *Industrial Engineering* of Pittsburg, Pa., and the *Engineering Digest*, New York, with the title *Industrial Engineering and Engineering Digest*, Mr. Robert Thurston Kent assumed the editorship of the consolidated publication, succeeding Mr. Harwood Frost, who was the founder of the *Engineering Digest*. Mr. Frost has been forced by the pressure of his duties in connection with the *Engineering News* to devote the whole of his time to that publication.

Frank A. Foster, Providence, R. I., will sail from Seattle about March 22 for China where he will take a position as representative of the American Locomotive Co., in which he will have to do largely with machinery and the mechanical parts of railroad work. He requests catalogues and full information regarding products from American manufacturers of machinery. Mr. Foster is a graduate of the Worcester Polytechnic Institute, and his address will be Davenport Road, Tientsin, China, care of Albert C. Lee.

Alfred Spangenberg, Plainfield, N. J., a well-known contributor to MACHINERY, will lecture before the students of the mechanical engineering classes of Columbia University, May 9, on the subject "Assembling in a Manufacturing Line," treating of the following topics: 1.—Elements of Assembling Operations: Definition of assembling, methods and processes of assembling, concrete examples. Assembling a motor-driven planer by two methods with approximate difference in cost. Factors leading to economical production. Machine processes versus hand processes. 2.—Effective Organization in the Assembly Department.

Caleb Rutter, who for the past eleven years was foreman of the machine department of the Pennsylvania Iron Works Co., Eddystone, Pa., has resigned to take charge of one of the tool-rooms of the Autocar Co., Ardmore, Pa. At the noon-hour of February 11, Mr. Rutter was presented with a smoker's case of stering silver, beautifully engraved, by the employees of the works as an evidence of their regard. Mr. A. E. Exton, assistant chief engineer of the plant, who made the presentation, said in part: "There is no donbt that this change means the addition of one more live man to the ranks of the great army of automobile builders."

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OBITUARIES

Fayette Brown, president of the Brown Hoisting Machinery Co., Cleveland, Ohio, died January 20 in his eighty-seventh year.

Freeland Oakley, well-known in his day as an expert builder of water wheels, died in Springfield, Mass., January 17, aged eighty-two years. Mr. Oakley was for years a member of the firm Phelps & Oakley, which built many of the paper mills in Massachusetts. His reputation was made in the construction of large over-shot and under-shot water wheels.

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COMING EVENTS

April 5-7.—Joint convention of the Southern Supply and Machinery Dealers' Association, and American Supply and Machinery Manufacturers Association, Jacksonville, Fla., Seminole Hotel, headquarters. Alvin M. Smith, secretary and treasurer of the Southern Supply and Machinery Dealers Association, Richmond, Va.

April 13-14.—Annual convention of the National Metal Trades Association at the Hotel Astor, New York. Robert Wuest, commissioner, 605 New England Building, Cleveland, Ohio.

April 17-June 1 (April 4 to May 19, O. S.).—International exhibition of internal combustion motors under the auspices of the Imperial Russian Technical Society of St. Petersburg on the premises of the society Panteleimonskaia No. 2. The object of the exhibition is to acquaint the consumer as well as the general public at large with the development and present condition of internal combustion motors, and to show the comparative advantages of each of the existing systems. The exhibit will be divided into sections as follows: Motors for agricultural purposes, motors for artisan in small industries, and domestic use, motors for factories, motors for marine, railway, tram-

car, automobile, aeronautical and similar purposes, motor details and accessories, literature on motors, drawings, diagrams, etc.

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria street, London.

May 10-13.—Seventeenth annual convention of the Air Brake Association, Indianapolis, Ind., Dennisson Hotel, headquarters. An interesting program has been prepared on air brake construction, air pumping, piping inspection and cleaning, triple valves and brake cylinders, recommended practice, etc. F. M. Nellis, secretary, 53 State St., Boston, Mass.

May 14-22. Prague agricultural exhibit intended to comprise all the leading innovations that have been introduced in agricultural practice, agricultural machinery and mechanical appliances in dairying, etc. Arthur Goblet, director, Karalinenthal, Prague, Bohemia.

May 31-June 3. Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-August 31. American Exposition in Berlin, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of foreign travel, when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church street, New York.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich., C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 15-17. Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 23-28.—International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology at Dusseldorf, Germany. For information apply to G. C. Lloyd, 28 Victoria street, London.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

SOCIETIES AND COLLEGES

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY AND SOCIETY OF ENGINEERS have been amalgamated under the name Society of Engineers, Inc. A. S. E. Ackerman, secretary, 17 Victoria Street, Westminster S. W., England.

UNIVERSITY OF KANSAS, Lawrence, Kans., dedicated a new engineering building, February 25. Addresses were made by Frank Warren, dean of the school of engineering; Richard C. Maclaurin, president of the Massachusetts Institute of Technology, and Ernest R. Buckley, president of the American Mining Congress. Chancellor Frank Strong presided.

COLUMBIA UNIVERSITY will present four lectures in the course in works management, by Charles A. Carpenter, March 5, 10, 12 and 17; two lectures by H. L. Gantt, March 31 and April 12; one lecture by Walter N. MacFarland, April 7; three lectures by Harrington Emerson, April 14, 16, 17; three lectures by Richard T. Lingley, April 30, May 5 and 7, and one lecture by Edwin J. Prindle, April 14.

THE SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY, New Haven, Conn., has received a gift of $250,000 for the construction and equipment of the new mechanical engineering laboratory from Mr. George G. Mason of New York, and his brother, Mr. William S. Mason, Evanston, Ill. The new laboratory will have a frontage of about 85 feet and depth of 200 feet. It will be four stories in height, constructed of Indiana limestone and brick. It will contain approximately 50,000 square feet of floor area and 880,000 cubic feet of space. The entire equipment will be new and will consist of the most modern appliances for assisting the students in studying those fundamental principles of applied science which are closely related to mechanical engineering, such as the strength of materials, the combustion of fuel in furnaces and in internal combustion engines, the making of steam in boilers of different types, the using of saturated and superheated steam in engines or steam turbines, the artificial production of cold, the production, transmission and use of compressed air, the pumping of water, transmission of power and the problems of heating and ventilation.

NEW BOOKS AND PAMPHLETS

ENGINEERING STANDARDS COMMITTEE, 28 Victoria St., Westminster, S. W., London. British standard specifications for keys and keyways No. 46. Price 2s, 6d.

BULLETIN OF THE COLLEGE OF ENGINEERING, POLYTECHNIC INSTITUTE OF BROOKLYN. 124 pages, 6 x 8½ inches. Published by the Polytechnic Institute of Brooklyn.

REPORT OF COMMISSION OF EDUCATION FOR THE YEAR ENDING JUNE 30, 1909. VOLUME I. 598 pages, 6 x 9 inches. Published by the United States Bureau of Education, Washington, D. C.

YEAR-BOOK OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 1910. 365 pages, 6 x 9 inches. Published by the American Institute of Electrical Engineers, 33 West 39th Street, New York City.

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, containing the president's report for the past year. 140 pages, 6 x 9 inches. Published by the Massachusetts Institute of Technology, Boston.

FOURTEENTH ANNUAL REPORT OF THE INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS, held at Atlantic City, N. J., September, 14-16, 1909. 153 pages, 6 x 9 inches. Frank P. Foster, secretary, Corning, N. Y.

TESTS OF TWO TYPES OF TILE-ROOF FURNACES IN WATER-TUBE BOILER. By J. M. Snodgrass. Bulletin No. 34. 20 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

THE INFLUENCE OF FORESTS ON CLIMATE AND ON FLOODS. By Willis L. Moore, Chief of the United States Weather Bureau. 38 pages, 6 x 9 inches. Published by the United States Government, Government Printing Office, Washington, D. C.

PROCEEDINGS OF THE ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS, Chattanooga, Tenn., December, 1909. 170 pages, 5½ x 8½ inches. Published by the Association. G. P. Conard, secretary, 24 Park Place, New York City.

STANDARD CODE OF RULES FOR INTERURBAN OPERATION. Adopted by the Transportation and Traffic Association at the 1909 Convention at Denver, Col. 99 pages, 3½ x 6 inches. Published by the Association. Office of the Secretary, 29 W. 39th St., New York City.

STANDARD CODE OF RULES FOR CITY OPERATION. Adopted by the Transportation and Traffic Association, at the 1909 Convention at Denver, Col. 44 pages, 3½ x 6 inches. Published by the Association. Office of the Secretary, 29 W. 39th St., New York City.

COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL IN LOCOMOTIVE BOILERS; BULLETIN NO. 412. By Walter T. Ray and Henry Kreissenger. 32 pages, 6 x 9 inches. Published by the Department of Interior, United States Geological Survey, Washington, D. C.

THE ESSENTIALS OF LETTERING. By Thomas E. French and Robert Meiklejohn. 72 pages, 9 x 6 inches. 74 illustrations. Published by the Varsity Supply Co., Columbus, Ohio. Price $1.

This book, which is already in its second edition, has been prepared as an introduction to the subject of lettering, and is intended as a manual for students and designers who use lettering either on drawings or in designs of an artistic character. The book contains chapters on the construction of letters, composition of titles, selection of styles, letters in designs, monograms, ciphers and marks, and on drawing for reproduction. That section of the book which is specially intended for the mechanical draftsman contains some very good plates showing the proper proportioning of letters used on drawings, and the chapter on composition should be of value in deciding upon neat looking arrangements for titles on drawings.

MODERN COKING PRACTICE. By T. H. Byrom and J. E. Christopher. 156 pages, 6 x 9 inches. 109 illustrations. Published by the Norman W. Henley & Son, New York City. Price $3.50.

This book contains, with some amplifications, a series of lectures delivered by Mr. J. E. Christopher, at the Wigan Technical College, to a class of men engaged in the working of coke ovens, and it is expected that the book will be as useful to others who are engaged in coke manufacture. There has been in the past too little published on this subject, and to those engaged in this kind of work the book should, therefore, prove of special value. It contains chapters on General Classification of Fuels; Coal Washing; The Sampling and Valuation of Coal, Coke, etc.; the Calorific Power of Coal and Coke; Coke Ovens; Cooling and Condensing Plant, Gas Exhausters; Ammoniacal Liquor; Treatment of Waste Gases from Sulphate Plants; Valuation of Ammonium-sulphate; Recovery of Ammonia from Coke Oven Gases, and Surplus Gases from Coke Ovens.

TEST OF TUNGSTEN LAMPS. Bulletin No. 33, by T. H. Amrine and A. Guell. 33 pages, 6 x 9 inches, 28 diagrams. Published by the University of Illinois, Engineering Experiment Station, Urbana, Illinois.

This bulletin presents the results of tests upon tungsten lamps of 25 watt size. Of the three kinds of lamps tested, one kind was of American manufacture with filaments made by the paste process, the other two being of German manufacture with filaments made by the colloid and deposition process. The tests show that when the lamps are subject to vibrations, the life depends to a great extent upon the style of filament mounting. Filaments mounted under no tension have longer life when subjected to vibrations than those having tightly strung filaments. It was found after burning 2,000 hours under good conditions, that the average candlepower of the filaments made by the paste process decreased to 88 per cent.; by the deposition process, to 89 per cent.; by the colloid process, to 77 per cent. of the initial value.

PATENTS, DESIGNS, AND TRADE MARKS. By Kenneth R. Swan. 386 pages, 5½ x 8½ inches. Published by D. Van Nostrand Co., New York City. Price $2.

This book deals with patents, designs and trade marks from the legal point of view, and being written by an Englishman, it deals in particular with the English law in relation to patents. As, however, American and English law have much in common in this respect, the book will undoubtedly be of value to those Americans who are interested in patent law, and particularly to those who have patent interests in Great Britain. In producing the book, the author has aimed at presenting its contents in such a form as to make it comprehensive to the layman unfamiliar with legal phraseology, and the subject has been handled from a commercial as well as a legal point of view. Two chapters are included touching upon the subject of patent laws in the United States, Germany and France, together with information in tabulated form of the terms, fees, and conditions as to the working of patents, in several of the larger foreign countries.

INTERNAL LUBRICATION OF STEAM ENGINES. By T. C. Thomsen. 97 pages, 5 x 7¼ inches. 24 illustrations. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, W. C., London. Price 2s 6d.

This book has been written with the end in view of assisting mechanical engineers directly interested in the satisfactory running of steam plants. Designers of steam plants will also find suggestions which will be of value when deciding upon the proper means of applying cylinder lubricants, and the best way of distributing them to the internal surfaces needing the lubrication. Among other things the book treats of the chemical and physical properties of cylinder oils, impurities of cylinder oils, internal lubrication of steam engines, lubrication for engines of different types, including Corliss engines, winding engines, engines using superheated steam, and locomotives, lubrication of valves, and graphite for internal lubrication. The book is of a decidedly practical character, and recommends itself to those who do not wish to go too deeply into the matter of lubrication, but who require a general working knowledge of the subject.

ELEMENTARY COURSE IN PERSPECTIVE. By Sherman M. Turrill. 71 pages, 5 x 7½ inches. 16 illustrations, printed on inserted folders. Published by D. Van Nostrand Co., New York City. Price $1.25.

In writing this treatise the author has assumed that the student is somewhat familiar with ordinary descriptive geometry, and the book is devoted to illustrating the application of the principles of descriptive geometry to the making of perspective drawings. Two methods for making perspectives are treated, the one intended mainly for the assistance of the mechanical draftsman, and the other for the artist and free-hand draftsman. A large number of problems covering the principles are given throughout the book. The subjects of parallel perspective, angular perspective, perspective of curves and perspective of shadows are dealt with. The mechanical draftsman, in general, is too little informed on the subject of perspective, which, in many cases, would be helpful to illustrate correctly the actual appearance of an object to a non-mechanical person, and the book is recommended to all who are desirous of increasing their knowledge of this method of representing objects.

THE DESIGN OF CONDENSING PLANT. By F. W. Wright. 200 pages, 5 x 7½ inches. 96 illustrations. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, W. C., London. Price 3s. 6d.

This book has been especially written to fill the demand for a book devoted exclusively to the various problems connected with condensing. In the various standard text-books on the steam engine, the references to the subject of condensing are very brief, and a more thorough treatment has therefore been deemed necessary. The several problems met with in the intelligent study of this subject,

such as the transference of heat from steam to water, the elimination of air leakage, and the withdrawal of air and vapor, etc., have all been dealt with. The book is practical in its character to the extent that it deals with its subject only with refereuce to practical requirements, but mechanical details of construction have not been considered except in so far as they are necessary for describing the several types of condensers, pumps, cooling towers, etc., required. The book contains chapters on heat units, jet condensers, ejector condensers, surface condensers, design of jet condensers, design of surface condensers, evaporative condensers, water-cooling plants and air pump efficiencies.

MECHANIC'S HANDBOOK. 330 pages, $3\frac{3}{8}$ by $5\frac{1}{4}$ inches. Illustrated. Published by the International Correspondence Schools, Scranton, Pa. Price in cloth binding, 50 cents; in leather binding, $1.

The first edition of this well-known mechanics' handbook was issued in 1893 in the form of a notebook containing 74 pages. It has since passed into the seventh edition and has been greatly improved and enlarged. Its popularity is testified to by the fact that the copy in review is of the 317th thousand. It was the aim of the publishers to present to the public a handbook of convenient size for the pocket, which would contain rules, formulas, tables, etc., in common use by engineers, and it will be generally conceded that this handbook answers the requirements exceedingly well. The contents comprise weights and measures, metric system, specific gravity, elements and alloys, weights of round and square rolled iron, weights of cast iron pipe, logarithms, trigonometrical functions, prime numbers, circumferences and areas of circles, use of formulas, tables of powers and roots and reciprocals, mensuration, formulas for mechanics, rules for belting, pumps, hydro-mechanics, strength of materials, boiler design, care of boilers, chimneys, machine design, change gears, screw cutting, steam engineering, machine details, rope belting, wire rope, definition of electrical units, wiring and wiring diagrams, wire tables, underwriters' rules, dynamo and motor design, batteries, electric and gas lighting, cable testing, surveying, laying out railway curves, leveling, tables of radii and curves, retaining walls, tunnels, earthworks, etc.

DESIGN AND CONSTRUCTION OF INTERNAL COMBUSTION ENGINES. By Hugo Güldner. Translated from the second revised edition with additions on American engines by H. Diederichs. 672 pages, 9 x 11 inches. 728 illustrations in the text and 26 folding plates. Published by the D. Van Nostrand Co., New York City. Price, $10.

This book presents without doubt the most complete treatment of the subject of gas and oil engines that has as yet been published. It goes thoroughly into both the theory and practice of the design of gas engines and auxiliaries. No effort has apparently been spared in making the information as complete as possible, and several colored folding charts are included, showing with great clearness the arrangement of complete gas engine installations. It is not possible in a short review to give full credit to the work, but it should be mentioned that the aim of the book is to clear the ground for placing the internal combustion engine among the machines whose design can be worked out on a thoroughly scientific basis, rather than along experimental lines. The work is founded on practical experience gathered during fifteen years in an executive capacity. Being thus written by a gas engine designer and builder, it presents to the gas engine designer a useful practical guide which is not merely descriptive of what has been done, but which analyzes the problems underlying the design of gas engines and points out the necessary requirements and the path to follow. Besides the numerous illustrations in the text, the book contains twenty-six folding plates, practically all of which illustrate existing installations of gas engines or sections and plan views of actually built successful gas engine types. Besides, there are 151 tables of data both of theoretical and practical value to the designer, ranging all the way from tables in thermodynamics, necessary for a successful design along scientific lines, down to the practical everyday shop tables required by the designer when making his drawings for the shop. The book is divided into four specific parts. Part I treats of the various methods of operating gas engines, and the gas engine cycles. Part II deals with the design and construction of internal combustion engines, and treats specifically of each part of the machine, such as the beds and frames, cylinders and jackets, cylinder heads, stuffing boxes, pistons, piston rings, piston rods, crankshafts, connecting-rods, valves, valve gearing, fly-wheels, governors and ignition apparatus. All the auxiliaries of gas power installations, such as gas producers, starting apparatus, mufflers, cooling arrangement, piping, pressure regulators and general machine parts, including screws, studs, keys, gas pipes, pipe fittings and flanges, and helical springs, are also treated. Part III deals with the construction, erection and testing of modern internal combustion engines. In this case each of the various types of gas engines in common use as manufactured by various firms are dealt with specifically. Part IV deals with gas engine fuels and the combustion in gas engines. Finally a voluminous appendix is added, giving the theory of thermodynamics and the fundamental principles of thermo-chemistry, together with details from practice, giving directions for operation, attendance, etc. To anyone who wishes to study the subject of gas engines thoroughly, or who requires a reference book on the subject which deals authoritatively with all the phases of gas engine theory, design and intallation, this book can certainly be recommended as the most complete work on this subject available.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC COMPANY Schenectady, N. Y. Bulletin No. 4589 on ornamental street lighting.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Circular of insulating coverings for steam pipes and boilers.

GISHOLT MACHINE COMPANY, Madison, Wis. Leaflet illustrating construction of friction headstock and lever control of Gisholt vertical boring mill.

MANHATTAN ELECTRICAL SUPPLY COMPANY, 17 Park Place, New York. Catalogue of electrical supplies entitled, "Something Electrical for Everybody."

HARRIMAN ENGINEERING COMPANY, 53 State street, Boston, Mass. Catalogue of Harriman rotary steam engine, rotary gas engine, and rotary compressor and pump.

ADAMS-BAGNALL ELECTRIC COMPANY, Cleveland, Ohio. Bulletin No. 85 superseding Bulletin No. 79, descriptive of Adams-Bagnall regenerative flame electric lamps.

E. G. SMITH COMPANY, Columbia, Pa. Folder containing testimonials of users of Columbia calipers. It states that over 50,000 Columbia calipers are now in use.

NATIONAL MACHINERY COMPANY, Tiffin, Ohio. Circular of National interchangeable case threading dies illustrating construction, method of grinding and the National die sharpener.

NORTH WESTERN EXPANDED METAL COMPANY, 930-950 Old Colony Building, Chicago, Ill. Bulletin of data on concrete reinforced with expanded metal as used in sewers, tanks and walls.

WAGNER ELECTRIC & MFG. CO., St. Louis, Mo. Circular illustrating the Wagner motors applied to ventilating fans, ice cream freezers, bread mixers, coffee grinders, pumping organ blowers, etc.

BOULET'S FINE TOOL WORKS, Beverly, Mass. Circular of Boulet's improved universal micrometer test indicator, and measuring instrument which, within its range, is as accurate as a micrometer caliper.

WILLIAMS TOOL COMPANY, Erie, Pa. Copy of report of results of four tests conducted by the Westinghouse Machine Company, Pittsburg, Pa., of Riblet heaters for utilizing exhaust heat of gas engines.

GREENE-TWEED & CO., 109 Duane street, New York. Advertising card of M. Covel belt fasteners, made in six sizes. These cheap and efficient belt fasteners are made of specially tempered steel wire that clinches without breaking.

B. F. STURTEVANT COMPANY, Hyde Park, Mass. Circular of Sturtevant ready-to-run ventilating sets for small and general offices, reception rooms, telephone booths, toilet rooms, sleeping rooms, kitchens, basements, laboratories, engine rooms, etc.

BARBER-COLEMAN COMPANY, Rockford, Ill. Catalogue A of high-speed steel and carbon steel milling cutters, spur gear and worm gear hobs, gear cutters and form cutters. Special cutters of all descriptions are made to order by the company.

TERRELL'S EQUIPMENT COMPANY, Grand Rapids, Mich. Circular on metal lockers for factories, foundries, shops, clubs, schools, gymnasiums, hotels and hospitals. These lockers are made in a variety of styles suitable for the uses mentioned.

LEBANON STEEL CASTING CO., Lebanon, Pa. Folder illustrating steel castings for automobiles. The characteristics claimed for Lebanon steel castings are efficiency, toughness, truth to pattern, freedom from blow-holes and smoothness of finish.

SPRAGUE ELECTRIC COMPANY, 527-531 West Thirty-fourth street, New York. Reprint of article in the *Iron Age* entitled, "Handling Coal by Electric Shovels," being an article descriptive of installations of Sprague Electric Company apparatus.

C. W. LEAVITT & CO., 39 Church street, New York. Reprint of paper by Mr. Wilhelm Borchers, read before the Pittsburg meeting of the American Institute of Mining Engineers, February, 1909, on Girod electric furnaces and the Girod steel process.

GOLDSCHMIDT-THERMIT COMPANY, 90 West street, New York. Bulletin on repairing steel and iron rolls by the thermit process, illustrating the fractured rolls, the mold, the wax pattern in position, the apparatus ready for making the weld and the finished weld.

CUSHMAN CHUCK COMPANY, Hartford, Conn. Condensed catalogue and price list for 1910 of Cushman chucks and face-plate jaws. Cushman chucks are made in a large variety of styles and sizes adapted to all classes of machine work and general manufacturing.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y. Booklet on building lighting with General Electric tungsten and tantalum lamps, illustrated with views of public buildings in New York, sky-scrapers, stores, and other large buildings in New York and other cities.

WABASH GEAR WORKS, Terre Haute, Ind. Catalogue of transmission levers and cone clutches for automobiles. The gears and shafts are made from special gear steel forgings which are subjected to approved heat treatment. The shafts are mounted on roll or annular ball bearings.

GARVIN MACHINE COMPANY, Spring and Varick streets, New York. Catalogue E of screw machines, monitor or chucking lathes, automatic chucks (stop and open types), screw head shaving machine, double turret screw machines, screw machine tools and attachments. Descriptions are in English, German and French.

INTERNATIONAL EXHIBITION OF RAILWAYS AND LAND TRANSPORT, Buenos Ayres, Argentine Republic. Circular No. 17, giving list of foreign committees and commissaries, statistics of foreign commerce of Argentine Republic and other information of interest to manufacturers contemplating exhibiting products at the centenary.

GARVIN MACHINE COMPANY, Spring and Varick streets, New York. Catalogue C on universal and plain milling machines, constant drive universal and plain milling machines, hand milling machines, vertical milling machines, motor-driven milling machines, universal cutter and tool grinder, die slotting machine and milling machine tools.

TERMINAL ENGINEERING COMPANY, 30 Church street, New York. Circular of Burdon's oil-gas furnaces of portable or stationary types. The Burdon furnace operates with a Bunsen flame, produced by gas derived from crude oils, and is said to be absolutely smokeless. It is designed for heating rivets, nails, drop forgings, tubes, bolts, spikes, etc.

CHARLES T. MAIN, Boston, Mass. Copy of booklet entitled, "Approximate Cost of Mill Building," containing valuable data and information on mill building construction. Although fundamentally it refers to textile mills, its application is broad enough to establish fundamental facts regarding manufacturing buildings in the iron-working industries.

B. F. STURTEVANT COMPANY, Hyde Park, Mass. Bulletin No. 173 on the Sturtevant electric dust blowing set designed for blowing out dust from around motors, switchboards, textile machinery, type cases, and other places difficult to get at or dangerous to handle. The apparatus may also be used as a suction cleaner where a dust collector is not desired.

GARVIN MACHINE COMPANY, Spring and Varick streets, New York. Catalogue B of Lincoln and duplex milling machines and profiling machines, vertical spindle milling machines, universal cutter and tool grinder, vertical horizontal and automatic drilling machines, duplex drill lathes, gang drills, etc. The descriptions are in English, German and French.

PAWTUCKET TOOL COMPANY, Pawtucket, R. I. Circular of friction tapping chucks, which may be used to drill and tap holes, and set studs therein without change. The friction may be adjusted to suit the tap, thus insuring against breakages. It is made in two sizes; No. 0 will handle taps up to $\frac{3}{8}$-inch diameter, and No. 1 from $\frac{3}{8}$ to $\frac{3}{4}$-inch diameter.

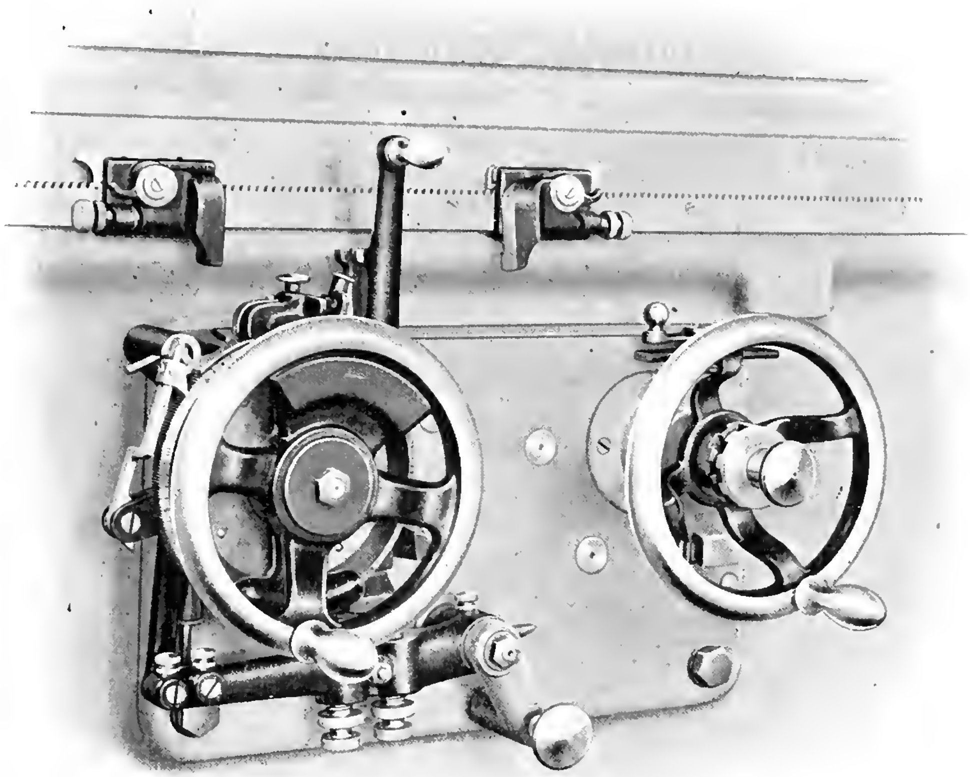
INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa. Reprint of editorial in *Colliers' Weekly* on teaching by correspondence. The editorial resulted from the personal investigation of Mr. Mark Sullivan, who found that the correspondence schools and the International Correspondence Schools in particular are doing a great work in the education of students in the arts and trades.

SWEDISH CHAMBER OF COMMERCE, New York. Bulletin containing, besides some general information regarding trade conditions in Sweden at the present time, a list of goods offered by Swedish firms in the United States, of American goods offered in Sweden, and of Swedish goods asked for by buyers in the United States. A short review of the extent of the Swedish iron industry in 1909 is given.

CARBORUNDUM CO., Niagara Falls, New York. Copy of "Revised American Statesman Series" entitled: "George Washington," by F. W. Haskell, president of the company. This number of the series is another of Mr. Haskell's satirical efforts which have attracted so much attention from those favored with copies. Copies of the Revised American Statesman series will be sent to any address upon application.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y. Bulletin No. 4715 superseding Bulletin No. 4693 on General Electric No. 210 railway motor. This is a 70-horse-power, 600 volt motor of substantial construction, having brush holder and field coil supports, and is practically sparkless even under heavy over-load. The bulletin gives detailed description and contains speed table, characteristic curves and dimension diagrams.

Increase in production and decrease in cost of operation are made possible in grinding machines by a well designed and accurately controlled automatic cross-feed mechanism.



B. &. S. Grinding Machines Embody These Features:

The feed is set for any desired size by pressing the thumb latch. It can be set to feed the full amount at both ends of the table travel or it can be set to give any part of the full amount at either end. When the work reaches the size for which the mechanism is set, the cross-feed is automatically thrown out. It is particularly advantageous when a large number of pieces are to be ground accurately to size.

Send for booklet giving other details of the machine.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis. Booklet on elevator controllers, describing the Cutler-Hammer line of controlling devices designed for use with alternating and direct current motors operating passenger or freight elevators. The booklet illustrates elevator controller apparatus in detail that never before has been shown in a publication. It should be of interest to electricians and others concerned in the problem of elevator design and up-keep.

CHARLES BESLY & CO., 118-124 North Clinton street, Chicago, Ill. Pamphlet on Besly disk grinding practice giving results of comparative circle tests and Helmet spiral circles, practice of machining castings with the Besly disk grinder, showing a large number of manufactured parts that are being machined efficiently and rapidly with the Besly grinder. The pamphlet will be found of general interest by all concerned with the economical finishing of machine parts, apparatus, etc.

WESTERN ELECTRIC COMPANY, 463 West street, New York. Booklet descriptive of the manufacture of lead-covered cable in the Western Electric Company's cable department which is said to be the largest and best equipped cable plant in the world. The booklet illustrates and describes a 600 pair B. & S. gage, paper insulated lead covered cable. It also illustrates the manufacture of telephone cables, and contains a double page illustration on the Hawthorne works, a 143-acre plant.

HILL, CLARKE & CO., Chicago, Ill. Circulars of 3- and 3½-foot Western triple geared radial drills; Chicago duplex bench miller; No. 1 Chicago duplex hand miller with power feed; No. 4 Chicago duplex band miller, with power feed; No. 3 Chicago duplex hand miller, with power feed; No. 3A Chicago duplex hand miller, with power feed and screw vertical attachment to knee; and circular illustrating feather keyseating as done on the Chicago duplex band miller, with power feed.

JOHN WILEY & SONS, 43-45 East Nineteenth street, New York. Catalogue of text-books and industrial works for schools, colleges, polytechnic institutes, engineers, architects, chemists, military and naval officers, etc., comprising works on agriculture, architecture, army and navy, assaying, astronomy, chemistry, civil engineering, drawing, electricity and physics, law, mathematics, mechanical engineering, pure and applied mechanics, medicine, metallurgy, mineralogy, mining, sanitary science and miscellaneous.

LODGE & SHIPLEY MACHINE TOOL CO., Cincinnati, Ohio. Folder on the evolution of the Lodge & Shipley "patent head" lathe. A halftone of the present patent head lathe has superimposed on it three halftone illustrations of the headstock as built in the beginning with the five-step cone with narrow belt, the three-step cone with double back gears, and the all-geared head; the disadvantages of each of these three types are pointed out. The folder will interest those concerned with the development and use of engine lathes.

KOLESCH & COMPANY, 138 Fulton street, New York. Circular of the "Lewis Ideal" tape reel for engineers and surveyors. The diameter of the reel is 5¼ inches and the weight 10 ounces, the capacity being 125 feet of tape. The frame is made of aluminum alloy and the wearing parts of hardened steel with handle of bronze. It has a high-speed gear which enables the user to wind up 100 feet of tape in about 12 seconds, thus saving much valuable time. The price is $15, with a ¼-inch wide 100-foot steel tape.

MANUFACTURERS' EQUIPMENT & ENGINEERING CO., Boston, Mass. Circular of all-metal sanitary and fireproof equipment for factories, foundries, gymnasiums, public buildings, department stores, offices, hospitals, etc., comprising individual wash bowls in batteries, metal lockers, all steel stools and chairs, steel stools and chairs with inset wood seats, stock and storage racks, metal shelving, metal vault fixtures, improved soda kettles, water heaters and instantaneous mixers, work benches with bench legs, drawing stands, etc.

W. S. ROCKWELL, 50 Church St., New York. Catalogue No. 3 of fuel oil and gas burning appliances comprising Rockwell oil burners, low-pressure oil burners, steam-actuated fuel oil pumping system, belt-driven fuel oil pumping system, positive pressure blowers, steam separators, high-pressure tanks, oil hose, fuel oil storage tanks and useful data and information. The catalogue contains a diagrammatic illustration of a fuel oil furnace installation, showing tank car on switch, storage tank buried in the ground, and pipe connections to oil pump, blower and forge furnace.

ROCKFORD MACHINE TOOL CO., Rockford, Ill. Catalogue of Rockford shapers and planers, comprising 14-inch single gear, 16-inch back-gear, 20-inch back-gear crank shapers, 16-inch Rockford shaper with constant-speed belt drive, 24-inch x 24-inch, 28-inch x 28inch, 32-inch x 32-inch and 36-inch x 36-inch metal planers. The catalogue also illustrates Rockford shapers driven by constant speed and variable speed motors and the Rockford variable speed planer with four cutting speeds and a high-speed constant return. The four-speed gear box is applicable to all sizes of planers built by the company.

J. T. SLOCOMB COMPANY, Providence, R. I. Pamphlet on measurement, containing suggestions in regard to accurate and economical measuring in machine construction. The pamphlet refers to the measurement with the common rule, with inside and outside calipers of the old type and external and internal micrometer calipers of the type made by the company. The construction of the Slocomb micrometer heads is shown and the various styles for shop equipment, also measuring machines, gages, etc., that are employed in the manufacture of Slocomb micrometers to secure a high degree of accuracy.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Bulletin No. 2, illustrating and describing the "Linolite" system of electric illumination, including a new line of desk lamps recently placed on the market. Proper illumination of desks is a difficult problem to solve. Most of the lamps used for the purpose to-day are the ordinary incandescent bulb lamps placed in a small reflector which throws the light all on one section of the desk, leaving the balance insufficiently lighted. The tubular "Linolite" lamps are 12 inches long between centers and distribute light more evenly and over a larger section of the desk than bulb lamps.

GEORGE H. GIBSON COMPANY, Tribune Building, New York. Pamphlet entitled, "Advertising and Its Service," being a reprint from the New York *Evening Post*, describing the economics of advertising, especially as regards the engineering and mechanical industries. It shows that contrary to academic opinions, properly directed advertising reduces the cost of distribution of goods. It provides the salesmen with a great number of selling opportunities in a given territory and in a given time. It performs a preliminary, but necessary work of informing and educating the prospective user as to the nature, possibilities and profitableness of improved machinery.

NATIONAL BRAKE & ELECTRIC CO., Milwaukee, Wis. Catalogue of National motor-driven air compressors, type "3VS." This type has three vertical cylinders with pistons driven by a three-throw crankshaft, direct-connected to an electric motor. The construction of a compressor is shown in detail by illustrations of the upper and lower half of the frame with crankshaft in place, herringbone gear and pinion, piston connecting-rods and cylinders mounted and disassembled, suction and discharge valves, etc. The catalogue also illustrates direct and alternating current motors, combined automatic controlling devices, air pump governor, air compressor equipment mounted on wheels for railroad service operating rock drills, pneumatic drills, etc., and the air lift well system of pumping water from wells by compressed air. It concludes with tables of dimensions, capacities of cylinders and air receivers.

TRADE NOTES

ROCKFORD LATHE AND DRILL COMPANY, Rockford, Ill., has increased its capital stock from $20,000 to $50,000.

HAMPDEN BROTHERS COMPANY, Springfield, Mass., maker of brass, composition and aluminum castings and specialties in these metals is building an addition to its foundry, 36 by 132 feet.

DUCKWORTH CHAIN AND MANUFACTURING COMPANY, Springfield, Mass., maker of chains for bicycles, automobiles, etc., and specialties, has built an addition that will increase its capacity about 75 per cent.

CARPENTER STEEL COMPANY, Reading, Pa., announces the appointment of Mr. Fred. A. Bigelow, formerly its representative in New England, as manager of its Cleveland branch, with office and warehouse at 1304 West Sixth street, Cleveland, Ohio.

COLUMBUS PNEUMATIC TOOL COMPANY, 1432 Parsons avenue, Columbus, Ohio, has changed its name to the Dunlap Engineering Company, with T. C. Dunlap president and treasurer, W. J. Dolan, sales manager, and J. H. White, superintendent, as heretofore.

J. A. FAY & EGAN CO., Cincinnati, Ohio, has sold to the Wright Bros., Dayton, Ohio, for use in their aeroplane factory, ten woodworking machines. Among these are a high-duty planer that will cut wood so thin that it is transparent, a special shaper, cut-off saw, mortiser and tenoner.

M. L. ANDREW & CO., Cincinnati, Ohio, are erecting a two-story brick and stone building at the corner of Colerain avenue and Alabama street, which will be ready for occupancy about the middle of May. The company is in the market for a grinder, gear-cutter, planer, radial drill, automatic screw machine and engine lathes.

EDGEMONT MACHINE COMPANY, Dayton, Ohio, manufacturer of friction clutch pulleys for countershafts and extended sleeve clutches for line-shaft duty, has recently added a number of new and specially designed machines to its already fine equipment, and is now in position to take care of its rapidly increasing clutch business.

H. W. JOHNS-MANVILLE CO., 100 William St., New York, because of rapidly increasing business, has moved its Chicago branch now at Randolph St. to the four-story and basement building at Nos. 27-29 Michigan Ave., with 32,500 square feet of floor space. Office, store and warehouse are all under one roof. Its Baltimore, Md., office, store and warehouse has been located at 30 Light St.

CHARLES T. MAIN, formerly 201 Devenshire street, Boston, Mass., has moved into more commodious offices in 817-833 of the new Boston Safe Deposit and Trust Company building. He will be better prepared than ever to conduct the work in engineering of textile mills and other industrial plants, water power and steam power development, examination and reports on plants with reference to their value, reorganization and development.

LODGE & SHIPLEY MACHINE TOOL COMPANY, Cincinnati, Ohio, has recently added an excellent dining hall to its factory. The dining hall building was formerly a large residence, which has been handsomely and tastefully decorated, and furnished appropriately for the purpose. Many beautiful pictures hang on its walls, which Mr. Shipley imported from Germany. The entire executive and selling force and heads of various operating departments take their meals here with all the conveniences of a first-class café.

TERMINAL ENGINEERING COMPANY, 30 Church street, New York, is the American office, in charge of Mr. E. C. Johnstone, agent for the James Hendry laminated leather products manufactured in Bridgeton, Glasgow, and Birmingham, Great Britain. An American factory has been completed near Newark, N. J., for the manufacture of these products, which comprise Hendry's laminated leather belting for dynamos, motors, and all classes of main drive also Hendry's helically laminated round leather belting to displace rope in rope drives.

JOHN B. MORRIS MACHINE TOOL COMPANY, Court, Harriet and Vogt streets, Cincinnati, Ohio, has been incorporated under the laws of Ohio with a capital stock of $125,000, and has purchased the machine tool trade formerly conducted by the J. B. Morris Foundry Company. Plans are being completed for a new factory building with a floor space of over 30,000 square feet, to be used in the manufacture of machine tools formerly built by the J. B. Morris Foundry Company. Additional machine equipment will be installed and the new company expects to increase its line of machine tools.

GREEN FUEL ECONOMIZER CO., Mattewan, N. J., in connection with the Rhode Island Construction Engineering Co., worked out a heating system for the Waterbury Castings Co., Waterbury, Conn., which is giving satisfactory results. The new foundry of the Waterbury Casting Co. has a capacity of 515,000 cubic feet. The walls are nearly all glass and the problem was difficult to handle, but by the arrangement of heater mains and discharge pipes, the heated air is discharged, in such a manner as to make working conditions uniformly comfortable and to displace the smoke, causing it to rise to the roof.

INTER-OCEAN STEEL COMPANY, 217 Railway Exchange, Chicago, Ill., expects to have its new plant at Chicago Heights ready to produce locomotive and car wheel tires, tire rings and ore crushing machinery, forged and rolled weldless steel flanges for use on high pressure steam and water pipe boilers, and other rolled rings, about April 1. The machinery was designed by Mr. Julian Kennedy, who enjoys a world-wide reputation as a designer, and tire mill expert. The mills have an unusual capacity; they will roll tires of considerably larger diameter and of greater width and section than any other in existence.

GOLDSCHMIDT-THERMIT CO., 90 West St., New York, publishes a quarterly periodical called *Reactions*, devoted to the science of aluminothermics. The fourth quarterly issue for 1909 contains an interesting description of the repair of a 48-ton pulley in the wilds of North Carolina for the Consolidated Nickel Co., under conditions of great difficulty. The repair was successfully made with thermit, and the pulley is shown before and after the repair was made. Views of Sylva and its inhabitants give the reader a good idea of the limited resources of the region for making the heavy repairs that were very simply performed with thermit.

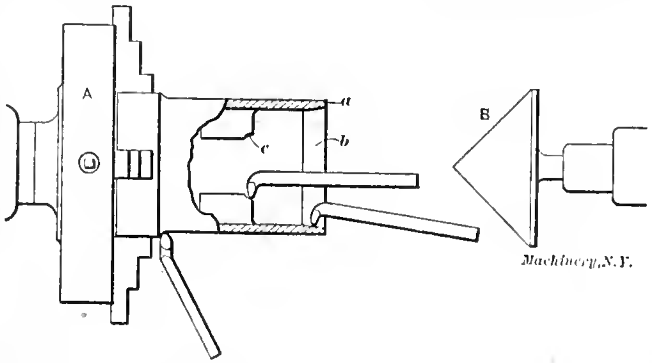
INGERSOLL-RAND COMPANY, 11 Broadway, New York, held its annual convention of managers and agents in New York, February 1 to 5. Mr. W. L. Saunders, president, presided at the meetings. The party left New York by private car February 1 for Easton, Pa., and passed en route through the Musconetcong Tunnel, the first railway tunnel in America driven entirely by machine drills. The rock drills used in this work were built by one of the pioneer companies now comprising the Ingersoll-Rand Company. The first day was spent at the Easton, Pa., plant examining the line of compressors, stone channelers, hammer drills, core drills, and pneumatic tools built in these shops. The second day was devoted to the Phillipsburg, N. J., works, inspecting the rock drills, electric-air drills, coal cutters and large compressors, which are the products of this plant. The party then went to the Painted Post, N. Y., shops by special train, where, on February 3, the compressors, rock drills, hammer drills, pneumatic tools and pneumatic hoists produced at this plant and at the Athens, Pa., shops were examined. The party returned to New York by special train and devoted February 4 and 5 to business meetings at the Hotel Astor. A social feature of the convention was a banquet and theatre party on Friday evening, February 4. Forty-two representatives of the company were in attendance.

Supplement to MACHINERY, April, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Turning Gas Engine Pistons in the Turret Lathe"

SHOP OPERATION SHEET NO. 130

Stanley Gould MACHINERY, April, 1910



Machining a Gas Engine Piston—1

NOTE.—The method of turning a gas engine piston here described is not given as one to be followed where pistons are being made in quantity, but rather as a good method for a jobbing or other shop where there is not sufficient work of this kind to warrant making expensive special tools and appliances. The machine used is a standard engine lathe.

1. First chuck the casting in a four-jawed independent chuck *A*, placing the solid end of the piston next to the chuck. Set the casting true by the inner surface, so that when it is turned on the outside the walls will be of uniform thickness. Face the edge *a* of the open end of the piston to the proper length, making allowance for truing up the top or solid end of the casting.

2. Bore out the open end for, say an inch, to a taper of about 1 or 2 inches to the foot as at *b*. When machining this surface, the compound rest should be swung around until it is within, say 8 degrees, of the right angle position, which will give about the right taper. The tool is, of course, fed by the feed-screw of the compound rest. This tapered surface is used in a subsequent operation for driving the piston while taking the finishing cut. If the work is held by chuck jaws it is likely to be sprung.

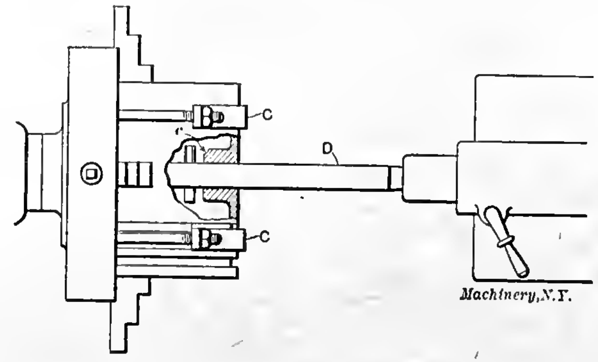
3. With the boring tool bore out the wrist-pin bosses on the ends to the finished width between them for a short distance, as at *c*, so that when they are being faced off in another operation there will be a surface to work to.

4. Next bring up the cone-center *B* and adjust it to the open end of the piston. This center is to support the work during the rough turning operation. Turn the casting, as far as the chuck jaws will permit, to within 1/16 inch of the finished size; then reverse the piston in the chuck and set it so that the rough turned surface runs true. Next center the solid end and support the piston by the tail-stock center. Then face the end until the piston is the correct length; also turn the outside surface previously held by the chuck jaws until it is reduced to the same size, or if anything a little smaller than the previously turned part.

5. Cut the grooves for the packing rings to the finished depth, but allow about 1/32 inch at the sides for finishing later. The depth should be obtained by calipering the diameter at the bottom of the groove, rather than by measuring from the rough outside surface.

SHOP OPERATION SHEET NO. 131

Stanley Gould MACHINERY, April, 1910



Machining a Gas Engine Piston—2

1. A hole is next bored through the piston for the wrist-pin. Before placing the work in the machine the center of the hole should first be located on the outside of the piston, the correct distance from the solid end and in line with the bosses on the inside.

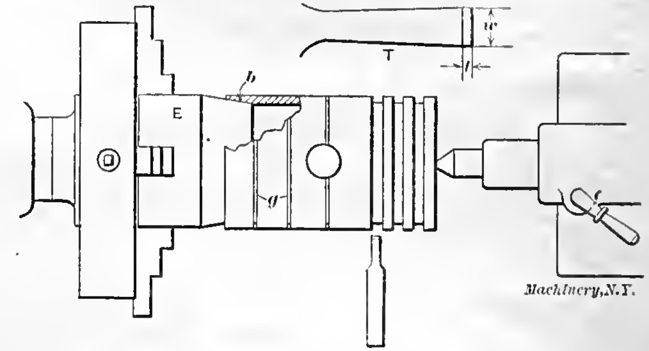
2. Hold the piston against the slot in the chuck with the tailstock and clamp it with a strap *C* across each end. As the engraving indicates, these straps are curved to fit the curved surface of the piston, which gives them a better grip. Set a chuck jaw against each side of the piston, and, if the swing of the lathe will permit, set a jaw against each end, as shown in the illustration. Before the clamps *C* are tightened, adjust the casting by turning it and by moving the chuck jaws until the center of the wrist-pin hole is in line with the point of the tailcenter, which should be set for straight turning. When the clamps are tightened withdraw the tailcenter and test the accuracy of the setting by bringing a pointer held in the toolpost close to the punch center while the work is revolving rapidly. If the punch mark moves in a circle, the work should be adjusted to bring it exactly in line with the axis of the lathe spindle.

3. With a centering tool cut a center for starting a twist drill and then, feeding the drill by the tailstock, drill a hole through both sides of the piston. This hole should be large enough to be followed by a boring tool, which is next used for boring the wrist-pin bosses to a running fit for facing-bar *D*, which should be smaller than the finished bore of the bosses.

4. With a double-ended cutter which is ground on both sides, face off the end of each wrist-pin boss. As the faces of these bosses should be central with the piston as well as the correct distance apart, the advantages of boring them, as described in the preceding sheet, will be understood. Just enough should be faced from each boss to barely remove the marks left by the boring tool. When facing the outer boss, the boring-bar may be held against the tailstock by a tool in the toolpost bearing against a lathe dog on the bar. A better method, however, is to use a bar that is turned taper on the end to fit the tailstock spindle. After both bosses have been faced, the bar should be removed and each boss finished to the required size with a boring tool.

SHOP OPERATION SHEET NO. 132

Stanley Gould MACHINERY, April, 1910



Machining a Gas Engine Piston—3

1. An old casting *E*, or other piece, is next turned to fit the tapered surface *b* in the open end of the piston. This is done by swinging the compound rest around to the same angle to which it was set when boring the part *b*, as previously explained. The piston is then forced tightly on this turned piece, and the outer end is supported by the tailcenter as shown. Evidently the work will now run, at least approximately true, and the method of driving by the tapered plug makes it possible to take a continuous finishing cut throughout its length. When taking this cut, allowance should be made for finishing either by grinding or filing. If oil grooves *g* are required, they are now cut with a small round-nosed tool. These annular grooves serve as a reservoir for the lubricant. It is the practice in some shops to finish a part of the upper surface of the piston, tapering to allow for the greater expansion which occurs at the upper end, owing to its proximity to the heat generated in the combustion chamber.

NOTE.—There is a difference of opinion among automobile and gas engine manufacturers in regard to the necessity of grinding pistons. Some makers claim that inasmuch as the packing rings prevent leakage, it is not necessary to grind the piston.

2. The packing ring grooves, which were previously roughed out, are now finished to the correct width. If a number of pistons are being turned the grooves may be quickly machined to a standard width by using a square-nosed tool, ground as at *T*. As shown, the sides, as viewed from the top, are ground straight back or without clearance for a distance *l* of about 1/16 inch, and the width *w* is made equal to the groove width. By having the straight part *l*, the tool may be ground without changing its width. If this straight part, however, extended clear back, the grooves in different pistons would be less likely to have a uniform width, as a slight change in the position of the tool would result in a tapering groove.

NOTE.—The following dimensions for gas engine piston ring grooves represent good average practice: For diameters between 3¼ and 4 inches, width 7/32 inch, depth 5/32; between 4¼ and 5, width 5/16, depth 3/16; between 5¼ and 6, width ⅜, depth 7/32; between 6¼ and 7, width ½, depth ¼; between 7¼ and 8, width 9/16, depth 9/32 inch.

NET AREAS OF STRUCTURAL ANGLES—I

Sum of Length of Legs	Thickness	Weight	Area	One 5/8 Rivet	3/4 Rivets One	3/4 Rivets Two	7/8 Rivets One	7/8 Rivets Two
4"	3/16	2.5	0.72	0.58	—	—	—	—
	1/4	3.2	0.94	0.75	—	—	—	—
	5/16	4.0	1.15	0.92	—	—	—	—
	3/8	4.7	1.36	1.08	—	—	—	—
	7/16	5.3	1.56	1.23	—	—	—	—
4½"	3/16	2.8	0.81	0.67	0.65	—	—	—
	1/4	3.7	1.06	0.87	0.84	0.62	0.81	0.56
	5/16	4.5	1.31	1.08	1.04	0.77	1.00	0.69
	3/8	5.3	1.55	1.27	1.22	0.89	1.17	0.79
	7/16	6.1	1.78	1.45	1.40	1.02	1.34	0.90
	1/2	6.8	2.00	1.62	1.56	1.12	1.50	1.00
5"	3/16	3.1	0.90	0.76	0.74	—	—	—
	1/4	4.1	1.19	1.00	0.97	0.75	0.94	0.69
	5/16	5.0	1.47	1.24	1.20	0.93	1.16	0.85
	3/8	5.9	1.73	1.45	1.40	1.07	1.35	0.97
	7/16	6.8	2.00	1.67	1.62	1.24	1.56	1.12
	1/2	7.7	2.25	1.87	1.81	1.37	1.75	1.25
5½"	1/4	4.5	1.31	1.12	1.09	0.87	1.06	0.81
	5/16	5.5	1.62	1.39	1.35	1.08	1.31	1.00
	3/8	6.6	1.92	1.64	1.59	1.26	1.54	1.16
	7/16	7.6	2.22	1.89	1.84	1.46	1.78	1.34
	1/2	8.5	2.50	2.12	2.06	1.62	2.00	1.50
	9/16	9.5	2.78	2.36	2.29	1.80	2.22	1.66
6"	1/4	4.9	1.44	1.25	1.22	1.00	1.19	0.94
	5/16	6.1	1.78	1.55	1.51	1.24	1.47	1.16
	3/8	7.2	2.11	1.83	1.78	1.45	1.73	1.35
	7/16	8.3	2.43	2.10	2.05	1.67	1.99	1.55
	1/2	9.4	2.75	2.37	2.31	1.87	2.25	1.75
	9/16	10.4	3.06	2.64	2.57	2.08	2.50	1.94
	5/8	11.4	3.36	2.89	2.81	2.26	2.73	2.10
	11/16	12.4	3.65	3.13	3.03	2.43	2.96	2.27
6½"	5/16	6.6	1.93	1.65	1.66	1.39	1.62	1.31
	3/8	7.8	2.30	1.97	1.97	1.64	1.92	1.54
	7/16	9.1	2.65	2.28	2.27	1.89	2.21	1.77
	1/2	10.2	3.00	2.63	2.56	2.12	2.50	2.00
	9/16	11.4	3.34	2.92	2.85	2.36	2.78	2.22
	5/8	12.5	3.67	3.20	3.12	2.57	3.04	2.41
	11/16	13.6	4.00	3.48	3.40	2.80	3.31	2.62
	3/4	14.7	4.31	3.75	3.65	2.99	3.56	2.81
	13/16	15.7	4.62	4.01	3.91	3.20	3.81	3.00

Note: The size of rivet holes is 1/8" larger than diameter of rivet.

Contributed by Martin Joachimson

NET AREAS OF STRUCTURAL ANGLES—II

Sum of Length of Legs	Thickness	Weight	Area	3/4 Rivets One	3/4 Rivets Two	7/8 Rivets One	7/8 Rivets Two
7"	5/16	7.1	2.09	1.82	1.55	1.78	1.47
	3/8	8.5	2.48	2.15	1.82	2.10	1.72
	7/16	9.8	2.87	2.49	2.11	2.43	1.99
	1/2	11.1	3.25	2.81	2.37	2.75	2.25
	9/16	12.3	3.62	3.13	2.64	3.06	2.50
	5/8	13.6	3.98	3.43	2.88	3.35	2.72
	11/16	14.8	4.34	3.74	3.14	3.65	2.96
	3/4	16.0	4.69	4.03	3.37	3.94	3.19
	13/16	17.1	5.03	4.32	3.61	4.22	3.41
7½"	5/16	7.7	2.25	1.98	1.71	1.94	1.63
	3/8	9.1	2.67	2.34	2.01	2.29	1.91
	7/16	10.5	3.09	2.71	2.33	2.65	2.21
	1/2	11.9	3.50	3.06	2.62	3.00	2.50
	9/16	13.3	3.90	3.41	2.92	3.34	2.78
	5/8	14.6	4.30	3.75	3.20	3.67	3.04
	11/16	15.9	4.68	4.08	3.48	3.99	3.30
	3/4	17.2	5.06	4.40	3.74	4.31	3.56
	13/16	18.5	5.43	4.72	4.01	4.62	3.81
8"	5/16	8.2	2.40	2.13	1.86	2.09	1.88
	3/8	9.8	2.86	2.53	2.20	2.48	2.10
	7/16	11.3	3.31	2.93	2.55	2.87	2.43
	1/2	12.8	3.75	3.31	2.87	3.25	2.75
	9/16	14.2	4.18	3.69	3.20	3.62	3.06
	5/8	15.7	4.61	4.06	3.51	3.98	3.35
	11/16	17.1	5.03	4.43	3.83	4.34	3.65
	3/4	18.5	5.44	4.78	4.12	4.69	3.84
	13/16	19.9	5.84	5.13	4.41	5.03	4.22
8½"	5/16	8.7	2.56	2.29	2.02	2.25	1.94
	3/8	10.4	3.05	2.72	2.39	2.67	2.29
	7/16	12.0	3.53	3.15	2.77	3.09	2.65
	1/2	13.6	4.00	3.56	3.12	3.50	3.00
	9/16	15.2	4.47	3.98	3.49	3.91	3.35
	5/8	16.8	4.92	4.37	3.82	4.29	3.66
	11/16	18.3	5.37	4.77	4.17	4.68	3.99
	3/4	19.8	5.81	5.15	4.49	5.06	4.31
	13/16	21.3	6.25	5.54	4.83	5.44	4.63
	7/8	22.7	6.67	5.90	5.14	5.79	4.91

Note: The size of rivet holes is 1/8" larger than diameter of rivet.

Contributed by Martin Joachimson

NET AREAS OF STRUCTURAL ANGLES—III

Sum of Length of Leg	Thickness	Weight	Area	Area after Deducting for ¾ Rivets: One	¾ Rivets: Two	⅞ Rivets: One	⅞ Rivets: Two
9"	3/8	11.0	3.23	2.90	2.57	2.85	2.47
	7/16	12.8	3.75	3.35	2.99	3.31	2.87
	1/2	14.5	4.25	3.80	3.39	3.75	3.25
	9/16	16.2	4.75	4.26	3.77	4.19	3.63
	5/8	17.8	5.23	4.68	4.14	4.60	3.97
	11/16	19.5	5.72	5.12	4.52	5.03	4.34
	3/4	21.1	6.19	5.53	4.88	5.44	4.69
	13/16	22.7	6.65	5.94	5.23	5.84	5.03
	7/8	24.2	7.11	6.34	5.58	6.23	5.35
9½"	3/8	11.7	3.42	3.09	2.76	3.04	2.66
	7/16	13.6	3.97	3.59	3.21	3.53	3.09
	1/2	15.3	4.50	4.06	3.62	4.00	3.50
	9/16	17.1	5.03	4.54	4.05	4.47	3.91
	5/8	18.9	5.55	5.00	4.45	4.92	4.29
	11/16	20.6	6.06	5.46	4.86	5.37	4.68
	3/4	22.3	6.56	5.90	5.24	5.81	5.06
	13/16	24.0	7.06	6.35	5.64	6.25	5.44
	7/8	25.7	7.55	6.78	6.02	6.67	5.79
	15/16	27.3	8.03	7.21	6.39	7.09	6.15
	1	28.9	8.50	7.63	6.75	7.50	6.50
10"	3/8	12.3	3.61	3.28	2.95	3.23	2.85
	7/16	14.3	4.18	3.80	3.42	3.74	3.30
	1/2	16.2	4.75	4.31	3.87	4.25	3.75
	9/16	18.1	5.31	4.82	4.33	4.75	4.19
	5/8	20.0	5.86	5.31	4.76	5.23	4.60
	11/16	21.8	6.41	5.81	5.21	5.72	5.03
	3/4	23.6	6.94	6.28	5.63	6.19	5.44
	13/16	25.4	7.47	6.76	6.05	6.66	5.85
	7/8	27.2	7.99	7.22	6.46	7.11	6.23
	15/16	28.9	8.50	7.68	6.86	7.56	6.62
	1	30.6	9.00	8.13	7.25	8.00	7.00
10½"	7/16	15.0	4.40	4.00	3.64	3.96	3.53
	1/2	17.0	5.00	4.55	4.13	4.50	4.00
	9/16	19.1	5.59	5.10	4.61	5.03	4.47
	5/8	21.0	6.17	5.62	5.08	5.54	4.92
	11/16	23.0	6.75	6.15	5.55	6.06	5.37
	3/4	24.9	7.31	6.65	6.00	6.56	5.81
	13/16	26.8	7.87	7.16	6.45	7.06	6.25
	7/8	28.7	8.42	7.65	6.89	7.54	6.67
	15/16	30.5	8.97	8.15	7.33	8.03	7.10
	1	32.3	9.50	8.63	7.75	8.50	7.50

Note: The size of rivet holes is ⅛" larger than diameter of rivet.

Contributed by Martin Joachimson

NET AREAS OF STRUCTURAL ANGLES—IV

Sum of Length of Legs	Thickness	Weight	Area	Area after Deducting for ¾ Rivets: One	¾ Rivets: Two	⅞ Rivets: One	⅞ Rivets: Two
12"	3/8	14.9	4.36	4.03	3.70	3.98	3.60
	7/16	17.2	5.06	4.68	4.30	4.62	4.18
	1/2	19.6	5.75	5.31	4.87	5.25	4.75
	9/16	21.9	6.43	5.94	5.45	5.87	5.31
	5/8	24.2	7.11	6.56	6.01	6.48	5.85
	11/16	26.5	7.78	7.18	6.58	7.09	6.40
	3/4	28.7	8.44	7.78	7.12	7.69	6.94
	13/16	31.0	9.09	8.38	7.67	8.28	7.47
	7/8	33.1	9.74	8.97	8.21	8.86	7.98
	15/16	35.3	10.37	9.55	8.73	9.43	8.49
	1	37.4	11.00	10.13	9.25	10.00	9.00
14"	1/2	23.0	6.76	6.31	5.89	6.26	5.76
	9/16	26.0	7.65	7.16	6.67	7.09	6.53
	5/8	28.7	8.44	7.89	7.35	7.82	7.19
	11/16	31.7	9.32	8.72	8.12	8.63	7.94
	3/4	33.8	9.94	9.28	8.63	9.19	8.44
	13/16	36.6	10.76	10.05	9.34	9.95	9.14
	7/8	39.5	11.62	10.85	10.09	10.74	9.87
	15/16	42.0	12.35	11.53	10.71	11.41	10.48
	1	44.4	13.06	12.19	11.31	12.06	11.06
16"	1/2	26.4	7.75	7.30	6.88	7.25	6.75
	9/16	29.6	8.69	8.20	7.71	8.13	7.57
	5/8	32.7	9.61	9.06	8.52	8.99	8.36
	11/16	35.8	10.53	9.93	9.33	9.84	9.15
	3/4	38.9	11.44	10.78	10.13	10.69	9.94
	13/16	42.0	12.34	11.63	10.93	11.52	10.72
	7/8	45.0	13.23	12.47	11.71	12.35	11.48
	15/16	48.1	14.12	13.31	12.49	13.18	12.24
	1	51.0	15.00	14.13	13.25	14.00	13.00
	1 1/16	54.0	15.87	14.95	14.01	14.81	13.75
	1 1/8	56.9	16.74	15.76	14.77	15.62	14.49

Area Deducted for Various Sizes of Rivets and Thickness of Angles.

No. of Rivets	Size of Rivets	Thickness 3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8
1	3/8	0.09	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34	0.38	0.41	0.44	0.47	0.50	—	—
1	1/2	0.12	0.16	0.20	0.23	0.27	0.31	0.35	0.39	0.43	0.47	0.51	0.55	0.58	0.63	—	—
1	5/8	0.14	0.19	0.23	0.28	0.33	0.38	0.42	0.47	0.52	0.56	0.61	0.66	0.70	0.75	0.80	0.84
2	5/8	0.28	0.38	0.46	0.56	0.66	0.75	0.84	0.94	1.03	1.12	1.22	1.31	1.40	1.50	1.60	1.68
1	3/4	0.16	0.22	0.27	0.33	0.38	0.44	0.49	0.55	0.60	0.66	0.71	0.77	0.82	0.88	0.93	0.98
2	3/4	0.33	0.44	0.54	0.66	0.76	0.87	0.98	1.09	1.20	1.31	1.42	1.53	1.64	1.75	1.86	1.97
1	7/8	0.19	0.25	0.31	0.38	0.44	0.50	0.56	0.63	0.69	0.75	0.81	0.88	0.94	1.00	1.06	1.12
2	7/8	0.37	0.50	0.62	0.67	0.87	1.00	1.12	1.25	1.38	1.50	1.62	1.75	1.87	2.00	2.12	2.25
1	1	0.21	0.28	0.35	0.42	0.49	0.56	0.63	0.70	0.77	0.84	0.91	0.98	1.06	1.13	1.20	1.26

Note: The size of rivet holes is ⅛" larger than diameter of rivet.

Contributed by Martin Joachimson

MACHINERY
April, 1910

COMMERCIAL RATINGS FOR INTERNAL COMBUSTION ENGINES*

By WILLIAM D. ENNIS†

VARIOUS empirical ratings have been proposed for automobile and other engines, based on the cylinder dimensions and the speed. These are founded either on tests of a large number of types, or on an analysis, such as follows, of the factors limiting the output of an engine running under stated conditions.

The Indicator Diagram

The power exerted by an engine during a working stroke is shown by such a diagram as that given by the indicator. The

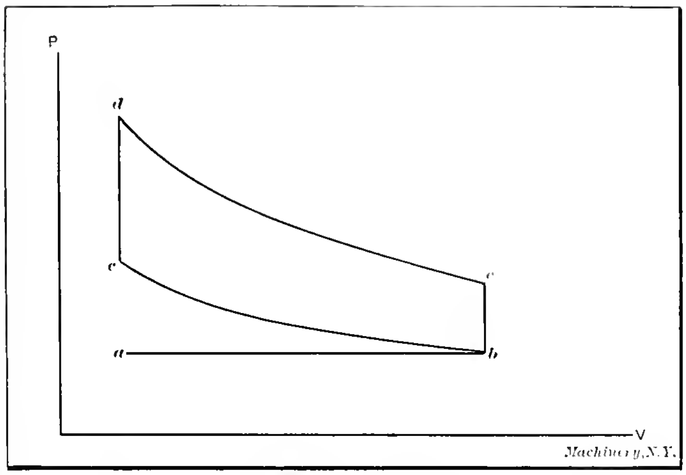


Fig. 1. Ideal Gas Engine Diagram

factors which would influence this diagram in an internal-combustion engine may be listed as follows:

a. The diameter of the cylinder and the stroke of the piston.

b. The type of the engine, whether 2-cycle or 4-cycle.

c. The mechanical design, including the questions of port areas, jacketing, and gas velocities.

d. The fuel used, the nature of the fuel limiting the temperature allowable during compression.

e. The clearance, which is determined by reference to factors *b*, *c* and *d*.

The ideal diagram of a gas engine is shown in Fig. 1. Gas enters the cylinder along *ab*, without friction, at constant pressure. It is compressed along *bc*, without gaining or losing heat, until the piston has reached the end of its stroke at *c*. Ignition then occurs. The spread of flame is instantaneous, so that the line *cd*, representing a rise of temperature and pressure, is straight and vertical. The piston immediately moves forward, the gas expanding behind it along *de*, again without gaining or losing heat. At *e*, the piston has reached the outer end of its stroke, the exhaust valve opens, and the gas passes out without friction. The pressure falls instantaneously to that at *b*, the remaining low-pressure gases leaving the cylinder (also without friction) during the return stroke of the piston along *ba*.

The actual indicator diagram of the 4-cycle type of engine is shown in Fig. 2. Gas enters as before during the outstroke of the piston along *ab*, but port friction wire draws the charge so that the pressure gradually decreases. The pressure at *b* in a 4 cycle engine may be about 12 pounds absolute (2.7 pounds less than atmospheric pressure) and in a 2-cycle engine about 20 pounds absolute. Compression occurs along *bc*, but the curve does not rise as rapidly as the corresponding curve in Fig. 1. This is to be explained on the ground that heat is being given up to the cylinder walls, so that the temperature and pressure of the gas at any point are less than they would otherwise be. It has been found that the curve *bc* follows approximately the law

$$PV^n = \text{constant},$$

in which P and V are corresponding pressures and volumes and the value of n may be taken at 1.3. Then

$$P_b V_b^{1.3} = P_c V_c^{1.3}, \text{ for example.}$$

An important principle in gas engine design may here be suggested. The temperature due to the compression reached at c must not exceed that at which the gases will ignite of themselves. Suppose this temperature, for the fuel in question to be 600 degrees F. Then by a fundamental formula for gases,

$$\frac{P_c V_c}{T_c} = \frac{P_b V_b}{T_b} \text{ and } \frac{V_c}{V_b} = \frac{P_b T_c}{P_c T_b} \qquad (1)$$

in which the symbol T refers to the absolute temperature, equal to the Fahrenheit temperature plus 460.

We have, moreover, as already stated

$$P_c V_c^{1.3} = P_b V_b^{1.3} \text{ and } P_c = P_b \left(\frac{V_b}{V_c}\right)^{1.3} \qquad (2)$$

Combining Equations (1) and (2), we find

$$\frac{V_c}{V_b} = \left(\frac{T_c}{T_b}\right)^{-3.33}$$

The value of T_b depends upon the temperature of the gases when admitted to the cylinder, and the warming which they undergo by transfer of heat from the walls during the suction stroke. Suppose it to be 200 degrees F. We then find $T_c = 600 + 460 = 1060$, $T_b = 200 + 460 = 660$, and $\frac{V_c}{V_b} = \left(\frac{1,060}{660}\right)^{-3.33} = 0.206$, whence $\frac{V_c}{V_b - V_c} = 0.26$ the clearance, expressed as a fraction of the stroke.

Ignition occurs at c; but as the spread of the flame is not

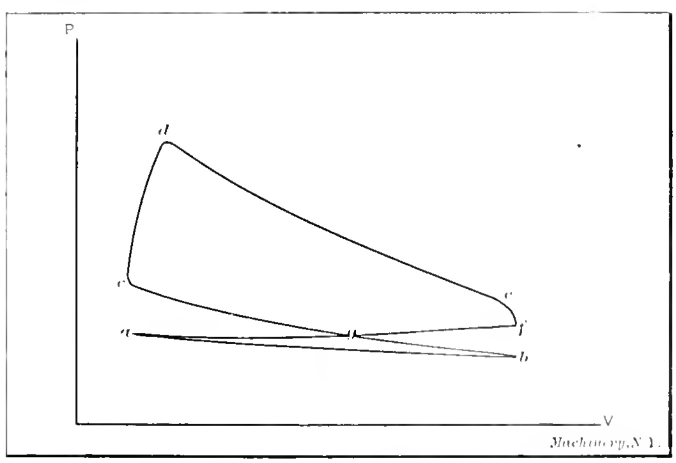


Fig. 2. Actual Diagram, Four-cycle Type Engine

instantaneous, the ignition path *cd* is swerved to the right by the movement of the piston. Further, the resulting rise of temperature attained at *d* is only a fraction of that which might be expected from a computation based on the composition of the gas. This fact is due to the increase of volume during ignition, the transfer of heat to the cylinder walls, and the slow burning, by reason of which some of the

* See also MACHINERY, November, 1909, "Approximate Horsepower Formulas for Gasoline Engines."

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combustion occurs along the expansion path de. The temperature attained at d seldom exceeds 3,000 degrees F. = 3460 degrees absolute, and the corresponding pressure, assuming no important change of volume to occur between c and d, is given by the formula,

$$\frac{P_d}{P_c} = \frac{T_d}{T_c}.$$

Along the expansion path de some heat is given up by the gas to the cylinder walls. Any "after-burning" due to incomplete ignition along cd will also affect the shape of de. In most cases, the curve in question may be approximately represented by the same sort of formula as that given for the compression curve,

$$PV^n = \text{a constant},$$

in which the value of n, for our present purpose, may be taken at 1.33. When the value of n is the same for the expansion curve as for the compression curve, we have the simple relation:

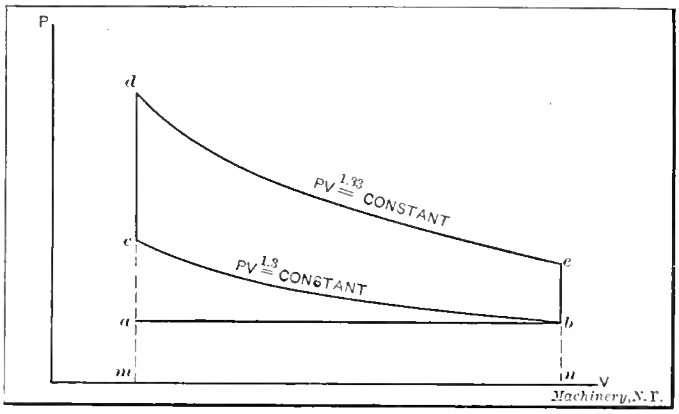

Fig. 3. Designer's Diagram

$$\frac{P_d}{P_c} = \frac{P_e}{P_b}.$$

The exhaust valve opens at e, and the gas is forced out of the cylinder against an appreciable resistance along efa. The indicated work is $cdefg - agb$.

The Designer's Diagram

We may now simplify the indicator diagram as in Fig. 3, eliminating the negative loop agb and the rounded corners of the diagram in Fig. 2, and treating the ignition line cd as straight and vertical. The indicated work of such a diagram would be represented by the enclosed area, or, we may say, by

$$mden - mcbn.$$

For an area like $mden$, subtended by a curve like de, we have the formula

$$\frac{P_d V_d - P_e V_e}{0.33},$$

the 0.33 being the quantity $n - 1$, where n is the exponent of the equation representing the curve. Similarly,

$$mcbn = \frac{P_c V_c - P_b V_b}{0.3}, \text{ and}$$

$$cdeb = mden - mcbn = \frac{P_d V_d - P_e V_e}{0.33} - \frac{P_c V_c - P_b V_b}{0.3}.$$

Computation of Pressures and Work

For a 4-cycle engine, $P_b = 12 \times 144 = 1{,}728$ pounds per square foot. To find P_c, we write

$$\frac{P_c V_c}{T_c} = \frac{P_b V_b}{T_b}, \text{ or } P_c = \frac{P_b V_b T_c}{V_c T_b},$$

and substituting values already given, we obtain:

$$P_c = \frac{1728 \times 1060}{0.206 \times 660} = 13{,}400 \text{ pounds per square foot, about.}$$

For P_d, we have, approximately,

$$\frac{P_d}{P_c} = \frac{T_d}{T_c};\ P_d = P_c\frac{T_d}{T_c} = 13{,}400\ \frac{3000 + 460}{1060} = 44{,}000 \text{ pounds per}$$

square foot.

For P_e, we write

$$P_e V_e^{1.33} = P_d V_d^{1.33};\ P_e = P_d\left(\frac{V_d}{V_e}\right)^{1.33} = 44{,}000 \times 0.206^{1.33} = 5380$$

pounds per square foot, about.

Let $V_b - V_c = V_e - V_d = D$, the displacement of the piston per stroke.

But $V_c = 0.206\ V_b$, whence $0.794\ V_b = D$; $V_b = V_e = 1.26\ D$; and $V_c = V_d = 0.26\ D$. Then,

$$cdeb = D\left(\frac{(44{,}000 \times 0.26) - (5380 \times 1.26)}{0.33} - \frac{(13{,}400 \times 0.26) - (1728 \times 1.26)}{0.3}\right) =$$

$$D\left(\frac{11{,}440 - 6780}{0.33} - \frac{3490 - 2180}{0.3}\right) = 9750\ D.$$

Under the assumed conditions, *viz.*, a pre-compression pressure of 12 pounds per square inch and a temperature of 200 degrees F., a compression curve $PV^{1.3}$ = a constant, a temperature after compression of 600 degrees F. and after ignition of 3,000 degrees F., with an expansion curve $PV^{1.33}$ = a constant, with a piston displacement of D cubic feet, the work per active stroke, measured in foot-pounds, is 9,750 D. This must be somewhat reduced to allow for the rounding of corners of the actual diagram, the negative loop agb, Fig. 2, etc., say to 9,000 D, which then represents the indicated work to be expected from the engine.

Engine Capacity

Let S be the piston speed in feet per minute, s the piston speed in inches, A the area of the piston in square feet, a its area in square inches, and N the number of revolutions per minute. The displacement of the piston in cubic feet per stroke is then $AS \div 2N$. The number of active strokes per minute depends upon the form of engine. Thus, for 4-cycle engines, we have the following ratio of active strokes to total strokes:

Single-acting,	1-cylinder,	1 to 4;
	2-cylinder,	2 to 4;
	4-cylinder,	4 to 4;
	6-cylinder,	6 to 4;
Double-acting,	2-cylinder,	4 to 4;
	4-cylinder,	8 to 4.

Since there are $2N$ total strokes per minute, the number of active strokes in a single-acting engine, if 4-cylinder, is $2N$; and if 6-cylinder, $\frac{6}{4} \times 2N = 3N$. The indicated horsepowers of the two forms of engine are then $\frac{9{,}000 \times 2ND}{33{,}000}$ and $\frac{9{,}000 \times 3ND}{33{,}000}$; and since $D = AS \div 2N$, these horsepowers may also be written:

$$\frac{9{,}000 \times 2ANS}{33{,}000 \times 2N} = 0.273AS, \text{ and } \frac{9{,}000 \times 3ANS}{33{,}000 \times 2N} = 0.409AS.$$

Empirical Ratings

Since $S = \frac{s}{12}$ and $A = \frac{a}{144}$, we have for the 4-cylinder engine:

$$\text{I.H.P.} = 0.273 \times \frac{s}{12} \times \frac{a}{144} = 0.000158sa.$$

If d be the cylinder diameter in inches, $a = 0.7854d^2$, and

$$\text{I.H.P.} = 0.000158 \times 0.7854sd^2 = 0.000124sd^2.$$

If the piston speed be taken in feet as in standard nomenclature, then,

$$\text{I.H.P.} = 0.00149\ Sd^2 = \frac{Sd^2}{670}.$$

From this we may formulate the following rule: The indicated horsepower of a single-acting four-cylinder four-cycle

engine is equal to the piston speed in feet per minute, multiplied by the square of the cylinder diameter in inches, and divided by 670. A $4\frac{3}{4}$-inch engine at 800 feet piston speed would then be rated at 28 H. P.

Ratings are sometimes based on the cylinder dimensions only, the number of revolutions per minute being regarded as standard. If L be the length of the stroke in inches,

$$S = 2LN \div 12 = \frac{LN}{6}, \text{ and, for a four-cylinder engine,}$$

$$\text{I.H.P.} = \frac{LNd^2}{4{,}020} = \frac{LNa}{4{,}020 \times 0.7854} = \frac{LNa}{3155}$$

$$\text{I.H.P. per cylinder} = \frac{LNa}{3155 \times 4} = \frac{LNa}{12{,}620}$$

At 1,000 R.P.M. the indicated horsepower per cylinder is then equal to the product of the length of stroke in inches, piston area in square inches, and number of revolutions per minute, divided by 12.62.

Another method of rating at 1,000 R.P.M. may be derived as follows:

$$\text{I.H.P.} = \frac{LNd^2}{4{,}020} = \frac{Ld^2}{4.02}, \text{ or}$$

$$\text{I.H.P.} = \frac{Ld^2}{16.08} \text{ per cylinder.}$$

If the diameter of the cylinder equals the stroke, we have:

$$\text{I.H.P.} = \frac{d^3}{16.08} \text{ per cylinder, or approximately } \frac{d^3}{16}.$$

For m cylinders this becomes:

$$\text{I.H.P.} = \frac{md^3}{16}.$$

Effective Horsepower

The effective horsepower may be assumed to be 85 per cent of the indicated horsepower. By inserting this value in the formulas for the indicated horsepower per cylinder we find the actual horsepower:

$$\text{H.P.} = \frac{Sd^2}{3{,}150} = \frac{LNa}{14{,}900} = \frac{LNd^2}{19{,}000} = \frac{Nd^3}{19{,}000}.$$

The denominators are given in round numbers to facilitate calculations. They are, however, very close to the exact values.

Rules Based on Formulas Given

Under the stated conditions of pressure, temperature, etc., which are approximately correct for four-cycle gasoline automobile engines, the effective horsepower per cylinder may be estimated by any of the following rules:

1. The product of the piston speed in feet per minute times the square of the diameter in inches, divided by 3150.

2. The product of the stroke in inches, the area of the piston in square inches, and the number of revolutions per minute, divided by 14,900.

3. The product of the stroke in inches, the square of the diameter in inches, and the number of revolutions per minute, divided by 19,000.

4. The product of the cube of the diameter in inches times the number of revolutions per minute, divided by 19,000. This last rule holds good only when the stroke equals the diameter.

Rule 1 appears to be the simplest and most direct. The rule sometimes quoted, giving the horsepower of the whole engine as equal to the diameter squared multiplied by the number of cylinders and divided by 2.5, can be justified only on assumptions of a constant piston speed and fixed length of stroke for all engines. Rules in any one of the four forms given are, however, satisfactory and scientific as long as their application is limited to a specific fuel and specific type of engine. The constants will vary if the rules are extended to cover such cases as, for example:

a. A double-acting four-cycle engine using producer gas.
b. The same engine using natural gas.
c. The same engine using blast furnace gas.
d. A single-acting four-cycle engine using kerosene.
e. A single-acting two-cycle engine using kerosene.

The following data will permit of establishing rules for the kinds of engines suggested, as well as for some other forms.

The value of P_b, Fig. 3, in two-cycle engines equals 18 to 21 pounds; in four-cycle engines, 12 to 14 pounds, absolute. The value of T_b will range from 140 to 300 degrees F.

The values of n (the exponent for the expansion curve) vary from 1.2 to 1.38, being lower in larger engines. T_c should not exceed 450 degrees F. if the gas contains more than 10 per cent, by volume, of hydrogen. In no case should it exceed 600 degrees F.

The value of P_c will usually be kept within the following ranges:

In automobile engines, 45 to 100 pounds.
In ordinary gasoline engines, 60 to 85 pounds.
In kerosene engines, 30 to 85 pounds.
In natural gas engines, 75 to 130 pounds.
In producer gas engines, 100 to 160 pounds.
In blast furnace gas engines, 120 to 190 pounds.

The value of T_d will seldom or never exceed 3,000 degrees F., and may, without serious error, be taken at this value for all the fuels mentioned. The percentages of deduction to be made for the rounding of the corners of the diagram, etc., and losses between cylinder and crankshaft will aggregate from 15 to 25 per cent in four-cycle engines, and from 30 to 40 per cent in two-cycle engines, being greatest in small engines.

* * *

NEW METHOD OF ELECTRO-PLATING—THE "GALVANIT" PROCESS

In a paper read before the Royal Society of Arts in Great Britain, Mr. A. Rosenberg described a novel process whereby metals of various kinds may be coated with nickel, silver, zinc or other metals with no more difficulty or exertion than that of using an ordinary polishing powder. The new method consists in the use of a mixture of pulverized materials in which the metal of which the coating is to be made is the main constituent; the deposition process consists simply in applying the powder by means of a rag or brush, and rubbing the object to be treated in the presence of moisture. The process depends upon the action between one ingredient (the electro-positive metal) and the other ingredient (the metallic salt) as soon as the addition of moisture to the mixture converts the latter into an electrolyte. The electro-positive metal constitutes the anode and the object treated the cathode. The action is explained on the principle that the finely powdered electro-positive metal makes innumerable contacts with the cathode surface and acts as so many minute anodes. These innumerable minute anodes gradually dissolve, and in dissolving set up in the liquid small local electric currents. In this way the metallic salt in solution forms a thick film on the cathode, which thus becomes plated all over with a deposit. The decomposition of liquid electrolyte is generally increased by heat, and this is found also to be the case with the application of powder for coating in the process just described. Although a rise in temperature is not necessary in the use of "galvanit," as these powders are called, a quicker and thicker deposit of metal can be obtained, in some cases, with the aid of heat. It is, therefore, an advantage to heat the article before applying the powder, to select ingredients in the mixture which will evolve heat while decomposing, and to use magnesium as the electro-positive ingredient.

As an example of a practical mixture, the following is given for depositing zinc, all parts being by weight: Zinc, 15 parts, ammonium sulphate, 5 parts; magnesium, 1 part; chalk, 10 parts; and talc, $2\frac{1}{2}$ parts. For depositing other metals, the zinc may be merely replaced by the metal which it is desired to deposit. The talc serves the purpose of preventing the mixture from absorbing moisture while being stored. The chalk used acts as a filling, and as a polishing agent. A powder for depositing nickel may be composed of 20 parts by weight of nickel ammonium sulphate, and 2 parts of magnesium powder.

METAL SPINNING—2

By WILLIAM A. PAINIER

A twenty-four-inch metal spinning lathe that is rigged up in a modern way, is shown in Fig. 17. The hand wheel of the tailstock has been discarded for the lever *A*, which is more rapid and can be manipulated without stopping the lathe. This lathe has a roller bearing for the center *B* which is a practical improvement over types previously used. The pin *C*, which is used in the rest as a fulcrum for the spinning tools is also an improvement, being larger than those ordinarily used. It is ¾ inch in diameter, 6 inches long, and

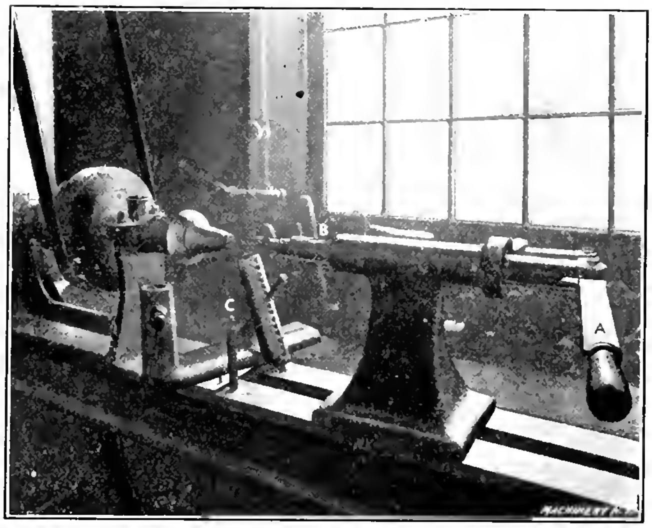

Fig. 17. A Modern Spinning Lathe

it has a reduced end for the holes in the rest, ⅜-inch in diameter by 1 inch long. This pin is large enough so that the spinner can conveniently hold it with his left hand when necessary, and it can also be rapidly changed to different holes. The pins ordinarily used, because of their small size, do not have these advantages. The speed of a spinning lathe having a five-step cone should be about 2,250 to 2,300 revolutions per minute with the belt on the smallest step, and from 600 to 700 revolutions per minute with the belt on the largest step. The fastest speed given is suitable for all work under

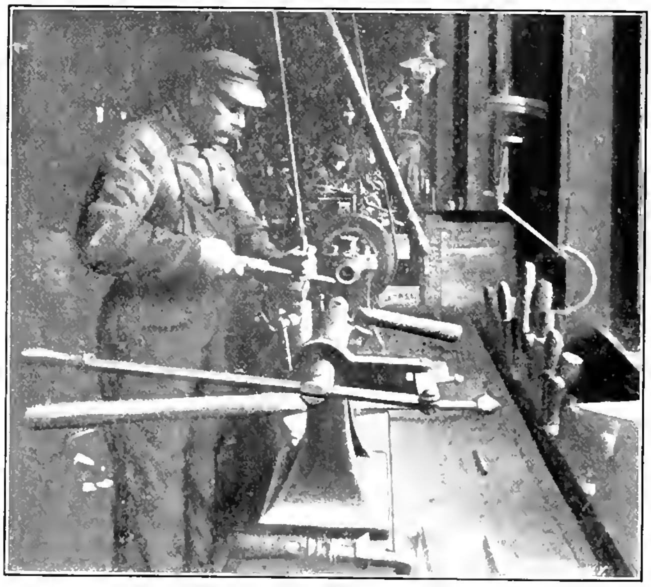

Fig 18. View showing how the Tool is held when spinning

5 inches in diameter, and the slowest for work within the capacity of the lathe. On large shells it is sometimes necessary to change from one speed to another as the work progresses.

Figs. 18 and 19 show the spinner at work, and illustrate how the tool should be held, and also the proper position of the left hand. This spinner, Alfred Danielson, learned his trade in Stockholm, Sweden, and he has worked in Europe, Canada and in several cities in the United States as a foreman. He learned his trade from German and French mechanics, of which countries both claim the origin of the art.

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Construction of the Tailstock and Back-center

Fig. 20 shows a spinning-lathe tailstock, which has been changed from the hand-wheel-and-screw type to one having a lever and a roller bearing. The spindle *A* which is withdrawn from the lever and turned one-quarter of a revolution to give a better view of the rollers, is made from 1¾-inch cold rolled steel. The rollers against which the center bears do not project beyond the spindle, so that the latter can be withdrawn through the tailstock. This eliminates the excessive overhang caused by ball bearings and other centers. When the center projects too far, the tailstock cannot be set close to the work, owing to the necessity of withdrawing the center when removing the spun part. The application of this principle to a spinning lathe is original and the type of center illustrated was used only after all other kinds had failed, including all the types of ball bearings and revolving pins. The best forms of ball bearing centers do not last over a year, if in constant use, and they will not always revolve on small work. Two other spindles are shown in this engraving, which were taken from other lathes in order to show different views of the parts. The cylindrical pieces *B* are the hardened friction rollers which belong in the slot of the spindle *F*, and *C* is the hardened pin upon which they

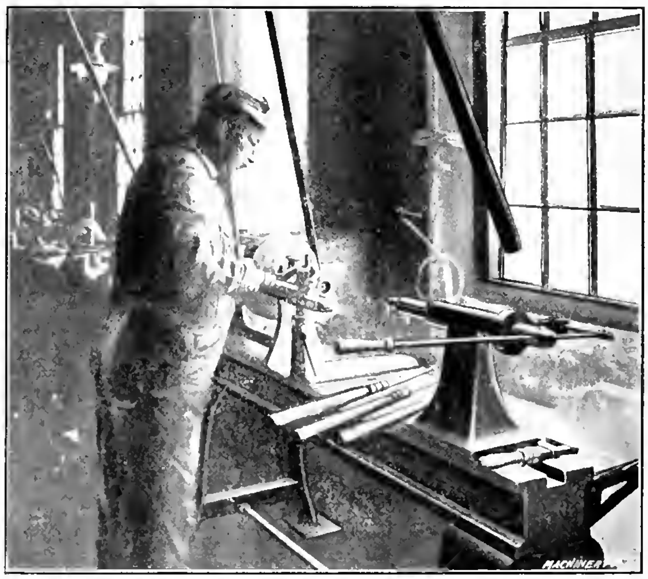


Fig. 19. Another View showing the Position of the Spinner and the Way the Tool is held when forming the Metal

revolve. The hardened center *D* has a threaded end on which the back-centers *E* of different lengths and shapes are screwed. The friction rollers should always be in a vertical position, and care should be taken to have them exactly central with the spindle.

Fig. 21 is a sketch which shows the construction of a back-center and also gives the principal dimensions of a roller bearing for a 1¾-inch spindle. *A* is a hardened steel bushing, which is driven into the machine steel spindle. The parts *B* are the hardened steel rollers which travel in opposite directions. These rollers have a small amount of friction, and this is distributed over a large area. A spindle revolving at 2,300 revolutions per minute will not cause these rollers to rotate very rapidly, while a ball bearing with balls traveling in a channel 1½ inch or 2 inches in diameter would be traveling at the same speed as the driving spindle. They also wear out rapidly as the end strain is very great, it being necessary to force the center against the metal with considerable pressure to keep it from slipping. *C* is the hardened pin upon which the rolls revolve, and *D* is the hardened spindle on which the various back-centers are screwed. The collar *E* should either be flattened for a wrench, or a 5-16-inch hole, in which a wire can be inserted, should be drilled through the spindle, so that it can be kept from rotating when screwing on the back-centers. Some spinners prefer the spindle loose, so that it can be withdrawn when changing the centers, while others prefer one with considerable lateral

motion, but not enough to permit of withdrawal. By inserting a screw-point in the recess *F*, the center has considerable lateral motion, but not enough to allow it to be withdrawn. This recess is useful in that it helps to distribute the oil. All parts should be hardened and drawn to a light straw color; they should also be ground or lapped to a true fit after hardening.

I started to replace ball bearing centers with this design over five years ago, and now have it on nine spinning lathes. Most of these have been in constant use now for over three years, and it has not been necessary to replace a single part.

Tools Used in Metal Spinning

Fig. 22 shows an attachment which is used to roll any bead or form. This tool, when in use, is inserted in the tail-stock spindle in place of the regular center. It is adjustable for any diameter. The roll illustrated is for making a sharp turn, but rounds and other forms are used. The shell being spun by this tool should be held on a hollow chuck. The roll is set at a point where the metal is to be turned over, and by its use the curve may be governed and made uniform with less skill than when the work is done by "air spinning." In addition, the spinning may be done in less time. This attachment, for some shapes, makes the use of sectional chucks unnecessary.

Fig. 23 shows several spinning tools, the heads of which were turned in the lathe instead of being forged. This method of making spinning tools is, as far as I know, original. The spinners prefer them to the tools which are forged in one piece, because the heads which are screwed to the shanks, are made of the best quality of steel, such as the high speed or

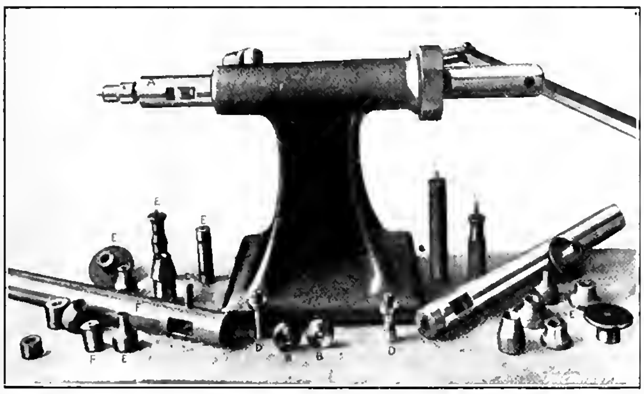


Fig. 20 Detailed View of a Spinning-lathe Tailstock

self-hardening steel. The shapes are also better and the surfaces more true. The heads of these tools are all threaded with standard 1/4-inch, 3/8-inch and 1/2-inch pipe taps, according to the size. Obviously, a spinner can have as many different shaped heads as may be required, and only one handle, of each of the sizes given. The tapering threads in these heads insure that they will always screw on the shanks tightly no matter how often they may be replaced. The 1/4-inch size takes a 1/2-inch cold rolled holder; the 3/8-inch, a 5/8-inch holder, and the 1/2-inch, a 3/4-inch holder. These will be found large enough for the heaviest work. The egg-shaped tool *A* is a good form for roughing or breaking down, as it has plenty of clearance on the heel, and a blunt point that will not tear the metal. This tool is shown in four sizes. The ball or spherical tool *B* is a good one to use on curves and large sweeps. The tool *C* is a double cone, and is slightly different from *A*, as it has a blunter point. One of these heads is shown at *D* screwed onto a reducer by which it is held in the lathe chuck while being turned. These heads or points can also be turned while on the handle by using a steady rest.

A group of trimmers, skimmers and edgers is shown in Fig. 24. Three skimmers of the built-up type are illustrated, the shanks being of machine steel and the blades being riveted to the holders. These blades are made of either high speed or regular steel. Skimmers which are forged in the regular way from one piece of steel, are shown at *B*. A number of edgers *C*, which are made of high-speed or self-hardening steel, are also illustrated. These tools are used without handles until they are worn down short, after which tangs are forged on their ends and they are used in handles. Edgers are utilized on all kinds of work for trimming the ends of the shells. The skimmer is seldom used on metal chucks, but mostly in connection with wooden chucks, where the metal cannot be smoothed down with a planisher. The skimmer is run over the metal lightly, taking a thin shaving and smoothing the uneven surfaces. It requires considerable skill to use this tool without wasting the metal. The surface of the work is finished with emery cloth after skimming.

Figs. 27 and 28 show a number of spinning tools of various shapes. The letters *A* indicate the breaking-down or round-nosed tools of different sizes. This type of tool, which is finished smooth and has a blunt point, is used for forming corners and sharp angles, and it is the tool most commonly

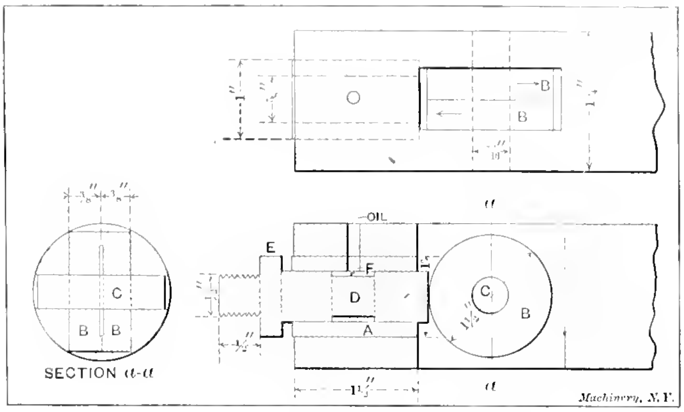


Fig. 21. Sectional View showing the Back-center and its Double Roller Bearing

used by spinners. The planishers and burnishers *B* are used on all convex surfaces and for finishing on metal chucks where there is to be no skimming done. The tools *C* are known as hook or poker tools, and they are used to turn up beads or curves from the inside of the shell. The holders having rollers are used for turning over beads, the metal first being trimmed and turned to a vertical position. The other shapes shown are irregular tools for special work and they are not in daily use.

Two pairs of spinners' pliers for turning over the edge of the metal when making large curves are shown in Fig. 29. The wedge-shaped pieces shown in this illustration are used when breaking down or roughing shells to give a bear-

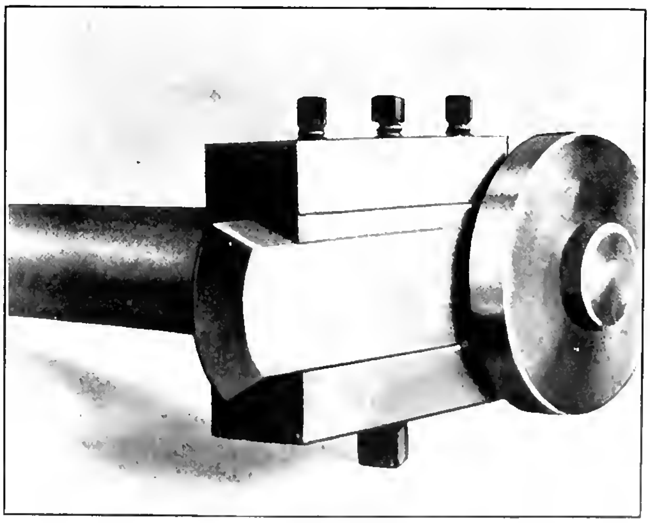


Fig. 22. Attachment used for Rolling Sharp Turns and Beads

ing to the metal in order to prevent it from wrinkling or buckling when changing its formation. These pieces are made of hard wood with the exception of the one to the right, which is of steel. When one of these pieces is in use it is held in the left hand at a point directly opposite the spinning tool, the metal being between the two. Wood is preferable in most cases, as it does not harden the metal blank.

The tools shown in Fig. 25 are used in spinning steel. The round tools are of drawn brass, and they can be used where the steel tools cannot, for while a steel tool is perfection on

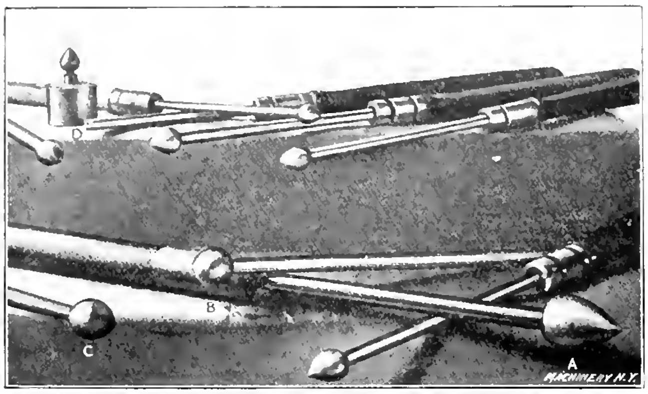


Fig. 23. Metal Spinning Tools with High-speed Steel Removable Heads

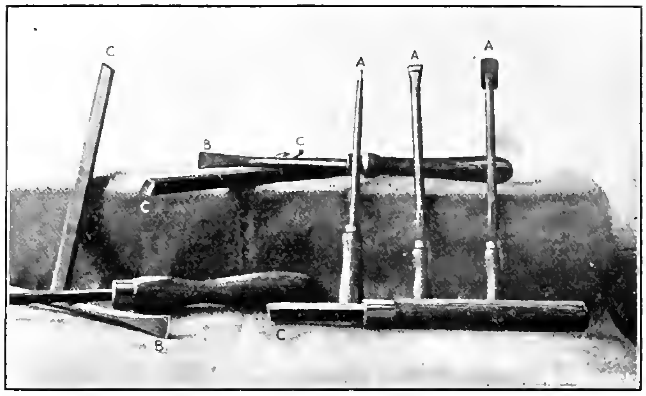


Fig. 24. Tools used for trimming and skimming Spun Work

brass, a brass tool is the only thing on steel. It wears out, however, much more rapidly than one of steel. The rolls shown in the center are used for breaking down steel shells. These tools are hardened and have hardened roller bearings. The handles are made of one-inch iron pipe, which is filled with lead to give weight and strength.

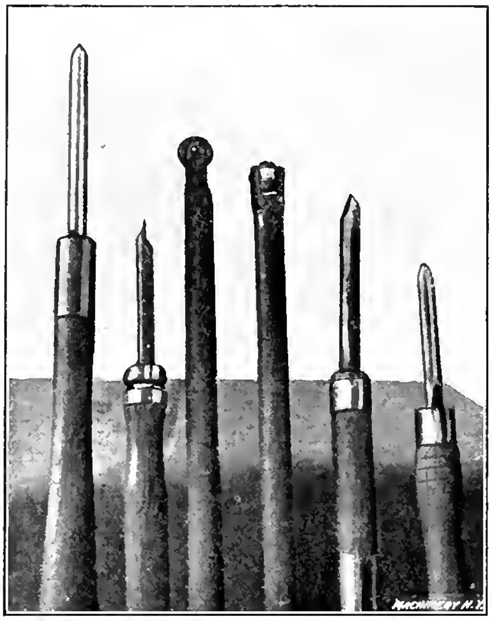


Fig. 25. Some Spinning Tools used in working Steel

Hard wood tools that are used for breaking down large thin copper blanks ranging from 2 to 5 feet in diameter are shown in Fig. 26. These tools are also used where the surface that the tool will cover without hardening the metal is important. Blanks which are broken down with these tools are finished with the regular types.

The handles of spinning tools vary in diameter from $1\frac{1}{4}$ to $1\frac{3}{4}$ inch, and in length from 16 inches to 20 inches. The tools should project from the handles from 9 to 18 inches, and the total length of the tool and handle should average from 30 to 34 inches.

A group of wood-working tools is shown in Fig. 30. These tools are of the type commonly used by spinners for turning the various shapes of wooden spinning chucks. As the tools illustrated are the kind regularly used for wood turning by patternmakers and other wood-workers generally, they will need no description.

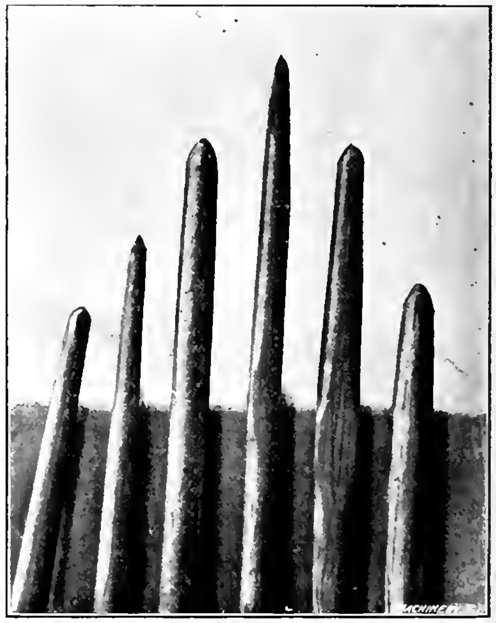


Fig. 26. Wooden Tools which are used on Large Thin Copper Blanks

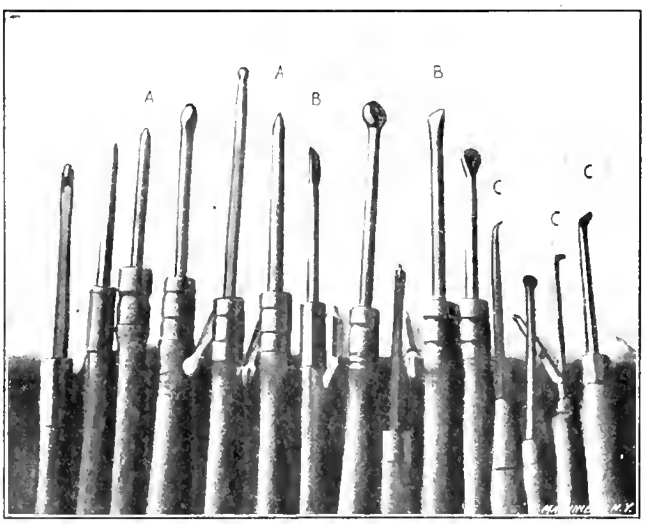


Fig 27. A Group of Spinning Tools of Various Shapes

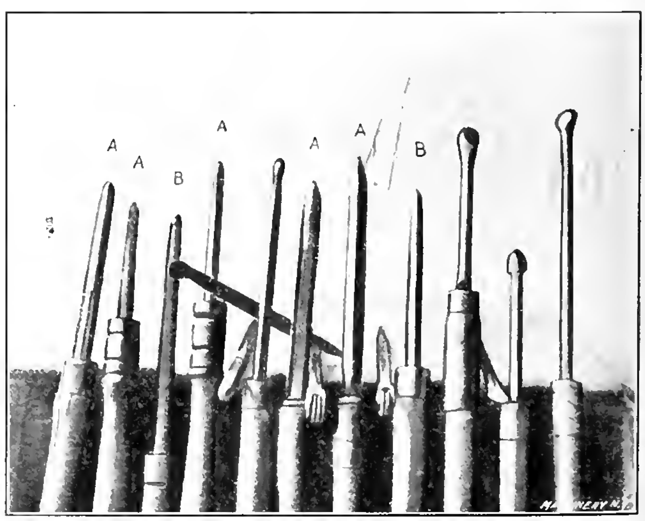


Fig. 28. Another Group of Spinning Tools

Preparation of the Metal

Brass, copper, and German silver should be pickled after annealing in order to get the scale or oxide from the surface. There are furnaces that anneal without scaling by excluding the air when heating, but they are not in general use. A pickling bath may be made by using one part of oil of vitrol (sulphuric acid) and five parts of water. The shells can be put in hot, or the bath can be heated by a coil of lead or copper pipe running through it. Steam in no case should enter the bath, as the iron in the feed pipe will spoil the pickle. Any basket or box that may be used to hold the shells in the pickle should not contain any iron. If a box is used it should be held together with copper nails. The pickle can be used cold, but it will take a little longer time to remove the scale. As soon as the scale is free, which will be in about half an hour, the shells should be removed or washed thoroughly in running water. The shells should

be allowed to dry before the next operation, which is that of spinning. A lead-lined wooden tank or an earthen jar may be used for holding the pickle. The pickle which is used for steel should be about half as strong as that employed for brass. After the work is in this pickle, the latter should be brought to the boiling point, after which the pieces should be taken out and washed. They are then replaced in the fire for a short time to evaporate any acid that may remain after washing.

Finished brass articles may be given different shades by dipping them in a solution consisting of one part aqua fortis (nitric acid) and two parts oil of vitrol. This solution should

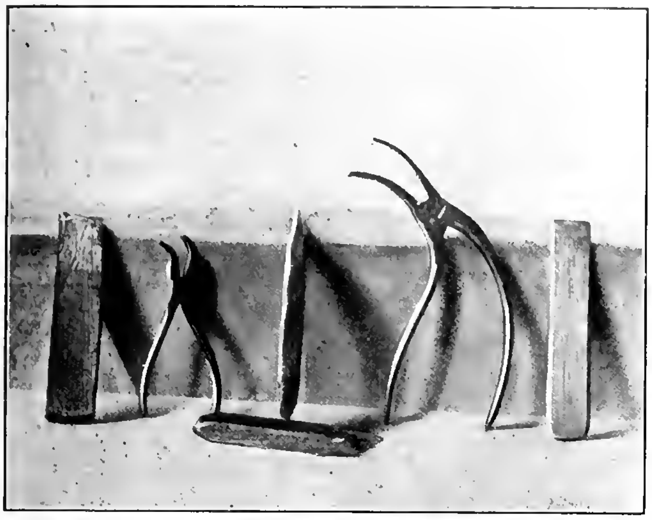


Fig. 29. Spinners' Pliers which are used for turning the Edge of the Metal when making a Large Bend

stand seven or eight hours after mixing to cool, and be kept in a crock immersed in a water bath.

* * *

"A New Departure in Photography," by Robert W. Wood in the February *Century*, describes some interesting experiments conducted by the author. He conceived the idea, or at least applied it, of photographing common objects with the ultra-violet and infra-red rays which are invisible to the human eye, lying beyond the visible violet and red section respectively of the spectrum. The results of his investigations may be valuable, as they indicate a means of analysis of non-luminous bodies shining by reflected light. A new conception of light and vision is given. "Painting a thing as it is" takes

Fig. 30. Wood-turning Tools which are used in turning Spinning Chucks

on a new meaning. Chinese white, for example, which is the whitest pigment known, when photographed with the ultra-violet rays only, reproduces jet black in the photograph. The light rays, of course, are passed through a ray filter which shuts off all but the rays desired. Zinc oxide, deposited on a snow-covered hill, for example, would be quite indistinguishable to the eye as compared with the snow, but its presence would be clearly shown with a camera fitted with a ray filter shutting off all but the ultra-violet light. In the same way deposits of sulphur on the moon, or what are believed to be sulphur, are shown clearly on photographs made through a telescope which is fitted with a filter that passes only ultra-violet rays.

THE CHOICE OF A FACTOR OF SAFETY FOR HIGH-CLASS MOTOR SPRINGS*

By F. E. WHITTLESEY†

In designing motors for automobiles, aeroplanes, etc., it is of the utmost importance to choose the proper factor of safety for every part. If this is true of the parts which are not deflected appreciably by the strains to which they are subjected, how much more important is it in the case of the springs, many of which deflect hundreds of times every minute. The risk of injury and loss of life which may be caused by a broken engine or clutch spring is so great, especially in an aeroplane, that none but the most carefully designed and manufactured springs should be used.

It is an easy matter to determine the fiber stress that a spring will stand without taking permanent set. This can be determined by testing the material in a torsional testing machine or more easily during manufacture of the springs by direct testing of the deflection for a given weight. The ultimate torsional fiber stress for wire springs is usually taken at about 150,000 pounds per square inch for the smaller sizes of music wire, down to 80,000 pounds per square inch for ½-inch wire. It is much more difficult to determine the proper factor of safety for a spring in order to give reliable service. This is a matter of the greatest importance and calls for the exercise of good judgment by the designer, who should also know the conditions under which the spring will operate.

The conditions entering into the matter are: 1. The physical conditions under which the springs operate. 2. The number of compressions per minute.

The Physical Conditions

The spring should have its ends squared and ground at right angles to its axis; the outside diameter should be at least one-third of the length, and it should be supported its entire length unless it is very short, these conditions being necessary to prevent buckling, which introduces bending and twisting strains. High-class valve springs when placed on end on a flat plate should not vary more than ½ degree from the perpendicular to the plate. Of course, this accuracy is expensive, but it pays when reliability, not cheapness, is desired. The spring should be protected from rusting by a good coat of Japan, baked on, or by electro-galvanizing, and should not be subjected to heat from the motor sufficient to affect the temper.

The Rate of Compression

A spring which acts only occasionally can be safely designed to carry a load which will cause a fiber stress nearly up to the elastic limit of the spring, but when compressions or extensions are at all frequent, a much larger factor of safety must be used. A valve spring operating, say, 200 times per minute should have a factor of safety of at least 4. In other words, a spring made of ¼-inch wire, having an ultimate torsional fiber stress of 100,000 pounds per square inch should be designed to work at a stress of not over 25,000 pounds per square inch. If the material is free from flaws, such a spring should give good results in practice.

The builder of high-class motors will be well repaid for giving careful attention to the design of their springs, instead of following the practice formerly more prevalent than now, of first designing all other parts of the machine and then accommodating the springs to the space that happened to remain for them.

* * *

PRIZE FOR INVENTION OF REVERSING MECHANISM FOR COMBUSTION ENGINES

A prize of 5,000 marks ($1,250) has been offered by a German association for the advancement of the industries for the best design and description of a direct reversing mechanism for combustion engines, the mechanism being especially adapted for the use on combustion engines on board ship. Detailed information on the subject and the conditions of the competition may be obtained from *Der Verein zur Beförderung des Gewerbfleisses*, Charlottenburg, Berliner Strasse 171.

* See MACHINERY, May, 1908, engineering edition: "The Design of Springs for Gas Engine Valves."

† Address: Raymond Mfg. Co., Ltd., Corry, Pa

THE CALCULATION OF CRANKSHAFTS FOR INTERNAL COMBUSTION ENGINES*

By D. O. BARRETT†

The crankshaft may rightly be termed the "backbone of the engine," and the designer should use his best judgment and skill in designing this most important member. In the following, the formulas are given for crankshafts for determining the diameter, and the breadth and thickness of cheeks, of single-acting, single-cylinder, four cycle engines of medium speed with over-hanging flywheels and two bearings, of the ordinary type up to 75 horsepower. The formulas have been actually applied to engines up to 60 horsepower, and as far as known, no crankshaft has ever failed. The data on which the formulas are based have been obtained from a complete line of engines built by one of the largest manufacturers, and from a few sizes from some other concerns.

Diameter of Crankshaft

The strength of a shaft as regards twisting, is proportional to the cube of the diameter, while the torque exerted upon the shaft by the force of the explosion is proportional to the square of the bore of the cylinder and to the throw of the crank, which is half the stroke. Expressing this as a formula we may write:

$$\frac{B^2 \cdot \frac{1}{2} S}{D^3} = c \qquad (1)$$

in which B = bore of cylinder in inches,
S = stroke of piston in inches,
D = diameter of crankshaft in inches,
c = constant determined by good practice.

The usual value of constant c for existing successful engines varies between 10 and 19, the average value being about 15, which, in the following formulas is assumed as good average practice.

The stroke S may be expressed as a function of the bore B. Assume, for example,

$$S = a\,B$$

Substituting in Equation (1) we have:

$$\frac{B^2 \times \frac{1}{2}\, a\, B}{D^3} = 15$$

Solving for D we have:

$$D = \sqrt[3]{\frac{a}{30}} \times B \qquad (2)$$

The average engine has a stroke of about $1\frac{1}{2}$ times the bore, but this factor varies from $1\frac{1}{4}$ to 2. For $a = 1\frac{1}{4}$, $D = 0.347\,B$, and for $a = 2$, $D = 0.405\,B$.

Fig. 1 is a diagram for determining diameters of crankshafts for gas engines, according to the formula given. To use the diagram, find the intersection of the bore-and stroke-lines at the right-hand side, and determine the corresponding value of a on the diagonal lines. Then follow the horizontal line from the intersection to the left-hand side of the chart to the same value of a on the diagonal lines, and then follow the vertical line down to the proper diameter of shaft. The heavy dotted line in the diagram shows the procedure for a 12-inch bore, 18-inch stroke engine, the diameter of crankshaft obtained being $4\frac{3}{8}$ inches.

Sizes of Bearings

For best results the mean pressure on the crank-pin should not exceed 400 pounds per square inch of projected area. In the following, 390 pounds per square inch has been assumed. The total pressure on the crank-pin bearing is the area of the piston multiplied by the mean effective pressure (M. E. P.).

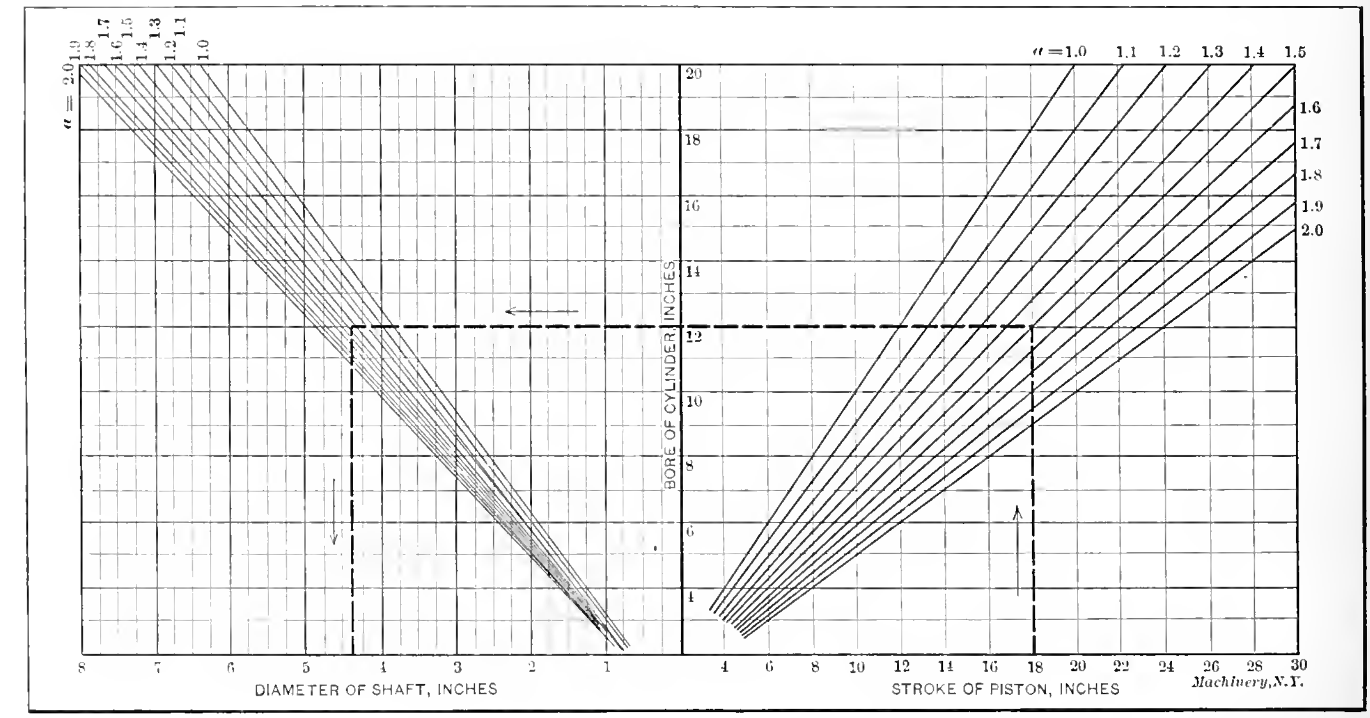


Fig. 1. Diagram for obtaining the Diameters of Crankshafts for Gas Engines

Hence, if P_1 = unit pressure on pin (390 pounds per square inch of projected area),
B = bore of cylinder,
l = length of crank-pin bearing,
d = diameter of crank-pin bearing,

then:

$$P_1 = \frac{0.7854\,B^2 \times \text{M.E.P.}}{l\,d}$$

and if the mean effective pressure is assumed as 75 pounds per square inch, then,

$$l\,d = \frac{0.7854\,B^2 \times 75}{390} = 0.151\,B^2$$

As in these bearings, length and diameter are usually equal ($l = d$), we have:

$$d^2 = 0.151\,B^2, \text{ or } d = 0.39\,B \qquad (3)$$

When this formula gives d smaller than D, the value of d should be increased, because in practice the diameter of the crank-pin is never made smaller than that of the shaft. They are usually made of the same size, and it is even better practice to make the crank-pin at least $1\frac{1}{4}$ times the diameter of the shaft.

The diameter of the shaft in the main bearings is usually about 1.1 times the diameter of the shaft, or

* For previous articles on gas engine design see: "Formulas and Constants for Gas Engine Practice," by Sanford A. Moss, February, 1906; "Current Practice in Petrol Engine Design," by G. W. Rice, October, 1906; "Formulas for Gas Engine Flywheels," by R. E. Mathot, August, 1907; "Formulas for Gas Engine Crankshafts," January, 1908; "The Design of Springs for Gas Engine Valves," by F. E. Whittlesey, May, 1908.

† Address: 87 Lincoln Ave., Freeport, Ill.

$$d_1 = 1.1\, D \qquad (4)$$

Making the shaft in this manner slightly increases the cost, but this style is used in the best designs.

The length of the main bearings varies from 1.75 to 2 times the diameter of the shaft, or

$$l_1 = (1.75 \text{ to } 2) \times D. \qquad (5)$$

Dimensions of Cheeks

Having now obtained the various diameters of the shaft and the lengths of the bearings, we will determine the formulas for the cheeks. The crank cheeks in horizontal and in the larger vertical engines are machined and rectangular in section. They act as a beam supported at one end. The strength of such a beam is directly proportional to its breadth b and to the square of its thickness t, and inversely proportional to the length (which, in turn, is proportional to the stroke S). The load acting at the end of the beam is proportional to the square of the bore B. Hence,

$$\frac{b\, t^2}{B^2 S} = c.$$

The average value of the constant c is 0.045, which has been found by plotting the constant for existing engines and assuming an average value. The thickness t is usually made about 2.2 b, and as $S = a\, B$, as mentioned before, we have:

$$\frac{t^3}{2.2\, a\, B} = 0.045, \text{ or } t = \sqrt[3]{0.099\, a} \times B \qquad (6)$$

All dimensions have now been reduced to some term containing B, so that, having decided upon the bore and stroke of the proposed engine, it is an easy matter to proportion the crankshaft.

In Fig. 2 is shown a diagram for determining the breadth and thickness of the cheeks for crankshafts for gas engines. To use the diagram, find the intersection of the bore- and stroke-lines at the right, and determine the corresponding value of a on the diagonal lines. Then follow the horizontal line from the intersection to the left-hand part of the diagram, to the same diagonal line a. Then follow the vertical line down to the bottom of the diagram where the breadth and thickness of cheek are given. The heavy dotted line in the diagram shows the procedure for a 12-inch bore, 18-inch stroke engine. The breadth and thickness found are 2 7/8 inches and 6 3/8 inches, respectively.

The ends of the cheeks are made concentric with the pin or shaft opposite, that is, the pin end of the cheek is turned when revolving about the shaft center and *vice versa*. The length of the crankshaft depends upon whether the driving pulley is to be bolted to the arms of the flywheel or keyed to the shaft. The latter method is preferable although slightly more expensive. The shaft, however, should only be long enough to engage the pulley hub, thus keeping the driving pulley close to the flywheel. A longer shaft gives an inexperienced operator an opportunity to set the pulley out far enough to seriously strain the unsupported end of the shaft.

* * *

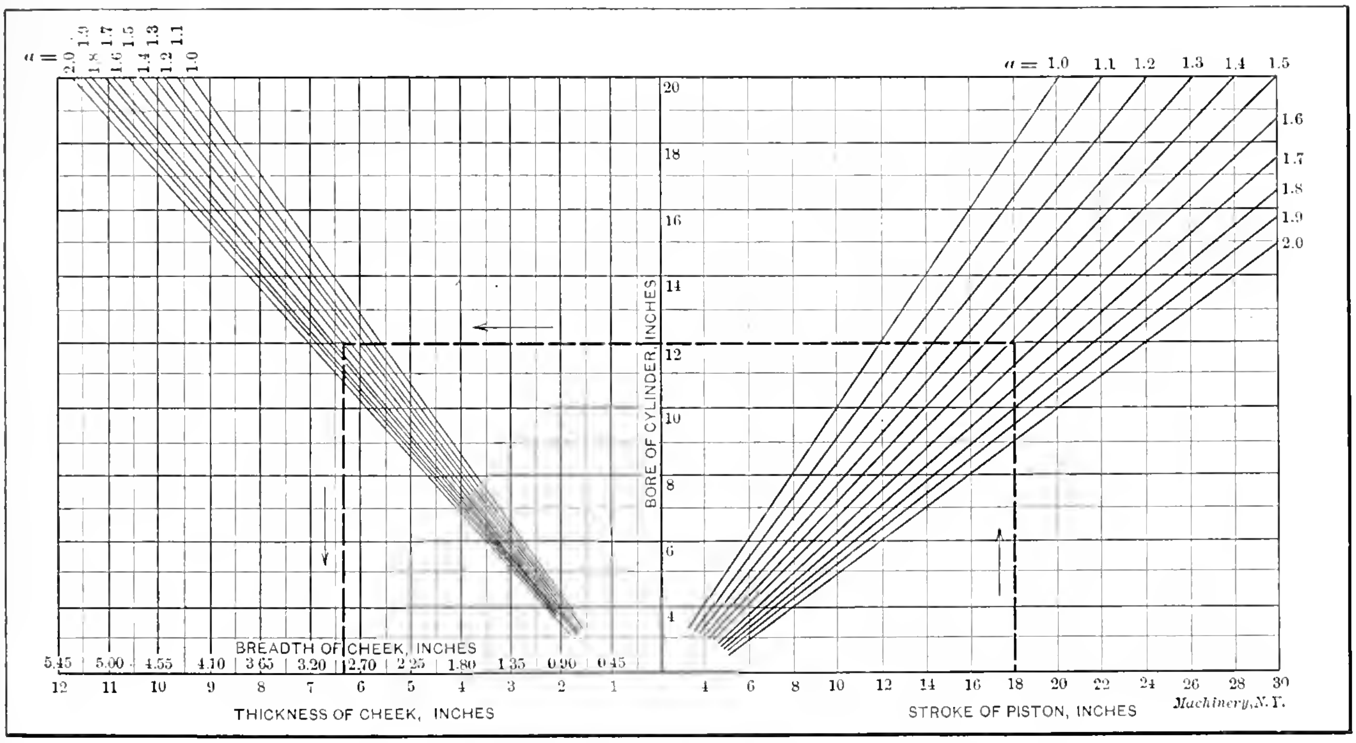


Fig. 2. Diagram for the Cheek Dimensions of Gas Engine Crankshafts

MAKING LEAKY GAS ENGINE PISTONS TIGHT

By GEORGE CORMACK, JR.*

There is no doubt that one of the most difficult tasks that the gas engine repair man encounters is a worn and leaky piston and cylinder. If the engine has been used for any length of time the putting in of new rings on the piston will not greatly improve matters, and many times will only make the leak at compression and explosion pressure worse. There is only one real way of overcoming this difficulty, and that is to rebore the cylinder and fit a new piston and rings. The following, however, is an easily applied makeshift which often proves satisfactory when the engine is an old one and the other parts are in a condition which would hardly justify the expense of reboring the cylinder and fitting a new piston. Gas engine pistons usually leak because the rings become too narrow for the grooves in the piston, allowing the gases to escape by getting under and around the rings.

The method is, briefly, as follows: Take out the piston and take off the rings. Clean the piston rings and grooves thoroughly. Get a piece of soft asbestos rope and before putting the rings back into place, wind some of the rope in the bottom of the ring grooves in the piston. Then soak the asbestos thoroughly with gas engine cylinder oil, and put the ring back in the grooves. Put in enough of the asbestos rope so that the rings will have to squeeze it down fairly tight when the piston is pushed into the cylinder. This method may not be considered as a very mechanical job, but an old leaky piston when so treated will, after running a few minutes, be very tight, and may run for months before the operation needs to be repeated.

* * *

What is said to be the largest belt in the world has recently been completed by a prominent belt-making firm. It is 210 feet long by 6 feet wide; 540 hides were used in its construction and the cost of it is stated to be $5,800.

* Address: Rockford, Ill.

LIGHT, VENTILATION AND DRAINAGE IN ONE-STORY SHOP DESIGN

We present herewith drawings showing the general construction of two types of one-story shop buildings, both particularly designed for climatic conditions as met with in the North, and both eminently successful in actual use. The controlling features in the design in each case were the obtaining of proper light, ventilation and drainage, together, of course, with adaptability to manufacturing purposes.

The shop illustrated in Fig. 1 may be said to have been designed along ideal lines. While it was not by any means built in a mood of reckless expenditure, it was the intention of the owners to spare no reasonable profit-returning expense in its construction. The details of the resulting design are shown in Fig. 2, where it will be seen to be of the single-story, saw-tooth construction. The building is intended primarily for erecting, and medium heavy machining operations. It is provided with aisles down the sides for the passage of stock, machine parts and finished work. The cross bays are provided with crane runways as shown in Fig. 2, which shows at the left a cross section of one of these bays.

In the matter of light, the advantages of the saw-toothed construction are well recognized. After deciding that this type would be employed, the designer in charge visited a number of similar shops for the sake of obtaining points as to the relative merits of various details of design. One difficulty met with, in some otherwise very satisfactory roofs, was that of an unexpected flood of heat reflected down upon the workman from under the side of the long slope of the saw tooth. This heat comes, by radiation, from the top of the following slope, in an upward direction through the windows, and then down again into the shop. In some places this reflected heat was so objectionable that the workmen formed the habit of standing behind posts or other shelter to get away from it. No difficulty on this score has been met with in the design here illustrated, owing, perhaps, to the particular roof proportions adopted.

Another difficulty which was investigated is that of excluding the direct rays of the sun during the long days of the year, when it rises and sets considerably to the north of the due east and west direction. It was at first attempted to settle, by calculation, on the proper angles for excluding these rays, and several expert investigators tried their hand at the problem. The results were unsatisfactory, however, so the roof angle of 27 degrees was arbitrarily selected. If the sun's rays became troublesome in the morning or evening, it was planned to put up vertical steel curtains at the sides of the windows, which would exclude this direct light, though leaving a free passage for the desired lighting from the north. This screen arrangement has been found unnecessary. It may be mentioned in connection with the roof proportions here given, that the latitude is about 43 degrees.

In the matter of ventilation the saw-toothed roof has often been found unsatisfactory, from having been built in too great a width. The attempt is made, especially in textile work, to cover enormous areas and still insure proper air circulation by the provision of ventilators in the roof. While these help, and should be provided, the constant flow and change of air necessary to preserve the comfort (and consequent productivity) of the workman, can only be obtained in summer by the natural sweep of the outside air through the building, or by the more expensive alternative of forced ventilation. This sweep of outside air is not effective in buildings of this kind of more than 100 feet width; consequently that is the dimension adopted for this particular structure. Additions to the area can be made by lengthening the building, or by erecting other units of the same width. The building is, of course, plentifully provided with side windows, which are opened in the summer to permit the desired sweep of air. Many of the textile mills have been made with blank walls.

Roof drainage is an important point to be considered in high latitudes. Travelers in northern New England have, doubtless, noticed the distinctive appearance given to the towns by the steep pitch of the house roofs. This steep pitch is necessary to make the roofs clean themselves of snow; otherwise the tendency is for the snow to melt at the warm ridge and run down to the cold eaves where it freezes, clog-

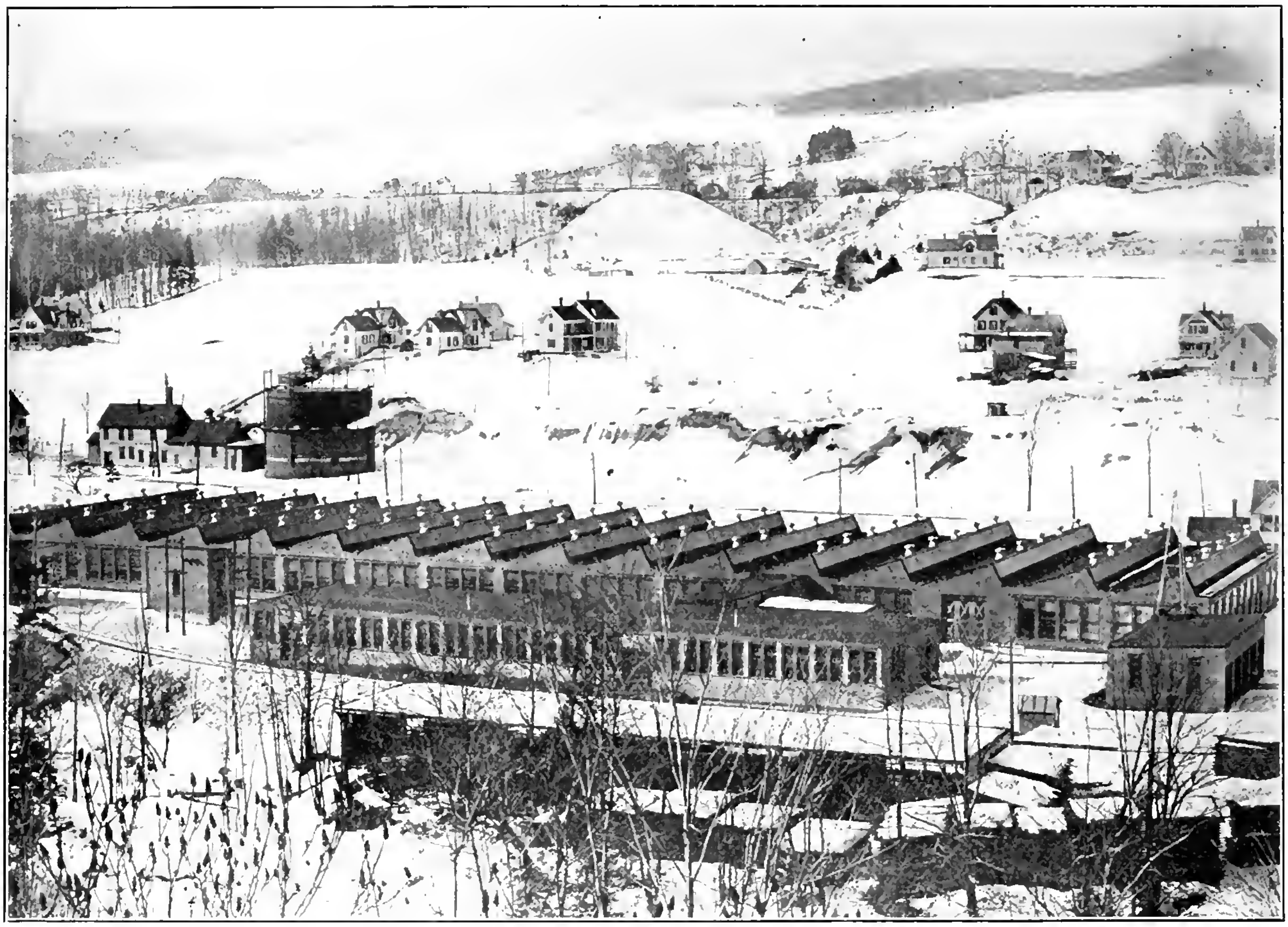


Fig. 1. A Successful One-story, Saw-tooth, Shop Design, for Northern Latitudes

ging up the drain pipes, and forming a dam of solid ice, which causes the water to work back in under the shingles. If the roof is self-cleaning, these troubles are avoided.

No attempt is made of course to build the roofs of manufacturing plants on the self-cleaning principle, nowadays. What should be done is to locate the drainage pipe at the warmest point in the whole area, so that when any melting is going on, it will be at this point, leaving a free, unobstructed flow for the water. The saw-toothed roof lends itself readily to drainage in this way. Each valley is provided with three drain pipes, one in the center and the other two, twenty

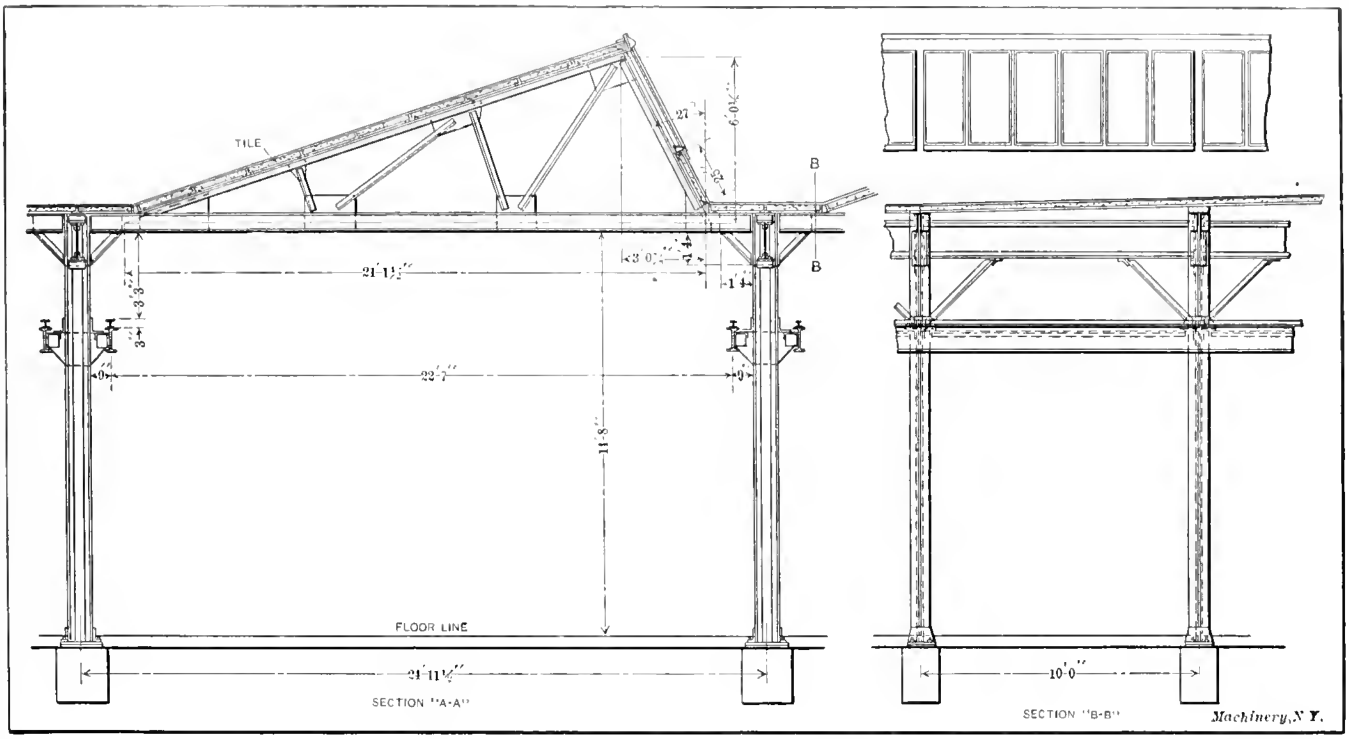


Fig. 2. Structural Details of the Building shown in Fig. 1

feet from either wall of the building. These pipes pass down alongside the rows of posts in the shop. If any freezing is done, it will be at the ends of the valleys next to the outside walls, and as the water is not expected to drain from there in any case, there is no danger of forming ice which will dam up the melting snow.

It will be seen that the valleys have a flat door, which permits free passage for workmen in repairing the roof, reglazing the windows, etc. The roof is covered with book tiling, supported by small T's as shown, and cemented. The whole is then covered with roofing. It was expected that it would be possible to drive roofing nails into the tiling, but when the latter was delivered this was found to be impossible, so the roofing is held on by laying it on heated asphaltum. This has been found successful and no creeping has been noticed.

As shown in Fig. 2, the bottom of the window sashes is 25 inches above the floor of the valley. This gives an ample reservoir capacity for snow and ice. The roofing is carried in an unbroken sheet down the side slope, over the valley and up under the window casing. At the ends of the valleys the roofing is lapped over the wall, which has the exact form of the saw tooth, instead of being a trifle higher as it is sometimes made. This construction avoids the extensive use of flashing, and gives a watertight construction at a minimum of expense. There are no trap doors in the roof. Everything is sealed up snug and warm, excepting that a large number of ventilators is provided, as shown in Fig. 1. This building belongs to the plant of the Jones & Lamson Machine Co., of Springfield, Vt.

The building shown in Fig. 3 is of a less expensive construction, but of a design which secures a maximum of serviceability for each dollar expended in its construction. It is one story high, of slow-burning construction, with a roof of the hopper type. The slow-burning construction is entirely practicable for a one-story building, though for two or more stories the advisability of using even very heavy wooden framing might be questioned. The advantages of the building from the standpoint of light, ventilation and drainage will be readily understood.

In regard to the light, it should be noted that the building is comparatively narrow (40 feet wide) with windows reaching to the ceiling. The useful light for machine shop operations, coming from the sides of the building, is that which

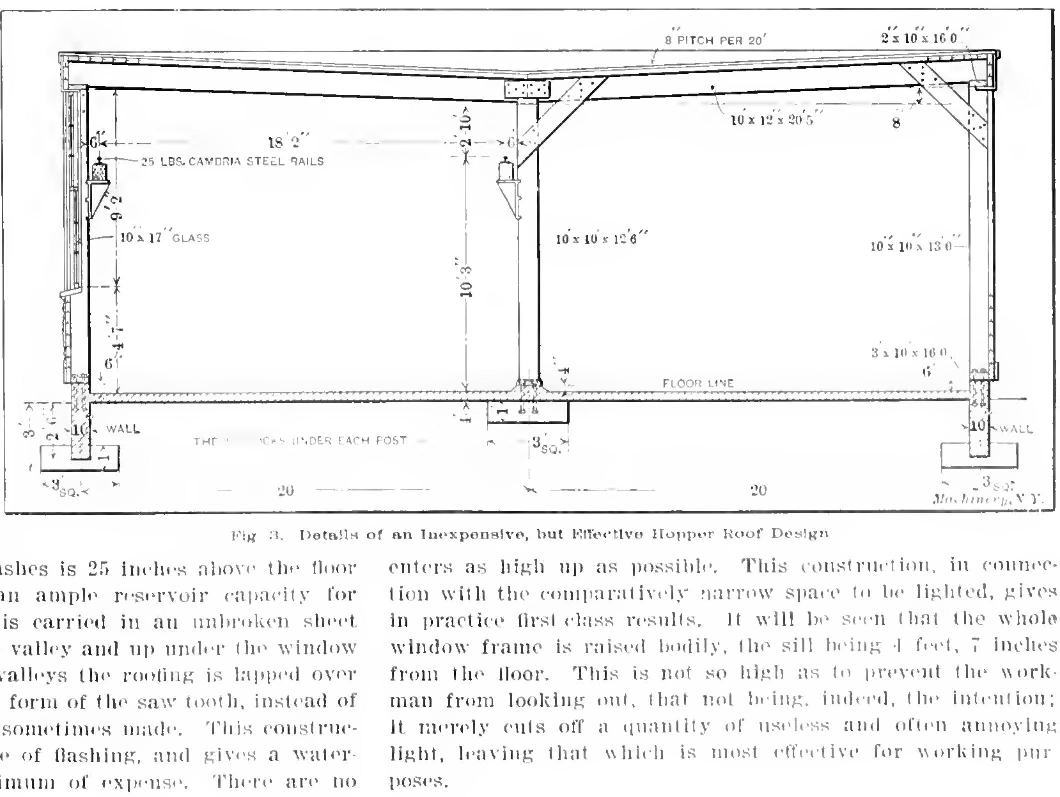


Fig. 3. Details of an Inexpensive, but Effective Hopper Roof Design

enters as high up as possible. This construction, in connection with the comparatively narrow space to be lighted, gives in practice first class results. It will be seen that the whole window frame is raised bodily, the sill being 4 feet, 7 inches from the floor. This is not so high as to prevent the workman from looking out, that not being, indeed, the intention; it merely cuts off a quantity of useless and often annoying light, leaving that which is most effective for working purposes.

This building is narrower than that shown in Figs. 1 and 2, and consequently easily ventilated and cooled in summer. The shipping doors at that time are also thrown open on each side, this serving to keep in motion the body of air near the floor of the shop. With this design, in the part of the building devoted to the offices the windows are brought down to the normal level. The shop windows only are located high in the wall.

The hopper roof, drained from the center, meets the requirements for northern climates as already described. As fast as the snow melts, the water runs off without requiring the thawing of drain pipes or the clearing of the gutters of ice. The roof, in fact, takes care of itself entirely. Owing to the manner in which the roofing is applied, no flashing is required over the windows, and projecting eaves are avoided as unnecessary. The roofing is carried over the edge of the building and laps onto the outside of the woodwork. This, in turn, laps over the outside of the window casings, effectually sealing the building from the entrance of water at these points.

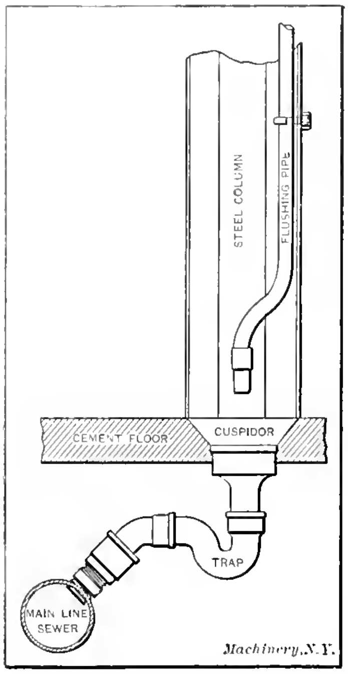


Fig. 4. An Automatic and Efficient Substitute for the Saw-dust Box

Another building of identical construction with this last is shown in front of the saw-toothed roof in Fig. 1. This smaller building is used for painting, snagging, carpenter work, etc. Enlargement in this case, as in the previous one, would be done by lengthening the old building, or by erecting other units of the same width, rather than by adding to the width of the original.

While we are on the subject of drainage, it will not be inappropriate, perhaps, to call attention to an interesting provision in the design of the Jones & Lamson shop shown in Fig. 1. This provision, shown in detail in Fig. 4, may be called an "automatic cuspidor." It consists simply of a series of drains in the concrete floor, placed at every other column across the width of the shop. These are connected, through traps, with sewer pipes embedded in the soil beneath the building, and are flushed at regular intervals of eight or ten minutes with a stream of water, controlled by the regular apparatus for such work.

A more sanitary arrangement could not easily be conceived of. It is certainly an attractive improvement over the practice of indiscriminate expectoration on the floors, machines and work; and even over the more advanced practice of providing individual boxes filled with saw-dust, cleaned and refilled at more or less regular intervals by the individual workman, or by some one especially appointed to the position.

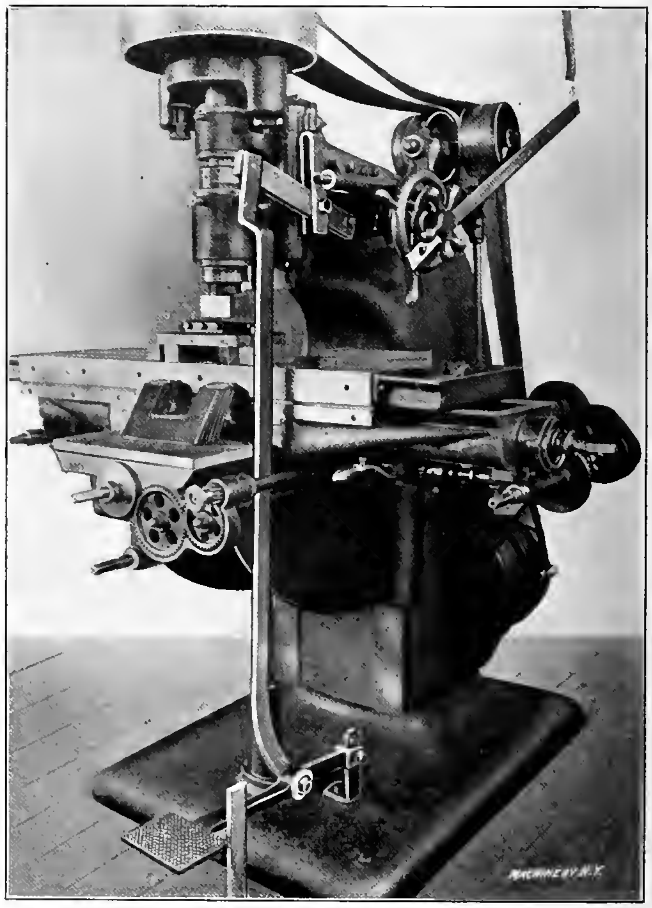
* * *

Fly-wheel repairs in a mountain town in North Carolina were recently made in an unusual manner by the Goldschmidt-Thermit Co., as related by the *Engineering News*. The fly-wheel was twenty-four feet in diameter, cast in two segments, each weighing ten tons. During transportation the rim was broken clear across, and two breaks took place in the spoke between the rim and the hub. Difficulties were experienced in supporting the wheel parts while making repairs, but finally this was successfully accomplished, and each weld in the spoke was made with a mixture of 250 pounds of thermit, 62 pounds of punchings, 5 pounds of ferro silicon and 2½ pounds of pure manganese. The rim was afterwards welded by using 500 pounds of thermit, 125 pounds of punchings, 10 pounds ferro silicon and 5 pounds of pure manganese.

A VERTICAL MILLER USED FOR A PUNCH PRESS ON EMERGENCY WORK

The Colburn Machine Tool Co., of Franklin, Pa., has built for some time past a line of welding machinery for the Toledo Electrical Welding Co. Included in the construction of an electrical welder is a transformer, whose coils are wound on cores built up of thin iron laminations. In making these laminated cores, this firm suddenly found itself in need of a punch press, when there was none available in the establishment. In this emergency, a few hours' tinkering on the part of the superintendent, Mr. Weller, produced the arrangement shown in the accompanying engraving, which worked well and gave first class satisfaction.

The die is mounted on parallels on the table of the vertical milling machine, as shown; this leaves a space underneath for the scrap to drop through, whence it is easily removed. The punch is mounted in a holder having a taper shank, fitting the regular taper of the spindle which is blocked from turning by suitable means. For working the spindle head and the spindle up and down for the operation of the punch, a foot-power movement was given by the connections as shown.



Converting a Miller into a Punch Press, with the Aid of a Few Pieces of Strap Iron

The treadle at the base was once used for another line of machinery. To it was bolted a long link, as shown, bent up out of scrap iron, and connecting with a lever pivoted to the upper overhanging frame of the machine. This, by means of the short double link shown, operates the vertical spindle slide, which could thus be brought down by foot pressure. For returning it, a long arm of strap iron is used, bolted to the quick-adjusting handwheel of the spindle slide as shown. The outer end of this lever is attached to a spring hung from the ceiling. When the treadle is pressed, the spindle is forced down against the pressure of this spring, returning again when released. The action of the foot-power connection is free enough so that the workman has no difficulty in keeping it going the greater part of the day on thin machine steel.

While an arrangement of this kind must be considered in the light of a temporary rigging, yet the ability in a few hours to rig up such a device is a valuable one, and one that will be very necessary in machine shop work so long as emergencies arise.

NEW ROTARY GAS ENGINE FOR AERIAL NAVIGATION*

By CHESTER L. LUCAS† and JOHN J. ROSS‡

The gas engine has long since passed the experimental stage, and its usefulness as a prime mover for automobiles and marine craft, as well as its superiority in generating power for the many industries into which it has been introduced, has been proven by actual practice. The principal reasons why the gas engine has forged to the front are: 1. The economy of its fuel and maintenance. 2. Low first cost and cost of installing. 3. Light weight and small space required. 4. It may be operated by comparatively unskilled labor.

On account of its light weight the gas engine has been adopted, almost without an exception, for use in aeroplane work. Generally speaking, there are but three forms of power that could be considered: steam, electricity and gas. As the excessive weight of fuel and water for steam, and the weight of the storage battery for electricity, are prohibitive, gas power has been adopted. The ideal towards which the aeroplane experimenters have been striving is an engine or motor that will be light, powerful, positive in its ignition, and reasonably simple in its mechanism so as to require little adjustment or attention from the aviator.

The L. A. W. Rotary Internal Combustion Gas Motor

To meet these requirements has been the aim of the designers of the new L. A. W. rotary internal combustion motor, recently exhibited at the First National Exhibit of Aerial Craft, Boston, Mass. This motor, which is of the six-cylinder, two-cycle type, is the result of seven and a half years' experimenting on the part of the inventors, Oliver A. Light, James O. Light, Edward Keeler (who was recently killed in an automobile race), and Victor W. Page. The latter has been associated with Messrs. Light for the last two years and he is largely responsible for the Page-Light aeroplane in which the new motor is to be used.

The Page-Light Bi-plane

The Page-Light aeroplane is of bi-plane type; its general design is shown in Fig. 1. The frame is light yet very strong, being composed of ash and aluminum. Steel wire is employed for bracing. The four wings are each 10 feet in length and $6\frac{1}{2}$ feet wide and are designed so that they may be detached for convenience in transportation. The motor, as shown in Fig. 4 is mounted on trunnions so that it may be tilted to any desired angle in the horizontal plane, thus helping the rudders to elevate or lower the aeroplane. The propeller, made of laminated ash and mahogany, is 6 feet 6 inches in diameter and located at the extreme front of the machine. The overall length is 22 feet and the width is 27 feet. The weight of the machine including the aviator is about 750 pounds, and it has a supporting surface of 300 square feet. It is the intention of the designers to materially reduce this weight in future machines.

The Motor and Its Parts

The first impression one gets of the L. A. W. 30 H.P. gas motor is the novel form; it resembles a flat disk, 22 inches in diameter and 7 inches thick, and weighs 150 pounds. Upon disassembling the motor it is found to be composed of but four principal members: the cylinder casting, the pistons, the outer case and the supply chamber.

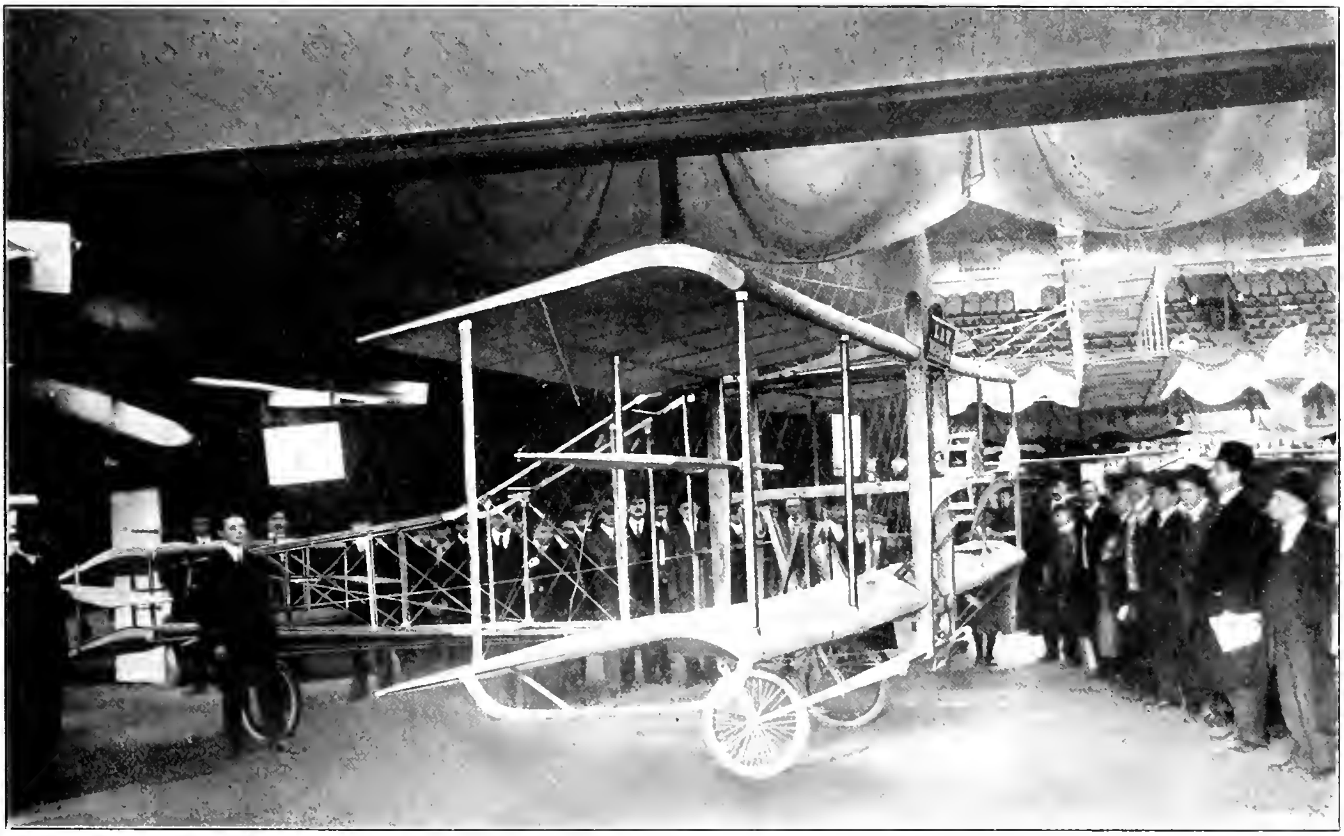


Fig. 1. The Page-Light Aeroplane, which uses the L. A. W. Gas Motor

The cylinder casting, which forms the larger part of the motor, weighs approximately 90 pounds, and has the six cylinders cast integral. These cylinders as shown in Fig. 3 are spaced equidistant around the casting, 60 degrees apart. The cylinders are not located radially, but are thrown off center. At their outer ends they are connected by a band of metal, a part of the casting itself. This band strengthens the cylinders and stiffens the casting in general and on it are located the fan blades for cooling the motor while in operation. The center of the casting is bored to receive the supply chamber and is mounted in the outer case, one and one-quarter inch off center. This casting is of gray iron and over all it measures $17\frac{1}{4}$ inches diameter and 13 inches thick.

The Cylinders and Pistons

The cylinders proper are covered with cooling spines [illegible] inch long of which there are 75 to each cylinder. The cylinders are bored $2\frac{1}{2}$ inches in diameter and have $2\frac{1}{2}$ inches of piston travel. For about half their length the cylinder walls are slotted to receive the guide-shoes that reciprocate in them. At the heads of the cylinders are the inlet ports E, and midway of the length of the cylinders are the exhaust ports J, of which there are eight to each cylinder, four on each side. The pistons P are of gray iron, turned and ground to size

* See MACHINERY, July, 1908; "Adams-Farwell Aeronautic Gasoline Motor."

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Two eccentric piston rings are fitted to each piston. At the end of each piston, on opposite sides of its walls are fitted square brass shoes *M* which run in the slots in the cylinder walls. These shoes take up the larger part of the wear on cylinder and piston and steady their action as well. At the extreme ends of these shoes are mounted annular ball bearings *H*, the balls in which are 5/16 inch in diameter. Both pistons and cylinders are very light, mere shells in fact. This is made possible by the system of guide-slots and shoes that relieve these parts of most of the strain.

The Outer Casing

The outer casing *L* is made of aluminum and consists of the front and back plates and the cylindrical part that encloses portions of the sides. Upon the sides of the casing are attached the lugs for the trunnion mounting. The front and back casings have numerous ventilation holes drilled near the center to supply fresh air for cooling.

The casing is held together by eight 3/8-inch bolts. Set into the casing are steel tracks *I* in which the annular ball bearings *H* attached to the pistons *F* run. These steel tracks are hardened and ground so as to give a perfect bearing.

The Supply Chamber and Blower

The supply chamber *A* is a cylindrical gray iron casting turned and ground on its outside surface. The interior is left as cast on account of the heat regulating spines *O* that project into the chamber. About this part the cylinder casting revolves. A large percentage of friction is eliminated by the use of a double row of annular ball bearings *P*. On the outer surface of the supply chamber are spiral oil grooves leading from each end toward the supply port hole. The blower *B* with its metal casing is located at the mouth of the supply chamber. The power for its operation, which by the way is but 1/8 horsepower, is obtained by means of a friction drive *N* connected to the cylinder casting. The blower, which has a 3-inch fan, runs at a high speed to insure an abundance of pressure, and will give good results at high or low speeds. This is the smallest size made by the American Blower Co., the fan, case and gearing weighing but one pound.

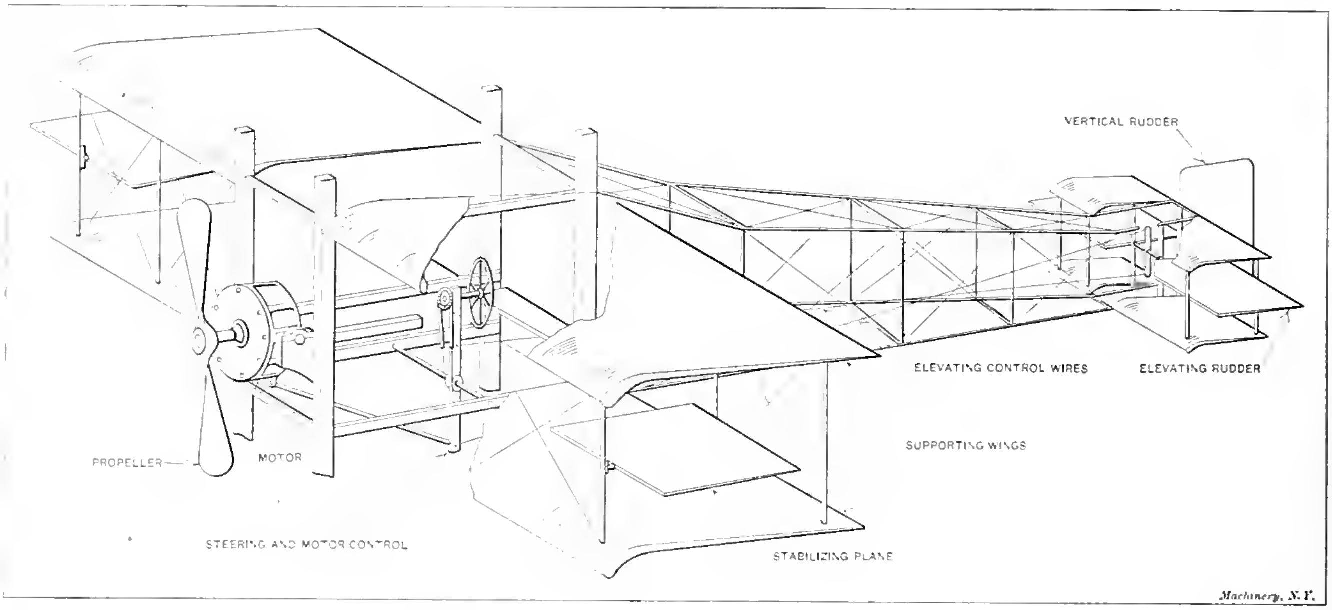


Fig. 2. Details of the Aeroplane, showing Control System

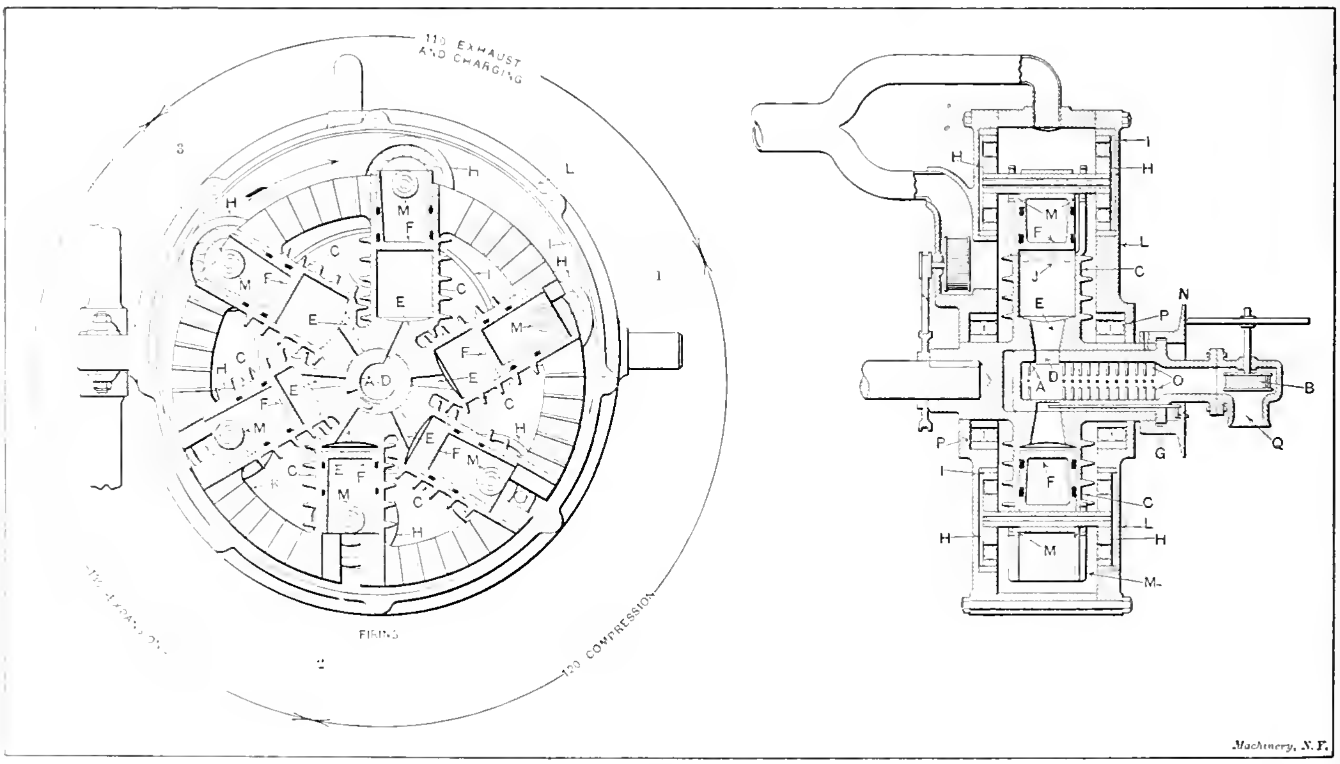


Fig. 3. Sectional Views of the Motor

Spark Plug and Wiring

One would think that a confusing network of wiring would be necessary for firing the six cylinders, but in reality but one spark plug and one set of wiring are required. This spark

plug, located in the supply chamber close to the end and near the entrance port to the cylinder, can be fired by means of any standard make of coil; the inventor of this motor has found the Splitdorf to give good results.

Operation of the Motor

The operation of this novel type of motor is quite distinctive from the working of other types of gas motors. The mixture is taken through a Schebler carburetor and thence to the intake and into the supply chamber *A*. The blower *B*, at its location at the mouth of the supply chamber, accelerates the flow of the mixture. From the supply chamber the mixture enters the cylinder *C* when the cylinder is between positions 3 and 1. At this position entrance port *D* of the supply chamber is in line with the cylinder port *E*. The rotation of the cylinder casting causes piston *F* to commence its inward stroke, thus compressing the charge. This inward stroke is actuated by the pressure exerted upon the ball-bearing end of the piston, caused by the cylinder casting being mounted eccentrically with reference to the track in the outer casing. As the charge in this cylinder is compressed, succeeding cylinders are filling in their regular order. At position 2, 120 degrees from position 1, the charge is compressed ready for

Fig. 4. The L. A. W. Motor and its Mounting

firing. At this point contact is formed by the timer *G* and the charge is fired. The pressure exerted on the piston *F* by the expanding gas is transmitted by the annular bearings *H* to the outer flange of track *I* in the casing and hence causes a rotation of the cylinders.

Ths expansion of the gas starts the piston on its outward stroke and at the end of the stroke the exhaust ports are disclosed, allowing the gas to escape. At this position, 3, the cylinder has traversed 130 degrees from the firing position 2, or 250 degrees from the time it starts to compress the charge. From position 3, to position 1, a distance of 110 degrees, the gas is exhausted; immediately a new charge rushes in. Thus it is obvious that the motor works on the two-cycle principle. The burned gas rushing out through the four holes *J* at each side of the cylinder keeps the cylinder from becoming unevenly heated, and thus all danger of warping cylinder walls and the resulting binding of the piston is eliminated. Best results have been reached by running the motor at the speed of 1,200 revolutions per minute though higher speeds have been employed.

The outside walls of the cylinders being covered with cooling spines, and the 84 fan blades mounted on the band that connects the cylinders are the principal factors in the air-cooling of the motor. The fact that the cylinders are in rapid motion through the air greatly aids the cooling process.

The system employed for lubricating the working parts of this motor is simple. The lubricating oil is fed into the supply chamber along with the mixture. The centrifugal force does the rest, by spreading it to every part of the motor, cylinder walls, ball bearings, and track. Restricted by the outer casing, the lubricant is drained to the base of the motor, filtered and again started on its journey.

One of the strongest points of this gas motor is its light weight in proportion to the horsepower. The machine has been perfected but a short time, and the inventor believes that further developments will bring the weight down to less than two and one-half pounds per horsepower.

Cooling System

Most of the efficient types of gas engines or motors are water-cooled. This means that a heavy water-jacket must be employed, which added to the weight of the water for cooling proves a serious drawback in aeroplane use. The fan-blades on the cylinder casting together with the cooling spines on the cylinders themselves and the fact that the

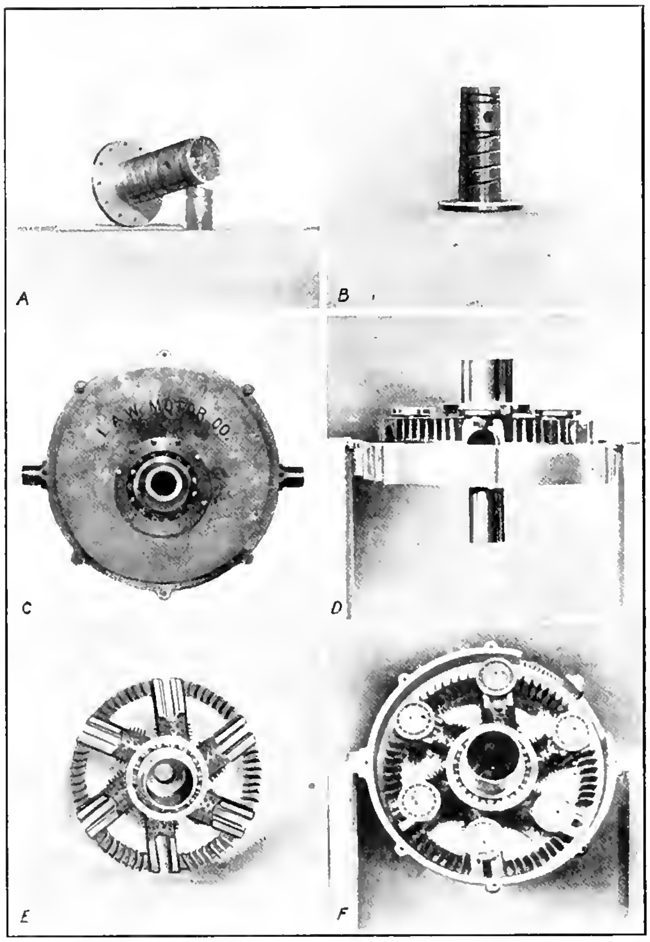


Fig. 5. A. Supply Chamber. End View showing Heat-regulating Spines. B. Supply Chamber, seen from the Side. C. Motor Assembled. D. Side View of Motor with Part of Casing Removed. E. Cylinder Casting. F. Motor with Front Casing Removed

ample exhaust ports let out the burned gas so quickly and evenly are the points that make the cooling system a pronounced success. In this connection, though not a part of the cooling system, it is well to note that the internal spines are for regulating the temperature of the mixture as it passes through the supply chamber.

Ignition

The simple method of firing is superior to the usual system and must not be overlooked. A six-cylinder gas engine with but one spark plug and one set of wires is novel. In addition, the inventors claim that the motor is self-firing after the first two revolutions. This is brought about by means of a small drilled hole through the supply chamber, off-set enough to prevent penetrating the inner wall of the supply chamber. This hole connects the two adjoining cylinders but is not open except at the very end of each explosion. The opening, barely an eighth of an inch in diameter, allows a little of the flaming charge to shoot into the next cylinder, whose charge is ready for firing. This operation repeats itself in the next cylinder and so on, doing all of the firing and dispensing with the use or need of any electrical appliances. The comparatively few

parts of the L. A. W. motor make its care very easy. Fewer adjustments are necessary and there is less danger of breakdowns—a point sought for by aviators. One example of this feature is shown by the absence of the fly-wheel, the entire cylinder casting taking its place and satisfactorily doing the work.

The fact that this motor will run in any position is advantageous to aeroplane use. As shown mounted on trunnions at the front of the Page-Light aeroplane, it illustrates the value of this point, which is made use of in manipulating the machine. Referring to Fig. 2 which illustrates the system used in elevating or lowering the bi-plane, if the aviator wishes to rise to a higher level, he pushes the steering wheel from him; this tilts the propeller upwards and at the same time throws the elevating rudder down in front. For lowering the biplane the process is *vice versa*.

It is claimed that the motor will run on alcohol, kerosene, benzol or crude oil as well as on gas or gasoline, or in fact any combustible mixture. The elimination of most of the packing required on the ordinary gas engine at cylinder heads, intake and exhaust fittings, etc., is commendable. The annular ball bearings used at all of the principal working points keep down the friction and lessen the wear and tear on the motor.

The makers of this new gas motor are L. A. W. Motors Company, 539 Howard Building, Providence, Rhode Island. At Providence this company has the first aeroplane factory in New England and the third one to be established in America. The company is prepared to give positive dates for delivery of rotary gas motors of 30, 40, 50, 70 and 100 horsepower to be used for any purpose.

* * *

HERSCHEL FALL INCREASER FOR HYDRAULIC TURBINES*

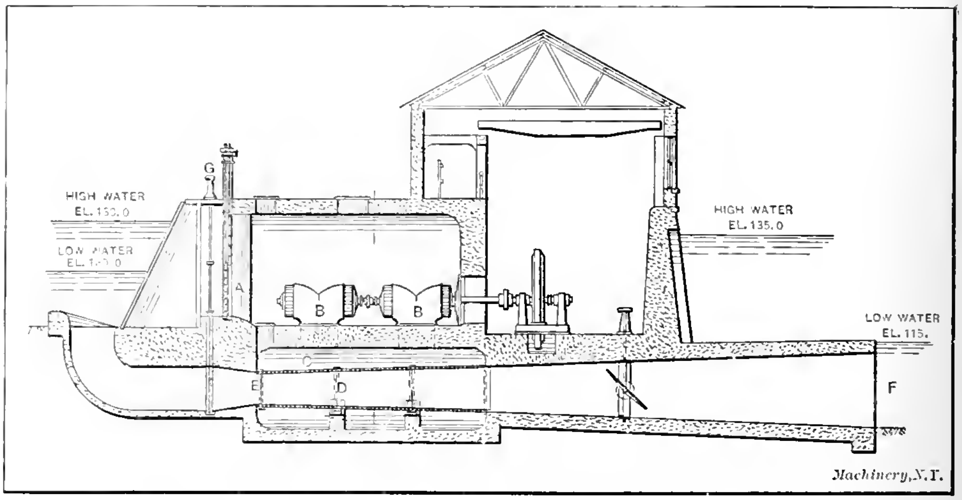
One of the difficulties which have to be reckoned with in installing turbines is that of the loss of head during high water. This condition always seems paradoxical to any one who is not familiar with the conditions, but it is easily explained. When a stream arises during a flood, the height of the water over the crest of the dam increases as a rule considerably less than the rise in height of the back water below the dam, so that the difference in levels is less than during the normal flow. This more rapid rise of the back water is due, of course, to the fact that the lower channel is almost invariably restricted, while the discharge of the dam itself is purposely made ample in area, so that a large increase in the volume of water makes comparatively little change in level.

The loss of head during high water has been at times so serious as to render the plant practically useless. It has usually been avoided by installing additional waterwheel units; or sometimes, in the case of hydro-electric plants, by furnishing an extra wheel on each generator shaft. These additional turbines make up for the loss of power due to the loss of head by employing more of the water going to waste over the dam. The disadvantage of the construction is, of course, the increased cost of wheels, gates, governors, water passages, generators, etc., required.

Mr. Clemens Herschel, the designer of the Venturi tube water meter, has devised a very simple and inexpensive method of overcoming the back water difficulty. This method employs a principle parallel with that on which the Venturi meter operates. It consists in effect of an apparatus similar to the well-known steam ejector for lifting liquids, but built on a large scale, and operated by water instead of by steam. It is applied to the discharge chamber to lower the head in the chamber below the level of the back water in the tail race. An application of this device is shown in the accompanying engraving.

In this particular installation the high and low water elevations above the datum line, give, as may be seen, a head of 15 feet for low water, and of 3 feet only for high water. The intake is shown at *A*. Two double turbines of the submerged type are used for each generator, discharging into chamber *C* and out through the perforations in pipe *D* into the tail race at *F*. During low water the gate in tube *D*, operated by handwheel *G*, is closed.

When, however, the head is so much increased as to lower the capacity of the station below that required, gate *G* is opened, permitting the water to flow through into tube *D*, and



Water Power Station Fitted with a Hydraulic Ejector for Lowering Head in Discharge Chamber below Back-water, during High Water

out into *F*. This tube, it will be seen, has a constricted throat at *E*, which increases the velocity of the water at this point above that due to the head. This velocity the water retains in passing through the enlarging sections at *D* and beyond. This condition results in lowering the pressure in *D* below that due to the height of the back water, and as this tube is perforated all around, this lower pressure draws in the water from *C*, whose head is also lowered, increasing the effective head under which the wheels work. The whole discharge of both ejector and wheels is, of course, through tube *D* into the tail race at *F*.

In the case of a plant on which Mr. Herschel recently made estimates, it was concluded that with the usual arrangement of surplus turbines an expenditure of $200,500 would have been required. By the use of the fall increaser this could have been reduced to $150,000 or $175,000 depending on whether the submerged, or the siphon type arrangement was used for the wheel.

* * *

In the March, 1909, issue of MACHINERY, engineering edition, the profit-sharing scheme of Sir Christopher Furness of the Middletown Ship Building Yard, England, was mentioned. The first dividends under the new system have now been declared, and it appears that the method employed is very profitable both to the employers and employes. The employes pay for their stock at regular par value, so that their participation is in the form of actual dividends rather than profit-sharing in the ordinary sense of that term. For the first year the regular stockholders, according to the rules of the agreement, received ten per cent on their invested capital, while the employes received nine per cent on their investment. It is a little difficult to see the justice in making the employes receive less on their investment than the stockholders, except that this method of declaring dividends was made part of the agreement under which the employes were permitted to acquire stock. Nevertheless, it must be admitted that the scheme has proved highly beneficial both to employes and employers and that the waste incident to strikes and lock-outs has been avoided. The idea of making the workers partners in the business also deserves commendation.

* Abstracted from *Engineering News*, February 24, 1910.

MACHINING GAS ENGINE FLYWHEELS, CYLINDERS AND BEDS*

PRACTICE OF THE FOOS GAS ENGINE CO.

By ETHAN VIALL†

Like many of the big manufacturing concerns, there is nothing very startling about the shop practice of the Foos Gas Engine Co., Springfield, Ohio, yet it is far in advance of the majority of similar shops in quantity, finish and economical production of its output. This firm builds all sizes of engines from 2 to 500 horsepower, and the methods used in handling the larger and less-called-for castings are necessarily different from those employed on the class of engines which are built in lots of one hundred or more at a time. As it is the usual shop practice that interests us the most, but a glance will be given toward the large sizes, while the medium sizes will be considered in detail. Taking up in order the parts as enumerated in the title, we first turn our attention to the flywheels.

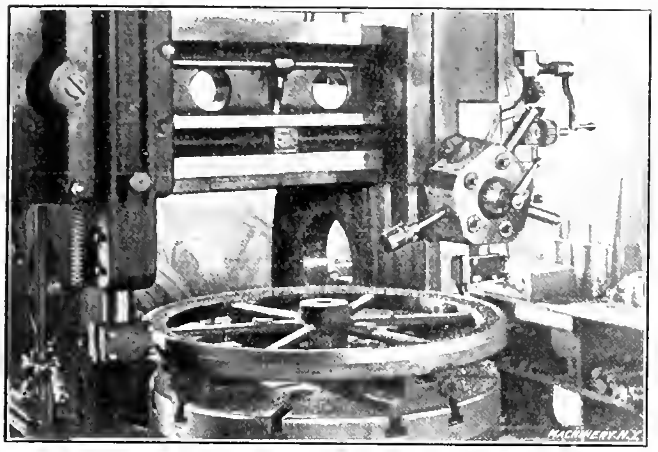


Fig. 1. First Operation on a Flywheel—Turning the Rim in a Vertical Boring Mill

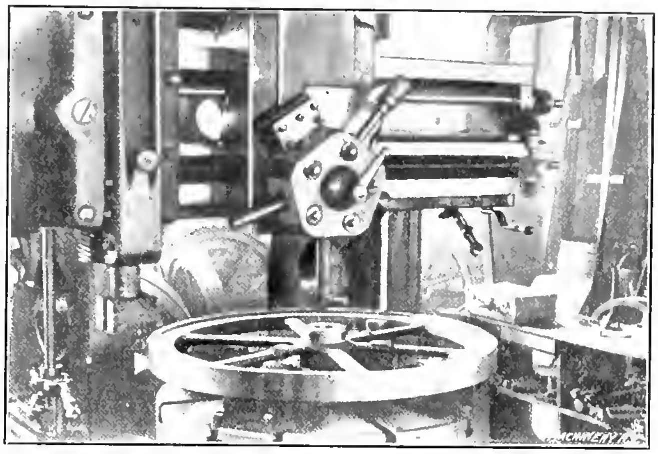


Fig. 2. The Hub Machined on the Outside end the Center Hole Bored and Reamed

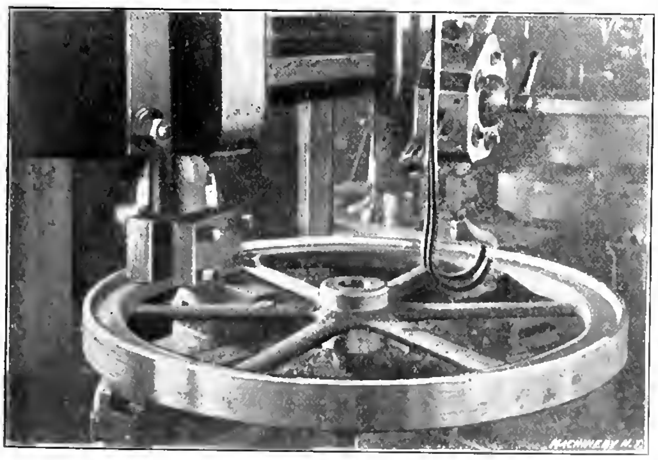


Fig. 3. Finishing the Opposite Side of the Wheel, which is centered by a Plug in the Table

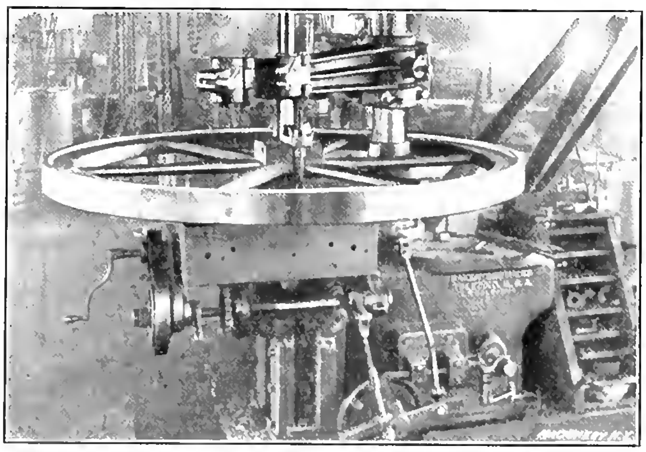


Fig. 4. Cutting the Keyway in a Flywheel of the Split-hub Type

Machining Flywheels

After coming from the foundry, the solid flywheels are cleaned of sand and carefully looked over for cracks or flaws, and any unsightly or unusual lumps of metal are carefully removed. The casting is then placed on a Bullard turret-head boring mill, the table of which is fitted with four independent chuck jaws, and chucked central, the jaws coming in contact with the inside of the rim. Two of the jaws are in contact with two of the spokes, to prevent slippage while taking the rim cut. The first operation is to true the outside of the rim as shown in Fig. 1, and the next to surface off the edge and side; the hub is then finished on the outside and the hole bored and reamed as in Fig. 2. After all of one lot of flywheels have been finished in this way, a plug which exactly fits the reamed center hole, is placed in the center of the table, the flywheels are placed over this plug and the other side is surfaced off as shown in Fig. 3. This engraving also shows the hooks used on the air hoist to handle the wheels. From the boring mill the flywheels go to a Baker Bros. keyseating machine, Fig. 4, and the keyways are worked out. The flywheels having split hubs are worked up in practically the same way, except that only the ends, and not the barrel of the hub, are finished.

Various Operations on the Cylinders

The first thing done with a cylinder by a machinist, is to insert pieces of wood like A, Fig. 5, in each end and mark approximate centers on them to line up by. The cylinder is then placed on the adjustable V's, B and C, on a Pratt & Whitney double spindle mill, with one end braced against the angle plate D, and strapped down as shown. A surface gage is used on the centers just described, to get the cylinders in the proper position. The cylinder ways E, on each side of the casting are now milled on the edges and bottoms. After the entire lot has been milled in this way, the special vise A, Fig. 6, is placed on the same machine, the small milling cutters are removed and the cylinder is turned end for end and is clamped in the jaws of the vise by the ways just milled; the inlet and exhaust box pads B are then surfaced off. Next the cylinders are placed in a Barrett horizontal boring mill, Fig. 7, on the supports A, being located by the cylinder ways, as in the last operation; they are then rough bored, faced on each end, counterbored and the head end grooved for the packing.

The machine shown in the engraving, has been fitted with an alarm bell on the turning head so that the operator can run several machines without danger of smashing his tools, the bell being so set as to ring a minute or so previous to the end of the cut. The last three engravings also show the hoist hooks used to handle the cylinders, one hook being inserted in each end.

* For additional information relating to gas engine manufacture, see the following articles previously published in MACHINERY: "Making Accurate Automobile Engine Pistons"; "Automobile Factory Practice," January, 1910; "To Determine Size of Gas and Oil Engine Cylinders"; "Gas Engine Cam-shaft Key-seating Fixture," February, 1909; "Determining the Actual Compression in a Small Gas Engine," August, 1909; "Gas Engine Valves," October, 1908; "The Manufacture of Piston Rings," June, 1909; "Automobile Engine Building in a Steam Engine Plant," April, 1907; "Formulas for Gas Engine Crankshafts," January, 1908; "The Design of Springs for Gas Engine Valves," May, 1908; "Formulas for Gas Engine Fly-wheels," August, 1907.

† Associate Editor of MACHINERY.

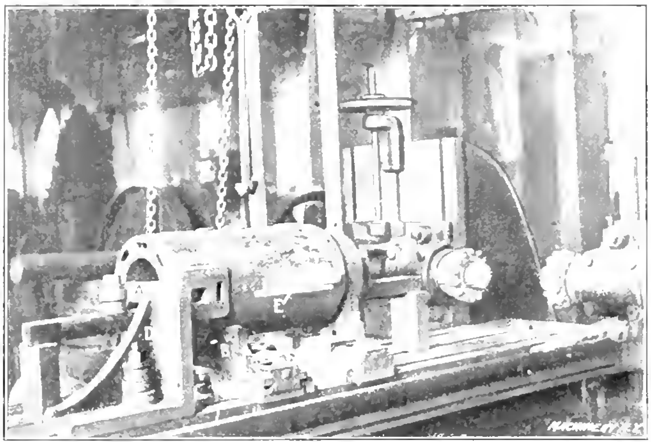


Fig. 5. Milling Bottom and Side of Cylinder Ways on Double-head Milling Machine

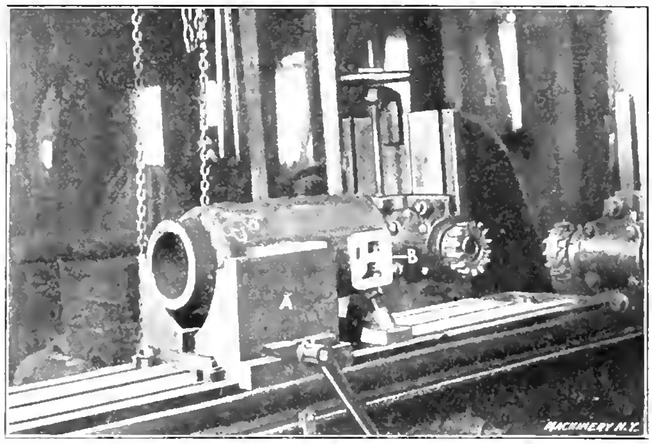


Fig. 6. Surfacing Inlet and Exhaust Box Pads

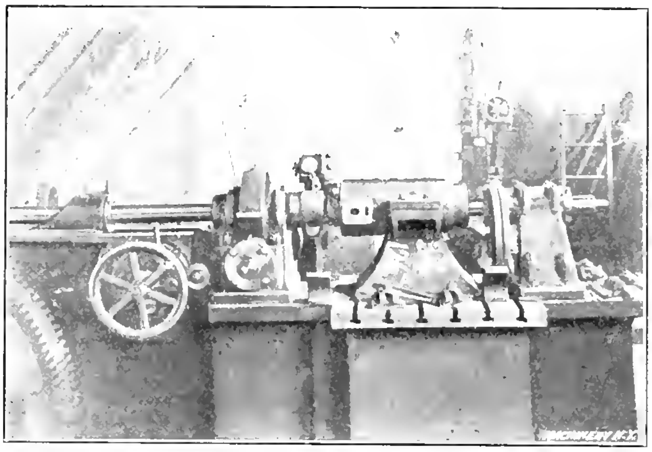


Fig. 7. Rough Boring a Cylinder on a Horizontal Machine

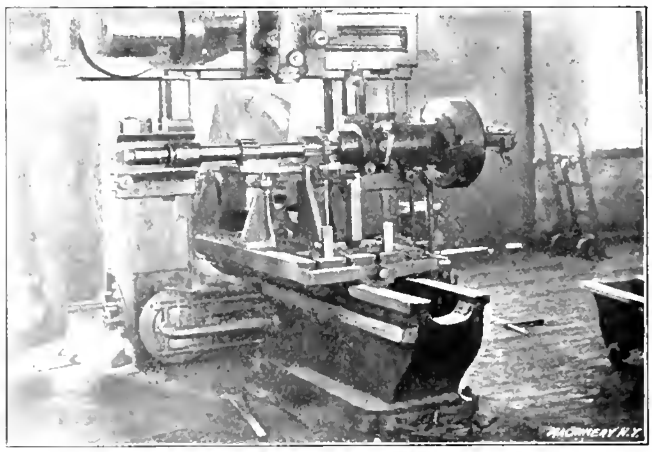


Fig. 8. Surfacing the Bottom and One Edge of the Bed

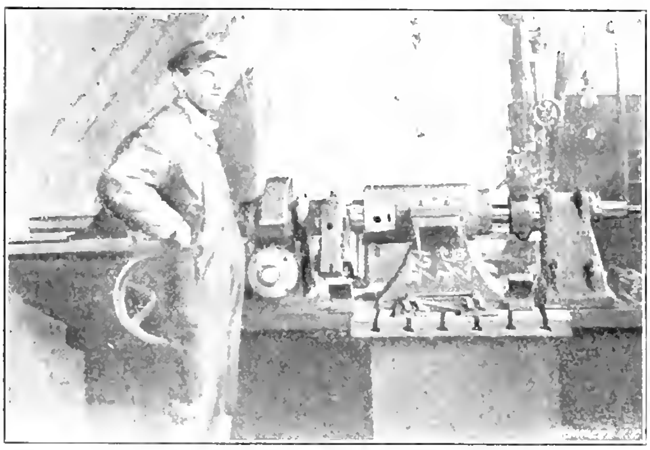


Fig. 9. Finishing the Bore of a Tested Cylinder

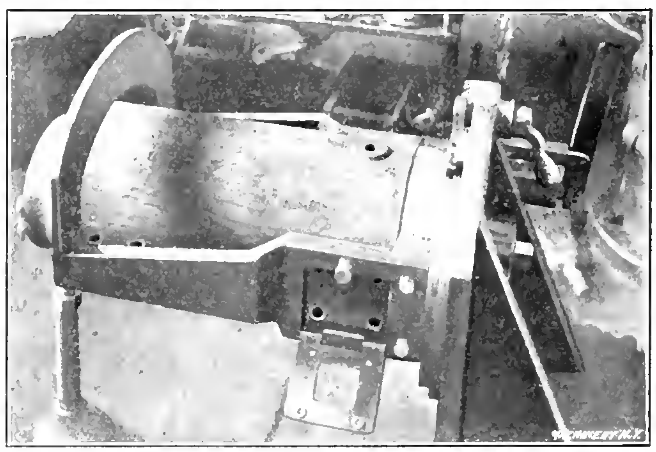


Fig. 10. Cylinder Mounted in Indexing Jig in which the Various Holes are drilled and tapped

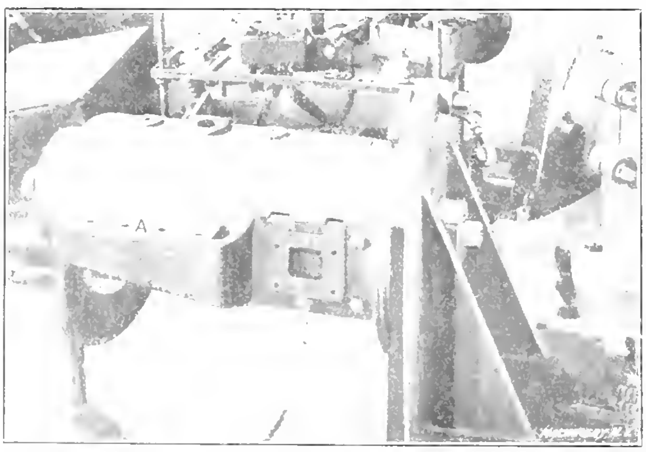


Fig. 11. Drilling and Tapping Lubricator, Relief Valve and Water Pipe Holes and Counterboring Bolt Holes

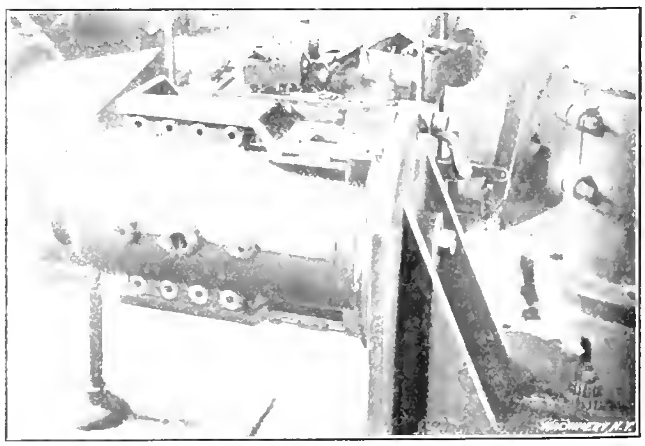


Fig. 12. Drilling and Tapping Inlet and Exhaust Box Pads

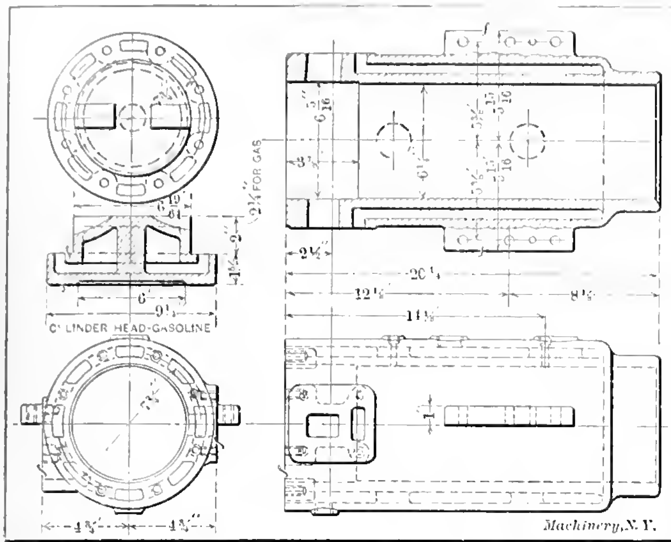


Fig. 13. Detail of a 6 1/4 by 8 Gas Engine Cylinder

As soon as the cylinders leave the horizontal boring mill, they are taken to the testing room where the water jackets are subjected to cold water pressure to detect flaws or leaks, the openings in the end of the cylinders being stopped up by rubber pads like *A* and *B*, Fig. 14, which are held down by a ring and clamp. The side opening is also covered up as at *C*, and water is admitted through the pipe *D* which runs down through one of the rubber pads and opens into the cylinder jacket. If the cylinders prove sound they are again placed in a Barrett horizontal mill and finish bored to exact size, as in Fig. 9, little time being needed for cylinders of this shape to "season," as the testing with cold water effectually cools them.

The holes in the cylinder-ways are drilled and the lower water pipe hole drilled and tapped, on a Bickford radial drill press, using the fixture shown in Fig. 10. Next the cylinder is indexed half a turn and the holes for the lubricator, water pipe and relief valve are drilled and tapped and the cylinder-way holes counterbored as at *A*, Fig. 11. Following this, the inlet and exhaust box pads are drilled and tapped as shown in Fig. 12, the drill bushings being placed in a "trap door" which is lifted up out of the way during the tapping opera-

Fig. 14. The First Cold Water Pressure Test after Rough Boring

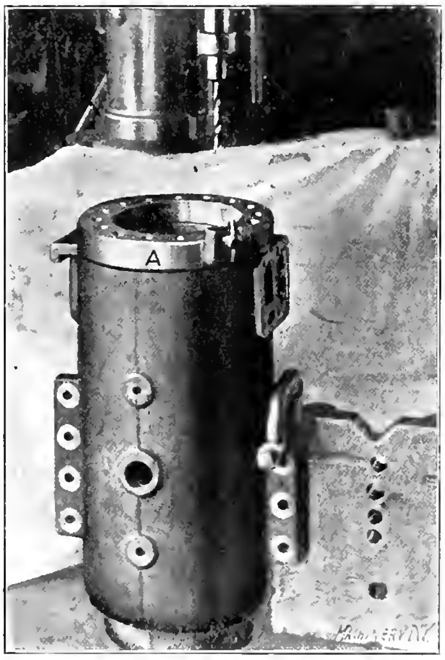


Fig. 15. Drilling and Tapping the Cylinder Head Stud Holes

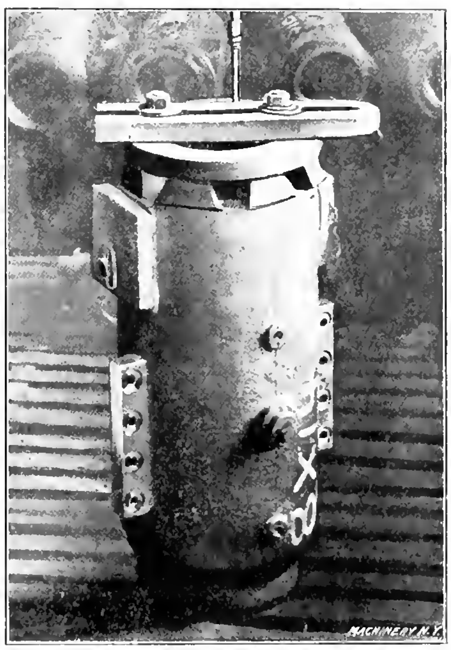


Fig. 16. The Final Cold Water Test of the Finished Cylinder

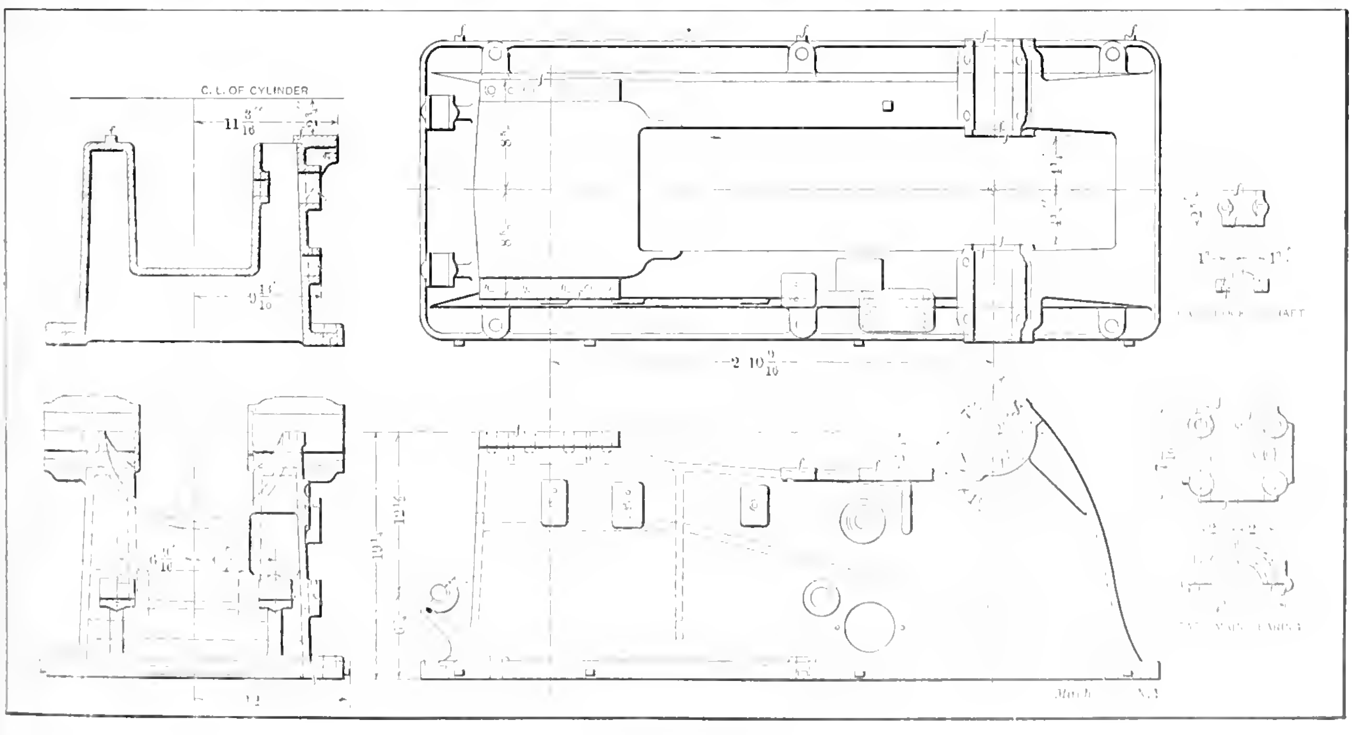


Fig 17. Plan and Elevations of a Bed for 8 3/4 by 11 Gas Engine

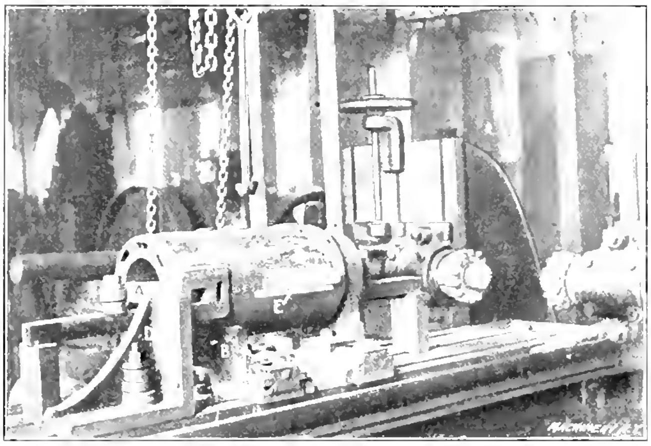


Fig. 5. Milling Bottom and Side of Cylinder Ways on Double-head Milling Machine

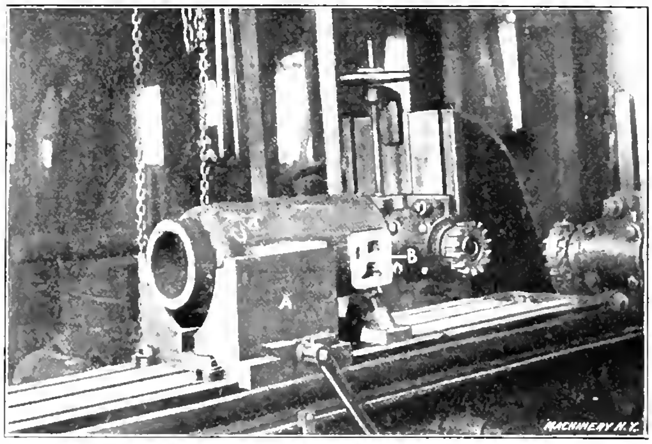


Fig. 6. Surfacing Inlet and Exhaust Box Pads

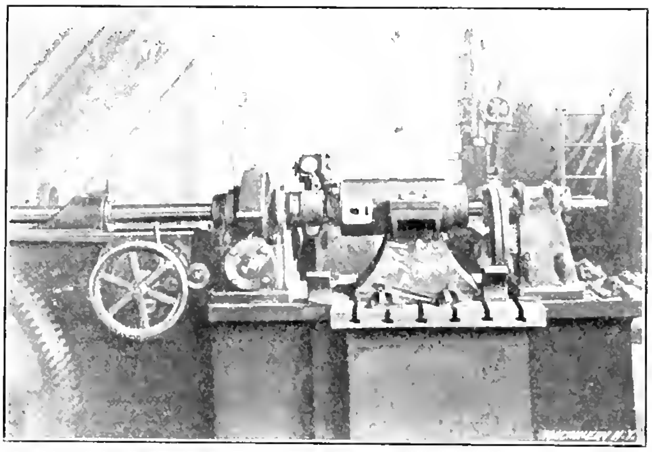


Fig. 7. Rough Boring a Cylinder on a Horizontal Machine

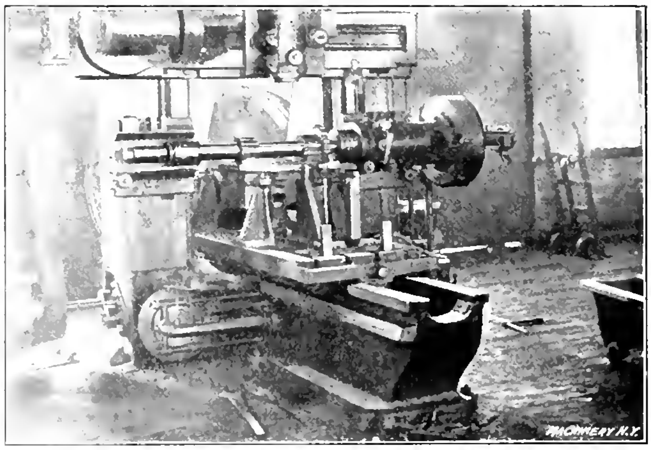


Fig. 8. Surfacing the Bottom and One Edge of the Bad

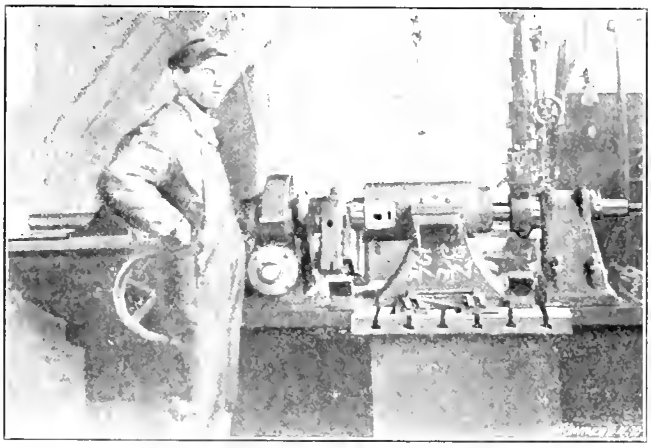


Fig. 9. Finishing the Bore of a Tested Cylinder

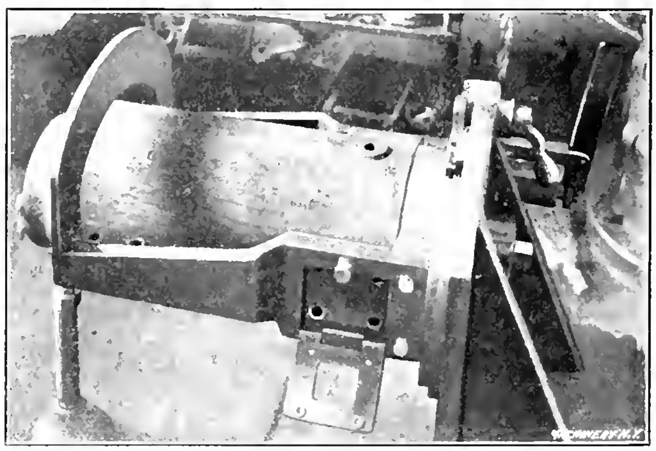


Fig. 10. Cylinder Mounted in Indexing Jig in which the Various Holes are drilled and tapped

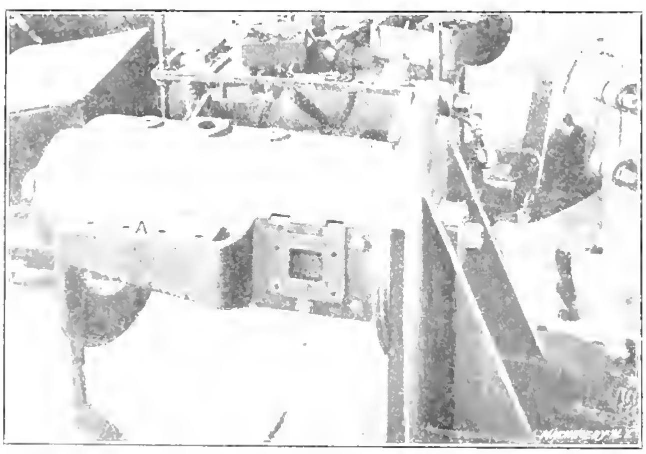


Fig. 11. Drilling and Tapping Lubricator, Relief Valve and Water Pipe Holes and Counterboring Bolt Holes

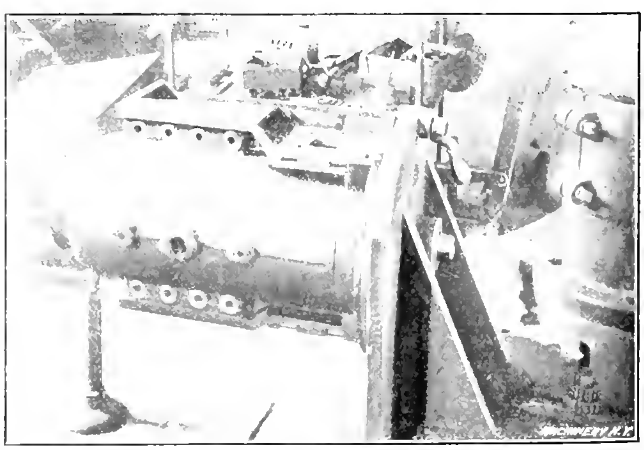


Fig. 12. Drilling and Tapping Inlet and Exhaust Box Pads

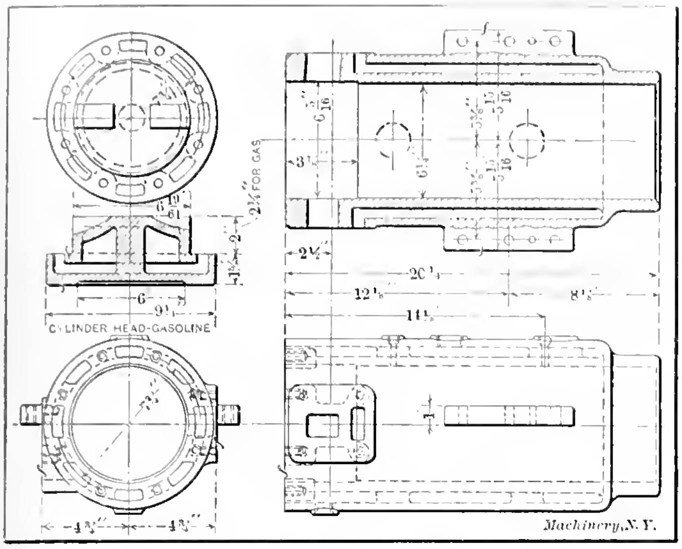


Fig. 13. Detail of a 6 1/4 by 8 Gas Engine Cylinder

As soon as the cylinders leave the horizontal boring mill, they are taken to the testing room where the water jackets are subjected to cold water pressure to detect flaws or leaks, the openings in the end of the cylinders being stopped up by rubber pads like *A* and *B*, Fig. 14, which are held down by a ring and clamp. The side opening is also covered up as at *C*, and water is admitted through the pipe *D* which runs down through one of the rubber pads and opens into the cylinder jacket. If the cylinders prove sound they are again placed in a Barrett horizontal mill and finish bored to exact size, as in Fig. 9, little time being needed for cylinders of this shape to "season," as the testing with cold water effectually cools them.

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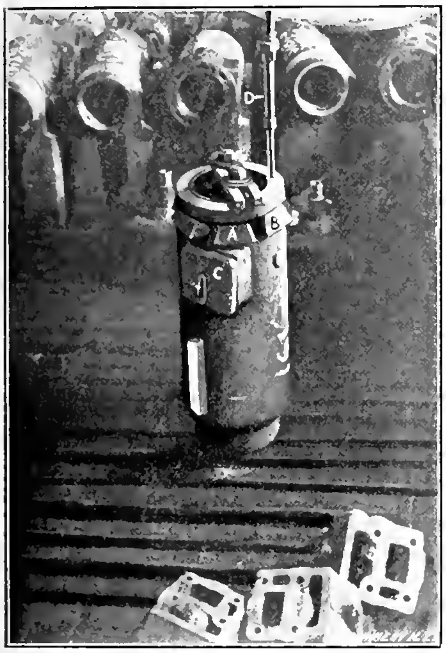


Fig. 14. The First Cold Water Pressure Test after Rough Boring

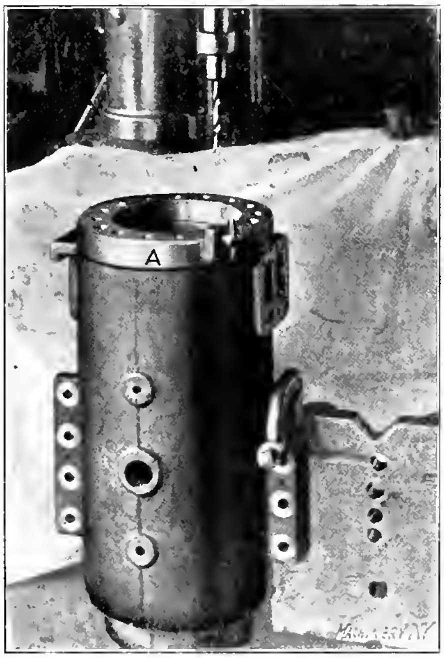


Fig. 15. Drilling and Tapping the Cylinder Head Stud Holes

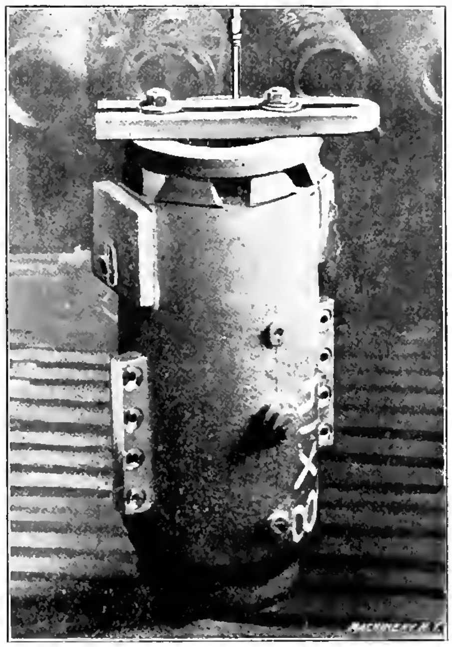


Fig. 16. The Final Cold Water Test of the Finished Cylinder

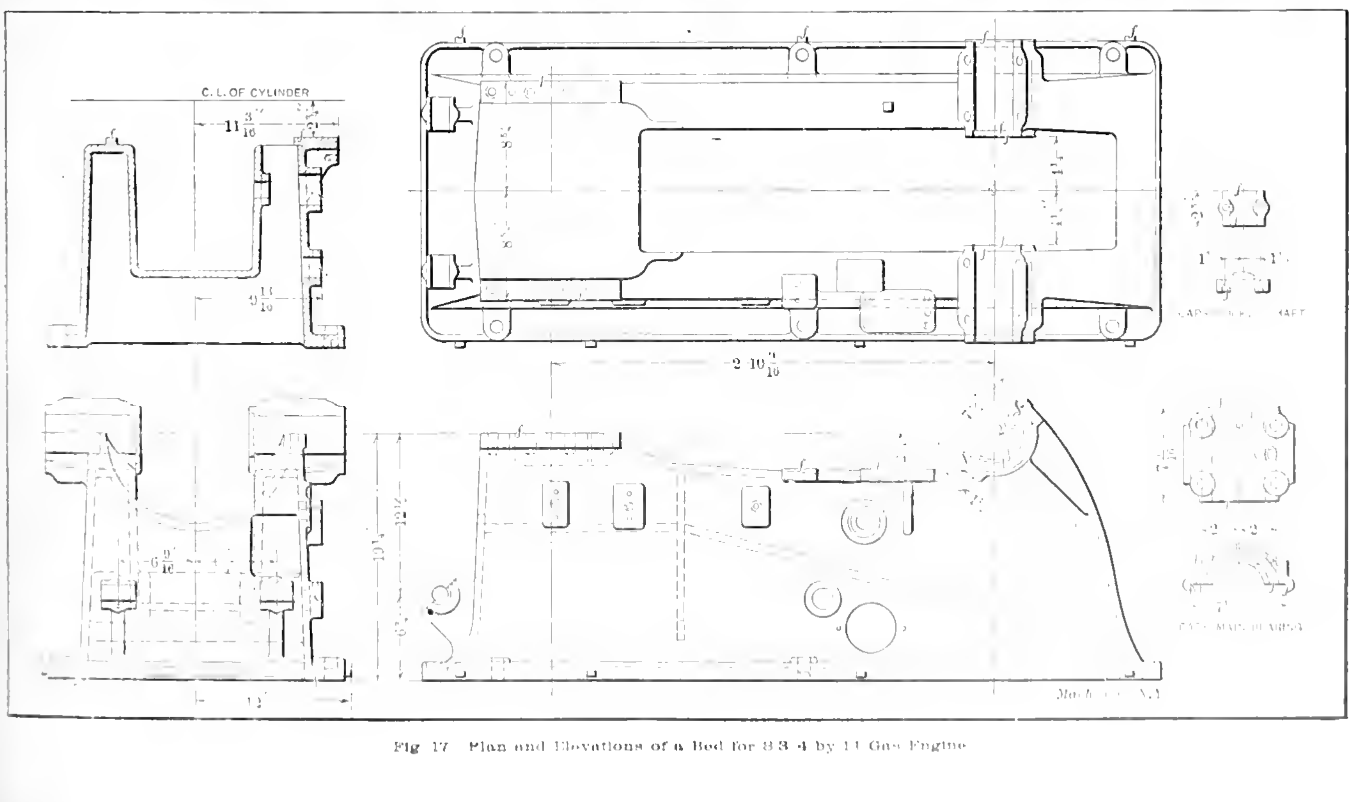


Fig 17 Plan and Elevations of a Bed for 8 3/4 by 14 Gas Engine

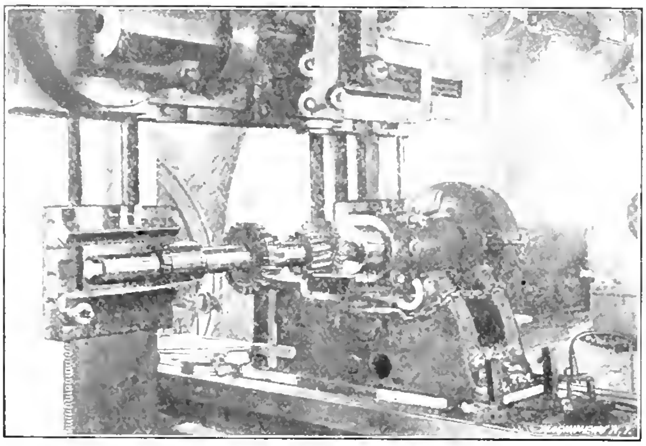


Fig. 18. Milling the Cylinder Ways on the Bed

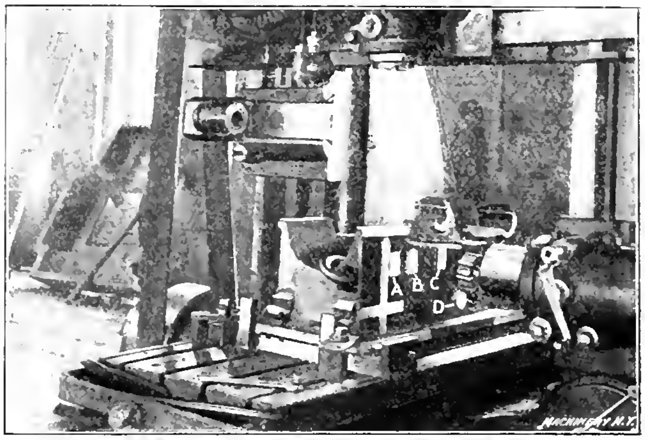


Fig. 19. Milling the Side Pads on the Bed

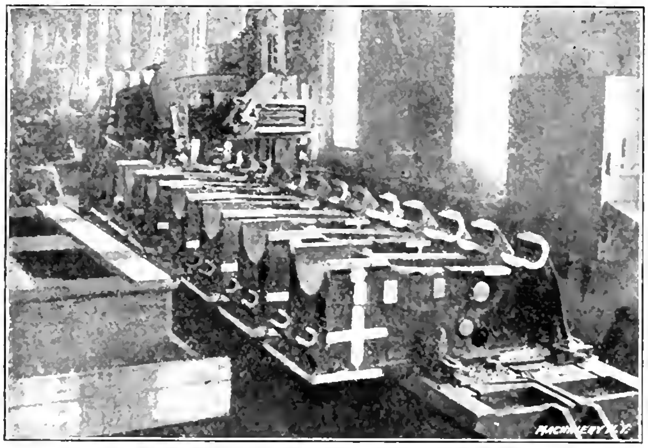


Fig. 20. Planing the Pillow Blocks, Gear Brackets and Governor Pads with an Open Side Planer

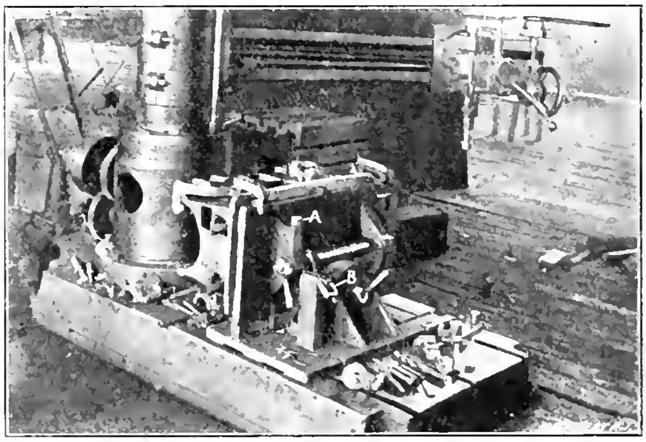


Fig. 21. Drilling and Reaming Side Holes in Small Bed, which is mounted on a Universal Fixture

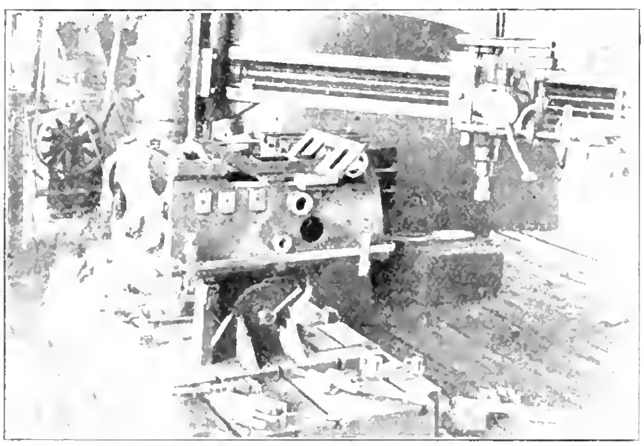


Fig. 22. Universal Fixture Set for Drilling Top of Bed

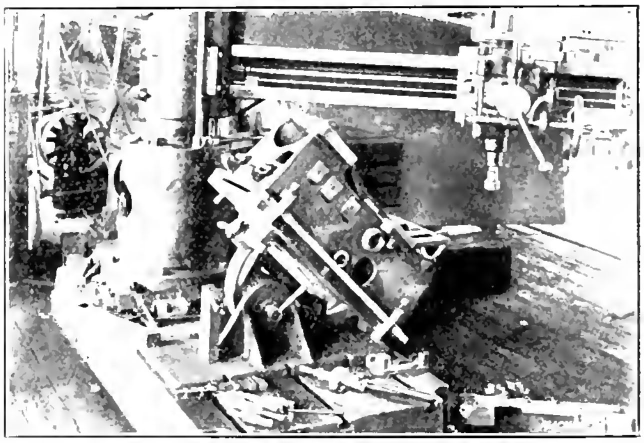


Fig. 23. Fixture and Bed inclined for Drilling Bearing-cap Holes

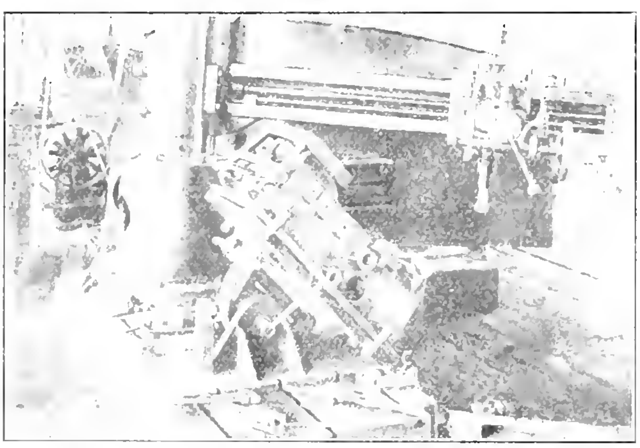


Fig. 24. Drilling and Tapping the Rockshaft-cap Holes

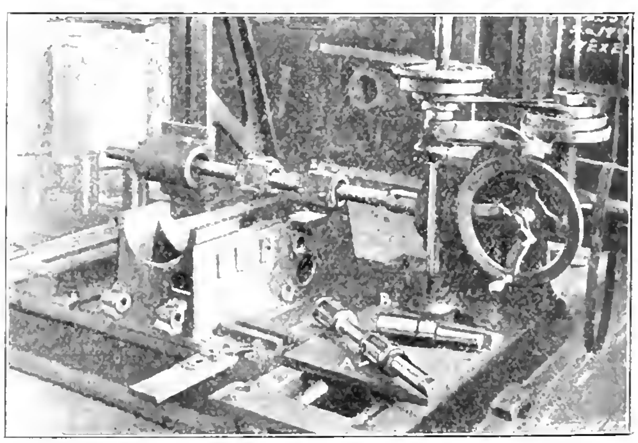


Fig. 25. Boring and Reaming Main Bearings on a Standard Bed

tion; the scheme is more plainly shown at A, Fig. 10. After all the side holes are finished, the cylinder is strapped to an angle-plate as in Fig. 15, and, using the ring drilling jig A, the holes for the cylinder head are drilled; then by removing the jig the holes are easily tapped. Finally, after all the pads on the cylinder have been finished and all the holes have been drilled and tapped, it is given another cold water pressure test as in Fig 16. It is then ready for the assembling department.

In order to make the foregoing operations and tests clearer to those not familiar with the construction of this type of cylinder, it is shown in detail in Fig. 13, and the bed is similarly shown in Fig. 17.

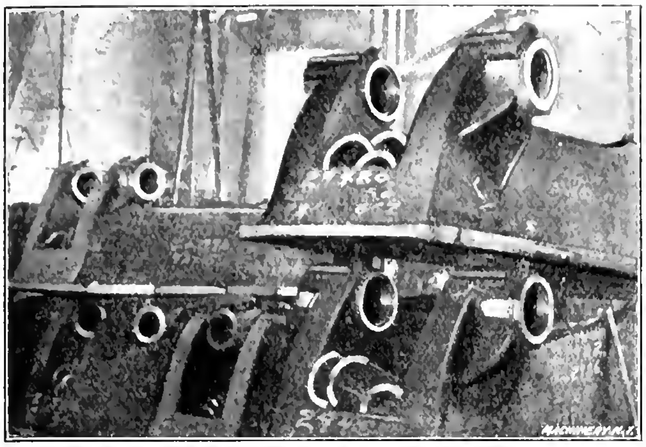


Fig. 26. Pile of Standard Beds ready for the Assembling Department

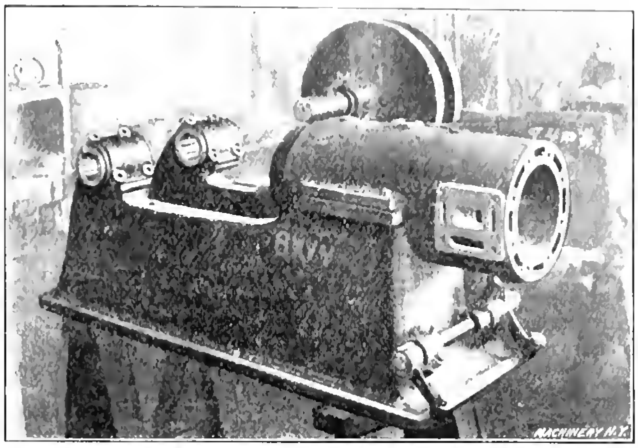


Fig. 27 Assembling the Foos Gas Engine

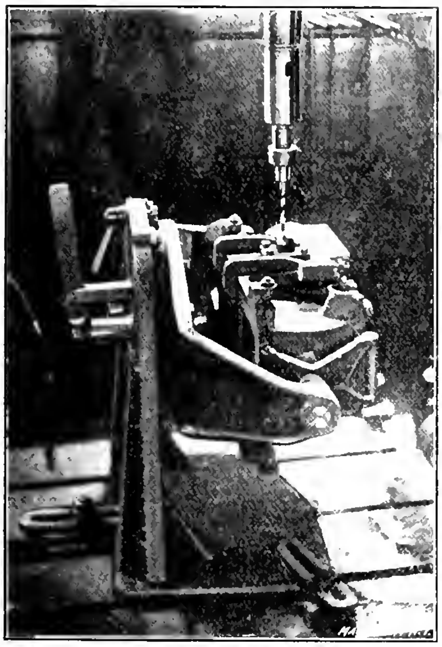


Fig 28. Drilling, Reaming and Tapping Fixture for Small One-piece Bed and Cylinder

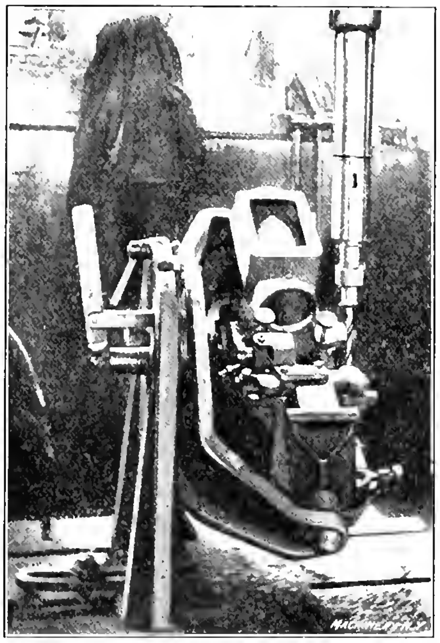


Fig. 29. Fixture Indexed for Drilling Bearing-cap Holes

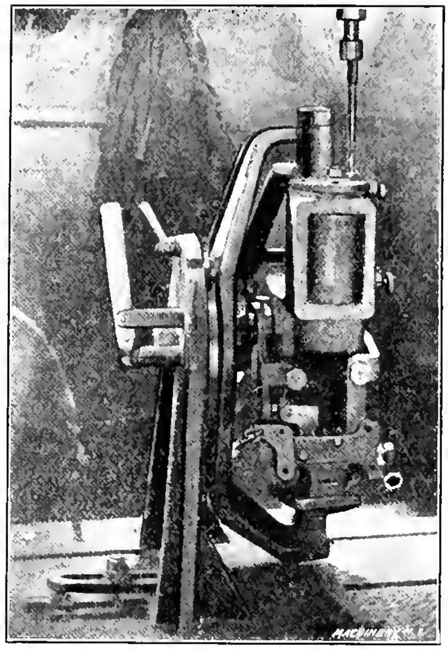


Fig. 30. Casting in Position for Drilling Cylinder Stud Holes

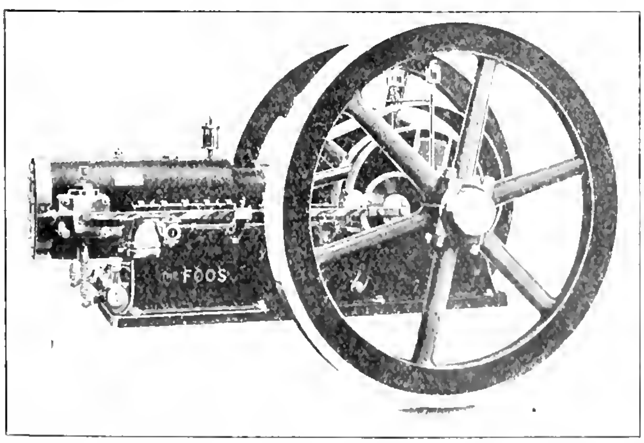


Fig. 31. A 13 1/2- by 21-inch Foos Gas Engine

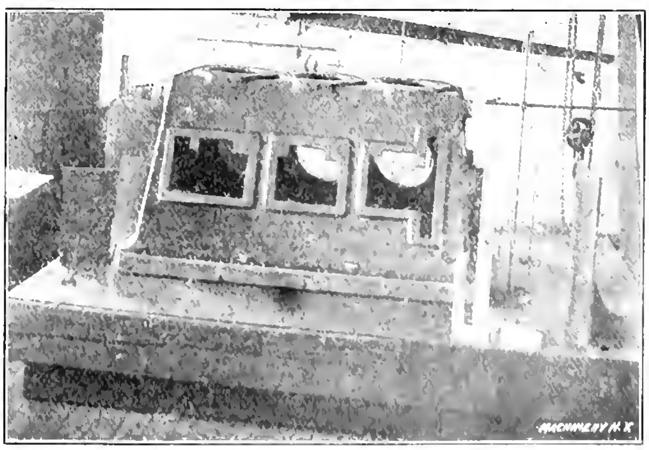


Fig 32. Laying out a 150 horsepower Engine Bed on an 8- by 12 foot Surface plate

Machining the Bed

Like the cylinder work, a number of the operations on the beds are milling operations, and in Fig. 8 is shown an Ingersoll mill at work on the bottom of a bed, one side and two surfacing mills being used. The side mill machines one edge which simplifies the subsequent setting of the bed for the various operations. The beds while being milled as shown, are held up and located by several angle-plate jacks and stops so that after one bed is correctly set, it is comparatively easy to set the others to be machined. When the beds have all been finished, the jacks and other fixtures are taken off and the bed is set on as shown in Fig. 18. The milling cutters are changed to two surfacing and two side mills which are

used to finish the outside and top of the cylinder pads as shown. Next the surfacing and large side mills are removed and an inserted tooth side-mill put in; the engine bed is then turned end for end, as in Fig. 19, and the pads *A*, *B*, *C*, *D*, and one which is back of the cutter, are surfaced off.

The next is a planing operation in which the beds are placed in gangs on an American Foundry and Machine Co. open-side planer, Fig. 20, and the surfaces for the main bearing caps, gear bracket and governor pads finished.

The drilling and tapping operations on beds that are not too heavy, are done with a Bickford radial drill, while the bed is clamped to the adjustable table of a special fixture, Fig. 21. In using the fixture, the table is set as shown, and the side holes drilled and reamed; next the jig-plate is removed and the table is turned, so that the top of the bed is uppermost, as in Fig. 22. The table is locked by the catch shown more clearly at *A* and *B*, in the preceding engraving.

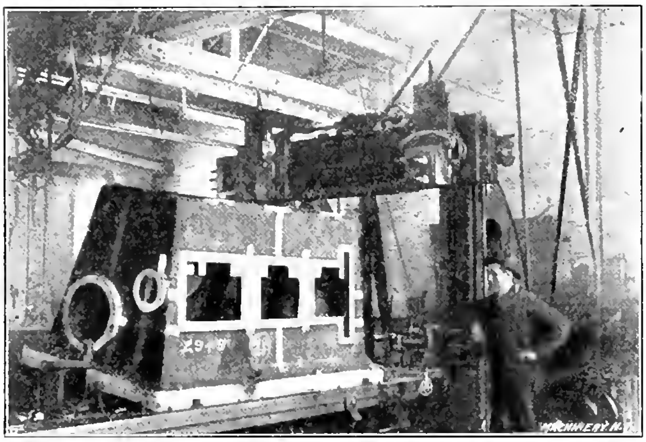


Fig. 33. Planing Side Plate Pads of Large Vertical Bed

While in this position, the governor, gear-bracket and cylinder-way pads are drilled and tapped, using the jig-plate as shown; now the table is tilted as in Fig. 23 and the main bearing cap holes are drilled and tapped. The jig-plate is then removed and the one shown in Fig. 24 is put in its place and the rocker shaft cap holes are drilled and tapped. The set-screw holes at *A* and *B* are also drilled at this setting, using the small jig shown at *C*. The bed is now removed from the drilling fixture, the bearing caps fitted on and bored out, faced, counterbored and reamed, on a horizontal boring mill as shown in Fig. 25. The main bearing reaming is done with the double adjustable-reamer *A*, and the floating driver

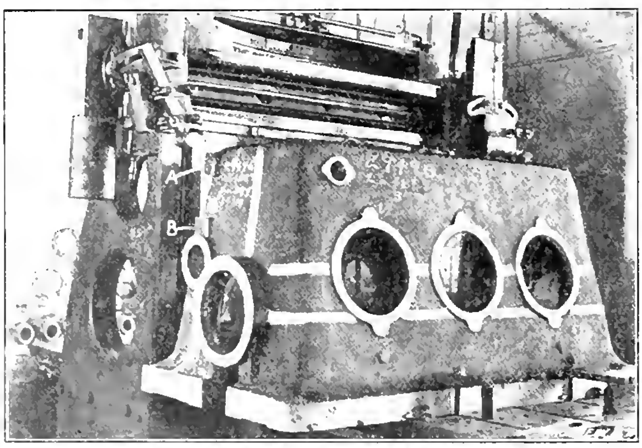


Fig. 34 Planing the End Pads on Vertical Bed

B. After this the brass bearing-bushings, which have been finished in the usual way, are fitted, and the beds are stacked up as in Fig. 26, ready for assembling.

In Fig. 27 is shown a bed with the cylinder in place and partly bolted down, the main bearing caps and bushings in place and the rocker shaft, arms and caps assembled, while in Fig. 31 is shown a complete engine ready for shipment.

Some of the two horsepower engines have the cylinders cast in one piece with the bed and are drilled, and the necessary reaming and tapping done in a universal fixture; all of this work is done, as in the previously described fixture, without removal, the various positions being obtained by means of index pins or stops. The first position of the casting is shown in Fig. 28, the second in Fig. 29 and a third in Fig. 30. There is one difference between this fixture and the one shown in Figs. 21 to 24, and that is that the drilling jig-

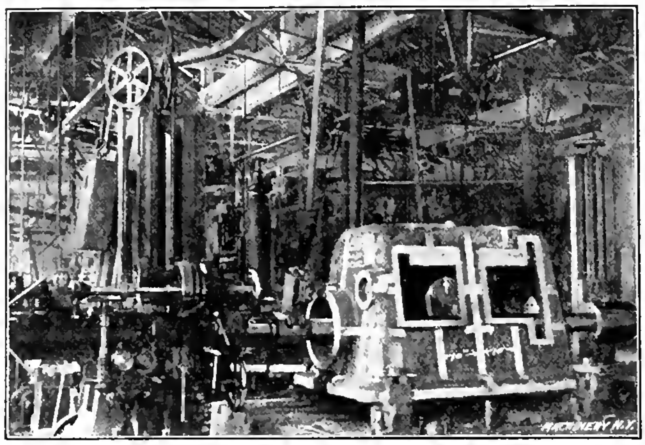


Fig. 35. Boring Crankshaft Bearing Holes in a Horizontal Boring Mill

plates are, for the most part, fastened to the fixture itself and so arranged, either by being hinged or otherwise, as to be shifted for tapping or the removal or replacing of the casting. This is possible owing to the comparative lightness of the casting, and the consequent lighter drilling-plates.

As stated at the beginning of this article, the large castings for engines above what might be classed as "commercial sizes," must be handled for the most part, as individual machining jobs, no "put in a hopper and grind 'em out" methods

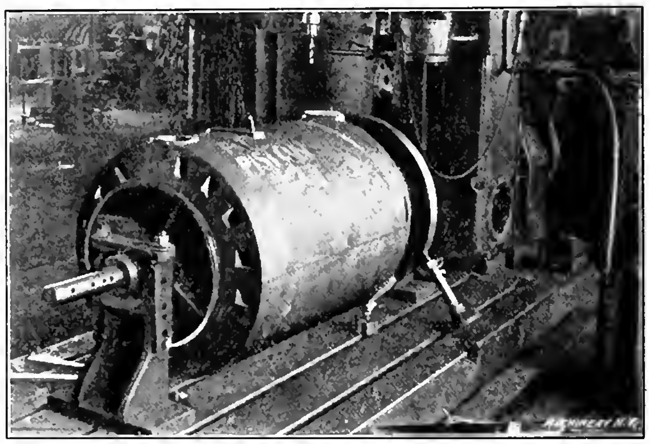


Fig. 36. Conical Centers used to hold Large Vertical Cylinders when Drilling and Tapping

being practical; so in order to make this point clearer, a few examples taken from the routing of a 150 H. P. vertical engine-bed will be given. Fig. 32 shows one of these beds placed on a huge surface-plate to be laid off. The surface-plate shown is one of the largest in use, being 8 by 12 feet, and it was made expressly for the Foos Gas Engine Company. The illustration also shows the surface gages, squares and angle-plates used in the work of laying off and marking the positions for the drilled holes and other work. From the surface-plate, the bed goes to the Cincinnati planer, Fig. 33, and the surfaces for the side-plates are finished as shown. The casting is then turned crosswise of the bed and the pads *A* and *B*, Fig. 34, finished. This engraving also shows the side of the bed opposite the one shown in Fig. 33. After planing, the holes for the crankshaft bearings are bored out on a Detrick & Harvey horizontal boring mill, Fig. 35.

Cylinders for the vertical type of engine have the side holes drilled and tapped while held in the fixture shown in Fig. 36, which consists of two large centers which fit into the ends of the cylinder and are adjustable for various lengths. The shaft on which the centers are placed, is supported on two V's across the top of which are clamping straps that make the setting of the cylinder easy. These locking straps are supplemented by small jacks used to keep the cylinder solidly in place while drilling or tapping large holes.

FIXTURES FOR MACHINING ECCENTRIC PISTON RINGS*

By C. T. SCHAEFER†

From time to time in the different technical papers there has been considerable comment on automobile engines and their manufacture, but none of the writers has solved the question of how to make perfect eccentric rings and it seems as though there are very few manufacturers of these engines who can turn out perfect rings at a minimum cost.

A piston ring is a very important part of a gasoline or gas engine, particularly on engines of the present day, as considerable compression is carried in the cylinders. We all know what a defective ring means—a loss of compression, which naturally means a loss of power—therefore it is essential to have the ring as nearly perfect as it can be made.

For a number of years it was the practice of many prominent manufacturers to put their rings through some fifteen operations; they even went as far as to grind the rings, which is a very expensive method. With the fixtures shown herewith, the grinding and quite a few other operations are eliminated and the cost of the rings reduced 50 per cent, which is more than the cost of these simple fixtures.

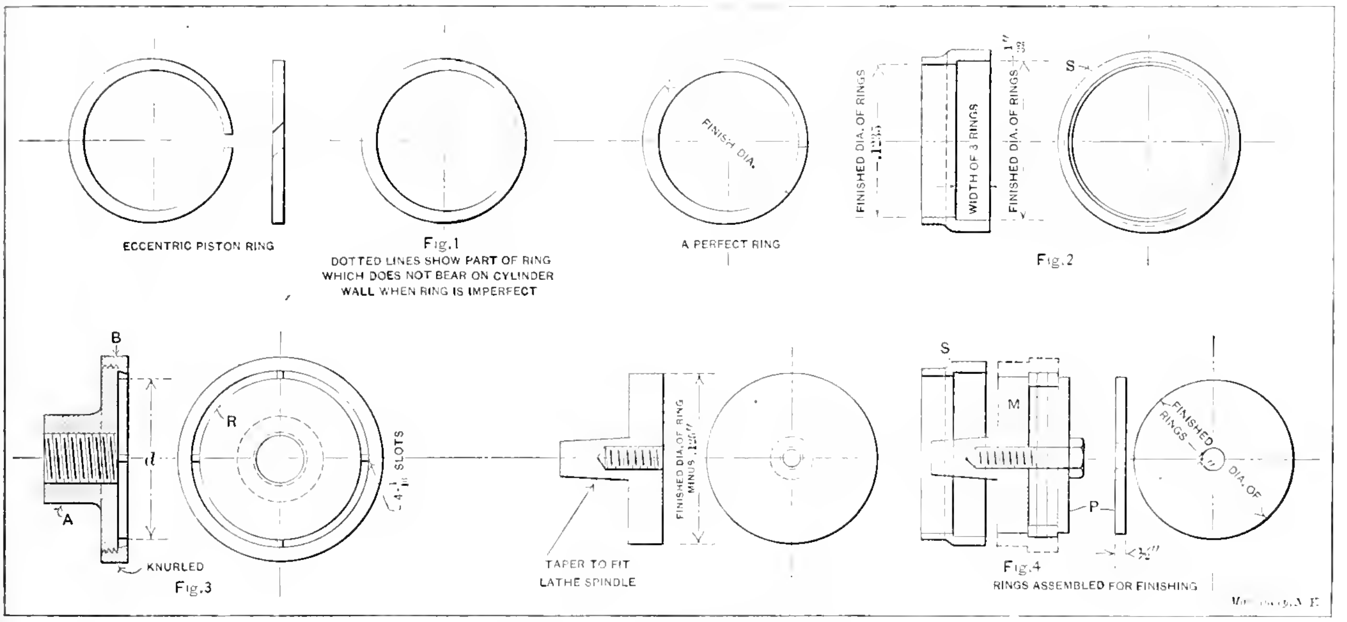
By referring to the fixtures shown it can be seen that they are not as elaborate as one might judge they ought to be, to produce an accurate ring. The secret of a perfect ring is to eliminate the hump, which presents itself at the slot when the ring is slotted and ready to put into the cylinder. A ring with this shape will only bear on two high spots, as shown in Fig. 1, where the dotted lines indicate the part of the ring which does not bear on the cylinder wall when the ring is imperfect.

It can easily be ascertained if the piston rings have a good bearing at all points by placing them in the piston and the piston in the cylinder and working it up and down, slightly revolving it at the same time. Before inserting the piston a little oil should be added to the cylinder wall. If a ring shows excessive wear on two points, it is evident that it is not perfect and should it be used in this shape, it would mean a loss of compression and consequently a loss of power, as previously stated.

Since the writer has been making rings with the fixtures described in this article, he has been getting considerable more power from engines on the test block, which shows the value of perfect rings.

The first operation on the rings is to turn the outside diameter of the blank eccentric, allowing 1/32 inch for finishing. When the inside diameter is finished, the rings are cut off 1/64 inch full of the required width, the sixty-fourth being allowed to true up the ring after it is slotted.

After the rings are cut off, they are clamped on a 6-inch faceplate, which is recessed to centralize the ring; they are then slotted in a hand miller, a spacing collar being used to space the saws. In slotting, a sixty-fourth should be allowed for filing the slots to the required opening. After this operation is completed, the rings are placed in the fixture shown in Fig. 3 and faced to the required width. By using this fixture, the rings will vary but a few thousandths in width. The hub *A* is made to fit the lathe spindle. The diameter *d* of ring *R* should be 0.001 inch larger than the outside diameter of the packing ring. Ring *R* should have four 1/16-inch slots cut into it to give it the necessary compression to grip the rings when the nut *B* is turned. The nut and ring *R* are tapered to get the action of a spring chuck. The nut is also knurled to permit the fixture to be used without the aid of any wrenches, making this operation quick and simple. The packing ring is placed in the fixture, the nut tightened and a very light cut taken off the ring—just enough to true it up; it is then reversed in the fixture and faced off flush with the side of the fixture. This should be done with a sharp-pointed tool and at high speed to get the best results. After this operation is completed, the rings are put in the sleeve *S* (shown in Fig. 2) which can be made to hold from one to five rings, but the writer has found it best to make the fixture take three rings. This sleeve is then placed over the mandrel *M* (Fig. 4), as indicated by the dotted lines, and the plate *P* is clamped against the rings as shown, with a one-inch bolt. The sleeve *S*, which served to set the rings concentric with the mandrel, is then removed. The taper shank of the mandrel is next inserted in the lathe spindle, and the rings are finished to the proper diameter.



Fixtures for Machining Eccentric Piston Rings

* * *

In a paper by Mr. W. H. A. Robertson read before the Institute of Metals, Great Britain, a formula for the power required to drive draw benches for the drawing of solid drawn tubes is given as follows:

$$H.P. = \frac{T \times A \times S \times \phi}{33,000}$$

in which T = breaking stress of material in pounds per square inch,

A = cross-sectional area of metal in tube in square inches,

S = speed of chain in feet per minute,

ϕ = efficiency of the draw bench.

This efficiency for a double-geared bench may be assumed to be approximately 65 per cent and for a single-geared bench 75 per cent. The formula, of course, is an approximation only, and it gives a result which is somewhat in excess of the actual requirements.

* For additional information on the manufacture of piston rings see the following articles previously published in MACHINERY: Making Piston Packing Rings; Faceplate for Eccentric Piston Rings, October, 1909; Making Piston Rings, November, 1908; The Manufacture of Piston Rings, June, 1909, and other articles there referred to.

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EXPERIENCES OF A YOUNG TOOLMAKER*

By T. COVEY

"Jim," said Mr. Corbin, "here are about two hundred fillister head screws that we use for inserted tooth mills and other work, and I want the heads slotted; do them right away as we have a job waiting now that we are unable to complete until we get them." Jim took the box of screws out to the bench and in a half-hearted way looked around for a machine to slot them in. George was working at a vise near, and Jim said to him: "What do you think of that job for a lemon?"

"Why, that job is all right, especially for an apprentice boy," said George. "You don't expect to be given a job at making tools every time, do you?"

"I should think he would give me a job that gave me a chance to learn something instead of such work as that."

"You are too particular. If you had the grit to serve a couple of weeks' apprenticeship under the conditions as they were fifteen years ago you would think you were in Heaven here."

"Well, in my opinion this shop is a poor likeness to that place," said Jim rather shortly, as he walked away to find a machine. He found a small mill idle and putting on the vise clamped one of the screws in it, got a saw which he mounted on an arbor and started to work. In about an hour George came along and, joking, said, "What! Not done yet?"

"This job will be done in about a week," said Jim. "I've got eight slotted now."

"Pshaw! You can slot those screws in half a day and not sweat either. I thought you said that there was nothing for you to learn about that job. From the way you go about it I would say that you never slotted a screw before."

"Show me," said Jim.

"Go get a larger saw—one at least four inches in diameter, then put on the index head, screw the chuck onto the spindle, and set the knee so that the center of the index head is the same height as the center of the arbor. There is a line marked 'Center Line' here on the slide for the knee. Raise the knee to that line and you will be near enough. Then put one of your screws in the chuck, clamp it by the body with the head resting against the jaws; set the saddle so that the saw comes in the center of the screw, start the machine and bring the screw up until the saw just makes a mark on it, then back it away and turn the index half around, bring it up again and if the saw cuts in the same place it's central, and you can cut in deep enough to make the slot, and then set the stop for the table so that the saw can go no deeper. After the first one is right, all you have to do is to back the screw away from the saw for two or three inches, take it out, put in another, feed up against the stop and so forth. All your screws will be slotted alike, and if you feed by hand you can easily do one a minute."

"Yes, perhaps I can, but there will be no snap about it."

"If snaps are what you are looking for you will never make a toolmaker. Better go out in the shop and get a job on a big lathe or planer and stay there. Become a fixture at fixed pay." With which remark George went back to his work.

The finished screws fell into their box at a much more rapid rate after Jim had things going in the proper manner, and he became more satisfied with himself and his job. The remarks George had let fall had given him food for thought, and he wondered what George had meant when he mentioned the conditions fifteen years ago, and he stopped his machine and went over to where George was at work. "George," said he, "in what way were the conditions of apprenticeship fifteen years ago different from now?"

"Well, I am personally familiar only with those in the shop where I served at that time, and they were different in a great many ways."

"Tell me about it. Will you?"

"I have not the time now, neither have you, but if you care to eat your lunch with me I might tell you a few of the things that at that time I considered hardships but have since learned were benefits."

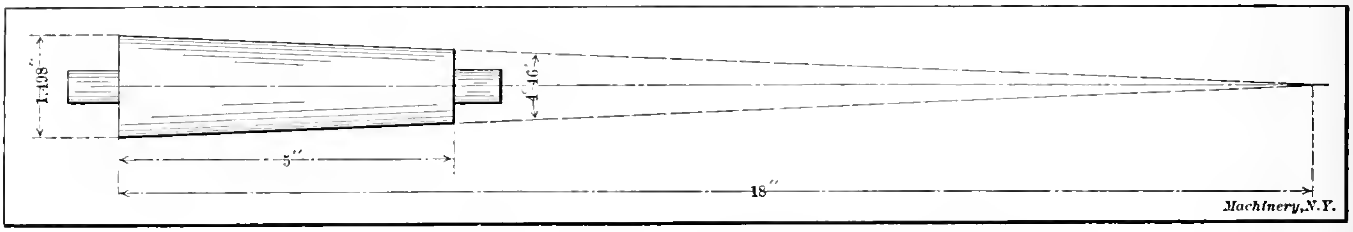
"Good," said Jim, "I'll be an interested listener," and he went back to his work.

When the whistle sounded for noon, Jim stopped his work, got his lunch basket and hunting up George remarked to him, "Well, here I am."

"I see," said George. "We will hunt up a nook by ourselves where we won't be interrupted. Here is a good place and a couple of seats."

"Now, as I told you, I can only speak of my own experiences, and while I am inclined to think that my lot was not as pleasant as some more fortunate, or unfortunate, apprentice boys of that period, I am quite sure that lots of other boys fared about the same. Generally speaking, a boy had to have more than an ordinary desire to become a machinist, and a good deal of stick-to-it-ive-ness to serve four years in those days.

"In the first place, I was raised on a farm, and my parents were poor. My capital when I started out for myself was their training and a district school education, the three 'R's' you might say. When I was 18 years old an old friend of my father visited him, and learning of my desire to become a machinist, agreed to give me work in his stave mill, and then do what he could to get me into a machine shop. I went with him to his home, a distance of 500 miles, and in a few days he took me to the machine shop where he got his repair work done, which was in another town about 15 miles away. Mr. Doring, the man that ran the shop, told us that there was no opportunity with him then as he had just put on a boy, and only had work for one. With this discouraging prospect we returned and I went to work in the stave mill at $1 per day. I stayed at this for a year, and saved about $75, which was pretty good considering that the mill only averaged half time. Then one day Mr. Doring sent for me to come down to his shop, which I did, and he agreed to start me in to learn the trade. His other boy had quit. He told me that for the first six months I would get three dollars per week, and could expect fifty cents a week raise every six months if I made good. Well, I considered it my opportunity and accepted it. He referred me to a boarding house where I was able to get my board for $3 per week."



Incomplete Sketch of Conical Roller Bearing, which made Necessary the Use of Elementary Geometry

"Say, you did not have much change left did you?" interrupted Jim.

"No; but I had the privilege of carrying my money once a week even if I could not spend any of it.

"Well, my hours were from 5.30 in the morning until 6 at night, and my work was first to care for the boiler and engine. I had to have steam up, the engine oiled, and everything in readiness to start up at 7 every morning. I had to oil all of the shafting twice a week; sweep out every other day; wheel out the chips and help the men, of which there were two, and clean all the castings, as my regular work.

"The shop did any kind of jobbing that Mr. Doring could get, and a great many of the jobs were taken for my benefit, among which were building a steel smokestack, cutting off an iron fence, sharpening lawn mowers, grinding plow points, and so forth. And among some of the odd jobs that I did about the shop was to paint the smokestack and roof; build a feed-water heater; pipe up a heating system; in fact, when work for outsiders was scarce I was likely to be put at any odd job about the place to keep me busy."

* Previous installments of this article have appeared in MACHINERY, August and December, 1909, and February, 1910.

"I don't see where you had much opportunity to learn anything about the trade at the class of work you got."

"Well, for the first year or so I did not learn much except what I could from observation, though I did get a simple job on a lathe or planer occasionally. I had more time than you think. We used natural gas under the boiler, so the firing was not much; and I generally did my sweeping and oiling in the morning before the shop started up, though this was not asked of me; all I was expected to do before 7 o'clock was to get steam up and the engine oiled. After I had been there about two years, Mr. Doring hired an old man to take care of the shop and help at such jobs as he was needed; then I was put on practically the same work as the men; and in my fourth year I was sent out on jobs by myself as occasion required."

"What kind of jobs were you sent out on?"

"Anything and everything. Sometimes to put some flues in a boiler or put on a patch, to set engine valves or install a pump or other work that in Mr. Doring's opinion did not require one of the men."

"Did you ever get stuck on any of them?"

"Yes, once in awhile, but not very often, because if a man came back and reported a failure, Mr. Doring made things uncomfortable for every one in the shop. He used to say when he sent a man out, 'Now take all the tools you want, and when you get there if you haven't the ones you need make them out of a fence rail.' He wanted the job done and seldom dictated how it was to be done—seemed to think that there was a way to do every job and he was paying his men for knowing it.

"The result of my apprenticeship with Mr. Doring has been very satisfactory to me, as I am confident that my training in that little jobbing shop was of more real benefit to me than ten years in a large manufacturing plant such as we are working in here. Now I don't want you to think that you do not stand a good show here; conditions in general have changed since then. In those days we had no toolmakers, at least in that part of the country, and a man that was classed as a machinist was considered competent to undertake and execute any job that came into the machine shop. Now it is different. A machinist may be a specialist; able to run but one machine properly, still he is a machinist. The majority of our old all-around machinists are in toolrooms now, classed as toolmakers. Even with toolmakers this specialization is growing, and we have our jigmakers, templet men, tool grinders, repair men, and so forth.

"You are having an excellent chance here, and though you may not learn anything about boiler work, tool forging and general repair work, you will, if you try, be able to hold a good job with good pay. Just remember that it is the men that can be depended on to do their best whether they are watched or not, and not the ones that work with one eye on the clock, the other on the boss, and their mind on pay-day, that will be found at the top of the list with a good job to carry them through hard times. Don't get the idea that the foreman don't know these men, for he does; nine times out of ten he has worked up from the bench himself and is wise to every play in the game. Remember that the foreman has troubles of his own, and enough things to see to without explaining every detail of a job he gives you; or why he gives it to you. I frequently get jobs that an apprentice boy could do if Mr. Corbin had the time to show him how; but the job has to be done, probably right away, and done right; what choice has he but to give it to a man that can do it without consuming his time in giving instructions. Don't be a kicker—be satisfied with your job at least until you are out of your time."

"Are you satisfied with your job?" asked Jim.

"As a means to something better, yes; but I am living in hopes of a better one some day."

"I thought you had about as good a job as any one in this shop, and your pay is what I would consider pretty good. Can you do better somewhere else?"

"Not as a toolmaker. You know that I told you that my capital when I started in was a district school education. That has been my handicap in this business, though I did not realize it until about three years ago. My climb has been more rapid since I located the trouble than it was before."

"I don't see what good it did you to find that out; as long as you did not have the education you didn't have it."

"I have got it; or rather, I am getting it. My day's work is not done at 5 o'clock. I go home, eat my supper, and then put in a couple of hours hard study; and considering the rate of pay I was able to draw when I started, this firm is paying me about double time for those two hours' work, too. It is a mystery to me how I was able to hold even as good a job as I had."

"What are you studying?"

"Well, so far I have gotten a fair knowledge of arithmetic, algebra, logarithms, geometry, trigonometry, mechanical drawing, hydraulics, and elementary mechanics. And I expect to study, steam, heat, applied mechanics, electricity, machine design, and so forth."

"Say! but you are going some. What good do you expect from such knowledge?"

"I've got some of the good, and I realize that it is a fact that a man can't expect to get and hold a good job on practical training alone; but combine practical training with technical knowledge and there is no limit to a man's possibilities. Hello! There is the whistle and we will have to stop this talk and get to work."

Jim got the screws finished and turned them in soon after lunch hour and Mr. Corbin gave him a job turning up some rolls for a conical roller bearing, and told him that Anderson had the sketch and he could use it with him. It was an experimental job and the draftsman had drawn a sketch full size but had not worked out the details completely. All the dimensions that were given for the rolls were the length, the size at the largest diameter, the included angle of the taper, and the length and diameter of the small bearings at the ends of the roll. Jim looked it over and then said to Anderson, "Mr. Corbin gave me the job of turning up those rolls but I don't know how I am to get them right from a sketch like that. Why couldn't they have given the taper per foot of that roll instead of the angle, or else the diameter of the small end?"

"I'll figure it out for you," said Anderson, "it is only a few minutes work."

"How do you do it?"

"Why, it is simple. You notice here that the distance from the apex of the angle to the large end of the roll is given as 18 inches, and the diameter of the large end is given as 1.498 inch. (See accompanying illustration.) By dividing this large diameter by 2 we get 0.749 inch. This gives us a right angle triangle whose side adjacent is 18 inches and whose side opposite is 0.749 inch. Subtract the length of the roll or 5 inches from 18 inches and we have another triangle whose side adjacent is 13 inches and whose side opposite we want to find as it represents half of the diameter of the small end of the roll. We know that since the angle is the same in both cases, the functions must be in direct proportion to each other; hence, 18 is to 0.749 as 13 is to x, or the required number. $0.749 \times 13 = 9.737$; $9.737 \div 18 = 0.5409$, or half the diameter of the small end; $0.5409 \times 2 = 1.0818$, or 1.082 inch as the diameter of the small end of the roll. Now to get the taper per foot, we subtract 1.082 from 1.498, which gives us 0.416 as the taper in five inches; using proportion again, $0.416 : 5 = x : 12$; $0.416 \times 12 = 4.992$; $4.992 \div 5 = 0.998$, or the taper is approximately one inch per foot."

"Well," said Jim, "to see you do it looks easy, and I suppose if one understands it it is easy, but I could not do it."

"Of course one should have some knowledge of the principles of geometry and trigonometry to understand why some of the operations are performed, but the actual figuring is generally pretty simple, especially in problems like this one."

"Did you get your knowledge of geometry and trigonometry before you started at this business?"

"No, when I started I had only a common school education, and when I realized that I had need of more I got it by studying at home. And I believe that is the case with the majority of mechanics. If a young man has a good education he usually starts in some other business than this—or at least that was the case in my time."

"Do all mechanics have to have this education in order to hold their jobs?"

"No. There are lots of mechanics holding comparatively good jobs without any other education than they obtained in a common school; they manage to worry along some way, and I suppose that as long as they know nothing of the advantages of an elementary knowledge of mathematics, they don't realize that they are working to a disadvantage."

"What is the reason that more men don't study and make themselves more able to do their work, if it is any great advantage?"

"There are numerous reasons; some men don't realize the intimate relationship which must necessarily exist between mathematics and mechanics; others, when the terms mathematics, algebra, geometry, trigonometery, and logarithms are mentioned become scared and make up their minds that these subjects are only comprehensible to men that have had a college education. In my own case I shied at logarithms until it was really forced upon me by circumstances which made it imperative for me to use certain formulas involving their use. I procured an elementary treatise on logarithms, and when I discovered the simplicity and time-saving qualities of the logarithmic method of figuring I kicked myself good and hard. It is safe to say that not more than two per cent of the machinists and toolmakers working at the trade could tell how to extract the square root of a number, and it is also safe to say that but a very few of them could learn how to do it by ordinary arithmetic methods, so as to remember the rule in less than a week's study. But if these same men would spend but a few hours in the study of logarithms they would find that by their use the extraction of the square, cube, or any root in fact, is reduced to a simple problem in division. It is surprising to me that many young men who pass up mathematics as beyond their powers of comprehension—as being too difficult for them to ever learn—are experts in other things requiring far more time and application to become proficient in. Take, for instance, billiards, pool, or bowling, at which many of our young men from the machine shops are able to put up a good game. Any man that will regularly devote a small portion of his spare time to the study of mathematics will find that it is an easy matter to absorb an elementary knowledge of them, and that they will help him far more than he ever anticipated."

"Well, I am pretty well satisfied that I want to know more about mathematics. What is the best way for me to go about it to get the knowledge? I am so situated that I cannot afford to go to a college to get it, and if I could I would not like to stop my work to do it."

"There are several methods open to you. You can take a course in some correspondence school; go to a night school; or, if you don't like either of these you can buy some books and study in your own way. The correspondence or night schools are better though, as you would have a systematic course of study mapped out for you, and some one to correct your work; but in any case you will have to put forth an effort to get an education, as it takes hard and diligent work to get knowledge in any of these ways; or any other way for that matter."

"In what way did you go about it?" asked Jim.

"I bought a few textbooks and studied them. I also subscribed to a couple of mechanical papers and read them very closely. It is hard for me to say which did the most good. There is lots of room for me to improve yet, and I still keep up my subscriptions to the papers, and when I come across a book that I think would benefit me I buy it. I don't study systematically now, I just read; in fact, I read practically all of my spare time and I find that it is a great help to me."

Jim went on with his job and did some thinking on what George and Anderson had said about the mathematics. He had made up his mind that he was going in for some study, but was still uncertain what action to take as he did not want to make a false start. "I'll just ask Mr. Corbin's opinion as soon as a good opportunity arrives," said he to himself. The opportunity came sooner than he expected, for in the course of an hour or so Mr. Corbin came along and noticed him turning the taper on the rolls and asked if he had got the taper off the sketch.

"No," said Jim, "Mr. Anderson figured it out and gave it to me. I have noticed a number of instances where figuring was necessary since I have been here, and if you have the time I would like to ask your opinion on a matter that has been on my mind lately."

"Go ahead," said Mr. Corbin.

"I have only a common school education, and by talking with some of the men here I have been led to believe that if I should study mathematics it would be of great benefit to me. I want to study at home, as I am not able to go to college, and if I were I would not like the idea of giving up my apprenticeship. Some of the fellows are in correspondence schools, and some are going to night schools, and I would like to ask you which you think the better way."

"Well, there is no doubt but what a knowledge of mathematics will be of use to you if you intend to continue in this business. Mathematics and mechanics are necessarily very closely associated, and a good practical man with a knowledge of mathematics has a decided advantage over a practical man without the mathematics, or over the technical man without the practical side. It takes the combination to fill the requirements of the responsible positions.

"As to the best method of getting an education along these lines a great deal depends on yourself. If you have a faculty of studying out a problem from printed instructions and similes, and the stability to keep steadily at it until you attain the desired results, you can do well by systematic home study; but if you can't get an understanding of a subject unless you have a personal instructor, and are unable to stay at a thing without someone to urge you on you will do better at a night school.

"Personally, I am an advocate of the methods of teaching followed by the leading correspondence schools; mind, I say methods of teaching; their indiscriminate methods of selling courses to persons regardless of their adaptability for the subject involved is greatly to be deplored, but it must be acknowledged that the larger ones are able to obtain a much more efficient corps of instructors, and map out and keep revised to the latest practice more systematic and complete courses of study than a school of small financial resources could hope to. Generally speaking, they give full value and good measure, but it's up to the student whether he gets the full benefit or not. You know the old saw, 'You may lead a horse to water, but you can't make him drink.' It's the same way with them, they will put the material before you and the remainder rests with you."

"Would you advise me to take the matter up now or wait until I have had more experience in a practical way?"

"Now! by all means; you can't get it too quick or too much of it, and when you do get it you will have a valuable asset that will be of use to you in practically any vocation. If you succeed in getting an education, and live long enough, you will realize that you have a good paying investment that no one can swindle you out of, and which will be all the more valuable to you because you worked hard to obtain it."

"If I decide to take up a course of study what do you think would be the most useful subject?"

"Mechanical drafting or mechanical engineering. In mechanical drafting you should get a good amount of the necessary mathematics, and in mechanical engineering you would get, without doubt, both the mathematics and the drawing with a good amount of other useful knowledge as well."

"Do you think I need to learn drawing? I thought that a trade by itself."

"In this business you will always be more or less closely associated with the work of draftsmen, and have to take your instructions from drawings made by them; hence a knowledge of the rules and methods followed in making these drawings will be of great assistance to you in enabling you to clearly and fully comprehend all the instructions and explanations represented on them; and if you should ever be placed in a responsible position where you would have the supervision of draftsmen, do you think you would be competent to direct in a matter of which you were ignorant?"

"You are right," said Jim.

"Of course I am. Well, I am glad to see you so much interested in this, and I hope you are rewarded with success."

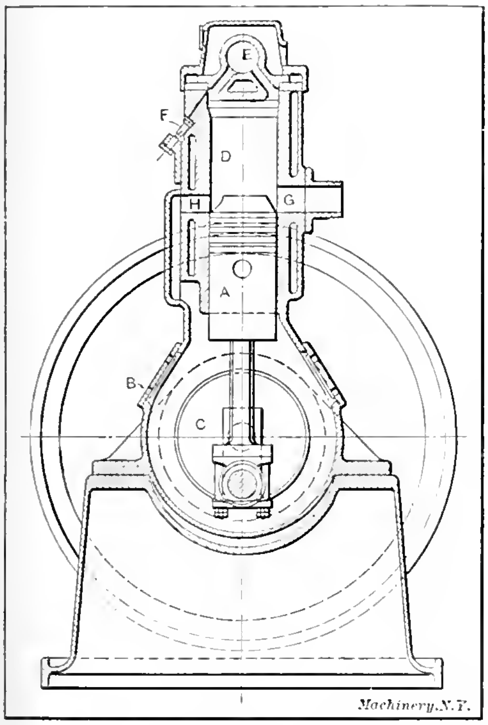
That night Jim took the first step toward obtaining a suitable education to assist him in his climb to the top of his

chosen profession by beginning a course of home study, and soon became a student filled with the desire to absorb everything treated on in his course in a thorough and efficient manner; and though some may criticise the method by which he decided to obtain his knowledge, it must be conceded that so far as an elementary knowledge of a subject is concerned, it matters not so much *how* it is obtained as it does that it *is* obtained. The point is that it is desirable, needful, imperative, and that a young man desiring to become a progressive, successful mechanic, should have it.

* * *

REVERSIBLE MARINE OIL ENGINE

As is well known, the two cycle petrol engine will run in either direction, according to which direction it is started, and it is possible to reverse it by first bringing it to a standstill and then pre-igniting the charge. Considerable efforts have been made to construct a two-cycle oil engine which would be capable of being reversed by means of a simple reversing lever in a manner similar to that used for steam engines. What appears to be a simple and practical solution of this problem has now been brought out by the J. & C. G. Bolinders Co., of Stockholm, Sweden. By adding certain devices to the engine, the reversing has been made both simple and certain, and an 80-H.P. engine of this design has been installed on board ship for testing purposes under actual working conditions. The accompanying illustration shows the general principles of the design of the engine. Near the end of its stroke the piston *A* uncovers the exhaust port *G* and the inlet *H* through which air previously compressed in the crank case *C* enters the cylinder *D*, sweeping out the products of combustion in the usual way. On the return stroke the air entrapped is compressed to 150 pounds pressure per square inch, and a small jet of fuel is pumped into the cylinder just at the end of the stroke. The charge enters through the jet shown at *F* and passes up into the vaporizer *E*, where it is automatically gasified and ignited. The pump which supplies the oil is actuated by an eccentric. The length of the stroke of the pump is adjustable, and by the ordinary hit-and-miss arrangement it can be thrown entirely out of action. Now, to reverse the engine, a clutch operating in connection with the pump and inlet valve is disconnected and a reverse lever moved over. The operation of the fuel pump is thus cut out, and the engine, accordingly slows down. When the speed has fallen to a certain limit, another pump comes into action which supplies a jet of oil to the cylinder, which is ignited at such a moment that the motion of the engine is reversed. As soon as this has taken place the regular pump immediately comes into play and the engine continues to run backwards. No skill whatever is required on the part of the attendant, who simply has to de-clutch and hold over the reversing lever until the engine changes its direction of motion.



Section through Cylinder and Crank Case of Bolinder's Reversible Marine Oil Engine

* Abstract of an article in *Engineering*, London, issue of December 20, 1909.

CIRCULAR FORM AND CUT-OFF TOOLS—2

By DOUGLAS T. HAMILTON

To provide for sufficient periphery clearance on circular tools, the center of the tool is located a certain amount above or below the cutting edge, as shown in Fig. 16. The hole *b* in the tool holders is raised or lowered depending on the position of the tools and the direction in which the spindle is rotating. The block *a* is provided for raising or lowering the hole in the tool holder. Raising or lowering the cutting edge of the tool relative to its center, changes the clearance angle *A* and also changes the form produced with the same tool. Clearance angles and the relation of the holes in the toolposts to the center of the spindle are, therefore, points which require careful consideration. With a given material, the larger the diameter of the work, the greater the clearance angle required. With the same dimension *C*, Fig. 16, a small tool diameter causes a greater clearance angle than a large diameter. The maximum diameters *D*, the cut-down below the center, *C*, the width of the cut-off tool *W* and the size of tapped hole *B*, as shown in Fig. 17, are tabulated in Table II, for the various sizes of Brown & Sharpe automatic screw machines.

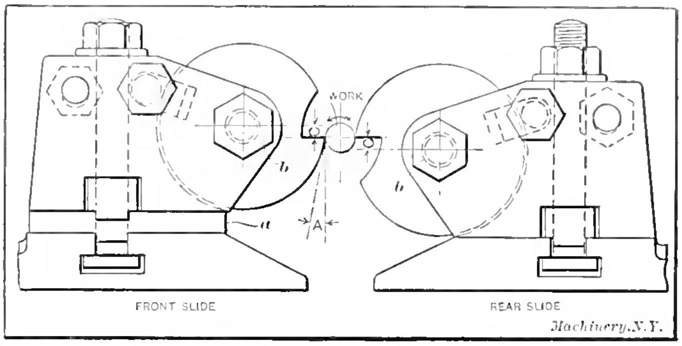


Fig. 16. Circular Form Tools and Holders showing Location of Center of Tool in Relation to Center of Piece being formed

Calculating the Diameter of Circular Tools

Locating the cutting edge of the tool below the center changes the form produced on the work. On account of this, the actual difference of diameters on the piece of work cannot be used for the measurements on the forming tool. If the dimension *A*, shown in Fig 17, on the piece to be formed, is transferred to the form tool and then the tool cut below the horizontal center line, as shown at *C*, it would make the dimension *A* on the piece greater than required. Therefore, it is evident that a certain amount must be subtracted from the dimension *A* on the work to find dimension *a* on the circular tool. A general formula may be deducted by the aid of geometry, by which the various diameters on the forming tool can be determined, when the largest or smallest diameters of the tool, the amount that the cutting edge is below the center, and the diameter on the piece to be formed, are known.

TABLE II. DIMENSIONS REQUIRED FOR DESIGNING FORMING TOOLS FOR B. & S. AUTOMATIC SCREW MACHINES (See Fig 17 for notation used

No. of Machine	D	C	B	W
00	$1\frac{3}{4}$	$\frac{1}{8}$	$\frac{3}{8}$–16	$\frac{1}{4}$
0	$2\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{2}$–11	$\frac{5}{16}$
2	3	$\frac{1}{4}$	$\frac{5}{8}$–12	[illegible]

Let R = largest radius of tool in inches,
A = difference in radii of steps on the work,
C = amount cutting edge is below the center in inches,
r = required radius in inches.

Then:

$$r = \sqrt{(\sqrt{R^2 - C^2} - A)^2 + C^2} \qquad (1)$$

If the small radius r is given and the larger radius R is required, the formula would be:

$$R = \sqrt{(\sqrt{r^2 - C^2} + A)^2 + C^2} \qquad (2)$$

Assume that it is required to make a circular form tool to

* Address: 169 Quarles St., Outremont, Montreal, Canada.

be used on the No. 0 Brown & Sharpe automatic screw machine for forming the piece shown in the lower view in Fig. 17, the diameters G and H to be formed by the tool. By referring to Table II it will be seen that the largest diameter should be 2¼ inches, and that the cutting edge is 5/32 inch below the horizontal center line. Half the diameter E, Fig. 17 (or radius r), is then found from Formula (1), by inserting the given values.

$R = 1\ 1/8$; $C = 5/32$; assume that $A = 1/8$.

Then

$$r = \sqrt{\left(\sqrt{(1\tfrac{1}{8})^2 - (\tfrac{5}{32})^2} - \tfrac{1}{8}\right)^2 + (\tfrac{5}{32})^2} =$$
$$\sqrt{\left(\sqrt{\tfrac{1271}{1024}} - \tfrac{1}{8}\right)^2 + \tfrac{25}{1024}} = 1.0014 \text{ inch.}$$

The value of r is thus found to be 1.0014 inch and diameter E will then be 2 times this or 2.0028 inches instead of 2 inches exactly, as would have been the case if the cutting edge had been on the center line. The formula may seem rather complicated, but when applied to circular tools used on the Brown & Sharpe automatic screw machines it can be simplified by inserting the values for R and C, these being constant for each size of machine. The formula would then take the following form:

No. 00 Brown & Sharpe automatic screw machine:

$$r = \sqrt{(0.866 - A)^2 + 0.0156} \qquad (3)$$

No. 0 Brown & Sharpe automatic screw machine:

$$r = \sqrt{(1.114 - A)^2 + 0.0244} \qquad (4)$$

No. 2 Brown & Sharpe automatic screw machine:

$$r = \sqrt{(1.479 - A)^2 + 0.0625} \qquad (5)$$

Top Rake

Most circular form tools are made without top rake, that is, they have the cutting edge in a horizontal plane when cutting, as shown in Fig. 17; tools made in this manner are best suited for cutting brass, but do not work entirely satisfactorily on tougher and harder metals, as the chip, instead of being cut away, is scraped off, this action destroying the cutting edge very fast. Form tools should, therefore, be provided with top rake, as shown in Fig. 18. The amount of top rake that should properly be used on circular tools for different materials varies from 0 to 18 degrees. Under general conditions the following angles are suggested as most suitable:

Material	Angle of Top Rake, Degrees
Rod brass	0
Drill rod and tool steel	8 to 10
Gun-screw iron	12
Machine steel	15
Norway iron	18

When top rake is ground on a circular form tool, as shown in Fig. 18, the calculations for the diameters must be accordingly changed. In Fig. 18 the case is shown exaggerated in order to be able to show clearly the various dimensions involved. To find the diameters of a form tool made in this manner, proceed as follows:

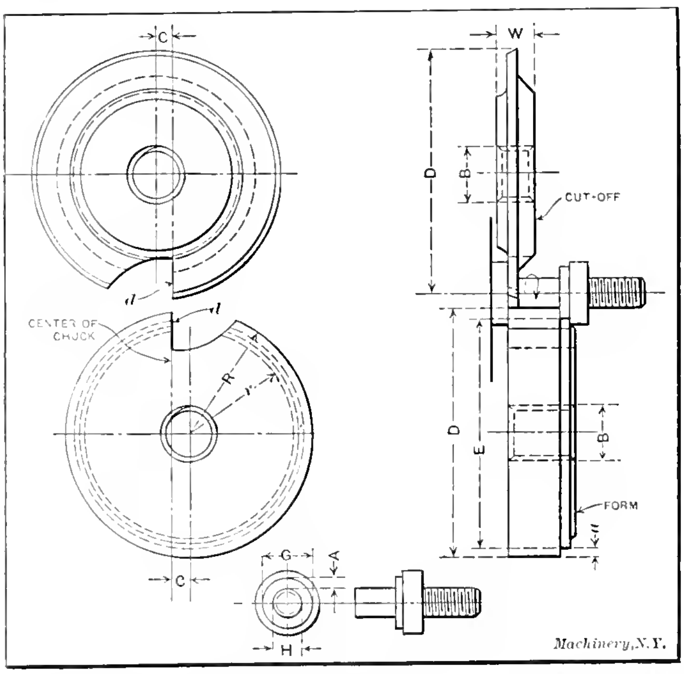


Fig. 17. Diagram showing Principal Dimensions of Circular Form Tools

First find radius R_1 which would be the actual radius if the tool were merely cut down the required amount C below the center of the tool, but had no top rake. Then the radius R_3 of the tool, required when top rake is given, must be found. In order to explain the procedure clearly we will assume a practical example. Let R = 1⅛ inch, C = 5/32 inch, D (see Fig. 18) = 9/16 inch, D_1 = 5/16 inch. Then A = 1/8 inch.

First find R_1 by means of Formula (1) or (4):

$$R_1 = \sqrt{(1.114 - 0.125)^2 + 0.0244} = 1.00126 \text{ inch.}$$

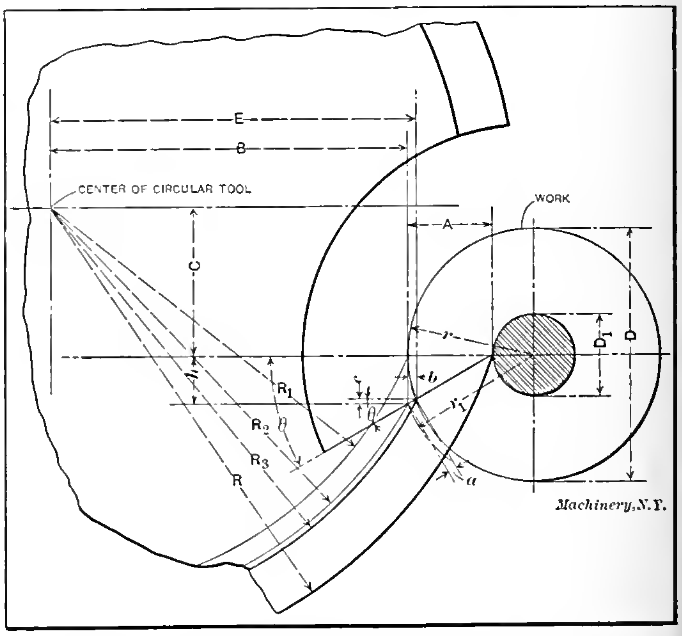


Fig. 18. Diagram for Calculating Form Tools having Top Rake

The next step will be to find dimension B:

$$B = \sqrt{R^2 - C^2} - A = 1.114 - 0.125 = 0.989 \text{ inch.}$$

The next step is to find dimension h and as the tool is to cut machine steel, angle θ is 15 degrees.

Then:

$$h = A \times \tan 15 \text{ deg.} = \tfrac{1}{8} \times 0.26794 = 0.03349.$$

This gives us the distance from the center of the work to the point where radius R_2 intersects the face of the cutting edge. Now R_2 may be found:

$$R_2 = \sqrt{B^2 + (C + h)^2} = \sqrt{0.989^2 + 0.18974^2} = 1.007 \text{ inch.}$$

Radius R_2 would be a fairly approximate dimension for the tool when the diameters of the tool and work are nearly of the same size, and when the angle θ is comparatively small. As the difference between the diameters of the tool and work increases, the diameter of the work being small in comparison with the diameter of the tool, it is necessary to find the theoretically correct radius R_3. To do this first find r_1:

$$r_1 = \sqrt{r^2 + h^2} = \sqrt{(9/32)^2 + 0.0335^2} = 0.2832 \text{ inch.}$$

We have further that $a = r_1 - r$, and $b = a \times \cos\theta$. Also $c = a \times \sin\theta$. Then $E = B + b$. Having obtained these dimensions we have:

$$R_3 = \sqrt{(C + h - c)^2 + E^2}.$$

Inserting the actual values in the formulas just given, we have:

$$a = \frac{9}{32} - 0.2832 = 0.00195,$$

$$b = 0.00195 \times \cos 15° = 0.00188,$$
$$c = 0.00195 \times \sin 15° = 0.00051,$$
$$E = 0.989 + 0.00188 = 0.99088,$$
$$R_3 = \sqrt{0.18923^2 + 0.99088^2} = 1.0088 \text{ inch.}$$

The found value of R_3 is the required radius of the tool. This radius is about 0.0075 inch greater than the radius R_1. The procedure may appear difficult at first sight, but a few examples in practice will make the user familiar with it.

While the angle of top rake as given is suitable for cutting the material specified, the distance C as given in Table II for the various machines is only suitable when cutting brass and drill rod and does not give sufficient peripheral clearance when cutting Norway iron and soft machine steel. The arrangement shown at C in Fig. 9 in the previous installment of this article should then be adopted, as the centers of both the form and cut-off tools would be raised as compared with the usual arrangement. This raising of the center is accomplished by putting packing strips of the required thickness under the tool-holder blocks.

Side Clearance on Circular Tools

The question of side clearance is a subject which few authorities seem to agree upon. Some advocate a great deal of side clearance, others only a slight amount, and still others, no clearance at all; in fact, some go as far as to say that a cut-off tool should be about 0.0015 inch narrower at the point than at the back. The greatest trouble with tools heating up and welding is not to be attributed to insufficient side clearance only, but to the quality of oil and other cooling lubricants used. It has been demonstrated that if a poor grade of oil is used and the tools made without side clearance, welding will surely occur; but take the same tools and use a good quality of lard oil, and the tools will run for days without welding. The writer admits that there are some cases in which side clearance is necessary, but the clearance should not be given as shown at *a*, Fig. 19, as this is not side clearance, but merely provision for pockets for the fine chips to lodge in, while the revolving stock forces the chips in and also tries to draw them out; and when a chip is drawn out, it leaves a rough finish on the end of the piece, and sometimes breaks the tool.

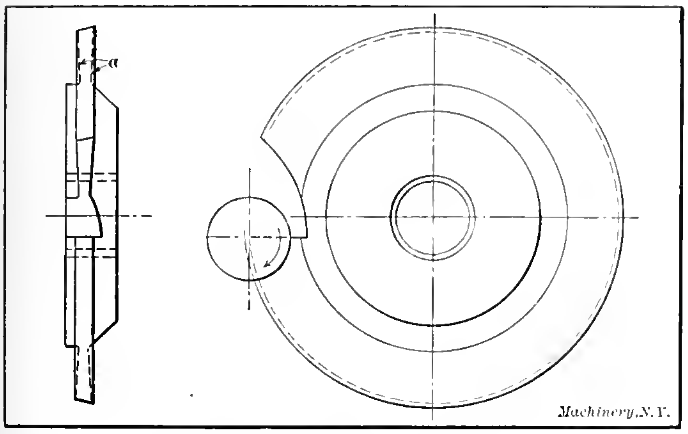


Fig. 19. Side Clearance on Circular Tools

When side clearance is necessary, and where the width of the slot is not important, a tool as shown in Fig. 20, where each section A of the tool is finished helically on each side, gives excellent clearance conditions. This tool is specially adapted for cutting vulcanite or fiber. It can also be used to advantage in cutting a very soft grade of iron. All the sections are ground, and when one becomes dull the following section is brought into position, and so on until the tool requires grinding again. When a tool is made without side clearance, it should be ground smooth on the sides, as any high spots on the face of the sides would cause heating and welding. A good grade of lard oil should also be used if good results are to be expected. When pieces as shown at A, Fig. 21, are being made the tools should be made without side clearance, and the faces ground and lapped as indicated. The form tool should be made in sections and straddle the thin portion of the piece; it should remain in position on the work until the angle on the edge of the cut-off tool is well into the stock as shown at *b*.

Speeds for Circular Tools

The conditions under which different work is made and the kinds of material used vary to such an extent that it is impossible to give any definite rules for the speed of the spindle or the feed of the tools, and whatever is said here is only by way of suggestion. The maximum speeds obtainable on the various Brown & Sharpe automatic screw machines are as follows: On the No. 00 machine the maximum spindle speed is 2100 R.P.M. and the maximum diameter of stock that can be turned is 5/16 inch; this gives a maximum surface speed of 197 surface feet per minute. On the No. 0 machine the maximum spindle speed is 1800 R.P.M. and the maximum diameter that can be turned is ⅝ inch, giving a maximum surface speed of 294 surface feet per minute. On the No. 2 machine, the maximum spindle speed is 1200 R.P.M. and the maximum diameter that can be turned is ⅞ inch, giving a maximum surface speed of 275 surface feet per minute. It can be easily seen that the greatest surface speed (294 feet per minute) is rather high for ordinary carbon steel tools even when working on brass rod. Then, if the highest speeds obtainable on the various machines mentioned are to be taken advantage of, a suitable grade of cutting steel must be used. This matter will be discussed later.

The following surface speeds can be used when the tools are made from Bohler's Styrian special steel:

Material	Surface Speed, Feet
Brass rod	200—300
Gun-screw iron	100—125
Norway iron and machine steel	80— 95
Drill rod and tool steel	60— 75

A good supply of lard oil should be provided, and the tools kept in good condition.

Feeds

In all cases, the feed is governed by the surface speed, the smallest diameter being formed and the width of the form tool. Feeds for forming tools are given in Table III. The widths covered here range from 1/16 to 1 inch, and the smallest diameters formed from 1/16 to 7/8 inch. It will be seen that a tool about ⅛ inch wide is, in general, adapted to take the coarsest feed. Tools from 3/32 to 3/16 inch (such as are commonly used for cutting-off purposes) admit of coarser feeds, as a rule, than either the wider or narrow tools. Thus the feed decreases as the tool decreases in thickness to 1/16 inch, except for small diameters, and increases from 3/32 to 3/16 inch. From 1/4 inch up, the feed must again be decreased to give satisfactory results. For cutting-off purposes the feed varies from 0.0008 to 0.0025 inch, depending on the nature of the material, the surface speed and the width of the tool. The feeds for machine steel, gun-screw iron and Norway iron should be less than the feed used for brass. The feed used in cutting off Shelby steel tubing should not exceed 0.001 inch per revolution; a surface speed as high as 125 feet per minute can be used with good results, when using tools made from Styrian special steel.

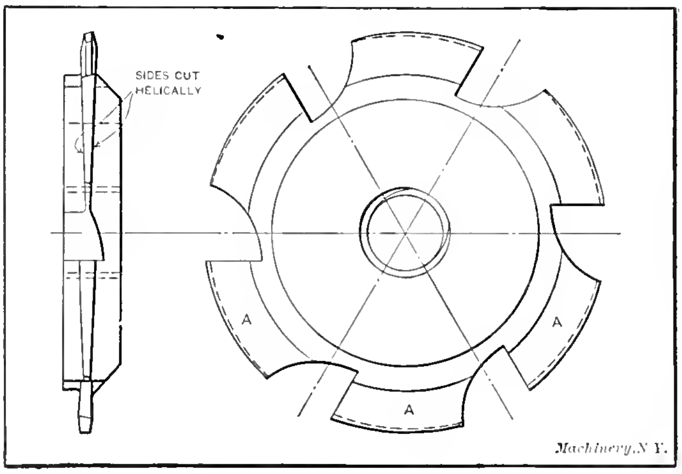


Fig. 20. Cut-off Tool with Side Clearance

Cooling and Lubricating Mediums

A proper cooling and lubricating medium is essential, if good results are to be expected. As previously stated, if a proper cooling and lubricating medium is not used, welding and excessive heating of the tools and work will result. There are various compounds on the market, some of them giving good results on certain classes of work, depending on the conditions under which they are used. Oil is used to advan-

tage in cutting internal and external threads where friction plays a very important part, but when cutting threads at high speeds, a cooling material largely composed of water is sometimes used. Oil will not conduct away the heat generated at high cutting speeds as rapidly as some of the special cooling compounds, because oil is more sluggish in penetrating to the point of the tool, where the chip is being cut or torn from the work. The writer would, however, advise that a good grade of lard oil be used on screw machines in preference to all other compounds or other poorer grades of screw cutting oil for the following reasons: 1. The speeds used are comparatively low. 2. A good supply can be furnished to the cutting edges of the tools. 3. Circular tools can be used without side clearance and yet give satisfactory results. 4. Good lard oil does not gum up the machines or cause rusting of the operating parts, as would be the case if cooling mediums composed of water and other compounds were used. The lard oil used should be thin and not sluggish, if good results are to be expected.

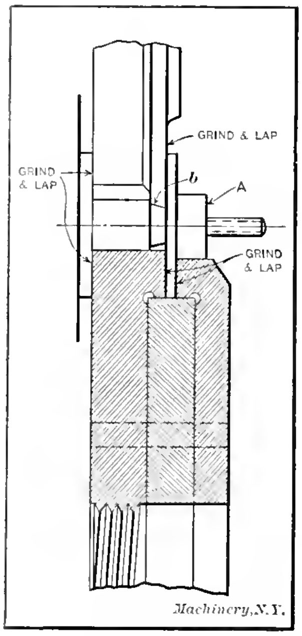


Fig. 21. Circular Form Tool without Side Clearance

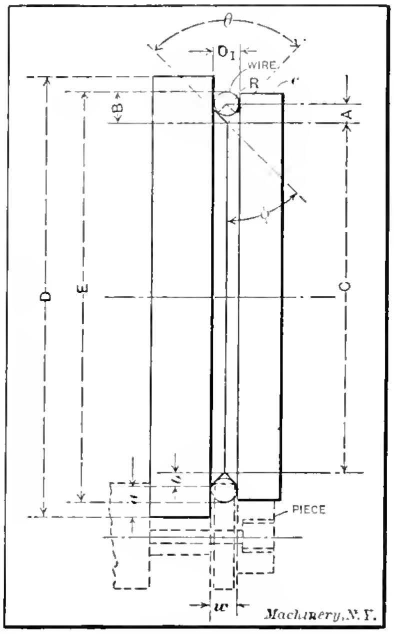


Fig. 22. Wire Method employed for Measuring Circular Form Tools

Selecting a Suitable Steel for Circular Tools

The conditions under which work is produced should determine the steel to be used in making the circular tools, *i. e.* if the piece to be made is of a very difficult shape, requiring sharp or thin projections on the tool, a grade of steel should be used which would not require a high heat to harden, as the thin projections are liable to become burnt or cracked while hardening. A brand of steel which has been found to give good satisfaction in such cases is Bohler's Gold Label special Styrian steel; this steel holds a fine edge satisfactorily and also gives a very smooth finish to the work; it is especially adapted for cutting brass. Care should be exercised in hardening this steel, as it hardens at a very low heat. Various other grades of special carbon and high-speed steel are used on screw machines, among which are the following: Jessops special steel, Novo high-speed steel, blue chip steel and Saben steel. Some of these kinds, especially Novo, give good results when high cutting speeds and feeds are used. Novo steel is frequently used for cutting machine steel and Norway iron, as it will stand a higher speed and a coarser feed than Styrian special steel; but where a high finish is required, Styrian steel should be used in preference.

Methods of Making Circular Tools

In designing circular tools, the question of making should be carefully considered, and where possible, the contour of the tool should be as simple as the requirements will permit. There are various methods employed in making circular tools of irregular shape, among them being the transfer scheme, templet system, master tools, and individual turning tools. For work requiring a fair amount of accuracy, the first two methods are not reliable. The master tool system is sometimes advisable when very difficult shapes are to be produced and when a large number of tools of the same shape are required. The writer considers that where a few tools are required, the individual turning tool method is the cheapest and best, and that direct measurements are more reliable than either the transfer scheme or templet system. The above-mentioned methods will be explained in the order in which they are given.

The Transfer Method

To illustrate what is meant by the transfer scheme, refer to Fig. 23; here a circular tool and setting gage are shown on the arbor *A*. The steps 1, 2, 3, 4, on the setting gage correspond with the various diameters required on the circular tool. The setting gage is turned to micrometer measurement and then copper plated with blue vitriol. To transfer the sizes from the setting gage to the circular tool, the master tools for the various shapes are brought in until they touch the setting gage, and the reading on the micrometer collar on the feed-screw is noted. The master tool is then brought into position on the circular tool and fed into the depth required, as indicated on the micrometer collar. The succeeding opera-

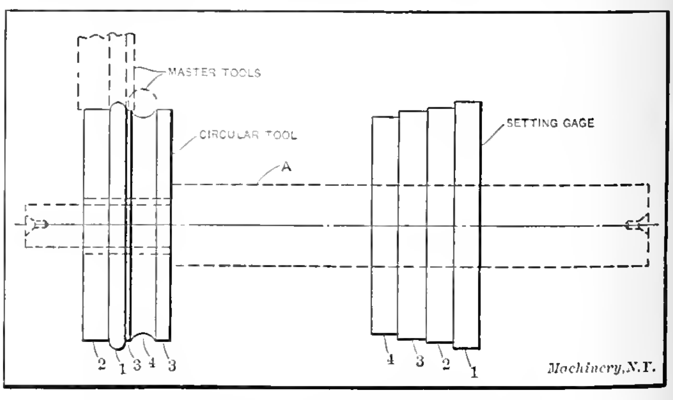


Fig. 23. Transfer Method for Making Circular Form Tool

TABLE III. FEEDS PER REVOLUTION FOR FORMING TOOLS

Width of Form	Smallest Diameter of Form												
	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8
1/16	0.0007	0.00075	0.0008	0.0009	0.001	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
3/32	0.00065	0.0007	0.0008	0.0009	0.001	0.001	0.0013	0.0014	0.0015	0.0017	0.0019	0.002	0.0021
1/8	0.0005	0.00055	0.00075	0.00085	0.001	0.00095	0.0012	0.0014	0.0016	0.002	0.0023	0.0025	0.0025
3/16	....	0.0003	0.0007	0.0008	0.00095	0.00095	0.0011	0.0015	0.0016	0.0018	0.0019	0.0021	0.0022
[illegible]	....	....	0.0005	0.00075	0.0009	0.0009	0.0011	0.0013	0.0015	0.0017	0.0018	0.002	0.0021
1/4	....	....	0.00025	0.0007	0.0009	0.0009	0.001	0.0012	0.0015	0.0016	0.0017	0.0018	0.002
5/16	....	....	....	0.0005	0.00085	0.00085	0.001	0.0011	0.0013	0.0015	0.0016	0.0017	0.0018
[illegible]	....	....	....	0.00025	0.0008	0.00085	0.00095	0.001	0.0012	0.0012	0.0014	0.0016	0.0017
[illegible]	....	....	....	....	0.0008	0.0008	0.00095	0.00095	0.001	0.0011	0.0013	0.0015	0.0016
[illegible]	....	....	....	....	0.0003	0.0005	0.0009	0.0009	0.00095	0.001	0.0012	0.0014	0.0015
[illegible]	....	....	....	....	....	0.0002	0.0008	0.00085	0.0009	0.00095	0.0011	0.0013	0.0014
[illegible]	....	....	....	....	....	....	0.0005	0.0006	0.00085	0.00095	0.001	0.0012	0.0013
1	....	....	....	....	....	....	0.0002	0.0005	0.0008	0.00085	0.00095	0.001	0.0012

tions are continued in like manner until the desired shapes on the tool are completed. As previously stated, where a fair amount of accuracy is required, this scheme is not advisable, for the reason that if the feed-screw or slide has any lost motion, as is generally the case, the same pressure could not be brought to bear on the gage, when setting the master tool, as would be exerted on the circular tool when cutting to the indicated depth; then the circular tool would be larger in diameter than the setting gage.

Templets

Some authorities advocate making templets which conform to the contour of the piece to be made. Considerable skill is required to file complicated templets accurately, as any error which might occur would be doubled in the diameters of the product. It is just as easy to measure a circular tool, as it

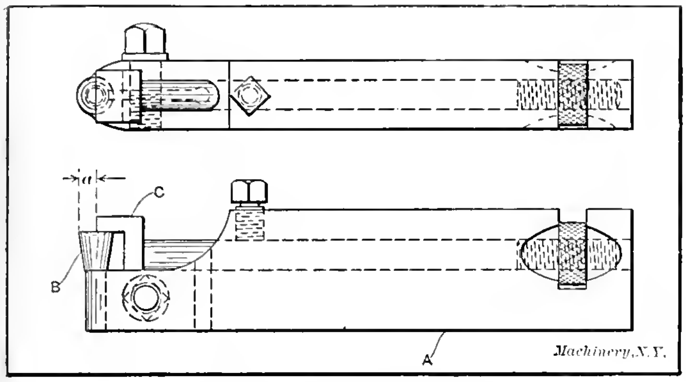


Fig. 24. Holder for Special Turning Tools

is to measure a templet, and in the first case the error would be less, as the measurement does not require to be transferred. The writer considers, that when accurate tools are required, templets should be avoided and direct measurements used instead.

Master Tools

Master tools are unnecessary, unless a large number of circular tools of the same shape are required. When master tools are being made, the differences in diameters due to the cutting down below center, should be calculated, and the tool made so that it can be set on the center of the work, when cutting the circular form tool, instead of setting the master tool below the center the required amount, as is advocated by some authorities. It is bad practice to set the edge of a tool much below the center of the work, as it tends to chattering, and the material is removed by a scraping action instead of being cut. In the majority of cases, it is prefer-

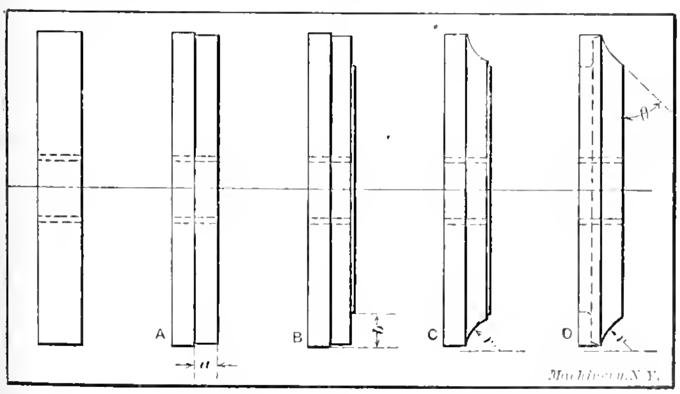


Fig. 25. Making Cut-off Tools for Spherical Work

able to make a circular master tool rather than a dove-tail tool, as the former is both easier measured and made.

Individual Turning Tools

The individual turning tool method, in conjunction with direct measurements, is preferable to all others, when only a small number of similar-shaped tools are required. In Fig. 24 is shown a tool holder A and tool B for forming the radii for oval head screws and other shapes of a similar character, special tools being inserted in the tool holder A, as required. When using this tool for forming circular cut-off tools, as shown in Fig. 11 in the previous installment of this article, the distance a is set equal to the radius of the tool B minus the amount that the center is ahead of the edge of the circular tool. The radius of the tool B is, of course, made equal to the radius required on the circular tool. The operating parts of this tool holder are clearly illustrated in Fig. 24.

The operations adopted in using this tool are shown at A, B, C, D, Fig. 25. The first operation A consists in taking a light cut (about 0.005 inch) across the circumference, making the distance a equal to the dimension D, shown in Fig. 11. Then a light cut is taken along the side as at B, making the distance b equal to the dimension X. Then the tool, shown in Fig. 24, is set square with the face-plate or at right angles to the centers, and the tool fed in, until the gage C touches the largest diameter of the tool, leaving the shape of the tool as shown at C, Fig. 25. A square nose tool is then set tangentially to the radius, forming the angle θ, as shown in Fig. 11. This square nose tool removes the material left after the operation at C, Fig. 25, and leaves the tool as shown at D. The individual turning tools used are concave tools, round or convex tools, square nose tools, and parting tools.

Measuring Difficult Shapes

When making circular tools of irregular contour, shapes difficult to measure are sometimes encountered. There are various tools and methods employed for this. An appliance to be used in connection with a micrometer for measuring deep slots and grooves is shown in Fig. 26. The special measuring pieces A are fitted to the anvil and spindle of the micrometer, and when the measurement is taken, the distances B are subtracted, giving the actual diameter of the tool. The pieces A can be made so that tools of very difficult shapes can be measured with accuracy. Where a form tool straddles a piece, the sharp corners produced by the tool rubbing against

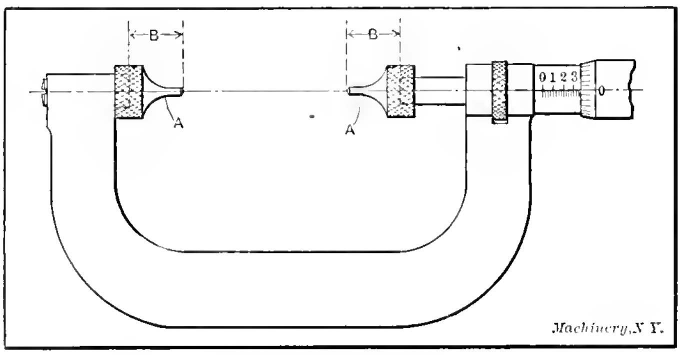


Fig. 26. Micrometer Arranged for Measuring Form Tools of Difficult Shapes

the sides are frequently objectionable and require to be removed. A form tool similar to that shown in Fig. 22 is sometimes used for this purpose. Making a tool of this description produces a form difficult to measure accurately, but by adopting the wire method, the measuring of the tool is somewhat simplified. To proceed with the wire method employed, refer to Fig. 22.

Let D = the largest diameter of the tool,
a = distance from outer edge of largest diameter of tool to bottom of chamfer, on the piece,
w = the width of piece to be chamfered,
ϕ = angle that chamfer makes with vertical line of tool,
b = distance from bottom of chamfer to apex or root of triangle,
C = the root diameter of tool,
R = the radius of wire,
A = distance from center of wire to apex or root of triangle,
E = the diameter over wires.

Then $b = \dfrac{w}{2} \times \cot \phi$; $C = D - 2(a + b)$

$$A = \frac{R}{\sin \phi}; \quad B = A + R; \quad E = C + 2B.$$

The dimension E can be calculated when the tool is being designed and put on the drawing, also giving the size of wire to be used. When the wires are below the part c, the pieces A shown in Fig. 26 can be used for finding dimension E.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition, $2.00 per year—coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages additional reading matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE NECESSITY FOR ACCURACY

Quite frequently the complaint that young technical graduates cannot be trusted to do accurate work involving calculations and the keeping of records and data is voiced in the engineering press. It is impossible to say to what extent complaints of that kind are based on general defects inherent in the training of the technical graduate. No doubt in many cases they have been called forth by the work of individuals who do not fairly represent the whole body of young engineers. The experience in this office in the editorial work of revising contributed articles written by a great many young engineers has been that while general formulas are deduced with considerable ability and ingenuity, the arithmetical work in the examples calculated by the deduced formulas to show their application, is very often lacking in accuracy. This is rather a paradoxical condition, but the fact remains that it exists, and it is not difficult to find an explanation.

It is not unusual that engineering students while at the technical colleges are led to believe, by the very training they receive, that the deduction of formulas and a knowledge of their application to practical problems are the most important parts of an engineering education; and that the actual arithmetical work involved in the solution of examples is of minor importance. The engineering student apparently reasons, "I know arithmetic anyway." This habit of inaccuracy and of slighting work requiring only elementary knowledge formed perhaps during the college years, is often the cause of bitter experiences. In practical engineering work accuracy is of prime importance. What practical use is a high order of ability in deducing complicated formulas if, when these formulas are applied, errors appear in the arithmetical work and inaccurate results are obtained for a specific case? The only purpose that formulas serve is the convenience of their practical application in solving problems occurring in everyday engineering work. No matter how ingenious is the work of deducing the formula, errors in calculation involving the numerical values inserted therein render all the previous work of no value. Indeed the value of such formulas becomes even negative, because the result of a calculation based upon a formula known to be correct will command attention and confidence. Its accuracy will be assumed and may, therefore, cause mistakes in design which will entail loss in time and money and, in certain classes of work, danger to human life.

No engineer, regardless of his ability and genius, who is inaccurate in his work even in small and seemingly unimportant details should be trusted to carry out any important problems where his work cannot be readily checked. Indeed it appears that the aversion to young engineering graduates which is rather common among many manufacturers is largely due to the fact that such young men do not usually perform the minor duties which are at first entrusted to them with sufficient care. The average young engineer imagines that such work is not worthy of his superior education and so he slights it. He gets into the habit of carelessness, and unless he awakens to a realization of the necessity for accuracy and care in small matters, and in what he may consider unimportant work, it is likely to hamper his success for many years. The young man of mediocre ability who brings to his work care and diligence is much more likely to win the race than is the brilliantly equipped man who slights details because he considers them unworthy of his ability, and who falls into habits of inaccuracy and carelessness through which he finally loses the confidence of those who might otherwise be in a position to open up to him opportunities for progress.

* * *

DESIGNING AND INVENTING

The art of the machine designer is one to which it is difficult to assign a rigid definition. The machine designer is to a certain extent an inventor, but largely he is an adapter; and it seems that his abilities in the latter field are in general far more valuable than in the former. Practical machine designing does not consist so much in inventing radically new devices as in adapting old and well-known mechanisms and principles to new uses and arranging them in different relations to each other so as to perform new functions. Sometimes work of this kind may be classed as invention, but as a rule it is not. Invention is rather the devising of an entirely new mechanism, or an application of mechanical principles in a radically new manner. If inventions are defined as fundamentally new departures, it will be conceded that the machine designer's work is seldom of the nature of invention, but almost entirely a work of adaptation.

This by no means lessens the importance of the work of the machine designer. It is often as difficult, and certainly as important, to be able to apply known and tried devices and methods, to perform new operations, as it is to devise something entirely new which may require considerable experimenting and great expense for its perfection. As an example, in the construction of a machine requiring a friction clutch, the experienced designer could naturally lay out his work so as to employ a clutch of standard make rather than to invent one himself. The adaptation of machines to the use of certain standard parts makes possible the unit system of manufacture which is the most economical method of building machines in large quantities, and at the same time it permits of flexibility in design at small cost. The machine designer who insists upon making original designs of his own for all mechanisms required in his machines is, as a rule, a far less efficient man than one who confines his work to the arrangement and modification of devices already known to give satisfactory service, and thoroughly tried out in practice. The best qualification of a machine designer, therefore, is not always ability to invent, but ability to make proper use of existing inventions as well.

* * *

The abrasive power of grindstones, correctly applied, is second to none, the emery wheel not excepted. The peripheral speed of a grindstone should be from 1,600 to 1,800 feet per minute. The bearings should be self-oiling and self-aligning and the stone should be kept true by use of some truing device that will turn the face smooth and accurate without waste. High spots may be reduced by nicking, causing them to wear more rapidly than the low parts. Water should be applied copiously, but not in a flood, the supply being just sufficient to cover the face with a film that will carry away the heat.

THE INTERNAL COMBUSTION ENGINE

The past fifty years have been remarkable for mechanical development in many lines, and one of the most important improvements of that period was made in the internal combustion engine. This type of prime mover, which comprises gas, gasoline, oil, alcohol and other engines of various descriptions in which the fuel is burned in the work cylinder, dates from the introduction of the crude Lenoir engine in 1860. This was the first gas motor brought before the public, although by no means the first actually built. Since that date there has been a steady improvement in design and growth in size, until to-day there are in use gas engines of four thousand horse-power, or more, driving dynamos with the regularity and smoothness which characterize the best steam engines.

Although essentially simple, the simplicity of the gas engine is more apparent than real. Possessed of but few parts, there are nevertheless many defects likely to affect the gas engine that never trouble the steam engine. Poor ignition, back firing, carbon deposits, poor compression and short circuits are a few of the troubles that have played havoc with its reputation as a reliable motive power. The simplicity of its mechanism is in part responsible for these troubles. Not sufficient care was taken in the design and construction and the conditions of operation often were notoriously bad. But the advent of the motor boat and automobile has been followed by a great improvement in design and construction. The number of users has greatly increased, and their requirements for uninterrupted service have made imperative the elimination of the ordinary faults inherent in the earlier designs. The battery system of ignition, for example, has been largely superseded in automobile design by the magneto apparatus, so simple and reliable in certain makes that it will work immediately after submersion in water.

The gas engine has been an attractive subject to machinists, having been even more popular with them than the steam engine as a model for home construction. Many a machinist has procured the rough castings and other parts for a few dollars, and by working nights has built an engine with which as the motive power he started a humble repair shop of his own, with perhaps a lathe, drill and grinder as his principal tool equipment. From these humble beginnings have developed thriving manufacturing industries, and many of the minor improvements in the gas engine have been made by these unknown mechanics in building model engines. The success of the aeroplane may be largely attributed to the work of machinists—amateurs in the gas engine art—who built motors after their own ideas.

The steam engine is rapidly passing for small stationary plants, and it is practically out of the automobile field. The competition between it and the gas engine as the motive power of the automobile resulted in a complete victory for the latter. Its simpler construction, compactness, great power, superior economy and other valuable characteristics have won for it the leading place, and the trend is toward the use of gas engines as the motive power for all purposes. The modern gas producer and the improved gas engine are for manufacturing plants practically as simple to operate as the steam engine, and the cost of fuel and labor is less. Cheap fuel can be used; there is no boiler to explode, no tubes to leak, no trouble with water supply and little or no waste of fuel after the engine is stopped. The number of machine shops driven by gas engines is large and is growing, but the great users of the future will be the farmers, to whom the coming of reliable gas power means a new era in agriculture in which power-driven machinery will play a still greater part in the emancipation of farm labor than has the horse-drawn machinery of the past and present.

* * *

An idea of the enormous amount of labor represented by a battleship may be formed by the fact that the breaking up or taking apart of an old obsolete British battleship, the *Thunderer*, built in 1877, will require the work of 100 men for nearly two years. During the thirty-three years of existence this battleship has never appeared in war, its usefulness apparently having been limited to that of "insuring peace."

LIGHT AND RELIABLE GAS ENGINES

By A. S. ATKINSON

In the evolution of the gas engine, little attention was given to the weight of the motor per horsepower until it had reached a stage which made it reliable and adapted it to wide fields of usefulness. The chief question which first concerned the designers and manufacturers was how much power it was possible to obtain from a single engine working under economical loads, and how reliable it could be made under continuous operation. The first gas engines were comparatively small, and it was not believed that large ones could be built; but to-day mammoth gas engines are constructed without difficulty, the twin-tandem, double-acting motors of the new Gary steel mills having 3600 horsepower capacity each.

The question of reducing the weight of gas engines arose when builders of boats and airships began to experiment with this form of motive power. The elimination of superfluous metal in the gas engine is following the lines of development of the steam engine. A hundred years ago a steam engine which produced ten horsepower weighed some ten to twenty tons, including engine, boiler and all equipment. Similarly, the early gas engines were heavy and unnecessarily clumsy. Even those first used in automobiles were so large, heavy and clumsy that when mounted on trucks they left apparently little room for passengers or freight. The systematic cutting down of weight has progressed rapidly, and to-day designers are confronted with the question of how light a reliable gas motor can be made.

In marine engines weight and bulk have always been of more concern than for stationary engines. A factory plant cares less about weight and size of the motive power than of the capacity, reliability and cost of operation. Designers have consequently emphasized these points for all stationary work, and as a result many engines are installed on land which carry a great surplus of metal. The marine engineer, however, had to study the bulk and weight of the motor very much as the pioneers in the automobile and airship industries did. In light, frail torpedo boats, the weight of the engines per horsepower was a vital question from the first, and when it came to equipping the small motor boats with gas engines the same subject was forced to the front. The swift motor boat built for racing purposes had to carry high-speed engines in which every ounce of superfluous metal was whittled off.

The designers of motors for airships and aeroplanes had even more difficult problems to solve. The engine that proved suitable for the motor boat or automobile was far too heavy for the flying machine. The reduction in weight furthermore had to be accompanied by an increase in speed. The automobile or marine engine making 800 revolutions per minute proved satisfactory, but the aeroplane motor had to make from 1,000 to 1,400 revolutions per minute. A speed of twenty or thirty miles on the land or water was satisfactory, but the airship had to attain a speed of approximately thirty-five miles to keep up in the air.

The systematic study of reduction of weight of gas motors per horsepower was therefore undertaken by designers of engines for flying machines, and to them we owe much of our knowledge of this subject. In the race for light motors, however, it is undoubtedly true that reliability has in most instances been sacrificed for speed and lightness. Every aeronaut to-day agrees that the greatest problem of flight awaiting solution is that of a light and reliable motor. The problem of flying has been solved but not the problem of the motor. Nearly all of the mishaps and troubles in flying are caused by the motor skipping, missing fire, or breaking down at some critical moment. When the modern airship is once in the air, it can fly as long as the motor runs and the fuel lasts.

The weight of the motor to-day with its magneto equals about one-fifth of the whole weight of the aeroplane. The aim is to whittle these motors down to the minimum and then construct them so that they will be absolutely reliable. The goal apparently is one pound of metal per horsepower, which to say the least is a rather startling proposition to

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those accustomed to heavier machinery. The inventors and designers of the leading types of airships are indefatigable workers in developing and perfecting their motors, and the secrets of this part of the equipment are jealously guarded. The new Herring-Curtiss motor weighs only fifty-two pounds and generates on a solid foundation approximately 24 horsepower. Some of the French motors for aeroplanes weigh 125 pounds, and generate thirty and forty horsepower. There are as many varieties of motors for airships as there are types of flying machines, and they often differ in many minor points and in some of the more vital ones. The horsepower varies from 25 in the Curtiss and 30 in the Wright machine up to 50 in the Antoinette monoplane. The American motors are mostly of the four-cylinder type, while some of the French motors run up to a dozen or more cylinders. The different airship motors are both air-cooled and water-cooled.

Taking the airships as a whole the average power generated is about twenty-five horsepower, and the approximate weight is three pounds to the horsepower. One firm, however, is now claiming that it can make good reliable motors which will weigh only one and a half pounds per horsepower generated, while another is making an 80-horsepower motor with a total weight of 300 pounds. This motor has eight cylinders grouped in pairs around a center crank chamber which contains a two-throw crank. Two carburetors and two magnetos are used; the piston bore is 3.54 inches and the combined stroke is 6.3 inches. Another modern high-powered light, reliable gas engine weighs 176 pounds and generates 40 horsepower. In all of these light engines designed for aeroplanes, high speed is, of course, as essential as lightness. A motor weighing one and a half to two or three pounds per horsepower running at 1,200 to 1,400 revolutions per minute, and mounted on a very flexible foundation, must of necessity be a remarkably delicate piece of machinery. It is the flexible base which gives designers of airship motors most trouble. It has been found by actual experience that the motor loses about 30 per cent of its power when mounted on the aeroplane. This loss must therefore be considered in testing the engines for actual use.

In the effort to solve the airship motor problem designers have turned their attention again and again to the gas turbine. If an efficient gas turbine could be constructed that would be suitable in other respects, the matter of revolutions would no longer present difficulties. Fifteen hundred revolutions per minute, which is now considered extremely high for the reciprocating motor, would be comparatively slow for an efficient gas turbine; but this would require in addition to a continuous force a perfect balancing of the whole engine, and this must be worked out better than it has been so far on the aeroplane.

The lack of reliability of gas engines designed for aeroplanes has been taken up by manufacturers of motors in general, and they are trying to solve the problems which the pioneer aeronauts have failed in. Probably every gas engine manufacturer to-day is experimenting with light high-speed motors, even though they do not advertise them or even put them on the market. They realize that for certain kinds of work these motors will prove of the greatest value. They will be suitable for speed crafts, hydroplanes, and possibly very light torpedo boats as well as for flying machines. Even very small boats such as skiffs and canoes will be greatly improved by having light high-speed motors.

Incidentally the question comes up for consideration as to whether the engines of extreme types have not been reduced in weight too much for practical and reliable work. Is it possible to design and construct a reliable and efficient high-speed gas motor that will weigh only a pound or two per horsepower? Not a few of the leading manufacturers agree that the craze for lightness in motors has handicapped the flying question, and that matters would be greatly improved if the aeronauts would accept a heavier machine which would run smoothly and easily for a long time. Motors for automobiles and boats can be run indefinitely without a stop or a miss, and if the airship expects to attain similar endurance the motor must be made heavier and more reliable.

It would be difficult to set absolutely the lowest weight of a motor for a given speed and horsepower, for in the past it has frequently been demonstrated that the triumphs of one generation have been easily eclipsed by those of the next. Apparently, however, a pound of metal per horsepower would seem to be the ultimate goal.

The air-cooled engine has an advantage over the water-cooled motor for airships if other things are equal, for the body of water which the latter must carry in the jacket must be taken into consideration in considering weight. But there are many difficulties in the way of designing light, speedy engines which can be practically cooled by air, and a motor that gets too hot after a short run in the airship is a decided failure. It cannot be stopped in mid-air to cool off as might be the case in a boat or automobile. It must keep on working at all times in order to keep the ship floating. A few skips or a short stop from overheating means an inglorious descent.

A type of air-cooled engine for flying machines which represents some of the greatest advances in designing is the French motor used in the Petleris airship which won a short distance prize last November. The specifications of these motors are as follows:

Horsepower	Number of Cylinders	Speed	Weight in pounds
20-25	5	1000 R.P.M.	115
35-40	7	1000 R.P.M.	150
40-50	10	1000 R.P.M.	216

The pistons of these engines are of turned steel, and the cylinders are placed fan-like; but these motors, like all others designed for airships, have their rating based upon actual work on a solid foundation. In all of these light-weight motors running at high speed there must be ample cooling surface, generous bearing surfaces in the wearing parts, perfect magneto ignition, and forced lubrication which will not get out of order.

* * *

THE NITER PROCESS FOR BLUING IRON AND STEEL

Attention is called in the *Brass World* to the niter process for bluing iron and steel. This process was first brought to the notice of the public in a paper read before the American Society of Mechanical Engineers, by Mr. William H. Weightman in 1886. This method produces a beautiful color and may, therefore, be of general interest. The process is very simple, the niter (nitrate of potash, often called saltpeter) is melted in an iron pot and heated to about 600 degrees F. The articles to be blued are cleaned and polished and then immersed in the molten niter, in which they are allowed to remain until the desired color has been obtained in a uniform manner. Only a few seconds are required, or, in general, only the length of time necessary for the articles to arrive at the heat of the niter. The articles are then removed and allowed to cool, after which they are immersed in water and the adhering niter washed off. Articles which will not warp or twist may be immersed in water immediately after having been removed from the niter. After the cleaning process the articles are dried in sawdust and then oiled with suitable oil, such as linseed, to prevent them from rusting. If a uniform color is to be attained continuously, a pyrometer should be used to control the temperature of the heated niter, because a higher heat than 600 degrees F. will produce a dark color, while a lower heat will make the objects light.

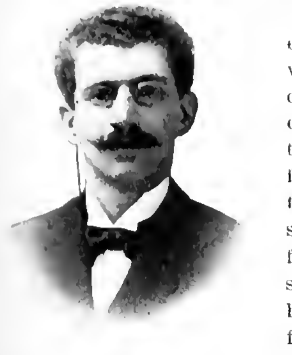
The niter process can scarcely be called suitable for small articles on account of its cost. Niter itself is not expensive, but the pieces must be dipped carefully in order to obtain the desired color and the handling in washing them off afterwards and drying them makes the cost per piece high. It is, therefore, used mostly for medium-sized and large work.

* * *

The German Post Office Department has adopted a letter-registering machine by means of which, in order to register a letter, all that is necessary to do is to insert it in a slot in the lid, which closes automatically as soon as the letter is dropped, and to turn a handle. This operation stamps the letter with the name of the post office, the date and a number, and delivers a receipt similarly printed. How the registration fee is collected by this device is not explained in the description published in an English contemporary, from which this information is obtained

THE DESIGN OF A PLATE GIRDER*

By MARTIN JOACHIMSON†



Martin Joachimson‡

While the design of plate girders does not strictly belong to the work of the mechanical engineer or draftsman, they are often called upon to carry out work of this character. Girders under uniform load, or with one concentrated load in the middle of the span, may readily be selected from tables in the handbooks issued by the steel manufacturers, but even these do not always conform to the building laws of the various cities, and their economy of steel is not always the greatest. Girders carrying a uniform load and a number of concentrated loads must be designed for their specific purpose, but this is a comparatively simple problem, as the following example shows.

The problem here given will be to design a plate girder to span an opening of 30 feet in a brick wall of 12 inches thickness; the wall above the girder, including roof and floor loads which it carries, produces a uniform load of 2,000 pounds per foot of girder. Besides this, provision should be made for two hangers to support shop trolleys at points 9 and 11 feet from the sides of the opening and each capable of sustaining a total load of 5 tons.

Dimensions of Girder

The depth of a plate girder may be taken as 1/12 of its span which gives 30 inches as the depth. The girder should rest on the wall on both sides for a distance of ½ its depth, which gives a total length of 32 feet 6 inches. The length used in the calculations is taken from center to center of pressure and equals 31 feet 3 inches.

To determine the effective depth of the girder and its weight, the sizes of material to be used must be assumed. As the wall above the girder is 12 inches thick the cover plates will be of this width, and the horizontal flanges of the angles will be made 5 inches, as the two angles and web included will then nearly come to the same width as the cover plates. The other flange of the angles may be 3 or 3½ inches, as only one row of rivets will have to be used. The web of the girder will tentatively be made ⅜ inch thick by 30 inches deep. This gives the weight as follows:

Weight of four $5 \times 3\frac{1}{2} \times \frac{1}{2}$ inch angles $= 4 \times 13.6 = 54.4$ pounds per foot.

The value 13.6 in the above calculation is found from the accompanying Data Sheet Supplement. The lengths of the legs are first added ($5 + 3\frac{1}{2} = 8\frac{1}{2}$), and then the weight is found in the section corresponding to the sum of the lengths of the legs and opposite the thickness, which in this case is ½ inch.

Weight of 2 cover plates, $12 \times \frac{1}{2}$ inch $= 2 \times 6 \times 3.4 = 40.8$ pounds per foot.

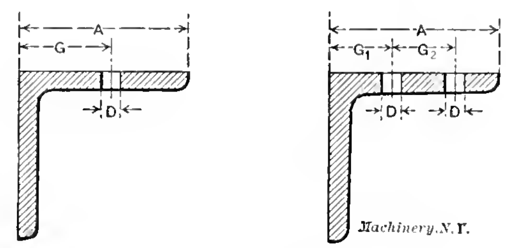
The factor 3.4 in the above calculation is the weight of a steel bar one square inch in section and one foot long.

Weight of web plate, $30 \times \frac{3}{8}$ inch $= 30 \times 0.375 \times 3.4 = 38.25$ pounds per foot.

Total weight per foot $= 54.4 + 40.8 + 38.25 = 133.45$ pounds, or with details, about 140 pounds.

The effective depth of the girder is the depth between the lines of centers of gravity of the flange angles. The location of the center of gravity for structural shapes is given in the steel manufacturers' handbooks, and for an angle $5 \times 3\frac{1}{2} \times \frac{1}{2}$ inch is at a distance of 0.91 inch from back of longer leg. In the example given, we have a web of 30 inches depth; the angles generally protrude from ⅛ to ¼ inch on both sides of the web which will give a distance from back to back of angles of, say, 30½ inches. Deducting from this $2 \times 0.91 = 1.82$ inch, we have an effective depth of $30.5 - 1.82 = 28.68$. We have now to find the combined bending moment of the concentrated and uniform loads. We lay out, in Fig. 1, the dimensions of the girder which we have found, to scale (say ¼ inch = 1 foot), and the bending moment of the concentrated loads can be found graphically by drawing, to the same scale as used for Fig. 1, the force polygon of these two loads (A and B) using a definite length as pole distance (say 100 inches), as shown in Fig. 2. If we use a scale of forces of 10,000 pounds = 1 inch, for the two loads, we will derive our bending moment in a scale of 100 inches × 10,000 pounds = 1,000,000 inch-pounds = 1 inch. We draw a vertical line cd (representing load A) equal to 1 inch or 10,000 pounds, and de (representing B) equal to 1 inch or 10,000 pounds. From d draw horizontally do equal to 100 inches to scale of Fig. 1, and connect c and e with o, which completes the force polygon.

TABLE I. RIVET SPACING IN ANGLES



One Row of Rivets

Length of Leg	Distance to Center of Rivet	Max. Size of Rivets	Length of Leg	Distance to Center of Rivet	Max. Size of Rivets	Length of Leg	Distance to Center of Rivet	Max. Size of Rivets
A	G	D	A	G	D	A	G	D
8	4½	⅞	3½	2	⅞	2	1⅛	⅝
7	4	⅞	3	1¾	⅞	1¾	1	½
6	3½	⅞	2¾	1½	¾	1½	⅞	½
5	3	⅞	2½	1⅜	¾	1¼	¾	½
4	2¼	⅞	2¼	1¼	⅝	1	9/16	¼

Two Rows of Rivets

Length of Leg	Location of Rivets		Max. Size of Rivets	Length of Leg	Location of Rivets		Max. Size of Rivets
A	G_1	G_2	D	A	G_1	G_2	D
8	3	3	⅞	6*	2¼	2¼	⅞
7	2½	3	⅞	5	2	1¾	⅞

* When the thickness of the 6-inch angle exceeds ¾-inch, make $G_1 = 2\frac{1}{2}$.

Minimum Rivet Spacing

Size of Rivet	¼	⅜	½	⅝	¾	⅞	1
Min. Distance...	1	1¼	1¾	2	2¼	2⅝	3

Returning to Fig. 1, we start from a vertical line through one of the points of support R and draw lines P, T, and S parallel to lines co, do, and eo of the force polygon and connect the ends of the lines P and S by a line V. Any vertical distance between lines P, T, or S and line V represents the bending moment due to the loads A and B at that point to the selected scale of 1,000,000 inch-pounds = 1 inch. We find that this moment in the center of the girder is 1,320,000 inch-pounds by scaling the vertical distance between the lines T and V at this point. The line of (Fig. 2) drawn parallel to line V divides ce into the two reactions R_a nearest load A and R_b nearest load B. The bending moment of the

* With Data Sheet Supplement.
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‡ Martin Joachimson was born in Breslau, Germany, in 1867, and received his general education at the high-school of his native town, and his theoretical technical training in a four-year course at the College of Technology in Berlin. He served a four-year apprenticeship in an instrument-making and general machine shop in Breslau, and has since been engaged with the Ludwig Loewe & Co., Siemens & Halske, the Union Electric Co., and the General Electric Co. of Germany. Upon coming to America Mr. Joachimson was first employed by the American Sugar Refining Co., and then by R. Hoe & Co. He is now in the employ of the city of New York in the Department of Bridges. He has worked as machinist, foreman, draftsman and mechanical engineer, and his specialty is machine design and the systematizing of shop work; some electromedical apparatuses have been designed and patented by him. Besides MACHINERY, Mr. Joachimson has contributed articles to the *Electrical World*, the *Engineering News* and the *Technologist*.

uniform load for the center of the girder is computed by the formula

$$M = \frac{wl^2}{8}$$

where w equals load per foot,

l equals length between supports.

From the given data and the computations already made, we have:

$w = 2140$ pounds (including weight of girder),

$l = 31$ feet 3 inches.

Hence:

$$M = \frac{2140 \times 31.25^2 \times 12}{8} = 3{,}135{,}000 \text{ inch-pounds.}$$

The variation of this moment is indicated by the ordinates of a parabola whose vertex is the maximum moment or 3,135,000 inch-pounds in the scale of moments already adopted (1,000,000 inch-pounds = 1 inch). We can draw this parabola by pointing off on the center line of the girder points C and L, 3.135 inches apart; draw horizontal lines through these points, divide the lines DC, DF, CE and EG into an equal number of parts, say 10, and draw horizontal and vertical lines through these divisions, numbering them respectively 1, 2, 3, etc., and I, II, III, etc., as shown. Draw, now, lines radiating from C to I, II, III, etc. The points of intersection of these radiating lines with the corresponding vertical lines are points of the parabola. After the curve is drawn through these points, lay off the vertical distances of the moment diagram of the concentrated loads above the parabola, which results in the com-

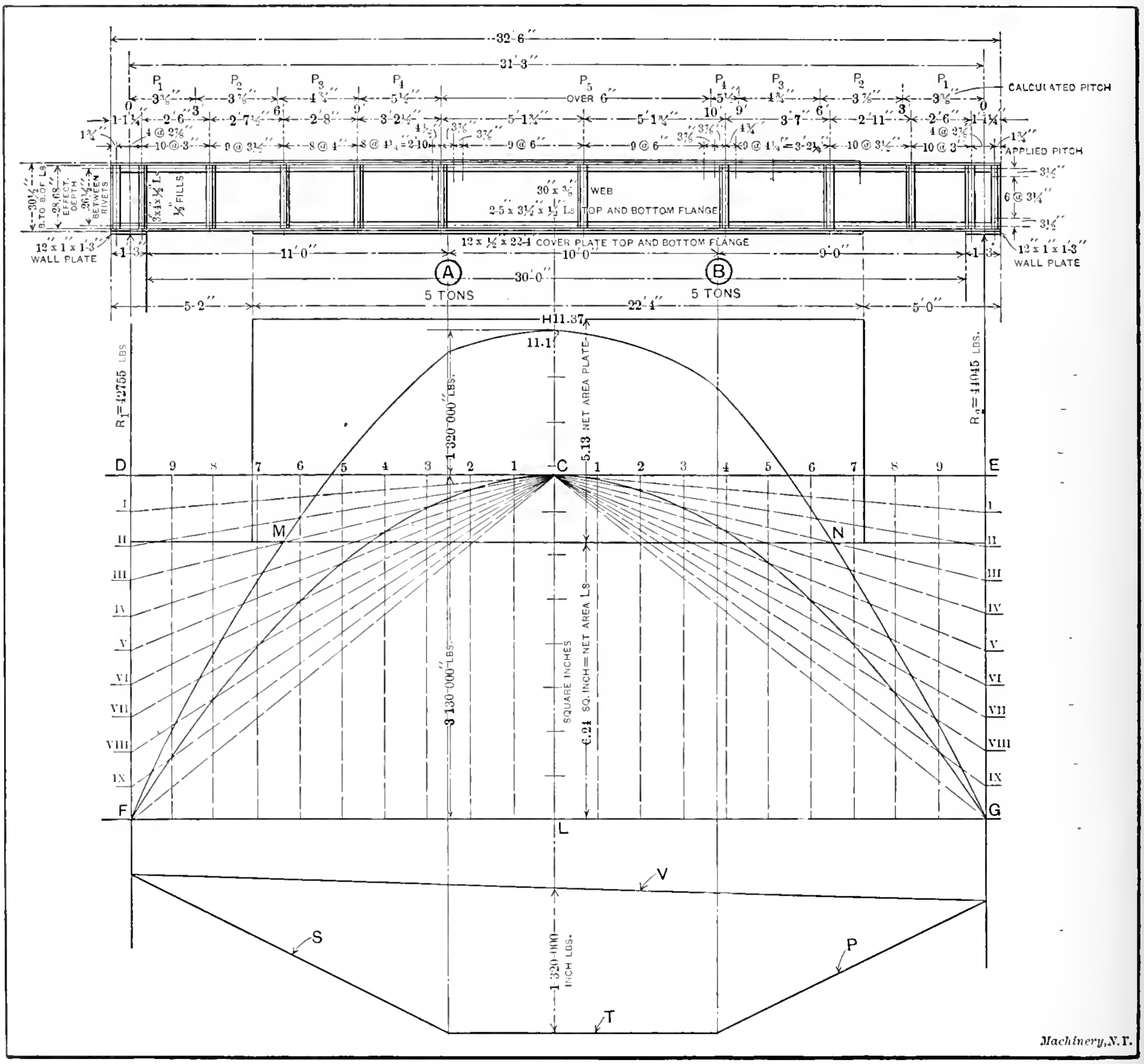


Fig. 1. Plate Girder and Graphical Construction for Obtaining the Bending Moments

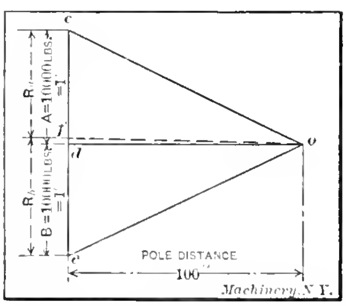


Fig. 2. Auxiliary Diagram for Obtaining Bending Moment Diagram in Fig. 1

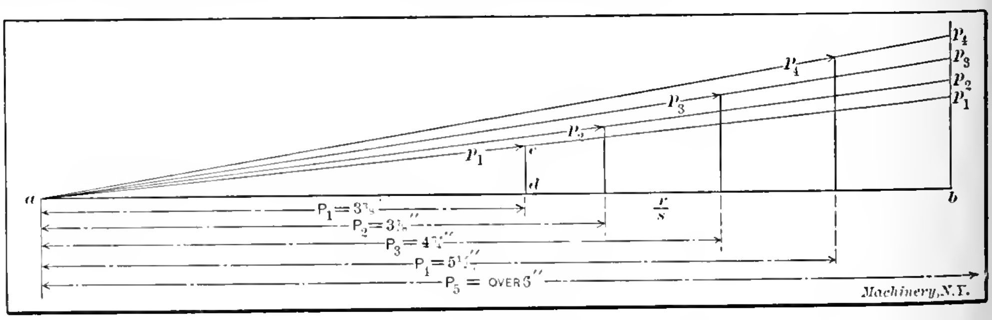


Fig. 3. Diagram for Aacertaining the Pitch of Rivets

bined moment curve FHG. The maximum bending moment in the center of the girder is represented by line LH and equals 4,450,000 inch-pounds.

We can now determine the flange area and length of the cover plates. The net flange area F_a, in square inches, is:

$$F_a = \frac{M}{df}.$$

where M = bending moment in inch-pounds,
d = effective depth of girder in inches,

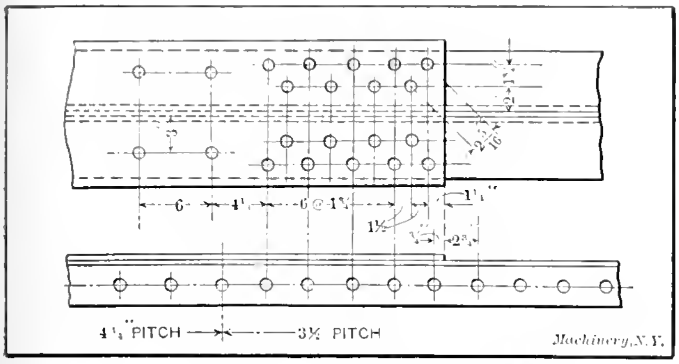


Fig. 4. Arrangement of Rivets and Ends of Cover Plate

f = permissible stress per square inch.

The New York City building law permits f = 14,000 pounds.

$$\text{Therefore } F_a = \frac{4,450,000}{28.68 \times 14,000} = 11.1 \text{ square inches.}$$

We divide now the distance HL, representing the maximum bending moment, in 11.1 parts, representing square inches of flange area. One-half of the flange area (5.55 square inches) should be included in the two angles. From the Data Sheet Supplement we find that the net area of a 5 × 3½ × ½-inch angle with two ¾-inch rivet holes deducted equals 3.12 square inches, and for two such angles the area is 6.24 square inches. A 12 × ½-inch cover plate has a gross area of 6 square inches from which two holes for ¾-inch rivets in ½-inch metal must be deducted. (The hole must be taken ⅛-inch larger than the diameter of the rivet.) The Data Sheet gives 0.87 square inch as the area to be deducted, and we have the net flange area:

Angles = 6.24 square inches
Plate = 5.13 square inches

Total flange area = 11.37 square inches

An inspection will show that a 5 × 3 × ½-inch angle would not give the desired area.

To determine the length of cover plates we point off in our diagram from L on line LH, 6.24 parts for the area of the angles, and continue the divisions above H to 11.37, drawing horizontal lines through both points. The theoretical length of the cover plate extends from M to N, the intersections with the curve of moments. The actual length of the plate is extended one foot on both sides or to 4 feet 6½ inches from the left and 4 feet 4½ inches from the right center of support.

We can now proceed to design the web plate of the girder, which must sustain the maximum shearing stress without buckling. The reactions at the supports are:

Reaction R_1:

From uniform load: $2140 \times 15.625 = 33,400$ pounds

From load A: $\dfrac{10,000 \times 19.625}{31.25} = 6,280$ pounds

From load B: $\dfrac{10,000 \times 9.625}{31.25} = 3,075$ pounds

Total $R_1 = 42,755$ pounds

Reaction R_2:

From uniform load: $2140 \times 15.625 = 33,400$ pounds

From load A: $\dfrac{10,000 \times 11.625}{31.25} = 3,720$ pounds

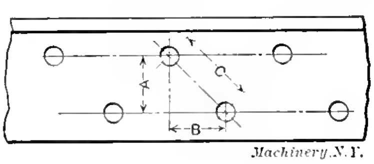
From load B: $\dfrac{10,000 \times 21.625}{31.25} = 6,925$ pounds

Total $R_2 = 44,045$ pounds

Our web plate will be 30 inches deep and we will try the assumed thickness of ⅜ inch for strength. The permissible shearing strain according to the New York City building law is 9,000 pounds per square inch for web plates.

The gross area of the web is 30 × 0.375 = 11.25 square inches. Assuming that 9 rivets, ¾ inch in diameter, connect the end stiffeners to the web, we must deduct 9 × 0.33 = 2.97 square inches (see Data Sheet), which leaves a net area of 8.28 square inches. This area will stand a shearing strain of 8.28 × 9000 = 74,520 pounds, which is ample, as the maximum required is 44,045 pounds.

TABLE II. CENTER DISTANCES C FOR STAGGERED RIVETS



Values of B	Values of A													
	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2
1 1/8	1 7/16	1 1/2	1 9/16	1 11/16	1 3/4	1 7/8	2	2 1/16	2 3/16	2 5/16	2 3/8	2 1/2	2 5/8	2 3/4
1 1/4	1 9/16	1 5/8	1 11/16	1 3/4	1 7/8	1 15/16	2 1/16	2 1/8	2 1/4	2 3/8	2 7/16	2 9/16	2 11/16	2 13/16
1 3/8	1 5/8	1 11/16	1 3/4	1 7/8	1 15/16	2	2 1/8	2 3/16	2 5/16	2 7/16	2 1/2	2 5/8	2 3/4	2 7/8
1 1/2	1 3/4	1 13/16	1 7/8	1 15/16	2	2 1/8	2 3/16	2 5/16	2 3/8	2 1/2	2 5/8	2 11/16	2 13/16	2 15/16
1 5/8	1 7/8	1 7/8	2	2 1/16	2 1/8	2 3/16	2 5/16	2 3/8	2 1/2	2 9/16	2 11/16	2 3/4	2 7/8	3
1 3/4	1 15/16	2	2 1/16	2 1/8	2 3/16	2 5/16	2 3/8	2 7/16	2 9/16	2 5/8	2 3/4	2 7/8	2 15/16	3 1/16
1 7/8	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8	2 1/2	2 9/16	2 5/8	2 3/4	2 13/16	2 15/16	3	3 1/8
2	2 3/16	2 1/4	2 5/16	2 3/8	2 7/16	2 1/2	2 9/16	2 5/8	2 3/4	2 13/16	2 15/16	3	3 1/8	3 3/16
2 1/8	2 5/16	2 5/16	2 3/8	2 7/16	2 1/2	2 5/8	2 11/16	2 3/4	2 13/16	2 15/16	3	3 1/16	3 3/16	3 1/4
2 1/4	2 7/16	2 7/16	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 7/8	2 15/16	3	3 1/16	3 3/16	3 1/4	3 3/8
2 3/8	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16	3	3 1/8	3 3/16	3 1/4	3 3/8	3 7/16
2 1/2	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16	3	3 1/16	3 1/8	3 3/16	3 1/4	3 3/8	3 7/16	3 9/16

Note: Values below or to the right of upper zigzag lines are large enough for ¾ rivets
Values below or to the right of lower zigzag lines are large enough for ⅞ rivets

We must now investigate for safety against buckling. Stiffeners must be used at proper intervals along the girder if the shearing strain exceeds

$$S = \frac{11,000}{1 + \dfrac{l^2}{3000t^2}}$$

where l = distance between upper and lower rivet lines,
t = thickness of web.

The distance back to back of the angles is 30½ inches, and the distance from back of angle to the rivet for a 3½-inch leg

is 2 inches, as given in Table I. This gives the distance between rivet lines $26\frac{1}{2}$ inches, and the safe strain against buckling per square inch

$$S = \frac{11{,}000}{1 + \dfrac{26.5^2}{3000\, t^2}} = \frac{11{,}000}{2.665} = 4{,}130 \text{ pounds per square inch,}$$

while the shearing stress equals

$$\frac{44{,}045}{8.28} = 5{,}320 \text{ pounds per square inch.}$$

Thus the web is not safe against buckling.

We require therefore either a thicker web or stiffeners at the ends of the girder, at the concentrated loads, and at regular intervals. These intervals should be about equal to the depth of the girder at the ends, getting larger toward the center, but never more than 6 feet.

Rivet Spacing

Enough rivets must be provided in the end stiffeners to transmit the end shear from the web plate to the supports. The permissible shearing strain for rivets is 10,000 pounds per square inch, and the bearing pressure 20,000 pounds per square inch. Tables giving values for different rivet sizes will be found in all the steel manufacturers' handbooks. A ¾-inch rivet in double shear will resist 8,836 pounds, but bearing in a ⅜-inch plate only 5,625 pounds, which, therefore, is the critical value in this case. Hence we find that $\frac{44{,}045}{5{,}625} =$ 7.8, or, say, 8 rivets are required. It is customary to provide two end stiffeners for girders resting on walls, at each end of the girder, and we will select 4 × 3 × ½-inch angles for this purpose, with 3 × ½-inch fillers between the flange angles. When determining the pitch of the rivets, we will find that the best arrangement is to place nine rivets in each stiffener, making six spaces of $3\frac{1}{4}$ inches and two of $3\frac{1}{2}$ inches, or a total of $26\frac{1}{2}$ inches.

The rivets in all stiffeners are generally spaced alike and should have the same or nearly the same pitch as the flange angles at that point, which makes the pitch of the end stiffeners governing all others.

The rivets connecting the flange angles to the web must transmit the horizontal shear. Their pitch is determined by the formula

$$p = \frac{r \times d_1}{S}$$

where r = value of one rivet = 5,625 pounds,
d_1 = distance between rivet lines = $26\frac{1}{2}$ inches,
S = horizontal shear.

The horizontal shear at any point is equal to the nearest end reaction, minus all the loads between the point and this reaction. We will determine the pitch at points 3, 6, 9 and 10 feet from R_2, the larger reaction.

Distance from R_2, Feet	Load between Point and R_2, Pounds	Horizontal Shear, Pounds S	Pitch $p = \frac{r \times d_1}{S}$ Inches	Corrected Pitch from Diagram Fig. 3
0	0	44,045	$3.38 = p_1$	$3\frac{3}{8} = P_1$
3	6,420	37,625	$3.96 = p_2$	$3\frac{7}{8} = P_2$
6	12,840	31,205	$4.78 = p_3$	$4\frac{3}{4} = P_3$
9	19,260	24,785	$5.60 = p_4$	$5\frac{1}{2} = P_4$
10	21,400 + 10,000	12,645	$11.80 = p_5$	over 6 $= P_5$

The rivets in the upper flange carry the direct load of the wall besides the horizontal shear, and the pitch must be corrected for this additional load, which is best done graphically.

Find the load s per 1 inch of the upper flange, which in this case equals $\frac{2000}{12} = 166.67$ pounds. In Fig. 3, line ab, drawn to any convenient scale, represents $\frac{r}{s} = \frac{5625}{166.67} = 33.75$, lines bp_1, bp_2, etc., are the pitches at the points required. If we lay out on line ap_1 to a larger scale the value of the pitch in the first 3 feet, as shown, the line cd perpendicular to ab cuts off distance ad, which is the corrected pitch P_1 in the first 3 feet. The same method is repeated for P_2, P_3, etc., for which the corrected pitch P_1 to P_5 is given in the foregoing table.

The rivets connecting the cover plates can be spaced 16 times the thickness of the outside plate or 16 × ½ = 8 inches apart, but 6 inches is the maximum pitch for any rivet spacing, which governs in this case as well as for the rivets in the flange angles between the two concentrated loads. At the ends of the cover plates enough rivets must be placed to develop their full strength, and the pitch of the rivets must be the closest possible. The full strength of the cover plates is their net area, times 14,000, or

12″ × ½″ — 2 holes for ¾-inch rivets = 5.125 square inches ×
14,000 pounds = 71,750 pounds,

which must be taken by the rivets which are in single shear.

Then $\frac{71{,}750}{4{,}418} = 17.3$, or, say, 18 rivets are required. Their closest spacing may be three times their diameters or $2\frac{1}{4}$ inches. These rivets will be "staggered" in two rows, and their position will be governed by the gage lines for 5-inch angles, the rivets in the vertical legs of the same angles, the minimum stagger, and the minimum distance from the edge of plate. The minimum distance of a rivet from the edge of a plate or angle is usually $1\frac{1}{2}$ times the diameter of the rivet, but is generally made $1\frac{1}{4}$-inch for a ¾-inch rivet, and $1\frac{1}{2}$-inch for a ⅞-inch rivet. The position of the rivets is shown in Fig. 4. The gage lines for 5-inch angles are 2 and $3\frac{3}{4}$ inches from back of the angle respectively (see Table I). Table II for the staggering of rivets gives $1\frac{1}{2}$ inch as minimum pitch for ¾-inch rivets and $1\frac{3}{4}$-inch distance of gage lines with 2 5/16 inches distance between centers of rivets. This can be adopted for the first two spaces but the pitch in the vertical ($3\frac{1}{2}$-inch) leg of the angle is $3\frac{1}{2}$ inches, and some of the other rivets would interfere. For this reason the pitch must be made $1\frac{3}{4}$ inch for the rest of the rivets.

The bearing plates at the ends of the girder must be large enough to transmit the end reaction to the wall. Generally a stone is placed beneath them and their size depends on the pressure this stone is able to sustain. For bluestone the building law permits 2,000 pounds per square inch. A plate 12 × 15 inches would be the smallest that could be used. The thickness of the plate should be double the thickness of the flange angles or 1 inch. For practical purposes the upper cover plate is carried to the ends of the girder to give an even bed for the wall.

* * *

SPOT ELECTRIC WELDING

A method of electric welding has been developed within a few years that differs from the common electric welding process in one important essential. It is known as "spot" welding and virtually amounts to electric riveting. The process is employed for joining thin metal plates that ordinarily would be united with iron or copper rivets and which are not required to make a watertight joint. The electrodes are pressed against the sheet metal pieces assembled in the desired relation and almost instantly the metal of both plates fuses and joins at the point of application. The union is of the most permanent nature, being much stronger than ordinary riveting because with the ordinary rivet the strength is generally limited to the shearing resistance of the heads, this usually being unequal to the tensile strength of the body. In the electric form of rivet the cross-section of metal in the spot is the measure of strength unless the metal is very thin, in which case the heads would shear out of the plate, of course. The number of applications in spot riveting depends on the area of the pieces joined, and the need for firm union. The process being rapid, the spot rivets may be thickly set at comparatively low cost.

* * *

It is stated in the *Brass World* that metals and alloys cast in chilled molds sometimes will have their tensile strength doubled by this process as compared with their strength when they are cast in sand.

THE FIRST AVIATION MEET IN AMERICA

A RECORD OF THE PERFORMANCES AND A DESCRIPTION OF THE MACHINES

By LEROY W. ALLISON*

Aeroplane development within the past year has been remarkable. The recent aviation contests, the first of their kind in this country, held at Dominquez, fourteen miles from Los Angeles, Cal., has brought forcibly to mind that we are now embarking upon an era of aerial navigation and that aeroplanes are to be a coming means of locomotion; one thing is self-evident, the flying-machine has great possibilities and the time is not far distant when it will enjoy much of the popularity now accorded the automobile.

This event was the second of its character to be officially recognized by the International Aeronautical Association (the first being at Rheims, France, in August, 1909). It served to elucidate to the American people many of the enigmatical problems surrounding the various types of air-craft. The climatic conditions of this section offer advantages to aerial work found in few other parts of the world, and records were made at this meet which only superior motor and controlling power in improved models of future aeroplanes can eradicate. The success of the exhibition far exceeded the expectations of the promoters, for during the eleven days, January 10 to January 20, there were over 176,000 paid admissions to the field, and fully 200,000 people, including press representatives, etc., witnessed the contests. The seating capacity of the grand stand was 26,000; it was set at the side of the inclosure, directly in front of a large marked-out square, which designated the starting point for the machines to leave the ground. To the rear of this square, for about one hundred yards, the ground was leveled to afford smooth running previous to flight.

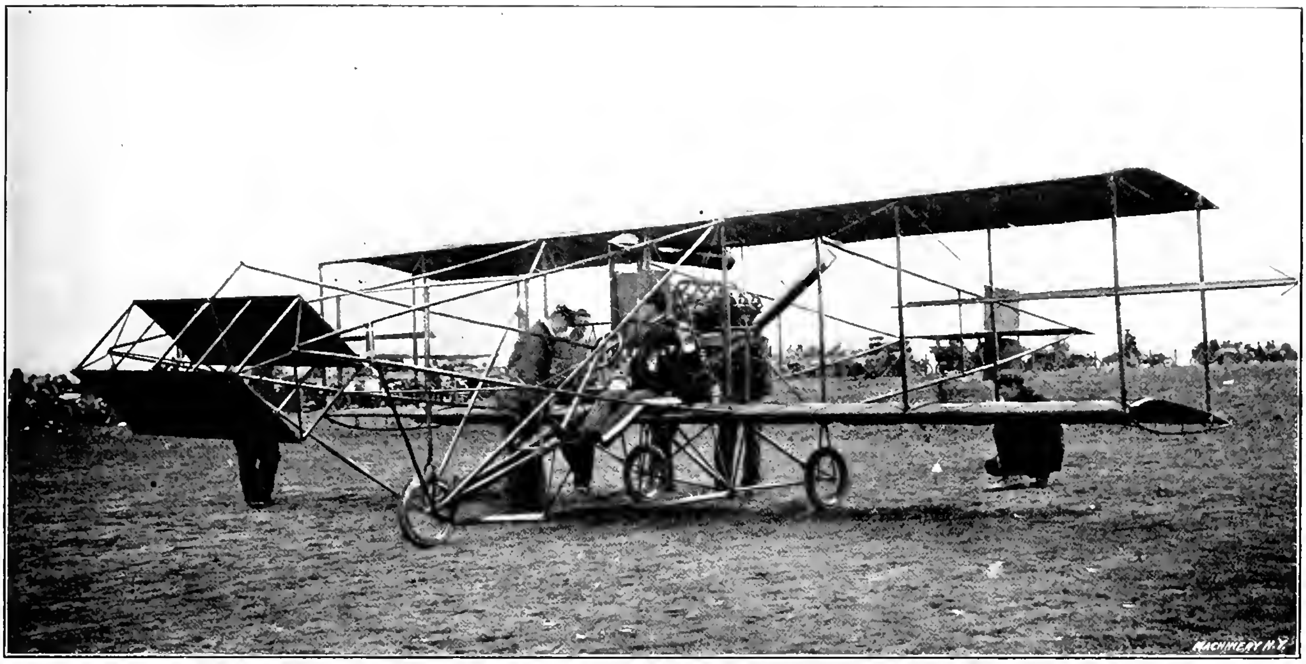


Fig. 1. Sixty-horsepower Curtiss Biplane

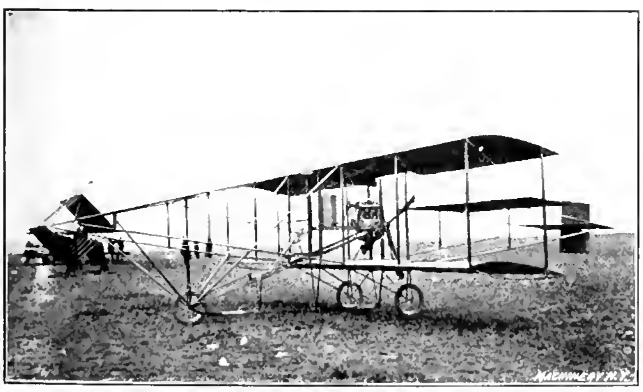


Fig. 2. Twenty-five-horsepower Curtiss Biplane

The course was hexagonal in shape, a lap measuring 1.61 mile. While proving a greater test of skill than a more extended circuit, it was evident that this lap was far too short to permit of possible speed records, and that one of twice this size would offer bigger advantages. At the Rheims meet, mentioned above, a lap was 6.21 miles, nearly four times this size. Conditions governing the prizes provided that they could be contested for any day during the event. Each contestant had to cover one lap each day when trying for a prize or forfeit a percentage of credit. To qualify for each lap, the aviator had to cross the line at the judges' stand off the ground at start and finish; should he touch the ground at any time during flight he was disqualified. The posts marking the circuit had to be encircled outside, and any contestant passed in flight was allowed the inside course. Notable in aerial circles and officiating as judges were Cortlandt Field Bishop, President of the Aero Club of America and Vice-President of the International Aeronautical Association, and Prof. H. LaV. Twining, President of the Aero Club of California.

Ten important machines were entered. Of the Herring-Curtiss models there were three different types, piloted by Glenn H. Curtiss, Charles K. Hamilton, Clifford B. Harmon, Hillery Beachy and Charles F. Willard (who has more successful flights in this country credited to him than any other aviator). Louis Paulhan, heading a French syndicate, entered four machines, two models of Voisin-Farman biplanes, and two of the Bleriot No. 11 monoplanes.

The 60-horsepower Curtiss Biplane

The 60-horsepower Curtiss biplane, piloted by the inventor, (Fig. 1) is the machine which holds the speed record and with which Mr. Curtiss won the international cup at Rheims. It weighs, complete, about 600 pounds, with a supporting surface of only 250 square feet in the main planes; this gives a weight factor of 2.4 pounds per square foot of surface. In the main planes the framework is of spruce, supported by laminated ribs, forming a parabolic curve of about 4 1/4 inch spring. The angle of the planes so formed is decreased when the machine is in flight. Verticals of the same material support the upper plane, which are of elliptical section with the long axis (about 2 1/4 inches) turned in a transverse direction; their connection with the frames of the main planes is by means of a socket joint, very similar to that used in standard motorcycles. The planes are 29 feet long by 4 feet 9 inches wide, and are divided, as shown in the illustration, into five panels, the middle one containing the power plant;

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they are covered with Baldwin's patent cloth, a sort of rubberized silk fabric, very light in texture. Featherbone is used to fasten it to the ribs. In each of these planes, at the rear, a cut is made to allow for the swing of the propeller. Central between the main planes are two 6 feet by 2 feet balancing planes; these are hinged at the end strut, with a projection of 33 inches inward and 39 inches outward beyond the planes. These movable surfaces act in harmony; that is, when one moves upward the other moves downward a corresponding distance. Through the medium of these planes equilibrium is maintained and aid is afforded in making turns. The framework and covering is similar to that of the larger planes.

As shown in the engraving, the horizontal tail-surface and rudder at the rear are supported by a V-shaped framework formed of bamboo, with intermediate laterals of galvanized wire. The vertical rudder, 2 feet by 3 feet, is for steering, being under the control of the handwheel in front of the operator's seat; the horizontal plane, which passes through it by means of a slit, is for stability. The front control is supported by a framework of similar construction to that of the rear frame, a more elaborate system of bracing, however, being required. The planes are about 2 feet by 6 feet, spaced 2 feet apart, with their axis a little over 4 feet from the ground level.

The most interesting features of the Curtiss machine are the control and the power plant; the minor devices of the former are ingenious and surpass those of any other aeroplane. The handwheel and front planes are joined by a long rod of bamboo, while the back rudder is connected by a wire cord which passes, by means of pulleys, completely around the wheel. This affords the operator control of the front and rear at any time in flight. By pushing or pulling the wheel, the front planes are directed to guide the altitude; by rotating the wheel the rear rudder is regulated to suit the course. Involuntarily the aviator maintains the lateral stability of the machine by means of a frame or yoke which fits around his shoulders; this frame is made of light tubing and is connected to the ailerons, as the movable planes are called by wires so that as he swings from side to side against the inclination of the aeroplane, balance is maintained. The operator's feet rest against two small levers; the right one is for speed control, and is connected to the throttle valve; the other acts upon the magneto and a brake upon the front chassis wheel, by which the machine is immediately stopped when on the ground. The engine can also be stopped by means of a switch, located under the seat and acting upon the magneto circuit.

The power plant is of the Curtiss design, and is patterned after that found in the smaller Curtiss machines. The engine has eight 4 x 4 inch cylinders; it is of the four-cycle type, and is rated at 60 horsepower. The cylinders are placed in a V-shaped manner, as shown; they are water cooled by means of a small pump. The lubricating oil is located in a three-gallon tank under the crank case. The bearings are lubricated through a hollow cam-shaft; a small pump, operated by the foot, is arranged to supply additional lubrication as required. A thirteen-gallon gasoline tank is carried above the engine, close to the upper plane. The entire motor weighs about 200 pounds; it is mounted on a frame, of ash, rigidly braced to the machine. The propeller is 7 feet in diameter; it is made of spruce, and has two straight-pitched blades with an average width of a little over 6 inches; it is flanged to the crankshaft direct, offering a simple form of drive.

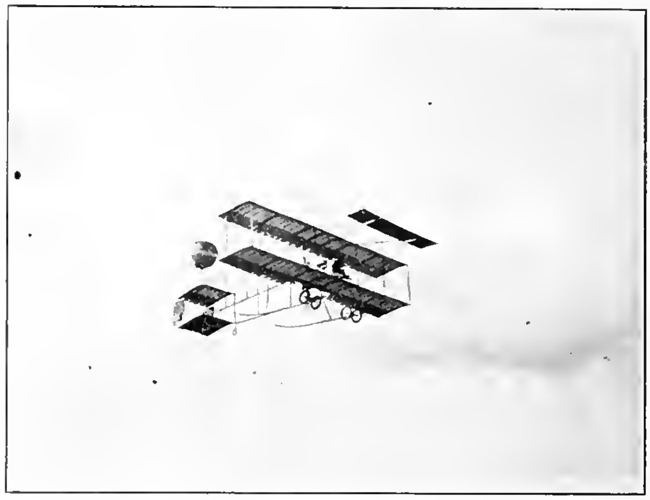

Fig. 4. Paulhan in Flight—Second Farman Biplane

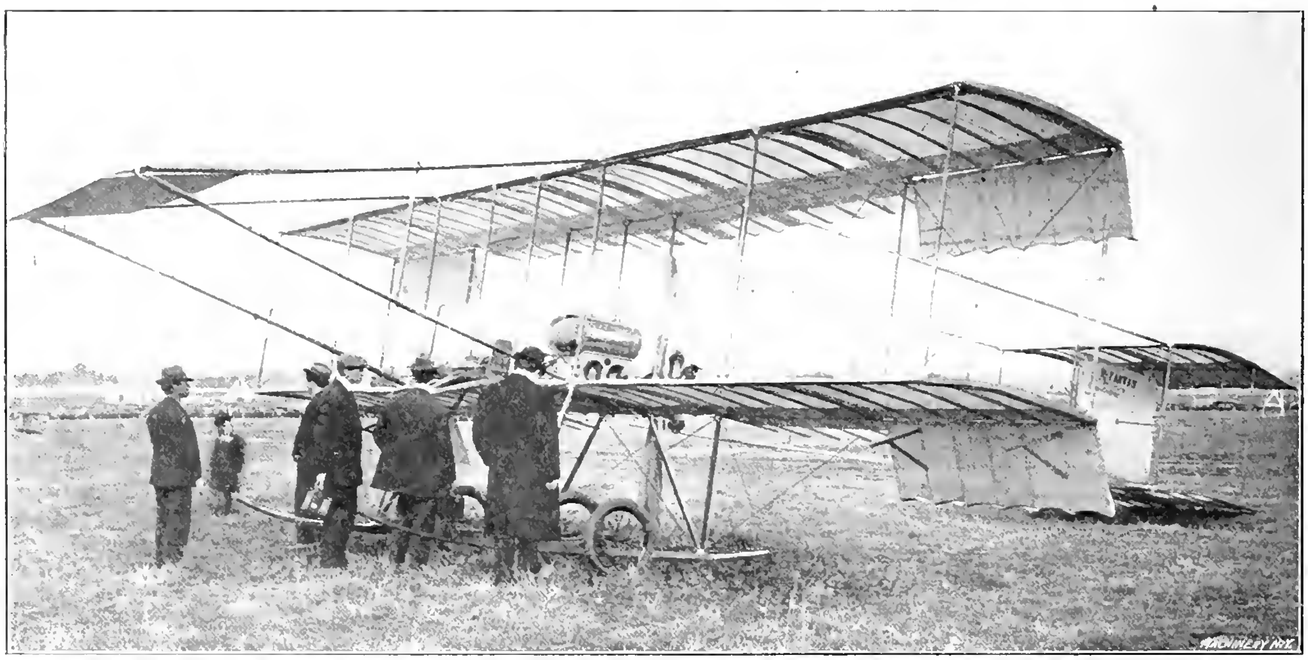

Fig. 3. Biplane of the Farman Type

The chassis is mounted on three 20-inch pneumatic-tired wheels, supported on rigid axles; this allows it to run on the ground in starting. When the machine is on the ground the height to the upper plane is about 7 feet.

The 25-horsepower Curtiss Biplane

As will be noticed by referring to the engraving, Fig. 2, the Curtiss machines of smaller sizes are of the same general type and dimensions as the one described in the foregoing, except in the power plant and a few minor instances. These are the smallest models of American aeroplanes which have proved successful; the Santos-Dumont creation, known as "La Demoiselle," is the smallest aeroplane on record—it is a monoplane and has found great favor in France.

In the power plant of these 25 horsepower Curtiss biplanes, the engine is four-cylinder, four-cycle, of $3\frac{3}{4}$-inch bore and 4-inch stroke. It is water cooled by a circulating pump driven from the cam-shaft. The heads are of the hemispherical pattern, and contain the inlet and exhaust valves, each set of which is operated by a rocker arm and a connection rod from the cam-shaft. The cylinders are of cast iron; a copper jacket extends around each cylinder, and is brazed to it, which incloses both the head and the body. The Curtiss type of carburetor is used. The magneto is gear-driven from the cam-shaft; this shaft also drives the force pump for oiling, the tank for which is situated below the engine. The overflow of oil from the aluminum crank-case is by way of two pipes, connecting with the tank at either end. A three-gallon fuel tank is located above the engine. The radiator is of the common type used in automobiles; it has a capacity of seven quarts and is placed in front of the engine, as shown in Figs. 1 and 2. All material used for piping is of brass and copper. The crankshaft is of steel alloy, and the piston, piston rods, valve arms, etc., of composition metal. The mechanism throughout is simple, and the design makes prac-

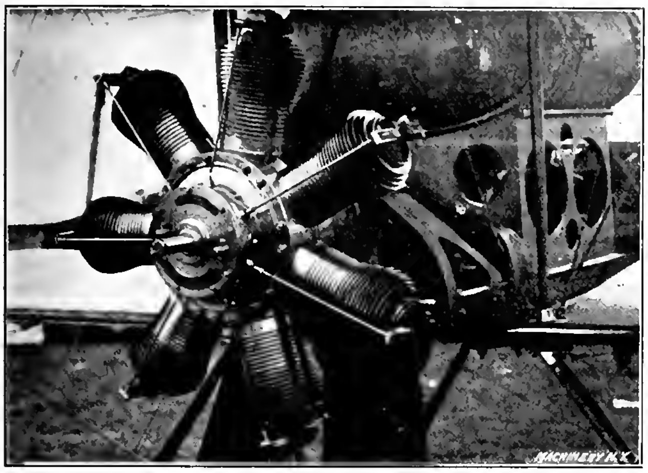

Fig. 5. Gnome Rotary Aeronautic Engine

tically all parts readily accessible. The engine develops a pull of 160 pounds; it runs at about 1,100 revolutions per minute and its weight is close to 100 pounds. The entire power plant ready for operation weighs about 150 pounds. The propeller and method of mounting is identical with that of the 60 horsepower machine. The machine shown in Fig. 2 had the only four-blade propeller on the field. This propeller is of the same general dimensions as the double-blade type.

The Gill-Dosh Biplane

The Gill-Dosh machine, operated by Hillery Beachy, is a Curtiss biplane with a standard automobile motor (the only

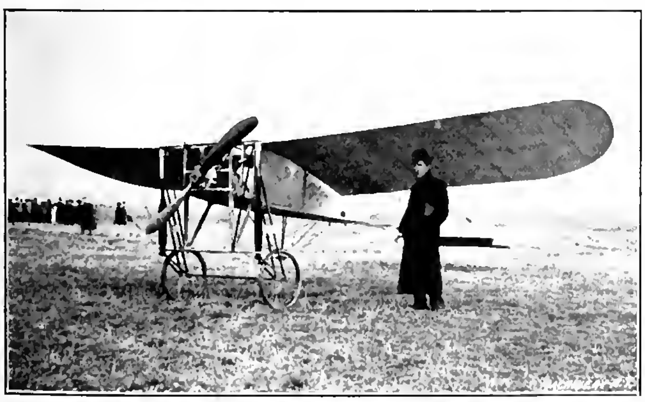
Fig. 6. Bleriot No. 11 Monoplane

one of its kind at the contests), and a propeller of the Gill-Dosh design, from which latter the machine derives its name. The engine was the well-known British-American with four 4 x 4 inch cylinders, four-cycle, of 26 horsepower. It was lightened by using copper jackets. This engine developed a pull of 200 pounds, or about 40 pounds more than the Curtiss engine of almost like rating. Like this latter engine, it is water cooled. The planes are covered with Baldwin "balloon cloth." This machine had the misfortune of being wrecked in the early days of the meet.

The Farman Biplanes

A modification of the first Farman aeroplane of the Voisin model is shown in Fig. 3. In Fig. 4 the second Farman ma-

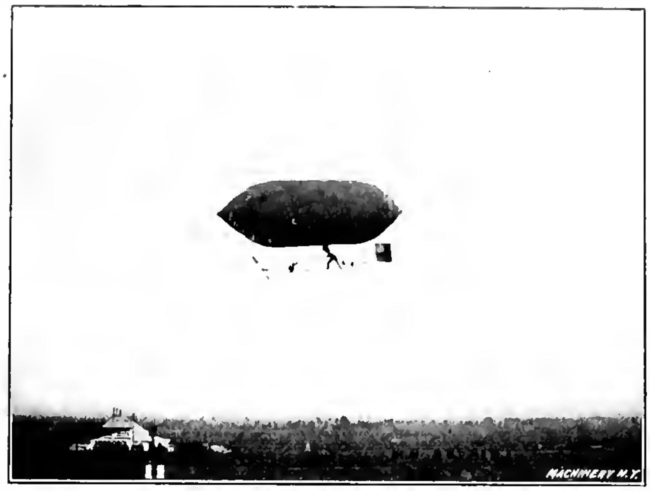

Fig. 7. Roy Knabenshue in His Dirigible

chine is shown in flight (the balloon seen in the illustration should not be confused with the biplane; it was in evidence throughout the meet, representing a local daily). Both of these machines were used at the Rheims exhibition and this was their first appearance in America. In the Voisin Brothers' model, the box-kite element is more evident than in any other type of flying-machine. The planes are about 33 feet wide, over all, three feet less than the Wright Brothers' model, and a little short of seven feet more than the Curtiss inventions. In length, these machines are much larger than either the Wright or Curtiss. The tail is also more prominent in the Farman aeroplanes than in other types. The weight of the aeroplanes in Figs. 3 and 4 is 800 and 1100 pounds respectively. As they are almost identical in construction, save for a few minor instances, only one will be described.

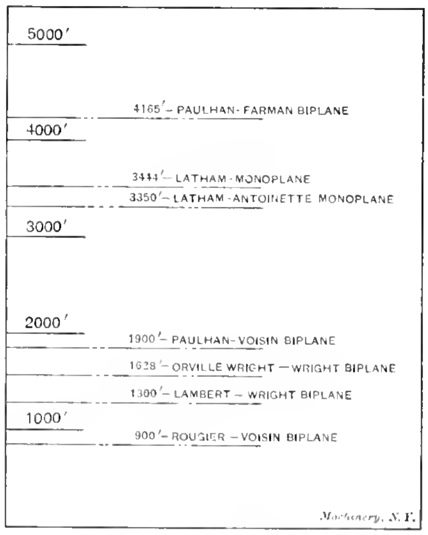

Fig. 8. Diagram showing Height Records

The framework of the second model illustrated is of steel tubing, and the ribs are of wood, covered with rubberized cloth. As mentioned, the planes are 33 feet; they are covered with Continental silk fabric. The upper plane is situated about $6\frac{1}{2}$ feet above the lower. To take the place of the movable balancing planes seen in the Curtiss models, at both sides of the main planes, at the rear, are hinged four stabilizing wings, two at each level; these planes are under the control of the operator by means of a hand-lever, and can be made to assume any angle. The framework at the rear is mounted upon two small wheels. The tail renders great stability to the main body, being located nearly 20 feet from the large planes. The two horizontal planes are square, measuring $6\frac{1}{2}$ feet along each edge. As seen in the illustration, Fig. 4, there are two vertical rudders, situated at either end of the horizontals; they are the steering apparatus for the machine. These are operated by the feet of the aviator, which rest on a pivoted lever connected to the rudders by wires; these latter act only in turning the biplanes to either side. The rudders are held up by the action of the wind to which they suit them-

selves. As will be noticed, the two Farman machines shown in the illustrations differ in the tail construction.

The front framework, which is built on the cantilever system, supports at the end a horizontal rudder 13 feet wide; this rudder is under the control of a hand lever and as in the other types, it is for regulating the height. In the former Farman machines, a handwheel controlled the front and rear rudders; this has given way to a hand-lever, controlling the front plane, while the rear planes are now acted upou by the feet of the aviator. This lever is pivoted, being capable of movement in all directions. While the previous Farman models had but two chassis wheels, this type has four, with the addition of skids; the chassis is supported on heavy rubber cushions, for eliminating shocks.

The Gnome Rotary Engine

The Gnome rotary engine, with which the two Farman aeroplanes are equipped, is a remarkable motor; it is one of the

Fig. 9. Curtiss Biplane with Mr. Curtiss and Lieut. Beck, U. S. A.

lightest (weighing 170 pounds) and most capable aeroplane engines yet invented, and it is the first of its kind to be used on flying-machines. This engine, which is shown in Fig. 5, develops 50 horsepower at 1,200 revolutions per minute and it is of four-cycle type. The seven cylinders are cast in one piece. The cylinders rotate around the crankshaft, while the pistons move in a circle about the crank pin, which is eccentric by half the length of a stroke ($4\frac{3}{4}$) to the center of rotation. This cylinder arrangement gives the advantage of a balance wheel effect without the additional weight of a fly-wheel and gearing, and eliminates to a great extent, the vibration current with reciprocating engines. The cylinders are air cooled by their own motion. The valve-rods travel over fixed cams, the centrifugal force making the action of the valves positive, without the necessity of springs. For ignition, the spark plugs each touch a common contact point as the cylinder turns into position, no separate leads being required in the magneto system. The Gnome motor holds the record for distance—118 miles made by Farman at Rheims.

The Bleriot No. 11 Monoplane

In Fig. 6 is shown the famous cross-Channel type monoplane, perfected by Louis Bleriot during the early part of last year, and known as the Bleriot No. 11 monoplane. It is probably more dangerous than the other dynamic machines. In flight the machine is more bird-like than any of the other biplanes; it also greatly resembles a dragon-fly.

The weight of the machine is 550 pounds, which, with a supporting surface of 240 square feet, gives a weight factor of 2.3 pounds. In over-all dimensions, the machine is approximately 28 feet square. The framework of the main planes is of ash supported by alternate aluminum and wood ribs, curved to suit the inclination of the wings, which are of unit pattern, being detachable from the body of the machine, and secured thereto, when in use, by means of a socket. These planes are about 6 feet wide and are rounded at each end as seen in the illustration; they are securely trussed with wires, and both sides are covered with Continental silk fabric, like that used on the Farman planes; this double thickness gives great stability. The socket joint mentioned above is arranged to keep the wings from interference with the motor.

As seen in the illustration, the body of the machine is of a sort of girder type. It is made of ash, with a little poplar, and trussed with steel wires. At the sides are the wing attachments, at the front is the space for the power plant, while at the rear the tail and rudder are connected. The tail is composed of three horizontal planes; one is a large fixed plane fastened to the tail frame, while two small planes are pivoted and act independently of each other. Above the main plane mentioned, a small rudder is placed, pivoted at the front edge; it is under the control of the operator's foot. The tail frame is mounted on a single pneumatic-tired wheel, (it is behind the man in the engraving). The two small pivoted wings mentioned are to the monoplane what the front rudders are to the other machines described, that is they are for altitude. In using these planes in connection with the main wings for balancing, the latter planes can be warped to suit the action of the wind. Paulhan, the French aviator, however, owing to the Wright brothers' injunction issued against the "wing warping" device, claiming an infringement, removed the apparatus from the machine, and used the rear control alone, thereby greatly handicapping the performances of the monoplane at this meet. As seen, the monoplane has no supporting surface in front. The propeller is located to act in "new" air, thus making the machine pull itself instead of pushing, as in the other machines illustrated.

The pilot's seat is located behind the motor between the main planes at the rear. All mechanism is visible from this position. The steering gear is in the form of a lever with a base of hemispherical shape attached to the main frame by a movable joint; to this latter the wires are attached for controlling the small hinged planes of the tail; it also formerly governed the wing warping. Neither the Farman nor Bleriot machine was equipped with wheel brakes.

The engine is of the reciprocating type, of Anzani design; it is three cylinder, four-cycle, size about $4\frac{3}{8} \times 6\frac{1}{4}$-inch, and air cooled. The inlet valves act automatically, and the exhaust valves perform mechanically. The engine is rated at about 25 horsepower and runs at 1,100 revolutions per minute. The ignition system is of ordinary design. Splash lubrication is used. The propeller is plainly seen in the illustration; it is constructed of walnut, variable-pitched, being composed of various sections glued together. It is fastened directly to the crankshaft, with a flanged reinforcement.

Great refinement of parts is more noticeable in the Bleriot monoplane than in any other type of machine shown at this meet; they are essentially a one-passenger machine (the Bleriot XII type is, I believe, suited for two passengers). In the model here shown, M. Bleriot made his famous flight across the English Channel, winning the $5,000 prize offered by the *Daily Mail*.

Other Aeroplanes

Lack of space will permit only mention of a few further models seen. A multiplane, a triplane and an "aerofoil" were entered. The former was composed of five main planes, patterned after a flight of steps, with the main body, very small

in comparison, and the power plant below the lowest plane. The vertical rear rudder and the rear horizontal planes almost met the fifth main plane at the top. None of these "freak" machines were attended with any degree of success.

Dirigibles

Roy Knabenshue and Hillery Beachy were in evidence with their well-known dirigibles. A picture of the former in flight is shown in Fig. 7, which also gives a partial view of the field. The dirigibles plainly showed their inefficiency as compared with aeroplanes; one particular advantage they have over the latter, however, is their ability to remain still in the air over a certain spot; the aeroplane is a dynamic machine; to keep aflight it must move.

Performances and Records

At the California meet, $80,000, more than double that offered at Rheims, was distributed (in prizes) for successful aeroplanes and "lighter-than-air" machines. Glenn Curtiss was the first aviator to ever fly in an aeroplane west of the Great Plains; this was in a trial flight on January 9. Mr. Curtiss, the speed champion of the world, carried off the speed honors for the course. On January 12 he circuited the course of 1.61 mile in 2 minutes, 12 seconds, in his 60-horsepower machine. Paulhan's best attempt to lower this record was 2 minutes, 21 seconds, in a Farman. Louis Paulhan, twenty-six years of age (born in the same year that wing-warping was invented), at one time an aeronaut in the French army, and later a mechanic at the Farman aeroplane factory, was the "star" of the meet. Coming to this country, practically unknown, his performances here in eleven days made him world-famous, and earned him the majority of the prizes. His remarkable record for height was made on January 12, when he was officially credited for 4165 feet. The aneroid barometer carried with him registered 4600 feet, but this figure was not considered by the judges, who took their measurements with level and transits. The diagram, Fig. 8, gives the world's records for height, and shows that Paulhan exceeded the former record by 721 feet.

In his endurance trial Paulhan was compelled to descend, because of accident to his fuel tank. His cross-country flight, which stands as a world's record, was to Santa Anita and return, a distance of 45 miles. Former achievements in such flights have been made by Farman (20 miles), by Bleriot in crossing the English Channel (25 miles), and by Cody with the heaviest type of aeroplane, at Aldershot (40 miles). It is noticeable that Paulhan failed to make any of his records with the monoplane; this can probably be attributed to the removing of the wing-warping device as mentioned elsewhere. At the conclusion of the meet, Paulhan was presented with a loving-cup, by the directors, for the best performances.

Willard's feat, of starting and landing in a designated square, was a remarkable one considering that aeroplane brakes for machines in flight have not, as yet, been invented. When these latter are perfected, far greater things may be expected of the machines.

As previously stated, the Gill-Dosh machine met with misfortune at the first part of the meet. Hillery Beachy, who has not had the experience in aeroplane piloting that he has had with dirigibles, wrecked the biplane in making too abrupt a descent after its first flight.

The illustration, Fig. 9, shows a Curtiss biplane, with Mr. Curtiss and Lieut. Beck, U. S. A., who was present throughout the contests in the interest of the government. Lieut. Beck rode as a passenger with many of the aviators, practicing bomb throwing and similar military maneuvers.

So far as distance is concerned, the flying-machine is limited only by the capacity of its fuel tank. Its future, while depending upon minor changes and improvements along established lines, seems to rest primarily with engines and propellers; this is not without solution. When the airship gasoline motor has reached a higher stage of perfection, aerial locomotion will no longer be a novelty and the aeroplane will be the master, not the slave, of the air.

* * *

Models of aeroplanes are said to be in such demand in England that a factory has been started at Sheffield.

CARBURETORS AND VAPORIZERS

By CHARLES A. SCHRANZ*

Charles A. Schranz†

The liquid fuels for operating explosive engines are all petroleum products, with the exception of alcohol, which, although of high efficiency, is, on account of its high price, but little utilized as a power-producing medium in this country. In gas engine practice the liquid fuels require certain devices, which, in accordance with the respective natures of these fuels, atomize or vaporize the same. The vapors combined with air form the explosive mixtures.

The petroleum products mostly used in explosive engines are gasoline (naphtha) and kerosene oil.

Gasoline (Naphtha)

The devices for forming an explosive mixture from gasoline and air are divided into two groups.

1. *Vaporizers.* In these the necessary quantity of gasoline for each charge of the engine is atomized by a valve, and then vaporized by the inrushing air, which process, especially when the air has previously been superheated, is so thorough that the mixture may be used immediately for charging the engine.

2. *Carburetors.* When these are used the engine sucks air directly through a gasoline storage tank, thus saturating it with gasoline vapors. Additional air must be drawn in before the vapors enter the engine cylinder to form an explosive mixture.

Each of these methods has its advantages and disadvantages. The first method renders it difficult to adjust the flow of the gasoline to the varying work done by the engine, but the vaporizers work very reliably, do not require much room, and scarcely any attendance. The main advantage of this method, however, is that any kind of gasoline may be used, while the fact that gasoline is composed of constituents of different volatility is unfavorable to the second method, as with the diminishing gasoline supply the explosive mixtures become variable and finally there remain residues which are too heavy to be taken care of by the air.

While formerly the second method of carbureting the air was much in use, because the forming of the explosive mixture is automatically regulated by the engine, the method of vaporizing the gasoline is now more in favor as it is more economical.

Vaporizers are built in many different designs, and it is difficult to say which construction is the most desirable. The principle, however of all the different designs is the same. Gasoline enters by gravity through a valve into the mixing chamber at the moment that the suction of the engine piston opens this valve. While passing through the chamber the gasoline is atomized, and upon striking the inrushing air vaporizes, and when thoroughly mixed with the air, is drawn off to the engine cylinder. According to the construction of the atomizing valve, the gasoline enters the mixing chamber either as a spray or in fine single streams. The simpler this atomizing device, the more dependable it is. Atomizers, for instance, in which the gasoline is pushed on the wings of a fan, set in motion by the inrushing air, are for this reason less recommendable.

Carburetors are also designed in many different styles, but all consist in the main of a cylindrical vessel, partly filled

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† Charles A. Schranz was born in Vienna, Austria, 1871. After going through the high school he took a complete course in mechanics at the University of Vienna. Following the completion of his university course, he served one year in the Austrian navy as engineer, and then filled a position with a large Vienna firm as designer of steam engines and boilers which position he held until 1896 when he became superintendent of a branch plant in Pressburg, Hungary. This plant built steam engines, boilers, brick making machinery and, in later years, gas engines and small pumping machinery. In 1905 Mr. Schranz came to America, and has since been employed by the Camden Iron Works, Camden, N. J., as designer of gas machinery, gas holders and structural work.

with gasoline, into which leads the air inlet pipe, reaching almost to the bottom of the vessel, and the gas pipe connecting the carburetor with the engine cylinder. Check or safety valves are placed in the gas pipe line to prevent the flame, at the moment of ignition, from striking back into the carburetor. The lower end of the air inlet pipe is usually designed in such a manner as to finely distribute the air, which is forced in through the suction of the engine piston. In passing through the gasoline these air bubbles become saturated with gasoline vapors.

The carburetor may be placed in the immediate neighborhood of the engine, or at a distance not farther than 50 to 60 feet from it. A practical arrangement is to place the carburetor in a well ventilated room, separate from the engine, so that there will be no danger from handling open lights in the engine room.

In order to increase the efficiency of the apparatus and to make the former independent of the temperature of the atmosphere, it is advisable to heat the air somewhat before it is drawn through the carburetor. This is usually accomplished by leading the air through a jacket placed in the exhaust pipe of the engine. Another method for obtaining the same result is to heat the gasoline instead of the air. In this case either the carburetor is provided with a jacket through which the jacket water of the engine is discharged, or the exhaust of the engine is utilized by placing the carburetor on a hollow pedestal connected with the exhaust pipe. These arrangements are of special value, where the carburetor is placed in the open air or in an unheated room.

Kerosene Oil

While gasoline has a boiling point of from 150 to 180 degrees, and is so volatile that it evaporates at the mean atmospheric temperature, which enables the formation of an explosive mixture by bringing it thoroughly in contact with air, the comparatively heavier kerosene oil needs different devices for the formation of the explosive mixture, as it can only be gasified when sufficiently heated.

When only atomized through a current of air, a mixture of air and minute particles of kerosene oil is formed, which when ignited, is not entirely consumed. If, however, the kerosene oil is previously heated to an extent that it evaporates, these vapors are able to form a mixture with air, which is the most economical explosive power fuel.

With regard to ignition and combustion this mixture has the same properties as mixtures of gas and air. Compression increases the inflammability, and even mixtures which ignite but poorly under atmospheric pressure, ignite readily when compressed, which fact is an important consideration, as quick and high compression in the engine cylinder may cause premature explosion due to compression heat.

The design of vaporizers for kerosene oil is further determined by the fact that it is made up of constituents with greatly variable boiling points (300 to 500 degrees). Therefore, it is not permissible to vaporize a larger quantity of kerosene oil at one time than is required for each single charge of the engine. Furthermore, the vaporizer must be designed to vaporize these small quantities perfectly, as every minute particle of liquid which is carried away by the flow of the gas is entirely lost for the development of power, and settles in the valves, cylinder, etc. The heating surface of the vaporizer must be large enough and sufficiently heated to allow the perfect gasifying of the fuel in the short time determined by the speed of the engine. Considering an engine running at a speed of 200 revolutions per minute, the duration of one stroke is only 0.15 second and as in this time the quantity of kerosene oil for one charge must be perfectly gasified, it is clear that the atomizing of the fuel is best performed by the air itself.

The actual design of vaporizers for kerosene oil conforms with all the above considerations, and consists in the main of the vaporizing chamber through which air and fuel are drawn through the suction of the engine piston. The kerosene enters the chamber through a valve, and is thus atomized and mixed with the inrushing air. This mixture is thrown against the walls of the heated chamber, and the atomized kerosene oil becomes gasified. On the way to the engine cylinder more air is drawn in to form the right proportions of the explosive mixture.

Care should be taken in designing the vaporizers to prevent spheroidal condition of the fuel, and, therefore, horizontal walls should be avoided. Cast iron is a very suitable material for kerosene oil vaporizers because the porous, rough surface forms a large heating area. To gasify the fuel perfectly, the temperature of the vaporizer must be at least 500 degrees F., which coincides with the boiling point of the least volatile constituent of the oil. This temperature may be produced by heating the vaporizer with a flame, or after the engine is started, through the exhaust gases. Another type of vaporizer (Hornsby-Okraid) is only heated while starting the engine, and after this is kept in a red-hot condition by the explosion heat.

To start a kerosene oil engine, either an oil torch has to be used to heat the vaporizer until a flow of exhaust gas is secured, or, as is more common, the engine is equipped with an auxiliary gasoline carburetor having a small tank for fuel, and when well under way the gasoline is shut off and kerosene oil turned on.

For alcohol motors the same vaporizers are used as on kerosene oil engines, and, in fact, all alcohol engines are built to run on both fuels.

* * *

EDUCATIONAL DUTY OF GAS ENGINE EXPERTS

By GEORGE CORMACK, JR.*

Women are usually blamed for talking too much, but the ordinary gas engine expert does not talk enough. In a great many gas engine trouble cases where an expert is called in, he fixes up the engine in a few minutes, and is "on his way." The expert who thinks that he has done his entire duty when he has fixed up the engine and got it running is very much mistaken; he has only done half his duty. The expert's whole duty consists not only in fixing the engine, but also in fixing the man who runs the engine. In ninety per cent of gas engine trouble cases, the difficulty is not really with the engine but with the operator. The writer has come to this conclusion from years of experience, and the fixing of the operator of the engine is really the principal duty of the expert or trouble man. If the expert fixes the engine without fully explaining to the man running the engine why the trouble occurred, and what methods to pursue to prevent its recurrence, the remedy is only temporary, and the operator is liable to get into the same difficulty again. The expert must not only be a good mechanic and have a thorough understanding of gas engines, but he must also be able to explain the working of the engine in a simple manner to the operator. He must cultivate this ability to explain the action of the gas engine, its principles, movements and adjustments to the operator. This is no easy task at times; it requires patience and tact together with a realization of the fact that although the gas engine may seem so simple to himself, and the adjustment of its different elements in their proper harmony seems self-evident, the large majority of gas engine users are ignorant even of what the terms four- and two-cycle mean.

The really good mechanic, is perhaps, naturally deficient in the ability to express himself clearly, and to all such the writer would advise a method which he has found very beneficial in his own case. When having a little spare time, when waiting for a train held up over night in some out of the way town, buy a five-cent writing tablet and write out a description of the principles of action, movements and adjustments of a gas engine. If not accustomed to expressing one's own thoughts in writing, the first attempt when read over after having finished it, may not seem a very polished literary effort. Yet, try it again after a few days when the opportunity again offers. On the second attempt it will be surprising how much better one can express oneself. The mental effort of trying to express one's thoughts has set the mind working along new lines. By keeping up this practice for some time, it will be found that when giving an explanation of the engine to the man who is in trouble, the verbal explanation will take the form of expression used in writing. The cases will be few and far between where an engine operator does not appreciate the efforts in giving him real instructions about gas engines.

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DERIHON PORTABLE FORM OF BRINELL HARDNESS TESTING MACHINE*

Readers of MACHINERY are acquainted with the method of testing the hardness of materials devised by Mr. J. A. Brinell, which we have previously described. It consists, briefly, of forcing a hardened steel ball into the material to be tested.

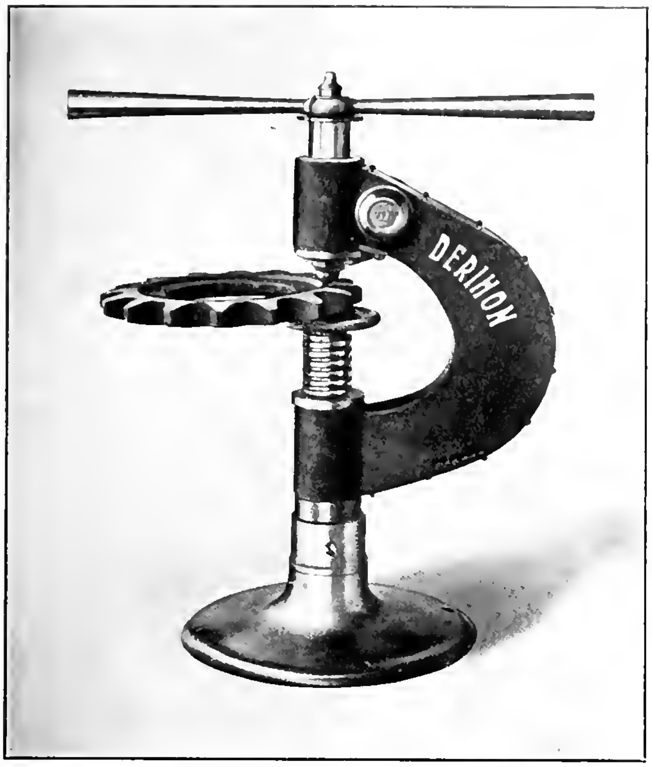

Fig. 1. Portable Press for Testing Hardness by the Brinell Method

For a standard diameter of ball and a standard pressure, the diameter of the impression is taken as a measure of the hardness; and it may be used in comparing the hardness of other materials tested with the same diameter of ball and the same pressure.

The only disadvantage of the Brinell method for practical use, lies in the cumbersome apparatus required and the comparative slowness of the operation. It is usually furnished in the form of a small hydraulic press, operated by hand, and weighing perhaps 300 pounds. It is evident that with such an apparatus the work has to be brought to the machine, so that its regular use for inspection purposes in different parts of a manufacturing plant is impracticable. Various attempts have been made to devise an apparatus in which the pressure is applied in the form of a blow on a falling weight instead of directly, but this scheme has not so far proved effective in the matter of uniformity in results.

The foregoing considerations lend interest to the apparatus shown in Figs. 1 and 2, which was devised by the Usines G. Derihon of Loncin, Belgium. This firm is an important manufacturer of high-grade drop forgings for automobile work, and it originally developed the machine for use in its own plant. As may be seen, the pressure is applied by a hand-operated screw, and the press is small enough to be perfectly portable, weighing about 12 pounds only.

The sectional view in Fig. 2 shows the action of the apparatus most clearly. The work is placed on the platen F, which rests in a spherical seat on top of adjusting screw G. By means of this self-adjusting seat, the work gets an even bearing and a direct pressure, even though its under surface may be quite out of true. The purpose of the adjusting screw G is, of course, to give a rapid adjustment for the thickness of the work. It will take in about 3 inches as shown. The thread of G, while of coarse pitch, still lies within the angle of repose, so that it is not disturbed when the pressure is applied by levers M.

A differential screw mechanism is used for applying the pressure. This mechanism consists of the double handle M, keyed to the sleeve D, which is threaded into the stationary nut E, and onto the ram C; this latter is kept from revolving by a stop K, which enters a slot cut in the flange, and is provided with a threaded chuck for holding the ball B. Sleeve D is, it will be seen, the only revolving member of this differential screw. The thread on the inside has a lead of 8 millimeters, while that on the outside has a lead of 7.25 millimeters. This gives an advance of $8 - 7.25 = 0.75$ millimeters, or about 0.03 inch per revolution of the levers M. The advantage of this construction is, of course, that it gives all the effect of a fine thread of lead 0.03 inch, with the use of threads coarse enough to withstand the great strain to which they are subjected in tightening down the work.

The most ingenious feature of the mechanism is the provision made for gaging the pressure with which the ball is forced into the work. By the arrangement used, the frame A of the press itself serves as the spring by which the pressure is measured. As the ball is forced into the work with greater and greater pressure, the frame A is deflected and B and F spring apart. Arm H is screwed to A at its lower end as shown, but is free at its upper end. Here it is provided with a bearing point X close to fulcrum Y of pointer P. As the frame A springs under the pressure, H, being free at the upper end, remains undistorted and stationary, while pivot Y rises. As pivot Y rises, lever P swings downward, since it

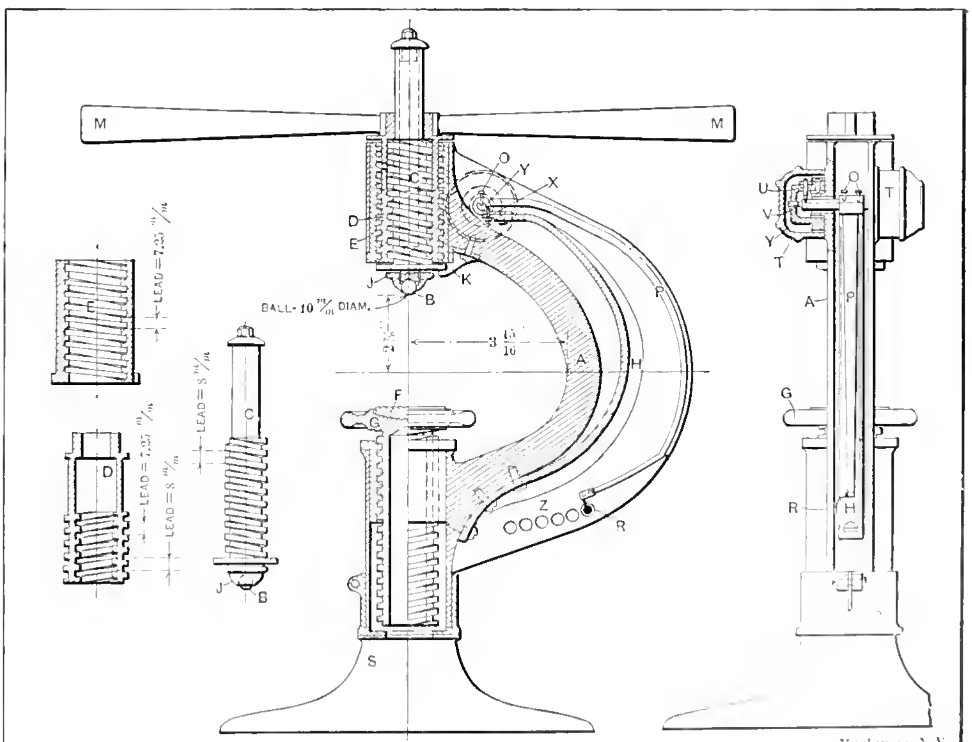

Fig. 2. Details of Design, showing Differential Pressure Screw, Indicating Mechanism

rests only on the point X of stationary arm H. The lower end of lever P is provided with a thin metal disk R, which is thus swung in an arc of a circle about center Y. A series of holes Z, bored in the side of the frame, permit the position of this disk to be seen. These holes are so calibrated that each reads to a definite number of kilograms of pressure.

* For additional information on this subject, see "The Time Element in Hardness Tests by the Brinell System," November, 1909, and "Influence of the Scleroscope in Metallurgy and Manufacturing," August, 1909, with accompanying references.

when disk R is centered with it. Under the extreme tension, when central with the left-hand hole, the reading shows the application of a pressure of 3,000 kilograms or 6,614 pounds.

The construction of the pivot joint at Y is interesting, and is best shown at the right of the engraving in Fig. 2. The hub of pointer P is clamped to Y by two set-screws O, which set in a V-slot cut in Y. Two caps T are screwed on at either side to protect the bearings of pivot Y. Set-screws V are adjusted to take up the end motion of Y; they do not, however, restrain it in any direction other than longitudinally. The real bearing is furnished by the points of screws U (one at each end) in the bottoms of the V-grooves. These furnish a knife edge or, rather, point support, which gives the utmost freedom and sensitiveness of movement to the pointer P and the indicating disk R. The various adjustments in connection with this bearing, and the various contact points in the lever system, will be clearly understood from the engraving.

Fig. 1 shows the instrument engaged in testing the hardness of a sprocket-wheel. The simplicity of its use will be immediately appreciated. The sprocket-wheel is placed on the platen, the adjusting screw is run up until the work makes contact with the ball, and then the handles are revolved until the indicating disk is centered with the particular hole in the frame, which shows that the standard pressure has been reached. Handles M are then screwed back again, the work is removed, and the diameter of the impression in millimeters measured. This gives the hardness number directly. The whole operation is evidently one of seconds only.

* * *

IT REALLY HAPPENED BUT—"IT NEVER CAN HAPPEN AGAIN"

Mr. P———, the president of a big manufacturing establishment in the Middle West, had shown his great factory to a company of Englishmen and upon returning to the president's office, one of the party who had greatly admired the remarkable order and system of the plant, said:

"Mr. P———, may I ask what salary you pay your superintendent?"

"Really, I do not know at the moment, but I venture to say that it is not half enough; I will call him and find out."

Pressing a button he summoned a messenger.

"Call Mr. C——— to my office at once."

In a few moments Mr. C——— came, wondering at the peremptory summons, and secretly quaking.

"Mr. C———, what do we pay you for running this plant?"

"Fifteen hundred a month."

"Very well, hereafter it will be three thousand. That is all, sir."

* * *

BRIGGS PIPE THREADS

Briggs standard pipe threads are known to every mechanic, but few persons know anything of the history of the adoption of this standard. It is named after Robert Briggs, who was for several years superintendent of the Pascal Iron Works and later engineering editor of the *Journal of the Franklin Institute*. Mr. Briggs, however, did not originate the thread standard which bears his name. According to the *Valve World*, the taper thread for tube connection was first used by Nason; and P. W. Gates, as far back as in 1847, patented a solid die for cutting a taper thread. Mr. Briggs was active in the gathering of information relating to various standards in use in this country thirty or forty years ago, and prepared a paper for the Institute of Civil Engineers of Great Britain, describing in detail the thread then generally in use in this country, and which is now called the Briggs standard. This paper was read before the society in 1883. Mr. Briggs died in the previous year. Within a few years the standard was officially adopted by almost all pipe manufacturers, and is to-day practically the only type of thread used in the United States for pipe connections and fittings.

* * *

At the meeting of the executive board of the Association of German Machine Tool Manufacturers at Düsseldorf, the machine tool industry was pronounced to be in an unsatisfactory state. Present prices are said to be too low, and American competition keen.

SUGGESTIONS IN THE DESIGN OF AERONAUTIC MOTORS*

By HARRY E. DEY†

Harry E. Dey‡

Motors of any type—gasoline, electric or steam—are compromises from beginning to end; we cannot design any one part to obtain the theoretically best results from it without interference with some other feature. With the gasoline engine there are certain advantages in a short stroke, but in the short stroke motor we also meet with many objections. This same condition applies to the number of cylinders and their mounting (horizontal, vertical or oblique), to the casting *en bloc* or individually, and to the amount of compression. In many cases the best results can only be arrived at by actual "cut and try" experiments, and the author, therefore, does not propose to give in this article any definite figures except for purposes of illustration. The suggestions given are based upon the writer's experience on automobile and marine engines, and also upon a great deal of thought given to the aeronautic motor.

Any steam engine will deliver more than its rated horsepower, owing to the fact that it is built to run economically by cutting off the steam as it enters the cylinder during the early part of the stroke. With a cut-off of one-quarter or one-fifth, the expansive qualities of the steam are utilized, and the engine is rated at its economical output. If, however, more power is required temporarily, the point of cut-off is shifted ahead until the required power is obtained, up to the maximum attainable, when steam enters during the full length of the stroke. With gasoline engines, however, this conservative rating has never been observed. The A. L. A. M. rating, for example, is about the best that an engine is capable of under the best conditions; under unfavorable conditions, such as bad carburetor adjustment, poor compression, weak spark, and innumerable other troubles, the power output may be an indefinite amount less.

Lack of Economy in Present Automobile Engines

It has always been the aim of the automobile engine designer to obtain all the power possible from a given bore engine, regardless of gasoline economy or other considerations. He has said, "Hang the expense, it's power we're after. What does the average autoist care for the additional cost of gasoline?" To design an engine and obtain less than the A. L. A. M. rating for it would be a disgrace. Hence the old-time efficient suction valves have been superseded by mechanically operated valves, offering no resistance to the incoming charge; and then, to squeeze in still more, the valve is left open long after the piston reaches the end of the outward stroke, thus taking advantage of the momentum of the gases in the pipes to crowd more than atmospheric pressure into the cylinder. The result of all this, of course, is increased power, the same as in the case of the steam engine taking steam the full length of the stroke; but who would buy a steam engine working in such an inefficient manner?

An engine working under the above conditions will exhaust at about 60 pounds pressure. This 60 pounds multiplied by 125 per cent of the piston displacement is a complete loss, and amounts to nearly 50 per cent of the original

* For description of a motor of this type, see MACHINERY, July, 1908: "Adams-Farwell Aeronautic Gasoline Motor."

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power of the charge. Compound engines have been built to utilize this exhaust pressure, but there is no excuse for this complication when the same results may be accomplished by proper design of a single-expansion engine, by simply carrying the expansion down as far as may be found desirable. When expansion is carried beyond certain limits in a steam engine, trouble is encountered from condensation, but as there is little or no moisture in the explosive mixture, we need fear no trouble from that source with the gasoline engine. With a compound engine of the gasoline type, a great deal of the unused power of the gases is lost by cooling when passing through the ports, a large quantity is used to fill the ports, and the extra piston adds a large amount of extra friction, so that the only benefit obtained is practically the muffling action.

In a flying machine the weight of the fuel is just as important as the weight of the engine, as frequent landings for purposes of replenishments are not desirable. Therefore, a little more weight in the engine is not objectionable when a consequent saving of several times the extra engine weight may be made in the weight of the fuel saved. Take, for example, a motor of 100 horsepower of the present type. It will probably consume about 68 pounds of gasoline per hour. If we can save 25 per cent of this it would mean a saving of 17 pounds per hour, or 170 pounds in ten hours. This percentage of saving is well within the range of possibilities.

In designing an aero engine, without aeronautic experience it should be patterned after the marine engine rather than that of the automobile, as the former is subject to the same general conditions. They are both generally loaded to their full capacity and speed, from the start to the finish, while an auto engine is seldom loaded to the limit, and when so loaded it is only for short periods. An air-cooled engine that is a success on an automobile might be a failure in an aeroplane. The writer does not mean to say, however, that an air-cooled engine will not be a success for flying machines if properly designed to suit the changed conditions. This may be accomplished by working with lower compression, greater expansion, and possibly it might be found advantageous to use a six-stroke cycle. There are also some conditions favorable to the air-cooled motor when used on an aeroplane that may, to a large extent, overcome the handicap of the constant full load; these conditions are the high speed through the air without a bonnet or other covering, and the dispensing with the crank-case. In the air we need not worry about the dust, and consequently the crank-case is unnecessary. Fresh air has then free access to the piston and cylinder.

General Outline of Design of Aeroplane Motors

As to the general design, the writer's choice would lie between a six-cylinder vertical and a six-crank horizontal opposed type. The radial arrangement might have certain advantages for air cooling, and also some advantages for reducing the weight to the minimum. The cylinders should not be rotated, however, as is often done with this form, for the same mechanical efficiency is not obtainable under these conditions. Upon first thought one would suppose that it was a case of "six for one and half a dozen for the other," relative to efficiency; but the facts are that the results are somewhat like those obtained from a worm and gear—the efficiency is much higher when the worm is the driver. The air-cooling qualities of the rotating cylinders would lose their force of argument when an aeroplane is driven at a speed of fifty miles per hour or more; there is no reason to complain of circulation then. And as to the other claim of the advantage of the rotating cylinders, that they serve as a flywheel, that feature is practically useless, as the propeller will take place of that element. In the early days of the automobile it was claimed that a steam engine would require a flywheel. The Stanleys demonstrated with their "Locomobile" the utter fallacy of the idea.

The Cooling Arrangement

If an engine is to be water-cooled, the six-cylinder vertical is probably the best form. Its six-throw crank gives us perfect mechanical balance, which can only be obtained with multiples of three; and the cylinders, all being mounted in one straight line, give us a straight unbroken jacket which may be made of light sheet copper. The cylinders are made of steel (or alloy steel) tubing. If the engine is to be air-cooled it may be designed upon the lines of any of the above forms. If, of the vertical type, however, it would probably be found desirable to mount it "broadside forward," after the manner of the old type Franklin automobile. All the cylinders would then receive an abundant supply of cold air. This arrangement has the objection, however, of slightly complicating the transmission to the propeller. For obtaining the full benefit of the draft of air, the radial type has the best distribution of its cylinders, and is probably the lightest form that can be constructed, due to its short length.

There should be no side pockets (for valves) in the cylinder heads, for the inside surface should be trimmed down to the minimum possible. The less internal surface we have exposed to the heat, the smaller the number of heat units there will be absorbed by the metal. Whatever is taken into the metal has to be gotten rid of, either by air or water, which adds to the difficulties of air cooling in the one case, and to the size of the cooling apparatus and the amount of water carried in the other. In both cases there is the loss in efficiency, for every heat unit radiated is one heat unit less power delivered at the shaft.

If we could obtain a material for the cylinders that was an absolute non-conductor of heat, we would not have cause to worry over any system of cooling. If the metal would not conduct heat, it would not absorb any. But suppose we go to the other extreme and obtain a metal that is a perfect heat conductor; then as soon as the first explosion takes place the outside of the cylinder would be just as hot as the inside surface; it would instantly become red hot. How would we keep the latter cylinder cool?

According to the above theory, it appears that it is desirable to have a very poor conductor of heat for the cylinder, for while we cannot obtain the absolute non-conductor, the nearer we reach that point the less heat will be absorbed by the metal at each explosion, and the greater proportionate effect the incoming charge will have toward cooling the internal surface. If the heat of the explosion were constantly applied, the beneficial results could, of course, not be expected.

Material for Cylinders

There is a nickel steel alloy, of between 25 and 30 per cent nickel, that is used very largely for electrical resistance. It appears to the writer as if it would best fill the conditions. As a general rule a poor electrical conductor is a poor heat conductor, following almost direct ratios. This alloy has about eight times the electrical resistance of plain steel, consequently, according to the above rule, it should have about an eighth of the heat conductivity of the latter. There are, however, no data to prove whether its heat reluctance is so great. The writer once made a rough test by coating thin sheets of each kind of steel with paraffine, and holding the ends in the flame of a Bunsen burner. It was found that the wax remained frozen much closer to the flame on the alloy piece than on the other. In fact, it was so close to the flame that it could not be decided whether it was the direct rays or the conducted heat that did the melting. This metal is very strong, finishes to a fine polished surface and stands up well under the effects of heat. It is worth experimenting with, but it will be quite an expensive experiment, as this alloy steel can be obtained only in the form of forging, for small quantities. It can be obtained in the form of drawn tubing or sheets, however, if a large enough order is placed.

Cylinder Design

The head of the cylinder should be as nearly hemispherical in form as possible and polished inside. With our best endeavors, however, it will be a very much flattened hemisphere unless the length of the stroke is carried far beyond the limits of good practice, for the cubic contents of a hemisphere would be too great for the piston displacement.

and hence the compression would be too low. A cylinder of this form, for air cooling, can be made from a heavy sheet stock of the alloy mentioned above, pressed into shape, and then put into a lathe for the turning of grooves 1-16-inch wide and ½-inch deep, leaving ribs 1-32-inch thick between them. This will give an immense radiating surface, far more than could be obtained by any casting method. The main body of the cylinder need not be more than 1-16-inch thick for a five-inch bore. Below the ribbed portion the whole shell may be turned down to a thickness of 1-16-inch, leaving a flange at the bottom for attaching to a plate, common to all the cylinders. The flange can be made of a square form in the original stamping.

Valves, Crank-case and Other Details

With the pocketless head the placing of the valves has always been more or less of a problem. The most popular method at present appears to be the placing of the valves obliquely, and to mount the cam-shaft directly over the center of the line of cylinder tops. Another method is that which the Franklin Automobile Company has adopted of mounting the valves concentrically; that is, the inlet valve is inside of the exhaust valve. But in the aeronautic motor, is it necessary to have two valves? Suppose we exhaust directly into the open air, with absolutely no piping; then take in a charge of pure air through the same opening, mixing it with a little liquid gasoline taken through a pin hole located at some convenient place. Many of the aeronautic motors are now taking their gasoline direct, without a carburetor. Of course the gasoline would require a minute valve to take care of it, but it need not be over a quarter of an inch in maximum diameter. Our main valve would then be right in the center of the head, free from all complications. It would remain wide open between the time of exhaust and intake giving an exceptional opportunity for clearing out the old charge. Another plan is to use two valves in the ordinary manner, but the inlet valve would be designed like the well-known Lukenheimer mixing valve. This valve is used very largely upon boat motors as a separate carburetor, but it and the inlet valve could be made as one. The first-mentioned plan would be the best, however, for it not only has the advantage of simplicity, but also the feature of cooling the valve with the incoming charge.

The crank-case preferably should be made of skeleton construction, and without covering of any kind. It may, of course, be cast, but the "built-up" construction will be stronger for a given weight. The connecting-rods may also be built up to good advantage, with ball bearings at the crank ends.

The crankshaft should be of a very liberal diameter with all cylindrical parts hollow. The material should be the best alloy steel, and the shaft should be mounted in ball-bearings. Cast iron is the only material that should ever be used for the piston or rings. The valves may be made of nickel steel.

Ratio Between Bore and Stroke

As to the problem of the ratio between the bore and the stroke, there is a wide divergence of opinion among designers. The writer is very strongly in favor of the long stroke, and especially so in flying machines where the increased height of the engine is not objectionable. Abroad, the long-stroke engine has become very popular on automobiles, and where racers have been limited by the bore, the long-stroke types have carried off the honors.

The reasons for a long stroke are several: 1. With a given cubic contents of compression space (and upon that the amount of power obtainable depends), the shape is nearer that of a hemisphere, and consequently possesses the least absorbing surface possible for the quantity of mixture. 2. There is less piston diameter for a given charge, which gives less leakage area. 3. There are less reversals of motion of the reciprocating parts, thus reducing the number of hammer blows, giving higher mechanical efficiency and longer life to the engine.

It may be argued that the engine will have to run slower and thus deliver less power. This difference of speed, however, is made up by the additional amount of the charge due to the additional length of the compression space, which, of course, is made proportional to the length. As a higher piston speed is practicable, an increase of power is thus obtained, although not commensurate to the additional weight; but the advantages obtained outweigh in value the objectionable weight.

Increase of Efficiency of Present Engines

The lack of efficiency of present engines has been mentioned. We will now take up the problem of how to increase it. For illustration, suppose that the compression space of motors as at present constructed is 25 per cent of the combined piston sweep and clearance, and let the bore and stroke ratio be 1 to 1. Design an engine with double this stroke, without increasing the bore; let the compression space remain the same, and design the cam so that the incoming charge will be shut off at one-half the stroke. When the piston returns and compresses this charge it will have the same maximum compression as the first-mentioned engine. Now the explosion takes place, and the pressure at one-half the outward stroke falls to the exhausting pressure of the former engine. Both engines have received the same amount of charge and have thus far delivered the same amount of power. The first one exhausts at this point, but the last one has as much additional distance to travel, commencing with a charge of about 60 pounds' pressure multiplied by four times the compression space. Owing to the latter fact the pressure will drop very slowly during the remainder of the stroke in comparison with the early portion, and there is no compression pressure to subtract from it, as the compression did not begin until after passing this point. Consequently the last half of the stroke is all "velvet," and is obtained at a high efficiency, for we have no losses in compression to subtract for this added power nor the loss due to large leakage and heat losses under the high pressure and intense heat at the beginning of the stroke. Taking these facts into consideration we will probably receive, additional, a third of the power of the first half of the stroke, thus obtaining a gain of 25 per cent in efficiency. The output of the motor, however, is only two-thirds of the maximum obtainable under the old system, and the efficiency and power may be still further increased by raising the compression, for the high point of compression is reached so much later in the stroke that the point of self-ignition will be just that much nearer the dead center. Another advantage of this plan is the fact that the average temperature is lower, and it is thus better suited for air cooling. The dimensions given are used only for convenient illustration. They will, however, probably be found, after experiment, to be not very far from the correct ones.

For a company that intends to take up the manufacture of such an engine the best plan will probably be to make up an adjustable engine—one in which the compression space and the length of the stroke can be varied at will, independently of one another. The cam should be designed so as to give a variable cut-off. This latter feature should also be made an element of the standard engine, as it can then be used in place of a throttle valve, and also for providing a larger charge when at high altitudes, so that the same compression may be obtained then as at lower levels. With the present type of engine there is a large loss in power capacity in high altitudes, as has often been demonstrated with automobiles when taken to elevated sections of the country.

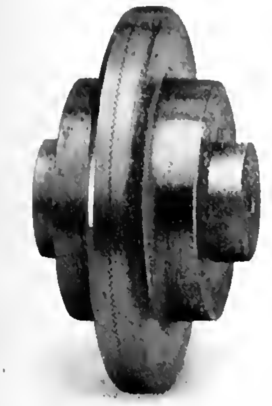
To sum up the advantages of the engine outlined we have: An unusually large cooling surface; a minimum of heat-absorbing surface; a lower average heat inside the cylinder; a metal that is a poor absorber of heat; inside of cylinder and piston fully exposed to fresh cold air; exhausting with such low pressure does not unduly heat the exhaust valve, and as the exhaust and inlet are one, the incoming charge cools it; it also avoids the use of an auxiliary valve; passing through the air at a mile a minute will be far more effective than the artificial draft provided upon automobiles.

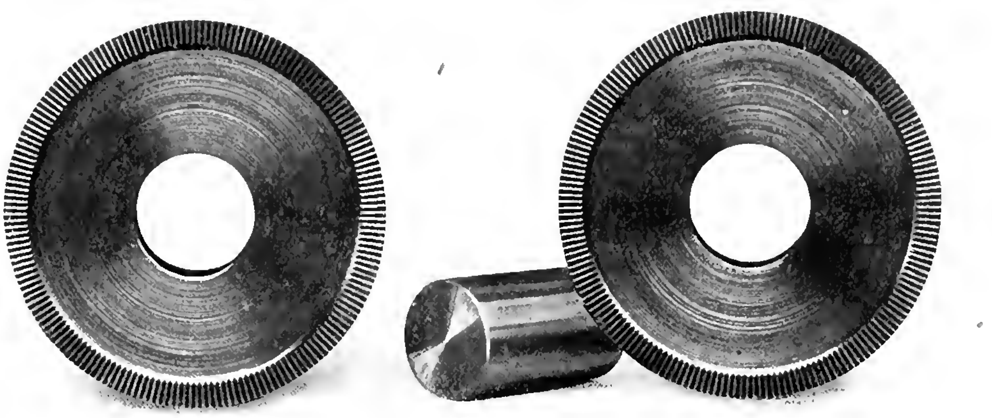
* * *

It has been found by Prof. Joly that the lava from Vesuvius is remarkably rich in radium.

UNUSUAL WORK DONE ON THE AUTOMATIC SCREW MACHINE

The new departures from time to time made by progressive manufacturers of automatic screw machines seem to indicate that there is hardly any class of work, circular in shape and within the range of these machines, which cannot be successfully produced on them at a great saving of time. From previous articles in MACHINERY (see the November and December, 1908, issues) our readers have become familiar with some of the interesting work produced on the Cleveland automatic screw machines, manufactured by the Cleveland Automatic Machine Company, Cleveland, Ohio. In the present article a piece of work of an even more unusual kind, finished on the automatic screw machine, is illustrated and described. The pieces of work made, known as adjusting plates, are shown assembled on a stud in Fig. 1, the different parts being shown more clearly in Fig. 2. The outside diameter of the disks is $2\frac{7}{8}$ inches.





Figs. 1 and 2. Adjusting Plates made on the Cleveland Automatic Screw Machine, in Mesh, and Separated to show Rolled Teeth

As will be seen from these illustrations, the work consists of two circular disks, on the inside faces of which teeth are provided, the pitch and uniformity of shape of which are so accurate that the teeth of the one disk will mesh with the teeth of the other in any position. This in itself is quite remarkable, as is apparent when considering that the thread on screws cut on a thread milling machine, for example, is frequently not as accurate as this. If two threaded pieces are milled off down to the center and then laid side by side so that the threads engage with each other, a perfect fit or mesh does not always result in every position. The good fit of the teeth in the disks shown is even more interesting, as these teeth are not cut on the milling machine, as one would naturally suppose, but are produced in the automatic screw machine by means of a rolling process. It is interesting to note that the teeth are as clean and smooth as if they had actually been cut by a milling cutter, and the simplicity of the method used for producing them by rolling, even without gearing up the roller producing the teeth with the piece of work, is startling in its significance of the possibilities of the automatic screw machine.

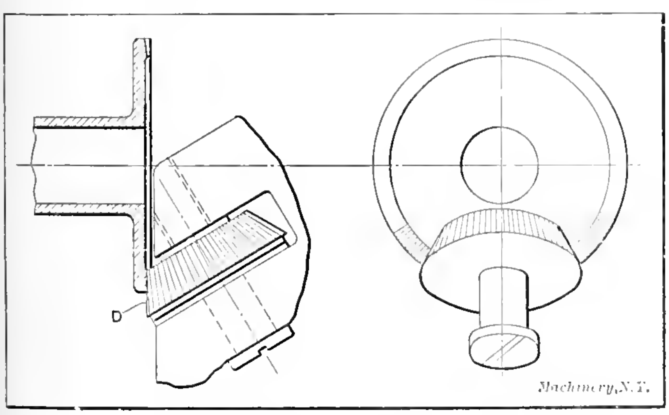


Fig. 3. The Beveled Roller which produces the Teeth

The rolling tool, by means of which the teeth are produced, is shown in Fig. 3. It is beveled as indicated, and the correct pitch and number of teeth is obtained by adjusting the roller radially in relation to the axis of the work on which the teeth are formed. If the face of the roller is sufficiently long in proportion to the width of the face of the teeth on the work, it is possible by this radial adjustment to obtain different numbers of teeth with the same roller on the same piece of work, and the roller can also be used for work of various diameters, rolling then, of course, a proportionately larger number of teeth on the larger diameters. When in action, the roller is held in a fixture or holder, which, in turn, is held in the turret. Owing to the possibility of adjustment, the diameter of the beveled roller is not required to be absolutely accurate, and new rollers can be made without the necessity of extreme precision. This is a great advantage in that the tools used for producing teeth in this way are thus comparatively cheap to make.

In Fig. 4 is shown a general perspective view of the tools in the turret used for making the pieces illustrated in Fig. 2. At *A* is shown the stock stop. At *B* is shown the tool which centers the work for the drill, and at *C* is indicated the tool which finishes the recess on the inside face of the disk between the teeth and the hole. At *D* is shown the beveled roller which produces the teeth, and the method of

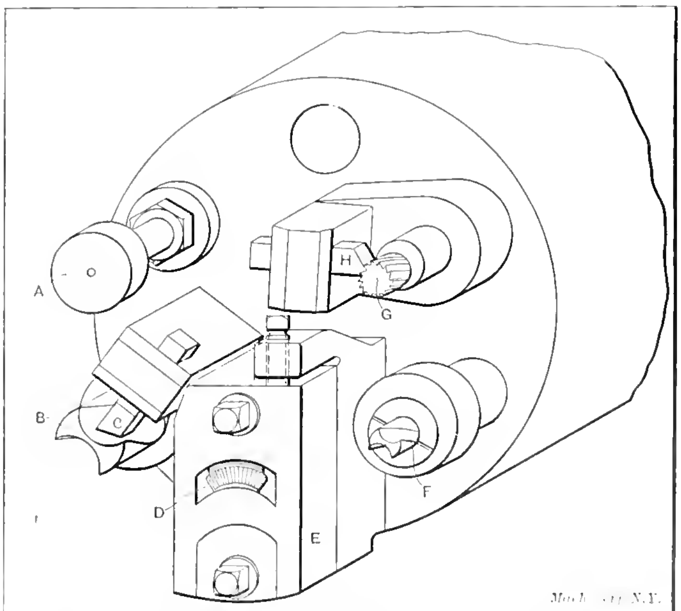


Fig. 4. The Arrangement of the Turret Tools for Making the Disks in Fig. 2

adjustment of this roller is also indicated, *E* being the adjustable slide. At *F* is shown the drill for the hole, and finally at *G* is indicated the reamer which finishes the hole.

One of the most interesting features of this work, outside of the mechanical accomplishment of producing the teeth by a rolling process instead of by a milling process, is the short time in which the work is finished. Each one of the pieces can be made in $13\frac{1}{2}$ minutes. There are 180 teeth in each, and anyone in the least familiar with milling machine work

knows that the milling alone would take a considerably longer time, considering the setting up and the 180 indexing moves that would have to be made. Of course, the actual milling cut can be rapidly taken, but the total time consumed would be out of all proportion to that consumed in the rolling process.

The adaptation of the automatic screw machine to work of this kind indicates to the thoughtful mechanic the possible development of automatic machinery in the future. It shows that radical improvements are possible in methods and processes, which but a few years ago were considered well-nigh perfect. It indicates that we have at the present time but commenced to realize the possibilities of the automatic machine in the mechanical trades, and undoubtedly a few years hence it will be possible to employ the automatic machine on work which to-day nobody dreams of performing on anything but hand-operated machine tools.

* * *

LOCATION OF THE IGNITER IN GAS ENGINES

By GEORGE MILLER*

It would seem at first glance that the position of the igniter in the explosion chamber of a gas or gasoline engine is immaterial—that as long as ignition occurs within the explosion chamber the results will be the same, no matter whether the point of ignition is at the top, at either side, or in the center of the chamber. This, however, is not strictly true, as the writer has found by experience. In all internal explosion engines there is some one point in the explosion chamber which gives far better and more satisfactory results.

A large number of manufacturers of gas engines assume, that "any old place" will do for the igniter, and they make its position on the engine conform to the other parts of the mechanism, instead of placing the igniter in its scientifically correct place and making the remainder of the mechanism conform to it. If cheapness of production is the one aim to be attained in the building of gas engines, this practice is all right; but if efficiency and economy are to have any consideration, a different plan must be adopted.

In a certain shop some years ago the writer took part in the building of gas engines, the sizes ranging from two to twenty-five horsepower. The engines with cylinders of six or eight-inch bore gave the greatest power in proportion to gas consumption. All the engines with cylinders of a smaller bore than six inches required a steadily increasing quantity of gas in proportion to the power developed, the increase being in an inverse ratio as the bore of the cylinder decreased in size below six inches. The engines with cylinders of a larger bore than eight inches required a far greater increasing quantity of gas to develop their respective horsepowers. The difference between the fifteen and twenty-five horsepower engines was remarkable, the ratio of increase being almost in a geometrical progression. So great was this difference that several of the larger engines were returned to the factory, as the purchasers refused to accept them; they used by far too much gas. As the design of the engines was the result of years of study by an expert in gas engine design and construction, the writer, with only three or four years in this work to his credit felt, at that time, that it would be sacrilege to question the design of the engine. Yet the occurrence started him on the road of investigation.

Some years later, in another shop, a very similar engine was being built with the exception of the position of the igniter, which was placed directly on top of the cylinder. This engine gave fairly good results. The principal difficulty experienced was in starting it, especially in cold weather, but certain sizes of this engine, although they had this drawback, were both efficient and economical. A new superintendent coming to this shop determined to change the position of the igniter; he had it set lower down on one side of the cylinder as close as possible to the inlet valve—"for the purpose," as he said, "of getting the incoming charge as close to the igniter as possible, and so lessen the possibility of a charge missing fire." But this brought about an entirely different result. The engine missed fire more frequently, and did not give as great power as under previous conditions.

Upon investigation it was found that the charge, coming as it did through the common mushroom-shaped valve, swept past and did not come in contact with the igniter until it had traveled around on the inside of the cylinder. To overcome this slowness in the ignition of the charge, the superintendent designed a shield or deflector to partially cover the inlet valve, and so designed as to force the full incoming charge against the igniter. The igniter on this engine was not in a pocket, as it is often placed, but operated directly in the explosion chamber. The result of this change was almost disastrous. So early and violent was the explosion after this change that no firing lead was possible. Therefore, the time was changed so that ignition took place on the center, with the result of greatly reduced power, and great dissatisfaction on the part of the purchasers. So great was the shock to the engine when any firing lead was given that the flywheel and the bed of the engine vibrated so much that the whole engine would have soon been nothing but a scrap heap. The shock could even be felt through the foundation.

After several consultations with the superintendent, the writer was asked to get out drawings for a new cylinder, with the igniter changed to the position which he advised. This new cylinder was placed on an engine which had been using a charge deflector, and which the purchaser had refused to pay for, as it was using too much gasoline and not delivering the required power. The result was astonishing even to the writer, although he had recommended the change, and expected better results than the engine formerly gave. Not only was the power greatly increased, but the consumption of gasoline was greatly reduced. Before the new cylinder was put on this engine, and while the old cylinder with the deflector was in use, the writer heard over a hundred consecutive explosions without one "cut out," while at the same time the engine was doing inferior work. After the change the engine would cut out after every eight or ten explosions, at the same time giving the required power.

Some of the writer's early experiences with hot tube ignition has had much to do with his present opinion on the question of ignition. In a certain shop, some years ago, a five horsepower engine was supplied with a hot tube. The burner was stationary, so the tube had to be made the proper length to get the best results. After considerable experimenting a certain length of tube was found, which gave the most power for a given consumption of gasoline. Some time later another five horsepower engine was equipped with a hot tube. Naturally the same length of tube as was used on the first engine was employed, but on testing this engine the results were very disappointing. After considerable experimenting it was found that the hot tube for this engine had to be two inches longer than the one on the first engine. After that the hot tubes for each engine were made of such a length as the requirements of each individual engine called for to get the best results with the greatest economy.

On the basis of this data the writer has partially worked out a scheme so that the point of ignition can be somewhat altered as the conditions of each individual engine may require, thus eliminating a considerable amount of "chance" as to what will be the power of a given size engine, and lessening the possibility of there being great variation of power in a number of engines of the same size.

* Address: 108 Symington St., Toronto, Canada.

* * *

During 1909, machine tools of the value of (in round figures) $400,000 were imported into Great Britain. The value of the exports of machine tools was $3,800,000. In 1908 the imports amounted to $575,000, and the exports to $2,050,000. These figures indicate that the British machine tool trade is doing a profitable business. The details of the exports for 1909 are not yet prepared, but in 1908 Japan was the best customer of Great Britain for machine tools. Of other foreign countries, France and the Argentine Republic come in the second and third places, respectively. The British colonies take, of course, a great deal of the exports. Thus the British East Indies imported British machine tools to a value of $350,000, and Australia and New Zealand to a value of $215,000.

AUTOMATIC PUNCH-PRESS WORK

BY ETHAN VIALL*

Comparatively few shops have enough punch and die work of any one kind and size to use automatic punch-press feeding devices with any degree of economy, but occasionally a factory building a certain class of articles or machines in immense quantities, finds automatic punch-press work advisable. Such is the case in the factory of the National Cash Register Co., Dayton, Ohio, where numerous parts are made on punch-presses; only a few, however, can be satisfactorily run out automatically, so that only a fraction of the number

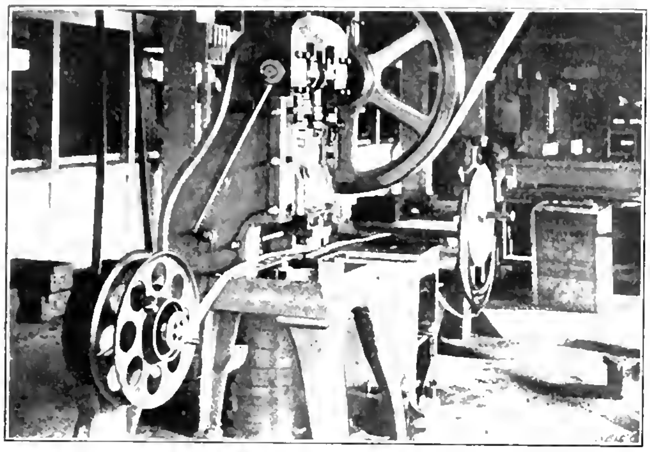


Fig. 1. Punch Press equipped with Automatic Stop and Friction Feed

of presses employed are equipped with automatic feeding devices, though a number of others are practically automatic, except that the stock is fed along by hand.

In equipping a punch press for automatic work, the stop and the method of pulling the stock along are, of course, the

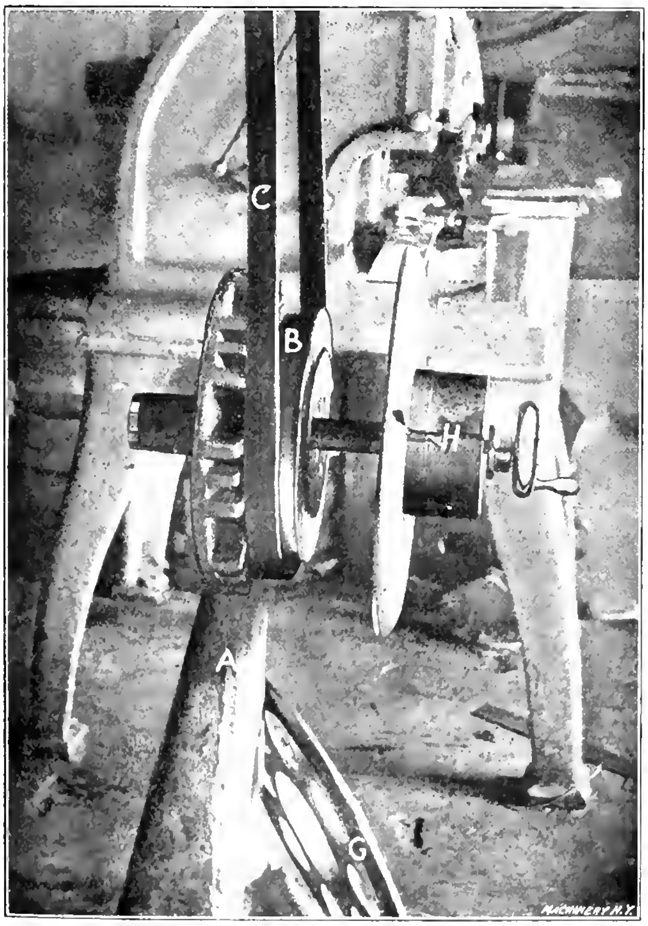


Fig. 2. Detailed View of the Friction Stock-feeding Device

most important points to consider. Mr. Sager, of the company referred to, has the best friction feed device that I have seen, as it is so arranged that any desired amount of tension or speed may be easily obtained. In Fig. 1 is shown a press equipped with one of these friction feeds. The friction feed is shown to the left of the press and a stock spool at the right. All presses whether automatic or not, are equipped with an automatic stop or spacing device, so that it is not

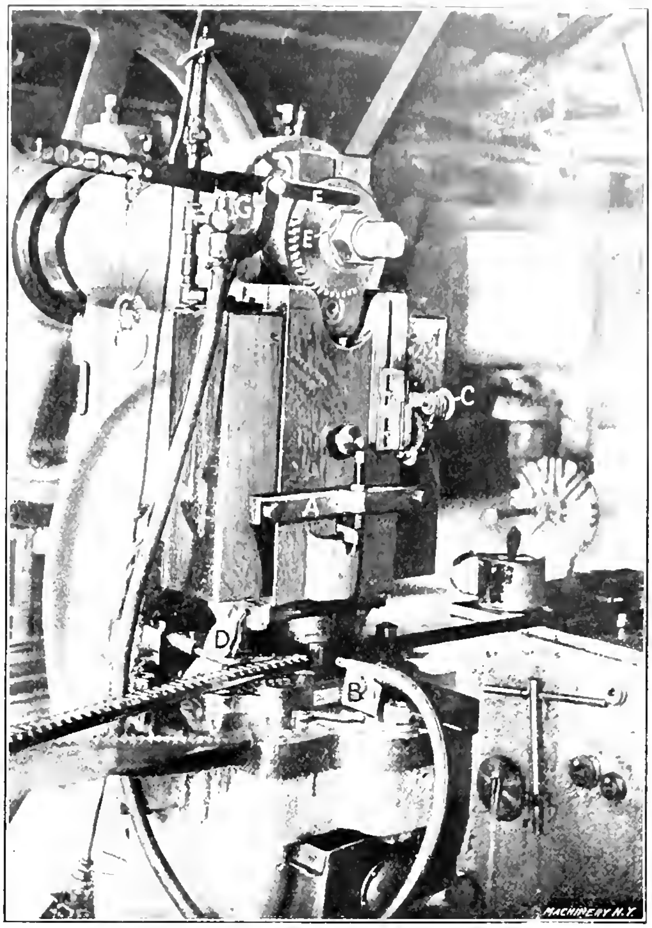


Fig. 3. Hand-fed Press Fitted with Counter, Automatic Stop, Blower and Blank Knock-out

necessary to put stops on the blanking dies themselves. The rod and lever used to operate the stop which will be shown in detail later, may be seen at the side of the press. In starting this press, the stock is, of course, fed through by hand

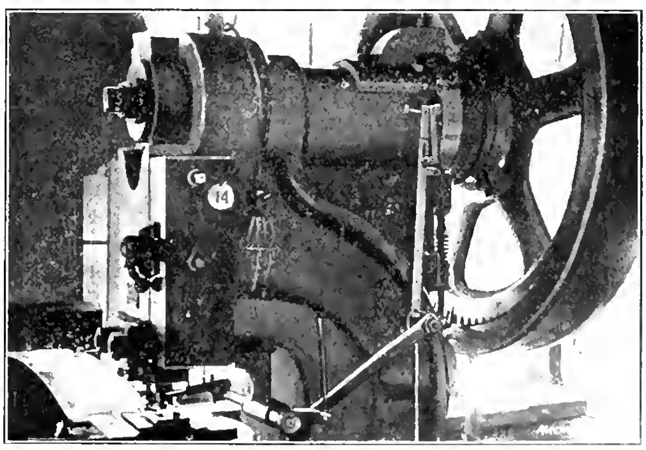


Fig. 4. Side View of the Press showing the Levers which actuate the Automatic Stop

until it can be caught in the slot in the hub of the friction feed, when the feeding becomes altogether automatic.

Fig. 2 shows the friction feed in detail. It consists of a cast iron stand or base A, carrying a pulley B, which is driven by a belt C from an overhead shaft. This pulley has a disk of leather D, fastened to the side next to the spool E, which can be pressed against it to any extent, by means of the small handwheel F. The flange G is slipped onto the hub of the spool and locked with a thumbscrew at the proper place to accommodate the width of the stock being fed. The end of the stock is inserted in the slot H, in the spool hub when starting. It will readily be seen from this engraving, just how the feeding device is made and works.

* Associate Editor of MACHINERY.

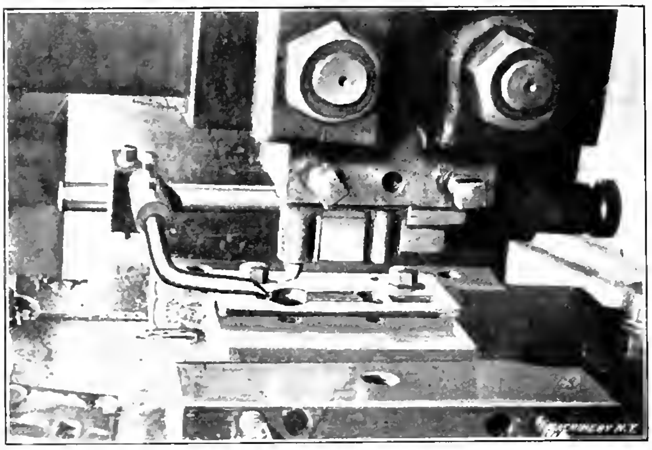


Fig. 5. Enlarged View of Automatic Stop

The general principle on which the automatic stops are made, is best shown on another press, Fig. 3, which, while a hand-fed machine, has practically the same stop used elsewhere in the shop. This press is also fitted with an automatic knock-out *A*, a pneumatic blank-blower *B*, a counter *C*, and the stop just mentioned, at *D*. By carefully examining the engraving, it will be seen that the blank knock-out works

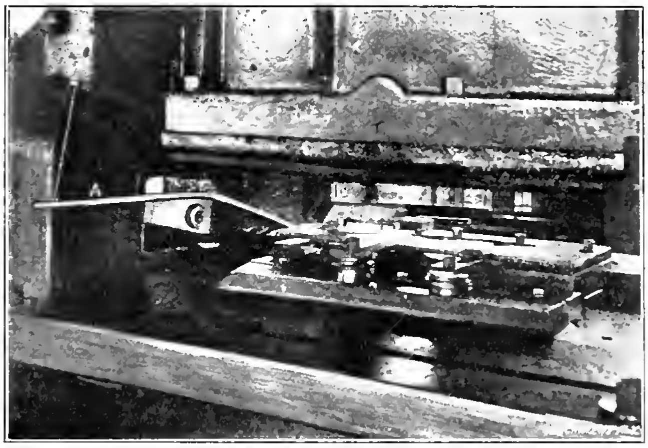


Fig. 6 Front View of Press which is equipped with an Automatic Stop that is operated by the Ram

as the ram rises, and the blank-blower throws a powerful jet of air onto the face of the die just at the instant the blank drops. The air is turned on at the proper instant by a cam and lever *E* and *F*, respectively, on the valve *G*, which automatically closes when released by the fall of the cam. The stop *D* consists of an adjustable hook which is raised and lowered by the motion of the press, through a system of levers

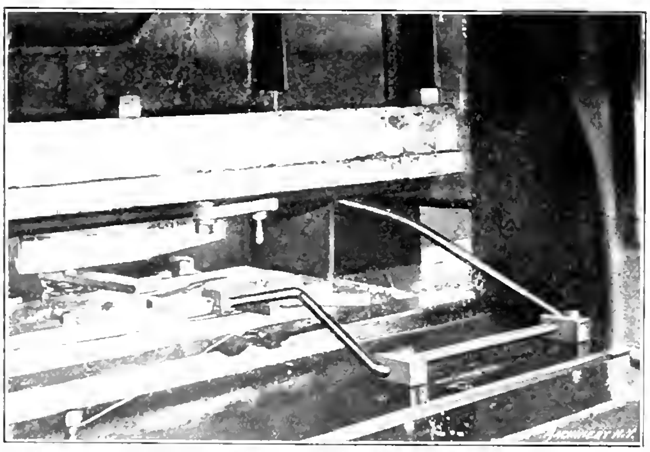


Fig. 7 Rear View of the Automatic Stop which is operated by the Ram

operated by a cam on the flywheel shaft. Fig. 4 shows how a similar stop and lever system has been fitted to another punch-press, while the stop itself is shown to better advantage in the enlarged view Fig. 5.

Another stop arrangement shown in Fig. 6 is used on a double crank-press and is operated by the bottom of the ram striking the lever *A*. A rear view of this stop is shown in Fig. 7. The letter *A* in Fig. 8 indicates where the stop comes in contact with the rear end of the punched hole. As shown, this stock is run through the press, then reversed and run through the other way to avoid waste.

The type of sub-press generally used in the shop is shown in Fig. 9. The knockout is indicated at *A*, while the felt washers used to keep the guides clean and well oiled are plainly shown. This idea of using felt washers around the

Fig. 8 View of Blanked Stock showing by letter A where Stop of Figs. 6 and 7 engages

posts is one worth copying, as it is but little trouble to put them on and they prolong the life and accuracy of the posts and guides almost indefinitely.

A very good device for lubricating stock with soap water is shown in Fig. 10; it consists of two rolls between which the stock is run, the lower roll being partly immersed in a small tank of soap water. This idea is equally good for applying oil to the stock used.

* * *

Not less than twenty governments have expressed their intention to participate in the International Exposition to be

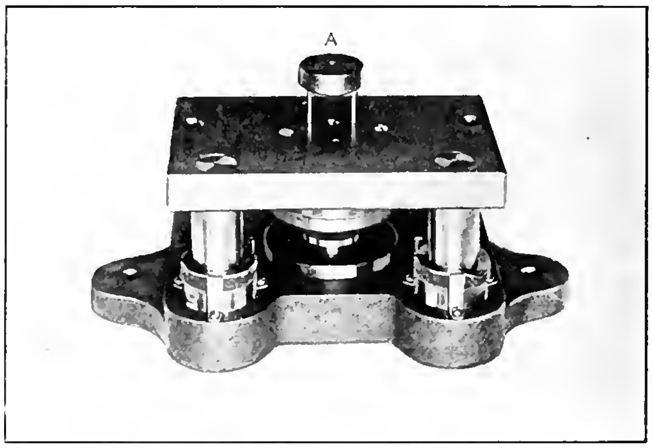


Fig. 9 View of Sub-Press showing Knock-out and Felt Oiling Washers for Posts

held at Brussels, Belgium, this year. Pamphlets and circulars relating to the exposition may be obtained from the Bureau of Manufacturers, Department of Commerce and Labor, Washington, D. C., or from the Belgian Legation in Washington.

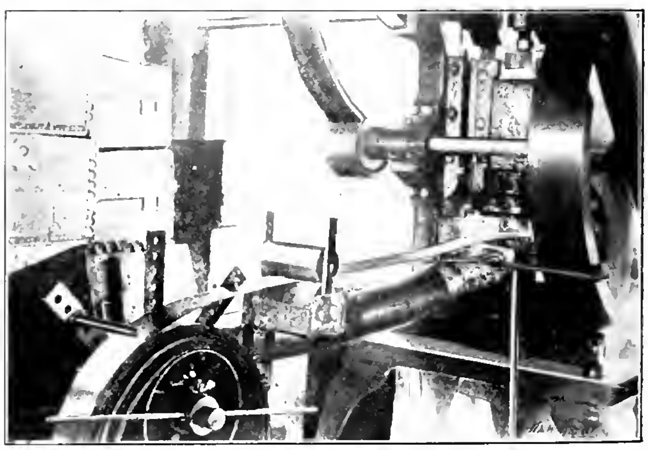


Fig. 10. Press with Stock Lubricating Rolls

MACHINE SHOP PRACTICE*

TURNING GAS ENGINE PISTONS IN THE TURRET LATHE

By CONTRIBUTOR

A good method of turning gas engine pistons when a turret lathe is available, is described in the following: A plan view of a piston casting mounted in the chuck of a turret lathe, is shown diagrammatically in Fig. 1. An extension is cast on the closed end of the piston to hold the casting in the chuck, so as to enable the operator to complete the turning operations at one setting of the work. This extension has the further advantage of insuring a sound casting at the solid end of the piston.

The casting, in accordance with standard practice, is set true by the inside surface, so that when the outside is turned the walls of the piston will be of uniform thickness. When the work is properly set, the turret tool or cutter *C* is brought into operation. This cutter bores the inside of the casting for a distance *A*, faces the end and rounds the inner corner. The turret is then moved back and indexed, bringing the roller *B* in position as shown in Fig. 2. This roller is inserted into the previously finished part of the bore, and as it is an accurate fit, it serves to steady the work during the turning

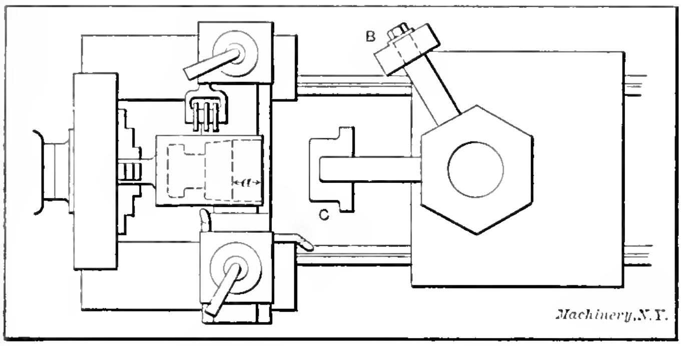


Fig. 1. Piston chucked ready for Boring

operations. The turning tool in the slide-rest is next used for rough turning the body of the piston. After the roughing cut has been taken, a bent round-nosed tool is used for facing the solid end as far as the extension will permit. This extension should not be cut away at this time, as the casting will need to be rigidly supported while the ring grooves are being cut. The finishing cut is then taken over the body of the piston, reducing it to the required size.

The grooves for the packing rings are next cut with a set of three disk tools. These tools are rigidly clamped in their holder, and are separated the correct distance by accurately made distance pieces. The holder is fastened in the toolpost of the back slide-rest. Before the grooves are cut, the car-

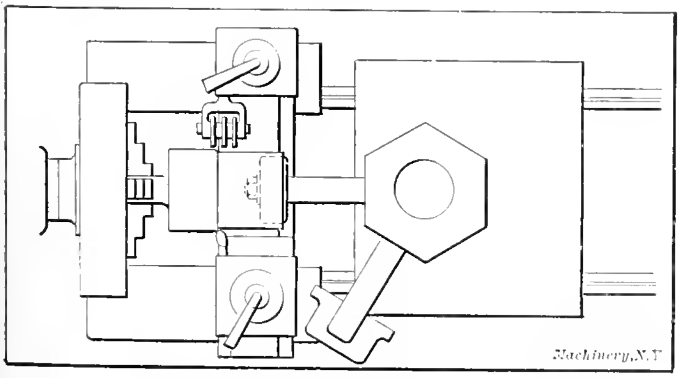


Fig 2. Rough-turning the Outside with Roller Support in Finished Part of Bore

riage is moved against a stop provided on the machine, which has been previously set so that the cutters enter the casting at the correct distance from its end. Another stop is used on the cross-slide to prevent the cutters from being fed too far into the work. After the grooves are finished, the final operation is to sever the piston from the extension piece by means of a parting tool held in the tool-holder of the front slide.

* With Shop Operation Sheet Supplement.

THE CRANK-CASE PROBLEM*

Volumes of catalogues and trade literature have been published descriptive of the operation of what is known as the enclosed crank-case two-cycle motor, but very little real information has been given relating to the principles of design and the inherent difficulties to be met in this class of engines.

Everyone knows that in this class of engines the crank-case is used as a pump to force the charge into the working cylinder; in fact, the crank-case is one end of the cylinder

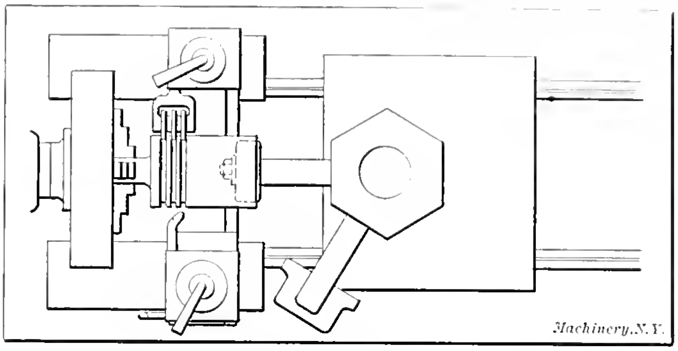
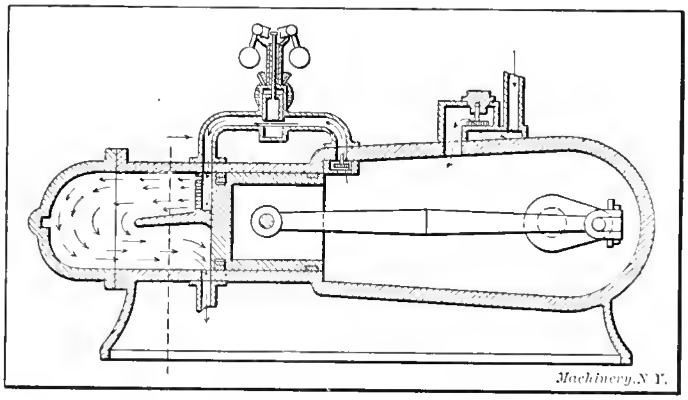


Fig. 3. Turning the Grooves

which has been enlarged enough to let the crank-shaft and connecting-rod inside and give them room to work. This makes a double-acting cylinder just like a steam engine, except that one end is an air or gas compressor with the moving parts of the engine inside of it, and the other is an explosion engine. The same piston serves for both uses and, of course, sweeps through the same volume or "displacement" at each end, this volume in cubic inches being the area of the piston in square inches multiplied by the stroke in inches.

The engine end of the cylinder has means for admitting the mixture to it, and releasing the burned gases from it, these means being two ports, or series of ports, in the cylin-



Diagrammatic View of Two-cycle Engine of the Type having a Check Valve for the Admission to the Crank-case or Pump

der walls which are covered by the piston, except for a short time near the end of the stroke. The exhaust port is wider and opens first, at a point ten to fifteen per cent before the piston reaches the dead center. This gives a chance for the hot gases to escape and reduces the pressure in the cylinder before the piston uncovers the inlet port at five to eight per cent from the end of the stroke. This is necessary to prevent the burning gases from shooting down into the crank-case and firing the new charge before it is time. Before the exhaust opens, the pressure in the cylinder may be as much as thirty or forty pounds per square inch, while the pressure in the crank-case is seldom over six pounds. One of the difficulties in two-cycle design is to get these ports right, so that the pressure in the cylinder will be lower than the crank-case pressure by the time the inlet port is uncovered. This inlet port to the engine end is the discharge port for the compressing or pump end; and for all three of the events thus far mentioned, *viz.*, admission and discharge in the engine end and discharge in the pump end, the piston is the controlling valve. The fourth event, admission to the pump end, is also controlled by the piston in the type known as three-port, or

* Abstract of article by C. A. Hawley in *The Sibley Journal of Engineering*.

valveless engine. In the two-port engine the admission to the pump is by a check valve.

In the operation of these pumps there are four main sources of loss in capacity or volume of charge: 1. Suction loss due to taking in charge at less than full atmospheric pressure. 2. Discharge loss due to failure of charge in crank-case to be fully delivered to the working end during the brief opening of the inlet port. 3. Exhaust loss due to entering charge partially mixing with exhaust gas, and going out the open exhaust port. 4. Leakage from the crank-case at bearings, etc.

Clearance space in the crank-case is often mentioned as a cause of reduced charge and is so, but in an indirect way, through its influence on suction and discharge. These latter are primarily due to fluid friction, or the resistance of the charge to passing through the inlet valve and inlet port. If there were no friction, the clearance would have no effect, but as a matter of fact it has a great effect in increasing both the suction loss and discharge loss, as will be shown.

The above losses are not all in the same direction; for instance, if an engine has a large clearance resulting in increased loss in (1) and (2) it will at the same time have a lower pressure and less leakage from the crank-case (4), and likewise, because of the reduced volume actually delivered to the cylinder, less chance of blowing fuel out through the exhaust (3). Designers nowadays do not worry so much about (3) because the other results are such that it usually is not important, but he who attempts to make his pump *too efficient* must watch out for this loss. An interesting commentary on this point was made by Mr. L. H. Nash at a recent meeting of the American Society of Mechanical Engineers. Mr. Nash exhibited the accompanying illustration which is of one of the first two-cycle engines. Note the large space in the crank-case and the enormous baffle plate on the piston with its precautions for heading the charge straight for the cylinder head. In this case the designer evidently feared nothing so much as blowing out at the exhaust.

TABLE I. SUCTION LOSS IN PER CENT OF DISPLACEMENT FOR VARIOUS CLEARANCES

Suction Pressure Below Atmospheric Pressure, Pounds per square inch	Clearance in Per Cent of Displacement			
	150	200	250	300
½	8.5	10.1	11.9	13.6
1	17.0	20.2	23.8	27.2
1½	25.5	30.3	35.7	40.8
2	34.0	40.4	47.6	54.4
2½	42.5	50.5	59.5	68.0

To return to the clearance, most designers work to keep this as low as possible. This is done by making the crank-case as close a fit as is safe, by using a short connecting-rod, by putting balance weights on the crank webs, and even by attaching false pieces in the pistons. The object of this is not merely to get a high crank-case pressure but also to reduce the suction loss. If we designate the displacement or volume swept by the piston as 100, the waste space in the crank-case will vary in different designs from say 150 to 250 additional, say 200 as a fair average; then the volume of air in the crank-case when the piston is clear up will be 300 and when the piston is clear down, 200. The pressure at the end of the down stroke depends on the pressure at the beginning of the stroke and on the nature of the compression. Theoretically there are two possible ways of compressing, known as isothermal and adiabatic. Practically, it is impossible to compress exactly by either, the usual result being somewhere between them. For comparison we may use the isothermal for figuring pressures, as this favors allowance for leakage, etc. If then we had before compression a pressure of 14.7 pounds absolute, atmospheric pressure, the pressure after compressing from 300 volumes to 200 would be 22 pounds absolute or 7.3 pounds gage, but if the suction pressure is two pounds below atmospheric, the final pressure would be only 19 pounds absolute or 4.3 pounds gage. In other words, a loss of two pounds on the suction is a loss of 3 pounds in the maximum pressure, and with larger clearance would be still more. How much this affects the volume delivered to the cylinder cannot be answered absolutely, as it depends on the inlet port and the speed. When the piston uncovers the inlet port the charge in the crank-case at once begins to enter the cylinder and the pressure starts to drop. It does not drop entirely to atmospheric pressure, however, and probably seldom to less than 1 pound gage pressure on account of the very limited time that this port is open.

TABLE II. DISCHARGE LOSS IN PER CENT OF DISPLACEMENT FOR VARIOUS CLEARANCES

Residual Pressure Above Atmospheric Pressure, Pounds per square inch	Clearance in Per Cent of Displacement			
	150	200	250	300
½	5.1	6.8	8.5	10.2
1	10.2	13.6	17.0	20.4
1½	15.3	20.4	25.5	30.6
2	20.4	27.2	34.0	40.8
2½	25.5	34.0	42.5	51.0

TABLE III. VOLUMETRIC EFFICIENCY OF CRANK-CASE FOR 1 POUND SUCTION AND 1 POUND RESIDUAL PRESSURE FOR VARIOUS CLEARANCES

	Clearance in Per Cent of Efficiency			
	150	200	250	300
Volumetric efficiency	72.8	66.2	59.2	52.4

With a clearance of 200 and a pressure in crank-case reduced to 1 pound at the point of inlet port closure, it will require 13.6 per cent of the return stroke before the charge remaining in the crank-case will expand to atmospheric pressure, and this reduces the charge delivered to the cylinder by 13.6 volumes in 100.

TABLE IV. CRANK-CASE PRESSURE (MAXIMUM) IN POUNDS GAGE PRESSURE FOR VARIOUS CLEARANCES

Suction Pressure Below Atmospheric Pressure, Pounds per square inch	Clearance in Per Cent of Efficiency			
	150	200	250	300
½	9.0	6.6	5.2	4.2
1	8.1	5.9	4.5	3.6
1½	7.3	5.1	3.8	2.9
2	6.5	4.4	3.1	2.2
2½	5.7	3.6	2.4	1.6

Going back to the suction pressure, if it is 2 pounds below atmospheric when the inlet valve or third port closes, it will require 41 per cent of the forward stroke to compress this charge up to atmospheric pressure resulting in a loss due to suction of 41 volumes. So that our net charge under these conditions will be 100 less (13.6 plus 41) = 45.4 volumes or 45.4 per cent of the piston displacement. This low capacity is frequently obtained in practice and the best practice seldom exceeds 60 to 65 per cent of the charge.

In Tables I and II the losses in capacity from both suction and discharge are tabulated for different percentages of clearance space in the crank-case. Clearances and capacities are stated in percentages of piston displacement. The tables are carried beyond the limits of good practice in order to show clearly the effect of excessive clearance or frictional pressure loss in suction or discharge. The "suction pressure" is the pressure in crank-case below atmospheric when the piston is up ready to compress and the "residual pressure" is the pressure above atmospheric when the piston has just closed the port into the cylinder and a new charge is about to be taken into the crank-case.

In Table III the net capacity is given under assumed conditions such as exist in good practice. These values are obtained by subtracting from 100 per cent the sum of the suction and clearance loss in Tables I and II. It will readily be

seen that for some of the conditions of Tables I and II the capacity would be zero or less. A study of these tables may lead one to wonder not why his engine *does not run* sometimes, but why it *does run at all.*

In estimating the suction pressure if the clearance is known or *vice versa*, the highest pressure obtained in the crank-case is a valuable aid. This can be found with a ball check valve connected to the crank-case and to a low reading gage. Table IV shows what the pressure will be under stated conditions. It may be remarked that the usual value in good engines is from 4 to 6 pounds. A leaky bearing or stuck inlet valve will at once cut this down. It will be easily seen from the tables why it is that motors choke up and refuse to run at speeds above what they are designed for, on account of the loss of charge at both ends of the stroke, and also what are the best results which may be expected of motors of this type.

* * *

CAST IRON PULLEYS

By AUGUST WACKERMAN*

A great many manufacturers, when buying pulleys, seem to think that as long as they get a round wheel, that will revolve, that is the only requirement. This policy always proves expensive, as a large amount of power is lost by giving no attention to the pulleys.

To obtain good results, it is absolutely necessary that the pulleys be well designed and perfectly balanced. The ordinary manner of balancing on parallel ways, may do for pulleys running at a very slow speed, but, for moderate and high speeds, pulleys after being balanced in this manner, must be tested at the speed at which they will actually be used when placed on their respective shafts at installation. A badly balanced pulley will destroy bearings, shaft, and, in fact, the whole transmission, in time. To have a good running power-saving line-shaft, depends as much on perfectly balanced pulleys as it does on good shafts and well-oiled bearings.

It is often claimed that when shafts break, they have been over-loaded, but investigation will sometimes show that the cause was due to imperfectly balanced pulleys. The following also should be carefully considered:

Cast iron pulleys should not be used for a higher speed than a mile a minute (5,280 feet); for a higher speed, they must be specially constructed, and, as a general rule, cannot be recommended. The accompanying table gives the revolutions per minute which pulleys of various diameters make, when the rim speed is equal to 5,280 feet per minute.

Pulleys, with a 20-inch face and over, should always have two sets of arms. The face of a pulley should be slightly wider than the width of the belt, as no belt runs absolutely true.

It is good practice to make pulleys with a 10-inch face and over, clamp hub or split; by this means the shrinkage strain in casting the pulleys is avoided, and the bore of the pulleys does not need to be especially fitted as they can be clamped firmly upon the shafts.

If the following rules are observed, they will generally save delay when ordering:

Do not order a pulley without stating whether it is to be crown or flat.

Do not measure a belt and then order a pulley the same width of face as the belt; state the width of the belt and you will receive a pulley with correct face.

If a shaft is already keyseated, give the width and depth, as the pulley must be keyed to suit. If the pulley is not to be keyed, state that it is to have setscrews only.

Do not fail to state whether the belt is single, double, triple or a four-ply; also, if of leather, canvas or rubber.

Always give the revolutions per minute if a certain horsepower that the pulleys must transmit is specified.

Always order pulley split, if it is to be used on a shaft already erected; you will have to take down the shaft if you don't.

A split pulley is always preferable to a solid pulley, as it can be easily erected or removed.

TABLE GIVING REVOLUTIONS PER MINUTE FOR PULLEY WHEN RIM SPEED IS EQUAL TO 5280 FEET PER MINUTE

Dia. Inches	R. P. M.	Dia. Inches	R. P. M.	Dia. Inches	R. P. M.	Dia. Inches	R. P. M.	Dia. Inches	R. P. M.	Dia. Ft.	Dia. In.	R. P. M.	Dia. Ft.	Dia. In.	R. P. M.	Dia. Ft.	Dia. In.	R. P. M.
5	4034	32	630	59	342	86	235	113	178	11	8	144	16	9	100	23	6	72
6	3361	33	612	60	336	87	231	114	177	11	9	143	17	0	99	23	9	71
7	2881	34	593	61	331	88	229	115	175	11	10	142	17	3	97	24	0	70
8	2524	35	576	62	325	89	227	116	174	11	11	141	17	6	96	24	3	69
9	2240	36	560	63	320	90	224	117	172	12	0	140	17	9	95	24	6	69
10	2017	37	545	64	315	91	222	118	171	12	1	139	18	0	93	24	9	68
11	1831	38	531	65	310	92	219	119	169	12	2	138	18	3	92	25	0	67
12	1681	39	517	66	306	93	217	120	168	12	3	137	18	6	91	25	3	67
13	1551	40	504	67	301	94	215	121	167	12	4	136	18	9	90	25	6	66
14	1440	41	492	68	297	95	212	122	165	12	5	135	19	0	88	25	9	65
15	1345	42	480	69	292	96	210	123	164	12	6	134	19	3	87	26	0	65
16	1260	43	469	70	288	97	208	124	163	12	9	132	19	6	86	26	3	64
17	1186	44	458	71	284	98	206	125	161	13	0	129	19	9	85	26	6	63
18	1120	45	448	72	280	99	204	126	160	13	3	127	20	0	84	26	9	63
19	1061	46	438	73	276	100	202	127	159	13	6	124	20	3	83	27	0	62
20	1008	47	429	74	273	101	200	128	158	13	9	122	20	6	82	27	3	62
21	960	48	420	75	269	102	198	129	156	14	0	120	20	9	81	27	6	61
22	917	49	412	76	265	103	195	130	155	14	3	118	21	0	80	27	9	61
23	877	50	403	77	262	104	194	131	154	14	6	116	21	3	79	28	0	60
24	840	51	395	78	259	105	192	132	153	14	9	114	21	6	78	28	3	59
25	807	52	388	79	255	106	190	133	152	15	0	112	21	9	77	28	6	59
26	776	53	381	80	252	107	188	134	151	15	3	110	22	0	76	28	9	59
27	749	54	373	81	249	108	187	135	150	15	6	108	22	3	76	29	0	58
28	720	55	367	82	246	109	185	136	148	15	9	107	22	6	75	29	3	57
29	695	56	360	83	243	110	183	137	147	16	0	105	22	9	74	29	6	57
30	672	57	354	84	240	111	182	138	146	16	3	103	23	0	73	29	9	56
31	651	58	348	85	237	112	180	139	145	16	6	102	23	3	72	30	0	56

* Address: Jones & Laughlin Steel Co., Pittsburg, Pa.

* * *

According to a report from Consul Frank W. Mahin, the reported good effects of the new British patents law in establishing new industries in the country are not fully substantiated by the facts. While some foreign firms have established branch factories in Great Britain, various reasons have been assigned for this, outside of the requirement of the patent act, and in at least one of these the avowed object of benefiting English workmen has not been realized, inasmuch as many foreigners were brought by the firm to work in their English factories. The most common cause, probably, for the establishment of branch factories in Great Britain is the increased demand for certain classes of goods in Great Britain and the colonies and the preferential tariff of the British colonies towards goods manufactured in Great Britain. Thus a large Swedish industry is now establishing a branch factory in Great Britain in order to be able to export to the British colonies without having to pay the higher duties exacted on imports from other countries than Great Britain. On the whole, the report indicates that the present law has had less influence in promoting new industries than was expected, and less than it has been represented to have.

HYDRAULIC PRESS TIE-RODS WITH SOLID HEADS AND BEARINGS IN CROSSHEADS

By BENJAMIN BROWNSTEIN

The bearings for the tie-rods in the upper and lower crossheads of hydraulic presses are usually made with caps, so that the rods can be made with solid heads and can be placed in the bearings of the crosshead and taken out with

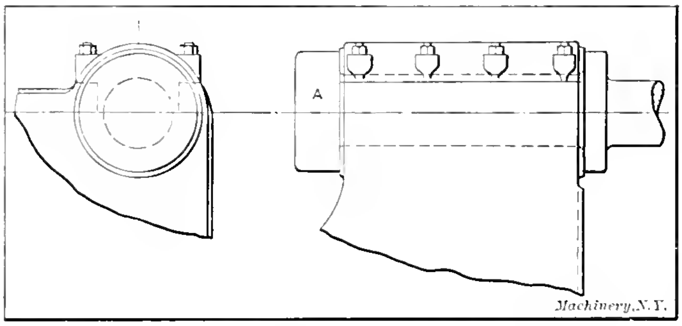


Fig. 1 Usual Method of making Crosshead and Tie-rod for Hydraulic Press

little difficulty. The method of construction is shown in the accompanying engraving, Fig. 1. While the strength of the tie-rods is increased by making them with solid heads, the strength of the crosshead bearings is lessened by the use of caps. Some manufacturers make the bearings in the crossheads solid and replace the solid head *A* of the tie-rods (Fig. 1) by nuts, and in this case the strength of the crossheads is increased while the strength of the tie-rods is decreased. Thus it will be seen that an increase in the strength of one member is always made at the expense of the strength of the other member.

A disadvantage following the use of bearings with caps is that when the hydraulic press is under heavy strain, the heads of the tie-rods are permitted to move away from the center of the strain, which action, in turn, causes the tie-rods to bend. It is for overcoming this difficulty that the bearings are made solid and the tie-rods with nuts, as mentioned, but even this is not satisfactory.

In the accompanying illustration, Fig. 2, is shown a design of tie-rod with a solid head and solid bearing in the crosshead. The joint between cap and crosshead is here eliminated, as well as the nut on the end of the tie-rod. At *E* is shown a top view of the crosshead with the tie-rods in place, and at *F* is a section through one of the bearings of the crosshead, in which *A* is the tie-rod, *B* an upper bushing, *C* a lower bushing, and *D* a nut screwed onto this bushing. The nut *D* is first put on the tie-rod, and then the tie-rod is put into the bearing of the crosshead. The bushing *C*, which is made in halves, is then put on the tie-rod and the head of the rod is pushed far enough out of the bearing at the upper end so that the bushing *B*, which is also made in halves, can be put into the bearing, after which the head of the tie-rod is brought to bear on the flange of the bushing. Now the nut *D* is screwed on the bushing *C* and tightened. Bushing *C* is prevented from turning by pin *H*. To take the crosshead and tie-rod apart, the operations are reversed. Bushings *B* and *C* are made either in complete halves, or solid and then split and provided with filling pieces put in for clearance. The one method is nearly as good as the other, but the former method is preferred.

The proportions of the tie-rod *A*, bushings *B* and *C*, and nut *D* are given in Fig. 2. The diameter of the tie-rod *A* is taken as the unit for all the other dimensions

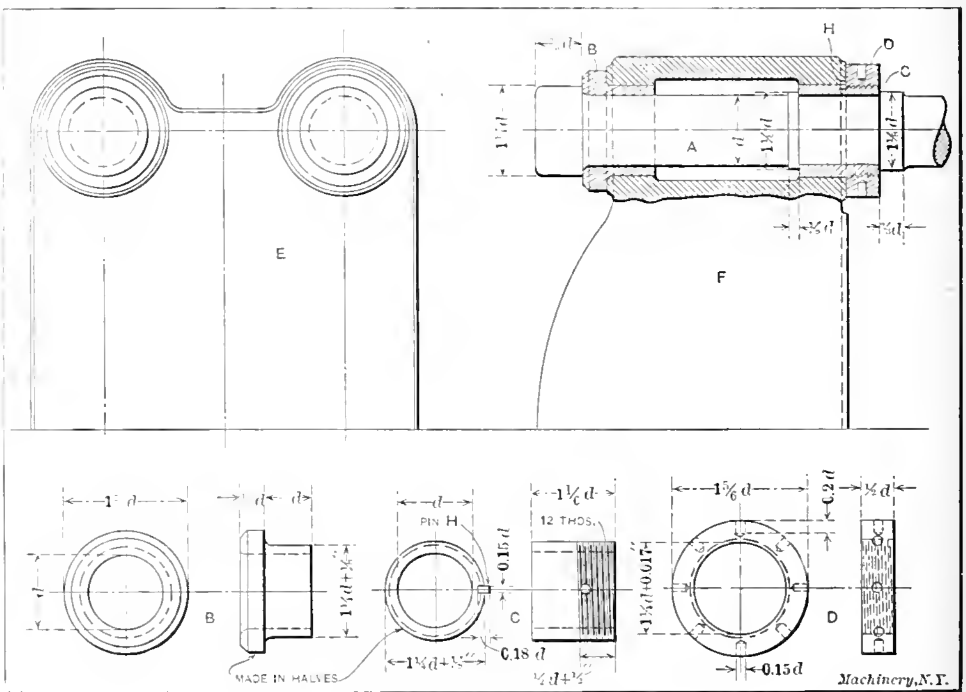
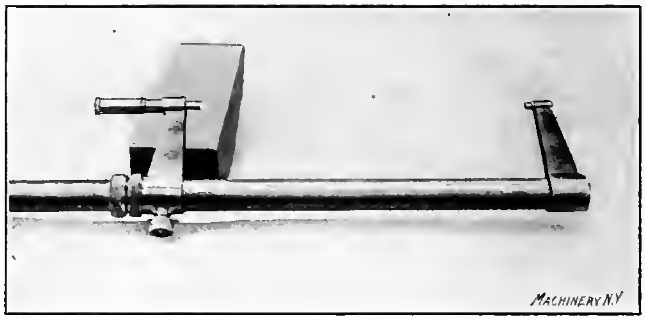


Fig. 2. Improved Method of Making Crossheads and Tie-rods

A CONVENIENT MICROMETER BEAM CALIPER

The tool shown herewith is, as may be seen, a beam micrometer caliper. It is not directly a measuring tool in itself, as it is designed to be set to end gages and then used in transferring the dimensions of those gages to other work. A micrometer screw and graduations are provided for comparing the measurements taken with the standard gage with that to which the caliper was set. It is obvious, of course, that by setting the adjustable head, with the screw reading at zero, to end gages of standard even inch lengths, the instrument may be used as a regular caliper for standard measurements.

The tool consists of a beam of tubing, carefully finished and fitted into a stationary jaw at one end and a sliding jaw at the other, the latter carrying the micrometer thimble and screw. The especial novelty of the device consists in the means secured for clamping the adjustable head at exactly



A Beam Caliper, with Micrometer Adjustment for Movable Jaws

the point on the beam desired, this being necessary, of course, as it is usually required that the graduations on the thimble shall read at the zero point when the end gage is held in contact between the screw and anvil points of the two jaws.

To the left of the movable head in the engraving will be seen two knurled nuts. It is by means of these that the fine adjustment of the head on the beam is made. When the one at the left is screwed down, it clamps to the beam, by means of a tapered and split thread, a bushing in the hub of the movable jaw. The turning of the other knurled nut with the thumb and finger adjusts the movable jaw along this bushing to the desired point. When this point has been reached (as shown by the readings on the micrometer thimble, set to the end gage), the knurled thumb-screw shown is turned, firmly clamping the movable jaw to the beam and thus preserving the adjustment. A keyway, not shown, keeps the anvil and screw points on the two jaws in line. This tool is the design of Mr. B. M. Weller, superintendent of the Colburn Machine Tool Co., of Franklin, Pa., in which plant it is in constant use.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ACCURATE SPRING WINDING APPLIANCE

It is often necessary in the tool-room or shop to wind both tension and compression springs that must be quite accurate as to diameter. This naturally puts one into a quandary, plus some guesswork, as to the diameter of the rod on which the spring is to be wound, owing to the enlargement of the spring after it is removed from the rod.

Fig. 1 shows an appliance which I devised and have used with success, with which a spring can be wound that will not enlarge 0.001 inch; on the contrary, it will contract in diameter when removed from the winding rod if sufficient pressure has been applied when winding, providing, of course, that the tool has been properly made. At first glance this tool may appear familiar to some mechanics, but it embodies a very important point in its construction that is not generally found in tools for this work in that it acts as a burnisher as well as a mere guide and tension appliance. The burnishing of

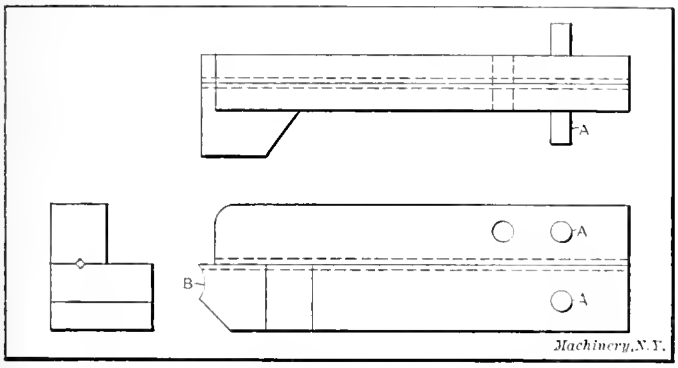
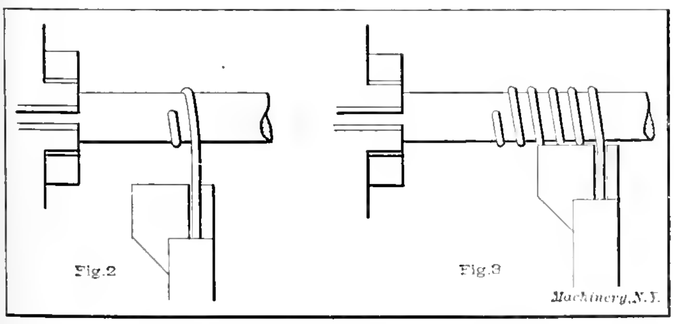


Fig. 1. Tool with which Springs may be wound to a Given Size

the coils while they are being wound is highly important if satisfactory results are to be obtained. This burnishing tends to expand the outer half of the wire due to the friction and heat, thereby causing the radius of the curvature of each convolution of the spring to either retain its diameter or contract when removed from the rod, depending on the pressure applied while it is being wound. The winding tool, as stated, is shown in Fig. 1. It is composed of two parts which are made of fiber for light work, or brass for heavy work. A very small V-groove is cut in the center of each piece to guide the wire. The pins *A* are to prevent the parts of the tool from being pulled through the toolpost when the work is being started. The burnishing nose *B* should, preferably, have the



Figs. 2 and 3. Method of Starting a Spring

same curvature as the spring to be wound as this will increase the friction, thus necessitating less pressure.

Fig. 2 shows the method of starting a spring. The tool, at first, is back from the winding rod a short distance; it is kept in this position until a few coils have been wound, when it is moved in against the work as shown in Fig. 3. As will be seen, the burnishing end then bears against the wire coils as they are being wound. By referring to Fig. 4 which shows a side view of the tool and a section of the winding rod, it will be noted that the upper half of the tool is set back a short distance; this is the position of the upper part when winding an open or compression spring as it permits an easy rise in the wire.

Fig. 6 shows a plan view of a spring being wound. It is advisable to gear the lathe when using this device, the same as if a thread were being cut, using gears that would give as many coils of spring to the inch as are desired.

As previously stated this tool can also be used for winding springs with initial tension. In close winding, the upper half of the tool is moved up forward as shown in Fig. 5, the

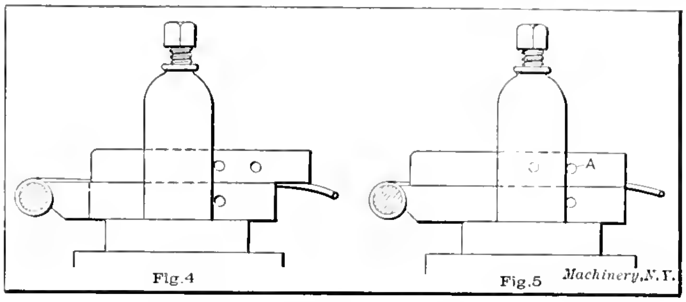


Fig. 4. Tool set for Winding Open-coil Springs. Fig. 5. Tool set for Winding Closed Springs

stop pin *A* being inserted in the rear hole; this is done to prevent the leading coil from jumping over the one adjacent to it. It is advisable, even in close winding, to use the burnishing nose, as it gives the proper diameter; in addition, burnished springs do not "set" as much as those wound with tension on the wire alone. When winding closed springs, the lathe should be run a trifle slower than for an open spring, in order to have a better control, as the carriage must be helped along by hand. The expression "helped along" explains this operation literally, as that is almost all that is necessary,

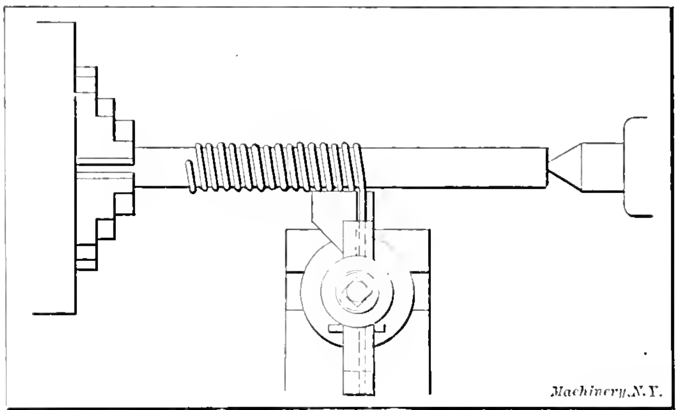


Fig. 6. Plan View of Spring being wound in a Lathe

because after a few coils have been wound, grooves are worn in the fiber or brass of the burnishing end, which act as a pusher or guide, and all one has to do is to just take up the lag in the lathe carriage. It is advisable to drill a small hole in one end of the winding rods of various sizes for holding the end of the wire, as this saves the chuck.

A very favorable feature of this device is that the rod and spring are always supported by the burnishing nose which is held against the coils by the tension caused by the friction of the wire in the slots, thus making the tool practically a traveling rest.

LOUIS E. KRAMER

Newark, N. J.

NICKED TOOTH MILLING CUTTERS

Recently I had occasion to order some nicked-tooth milling cutters and on receiving them, I found that the nicks were very narrow as compared with the length of cutting edge between them. Now as nicked-tooth milling cutters are generally used for roughing, would it not be better to have the nicks wider, say nearly the width of the cutting edge between the nicks?

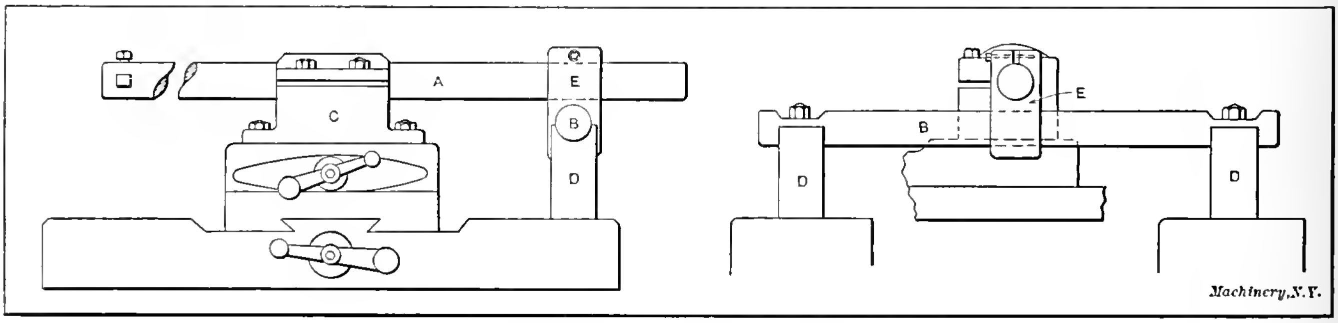
The manufacturers of cutters claim that the teeth are nicked to break up the chip, thus making an easier cut. It seems to me that they might go a step further and increase the width

of the nick. Take for example a cutter with a three-inch face, having nicks on each tooth the same width as the cutting edges between them, or one-half inch. Then each tooth will take three chips, one-half inch wide and having a thickness of twice the feed per tooth. For comparison with this cutter, take one with the same width of face but having nicks just wide enough to cause a break in the chip, the cutting edges between the nicks being, as before, one-half inch wide. Now with this second mill, each tooth will take a chip practically two and seven-eighths inch long and having a thickness equal to the feed per tooth. I think all will agree that the first mill will require less power, when milling, than the second one. Of course the cutting edge between the nicks would want to be a little wider than the nick, but not over one-sixteenth inch wider.

As a good example of a cutter with wide nicks, take the inserted tooth cutter having teeth made of round stock and inserted in a body. With this cutter the "nicks" are nearly the same width as the cutting face of the tooth and this style of mill for roughing is certainly a success. ALPHA

LATHE BORING-BAR FOR LARGE WORK

A special boring-bar that will be found very desirable for heavy duty, such as boring locomotive driving-boxes, pump cylinders, or any part requiring a long rigid bar, is shown in the accompanying engraving. This bar *A* was made for a 24-inch engine lathe. It is fitted to a toolpost *C*, which is mounted on the cross-slide in place of the regular toolpost.

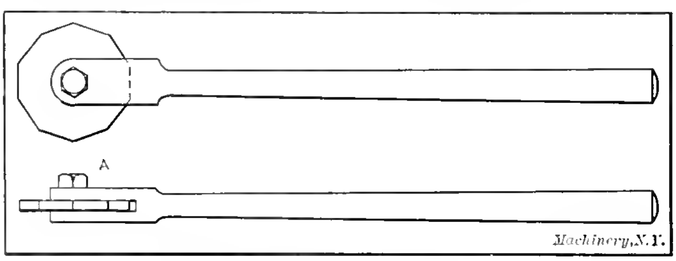


Rigidly-supported Boring-bar for Heavy Duty

The back end of the bar is additionally supported by a cylindrical cross-bar *B*, which is attached to the rear of the carriage by two columns *D*. These columns and the cross-bar are firmly bolted to the carriage as shown. Connection is made between the bar *A* and its support, by a block *E*, which is free to slide on the cross-bar, thus permitting the cross-movement of the tool-slide. The holes in this block are slotted so that it may be clamped in position, thus adding to the rigidity of the tool. The boring-bar in this case is 2½ inches in diameter, but obviously bars having reduced ends of any diameter and length to suit the work, may be made. S. W. GEORGE

SCRAPER WITH TEN-SIDED ADJUSTABLE BLADE

In a shop that I recently visited, I noticed a machinist using a scraper that was quite novel as well as useful. The blade of this scraper is in the form of a decagon; that is, it



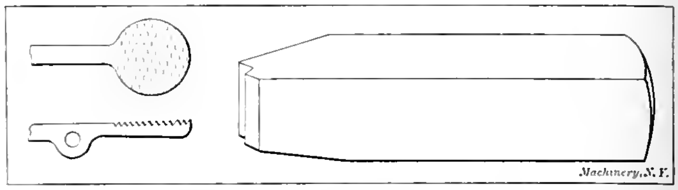
Scraper with a Blade having Ten Sides

has ten equal sides or flats, any one of which is available for use by releasing the locking or clamping screw *A* and turning the blade. This blade is made of carbon steel and is 3/16 inch thick. The flats were milled by mounting the work between the dividing head centers. The blade was hardened in a solution of water and salt and it was not tempered. The accompanying illustration clearly shows the construction of this tool. L. ROSENTHAL

Passaic, N. J.

TOOL FOR KNURLING FLAT WORK

Any toolmaker who has ever attempted to knurl or "cross-hatch" the face of a finger-plate like that illustrated herewith, will testify that it is not easy to do it regularly and easily with a three-cornered file, which is the usual way.



Flat Knurling Tool and Sample of its Work

These finger-plates are used quite frequently about jigs and fixtures, and as I had six to do the other day I hit upon the following quick and successful method: Taking a four-inch length of one-half inch square tool steel, I made a punch like the one shown in the illustration, by filing the sharp groove in the center and then filing away the metal from each side so as to leave the two 60-degree parallel ridges as shown. After hardening and drawing this punch to a dark straw color, it was driven lightly into the blank finger-plate, and by using the last impression to guide the stamp the work was gone over lightly in both directions. Going over the lines three times in all brought them up sharp and clean, thus finishing the job.

The secret of the success of this tool lies in the fact that as the punch has two ridges, it is easy to keep the spacing of the lines uniform, for one ridge locates itself in the last line struck while the other ridge strikes a new line. There is a tendency for the metal to push away around the edges of the piece during the process, and for this reason it is well to leave the blank a little large and bring it to size after knurling. CHESTER L. LUCAS

E. Saugus, Mass.

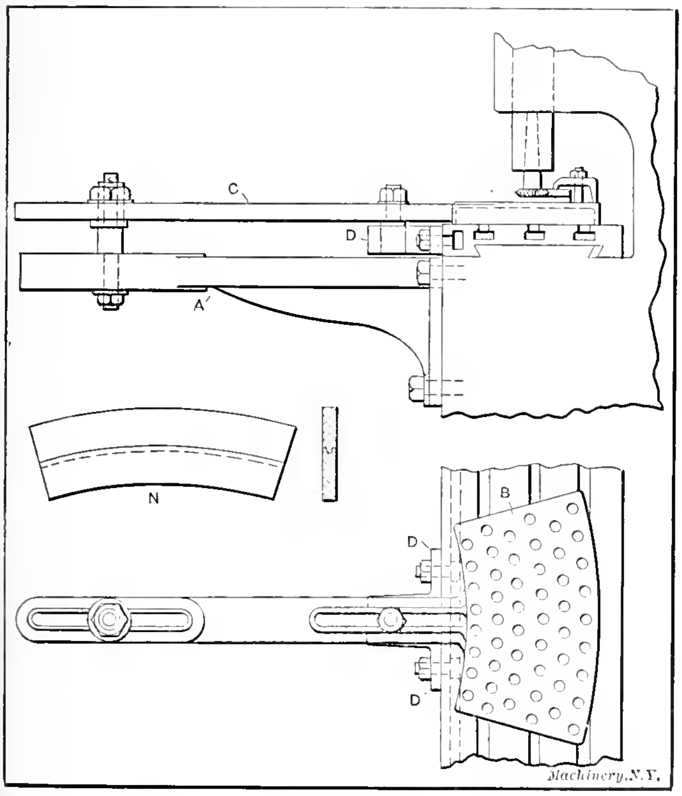
MILLING ATTACHMENT FOR MACHINING A CURVE OF LARGE RADIUS

In the December number of MACHINERY Mr. W. Alton contributes an article under the above heading. The article states that some pieces having a radius of about five feet had to be machined and that this radius was far too large for any lathe available. It must be presumed then that the curvilinear dovetail guide and saddle shown was either made by hand, entailing a very large amount of labor and expense, or it was made in another shop which had proper facilities for making the fixture and for which, no doubt, a very substantial charge would have been made.

Some years ago the writer was confronted with a similar problem, and as the method employed to arrive at the final result differs essentially from that described by Mr. Alton and has the merit of cheapness as well as efficiency, the readers of MACHINERY will unquestionably be interested in a description of the fixture.

We had always furnished and repaired the "nippers" required by a large worsted mill, which were of wrought steel and shaped as shown at *N* in the accompanying illustration, and we were able to turn them on a lathe of forty-two inches swing—the largest tool in the shop. Some new English machinery was then installed in the worsted mill and among it there was a comb which had nippers of a much larger radius, so that the lathe would not swing them by about twelve inches. The other tools in the shop consisted of a few smaller lathes, a drill press, a vertical milling machine and several minor machines.

To permit this job to go to another shop meant that probably all the other repairs of the mill would go with it. Such a contingency was not to be thought of and it was determined to rig up the vertical milling machine as quickly as possible to mill not only the pieces with the large radius, but also the smaller ones and to make the jig in such a way that there would be room for adjustment beyond present requirements. Accordingly a stand or bracket *A* was bolted to the front of the housing of the milling machine, the outer extremity of which was provided with a slot in line with the center of the milling spindle and of such a length that a stud fastened in it could be adjusted to both extremes of radius. A light table *B*



Simple Design of Milling Attachment for Curved Surfaces

of segmental form and having numerous holes drilled in it was finished parallel top and bottom and mounted upon the regular milling machine table. A radial arm *C* extended from it parallel with the bracket mentioned and at its extremity it had a slot similar to the one in the bracket. Into this slot a bush was fitted so as to be adjustable in the slot and a nut at the upper end of the bush held in place in any desired position. The bush in the radial arm oscillated upon the stud in the bracket, extra care being taken to have them swing upon each other with a good snug running fit. The front of the milling machine table had a T-slot in it running lengthwise, which contained ordinarily the lug used for the feed stop. In the present case two plain knee pieces *D* were fastened in this slot and between the two a plain stud was placed, which was adjustable in a slot in the radial arm; by this means the feed motion of the milling machine table was utilized to provide a feed for the segmental table, thus securing extreme simplicity of construction and consequently low cost.

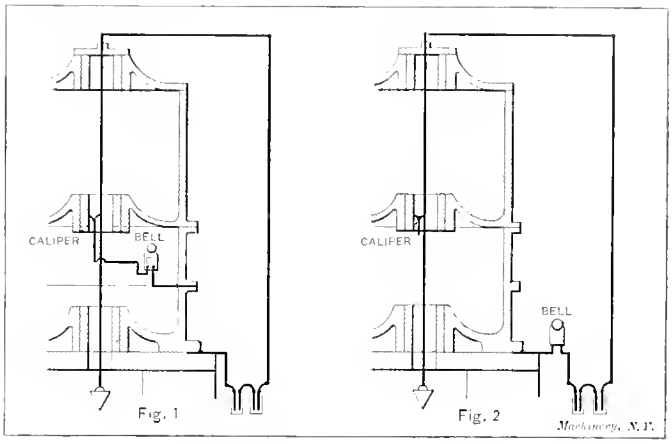
Another advantage secured by the adjustable center stud and bush was that the concentric curves on each side of the nippers could be milled by simply changing the milling cutter to one of the proper shape, and by moving the stud from or toward the milling spindle a distance equal to the width of the nipper and the diameter of the cutter. In this case the clamps for holding the nippers to the segmental table would have to be placed at the ends.

The device proved to be well adapted to accurate work within its limits and as an apprentice boy was able to run the machine, a cheaper and better article than had formerly been furnished was produced and the proprietor looked upon the fixture with the satisfied smile of the miner when he is thinking of his bonanza. CHAS. C. KLEIN

Philadelphia, Pa.

ELECTRIC CALIPERS

In the January issue of MACHINERY I noticed an article by Mr. Howard M. Nichols on the use of electric calipers for assembling vertical high speed turbines. His suggestion,



Figs. 1 and 2. Methods of Wiring for Electric Calipers

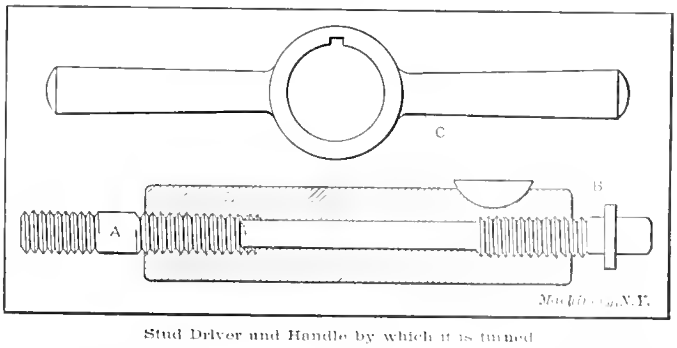
which is illustrated in Fig. 1, shows connections which would permit the bell to ring if the plumb-line were touched by the calipers without the calipers being in contact with the bearing at the same time. Fig. 2 shows how the connections can be made so that the bell will not ring unless the plumb-line and the bearing are touched at the same time by the calipers. This connection also makes its unnecessary to have a flexible connection to the calipers, which will thus be perfectly free as in ordinary work. W. F. HURLBURT

New Haven, Conn.

[The change suggested by our correspondent is undoubtedly an improvement. The arrangement shown in Fig. 1, however, would work satisfactorily, as one caliper leg would always be held against the bearing when testing the location of the plumb-line.—EDITOR.]

STUD-DRIVER

A stud-driver that is used in place of two lock-nuts and a wrench for screwing studs in the transmission cases of automobiles, is illustrated herewith. This work may be done much faster with a driver of this kind than when lock-nuts are



Stud Driver and Handle by which it is turned

used. One end of the driver is attached to the stud *A*, and into the other end a threaded locking or binding screw *B* is fitted. This screw has an extension, as shown, which passes through to the stud end of the driver. The end of this extension is cupped out so that it will have a good bearing on the stud. The pitch of the locking screw thread should be differ-

ent from that of the stud, to keep the latter from turning in the driver after it is in contact with the end of the locking screw. The driver is turned by the handle *C* which engages with the Woodruff key shown. FRANK LANG

Covington, Ky.

SHOP PHOTOGRAPHY

The article upon Shop Photography by Mr. R. F. Kiefer, in the January number of MACHINERY (engineering edition) contains some kinks that I think have been entirely dropped by British photographers.

First, why not call "non-halation plates" backed plates in order not to make people believe that they are a special brand, when they are simply ordinary plates backed with a very cheap preparation which can be easily made, or bought at any supply store. These plates may also be bought ready backed in England at threepence (six cents) a dozen extra. [The non-halation plates used in this country are not "backed plates," but a special brand having a double film which effectively prevents halation.—EDITOR.] Personally I seldom use backed plates. Reversing the plate in the holder, is a practice which I would not recommend, as the cure will generally be worse than the complaint.

The practice of brushing the plate with a camel-hair brush will put more dust onto the plate than it will take away, for two reasons: First, what is to insure the brush being clean? Second, the brushing will tend to magnetize the plate and so attract dust. The best way is to tap one corner of the plate against something; this will cause the dust to drop off.

Your correspondent advises various dodges which are very well in their way, but why not go in for an exposure meter at a very low cost and save all the bother? Mine, which I have had a number of years, cost 7/6 ($1.80), it is about the size of a watch, and it has saved its value many times over. A speed list of plates is given with the meter. I use a medium speed plate in winter, and a slow plate in summer, of the same make. My advice is to find a good plate maker and stick to one brand. If you use other brands, let it be on things which are not important until you are familiar with them. I agree with your correspondent on the factor development system, which has made developing a plate a simple job.

Before drying negatives, after washing, my advice would be *not* to use absorbent cotton, but the ball or side, of the hand. Furthermore *it is* advisable to change the position of the negatives when they are drying, because pools of water often collect at the bottom of the plate.

In conclusion I may say that photography has advanced from a mysterious operation, to calculated operation, with certain rules which, if followed, will insure correct exposure and development.

I can recommend to all photographers either a Wynnes or a Watkins exposure meter, and also Watkin's Manual of Photography. W. HAGGAS

Keighley, England.

CHART OF CROSS-SECTIONS FOR VARIOUS MATERIALS

From time to time there appear in the technical press as well as in the text books, charts of cross-sections for the various materials used in manufacturing. As the readers of MACHINERY are well aware, there is no recognized standard, and confusion often results.

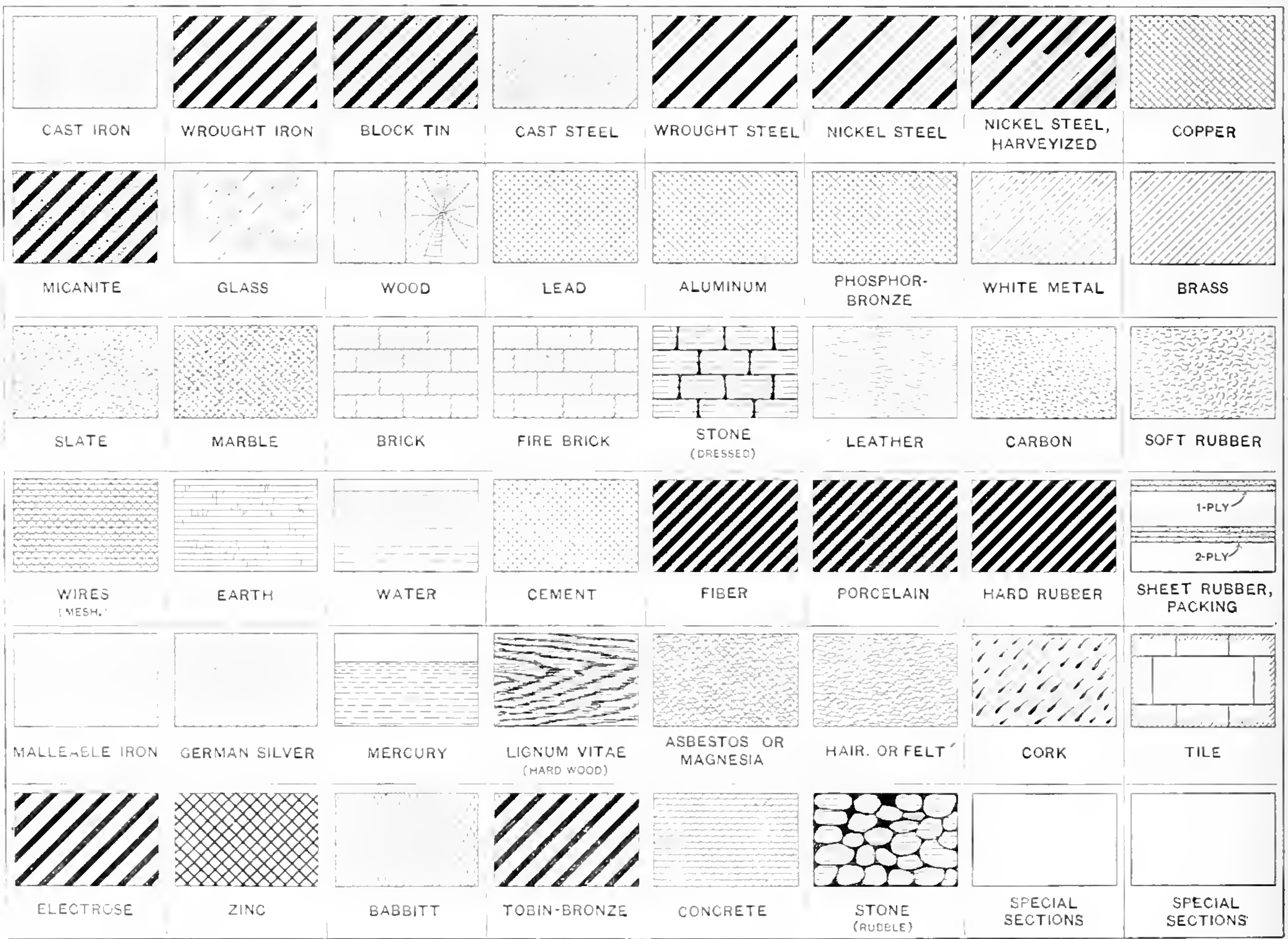


Chart showing Various Hatchings for Designating Different Materials on a Drawing

The accompanying chart was devised by the writer some years ago, and it has been adopted as a standard by a large department engaged in electrical and mechanical installations in marine work. As will be noted, many of the cross-sections are similar to those in general use, such as those for iron, steel, copper, brass, glass, etc. In addition, there are a number of other hatchings not so generally met with.

Brooklyn, N. Y. C. B. CHANEY, JR.

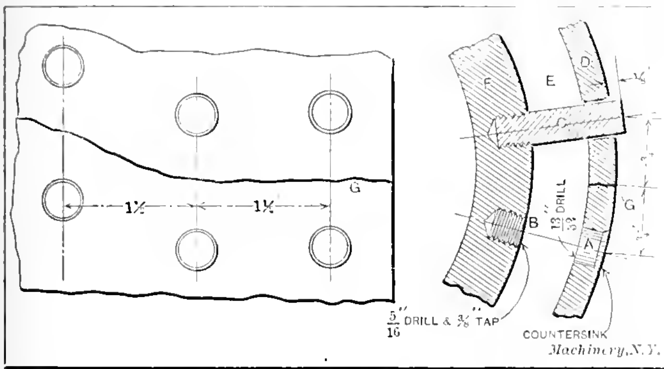
REPAIRING CRACKED WATER JACKETS

Many gas engine cylinders are thrown away as useless when the water jacket has been cracked by the water freezing in the jacket. There is, however, seldom a case of a water jacket so badly cracked that it cannot be repaired if the right methods are used. In the accompanying engraving a method has been illustrated which has been used for years

by the writer in repairing all kinds of cracked water jackets, even in cases where it has been necessary to put in pieces which have been entirely forced out. In many cases the work of repairing has been done by a blacksmith and the job has proved satisfactory in every respect. If the work is done with reasonable care, and the instructions given in the following faithfully followed, it will be impossible to tell that the cylinder has been cracked.

In the accompanying illustration the method of repairing the water jacket is clearly indicated; at *A* is a 13-32-inch hole, through the outer wall *D* of the cylinder; this hole is slightly countersunk on the outside. At *B* is shown a 5-16-inch hole, which is tapped in the cylinder wall proper with a 3/8-inch standard tap. At *C* is shown a stud screwed into the tapped hole, cut off and ready to be riveted. *E* is the water space between the outer and inner cylinder walls. At *G* is indicated the crack in the outer wall.

The method of procedure should be as follows: First lay out the holes about 3/4-inch back from the crack and about 1½ inch apart. Use first a 5-16-inch drill, drilling through *D* and into *F*, being careful, of course, not to drill through the wall *F* into the cylinder bore. Then re-drill hole *A* with a 13-32-inch drill and countersink as shown. Now tap hole *B* with a 3/8-inch tap, using first a plug tap and then finishing with a bottoming tap. From a bar of Norway iron cut off the studs one inch longer than necessary and thread one end the same distance as the depth of the tapped hole *B*. The thread should be a tight fit in the threaded hole.



Method of Repairing a Cracked Water Jacket

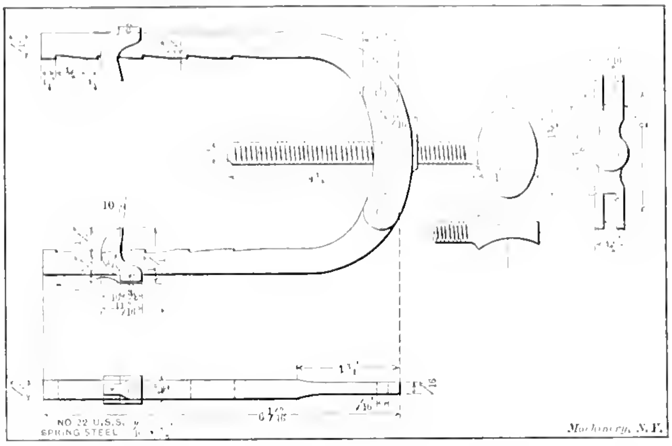
The studs are then screwed in tight by means of a pipe wrench applied to the one-inch extra length left on the end. This extra length is then cut off with a hack-saw and the stud is left projecting 1/8 inch outside of the outer wall as shown. When all the studs are screwed in and cut off, take a light ball-peen hammer and rivet down the pins. Rivet each stud a little at a time, bringing them all down together. When the studs are riveted down completely, the crack will be closed and water-tight. Then the heads of the studs are filed off flush with the cylinder wall and painted over.

Should the joint show any leakage, calk along the crack with a calking chisel or fill the water jacket with a saturated solution of sal-ammoniac and let it stand for a day. This will rust the metal in any small leaks so as to close them up. Nothing but Norway iron should be used for the studs. If the cylinder is very large, studs larger than those mentioned should be employed. GEORGE CORMACK, JR.

Rockford, Ill.

HANDY CLAMP FOR DIEMAKERS

A convenient form of crab-clamp for diemakers, that will doubtless be of special interest to those of MACHINERY'S readers who are interested in die making, is illustrated herewith. This clamp was also shown on Shop Operation Sheet No. 74, which I contributed, but the dimensions of the various parts were not given. It is particularly useful for holding a blank or templet in position on the face of a die while its outline is being scribed, or when transferring the irregular shape of a blanking die to the face of the punch, as the jaws upon which the die rests do not come near the hole in the die and therefore do not interfere with the scriber in any way. The principal feature of this clamp is that there is no time wasted in turning the thumb-screw up or down when pieces of different thickness are placed between the arms, as the sliding jaws are made so that they can be quickly adjusted on the arms which are provided with steps so that the jaws can rest at various places on them as shown. Springs which are attached to these jaws act as frictions and prevent the jaws



Diemakers' Clamp with Quick Adjustment

from dropping down when they are not resting on the steps. The arms swing on pins which are driven in the yoke, thus making it possible to accommodate various widths.

C. F. EMERSON

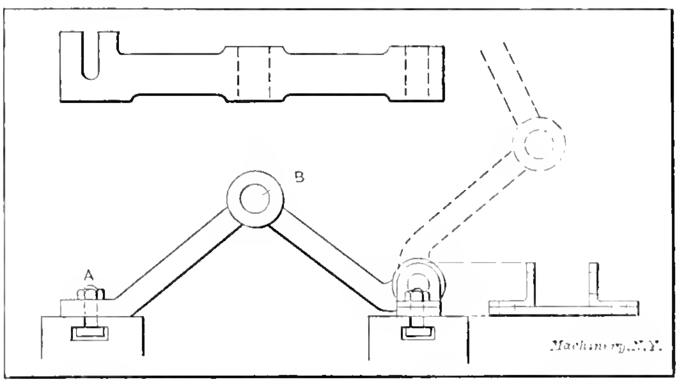
LEATHER CASES FOR MICROMETERS

In the December number of MACHINERY Mr. John F. Winchester suggests flexible cases for micrometers, protractors and other highly-finished and accurate tools. The Brown & Sharpe Mfg. Co. makes and lists in its catalogue soft leather cases for micrometer calipers, price 15 cents. They are all right and will also take caliper squares and verniers and probably some other tools, although they may not fit as well as the micrometers. J. R. RAND

Springfield, Mass.

LATHE STEADY-REST FOR DUPLICATE WORK

We had a large number of pieces which needed to be drilled while in the lathe and as it was necessary to support them during the drilling operation, the ordinary design of steady-rest proved to be very unhandy, as putting the rest in position and removing it for each part that was machined was a slow and expensive operation. The simple form of rest illus-



Convenient Form of Steady-rest for Duplicate Work in Quantity

trated herewith was then made. This rest is attached to the lathe carriage by a hinge on one side and the T-bolt *A* on the other. When the rest is not in use, it can be swung back out of the way as shown by the dotted lines. The hole *B* is, of course, in line with the axis of the lathe spindle. In machining this hole it was first drilled by a drill centered in the lathe chuck. An Armstrong boring tool was then used for boring out the hole. It was made 1½ inch in diameter, and bushed to 1⅛ inch, which was the size of the work in this particular case. Since the rest was first made, several bushings have been made for it to adapt it to work of various diameters. This attachment is not in the way and, consequently, it is very seldom removed from the lathe. It is employed for centering and drilling of all kinds, and its usefulness and value is apparent. S. W. GEORGE

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

SOCKET FOR BELT-SHIFTER

As the style of belt-shifter socket shown in Fig. 1 was the cause of frequent trouble, the type shown in Fig. 2 was made, and it has given satisfaction. The cast iron cap *A* is fastened to the upper end of the wooden shifter-rod by two No. 14 wood

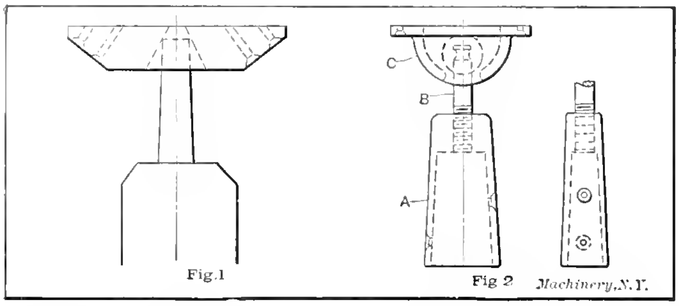
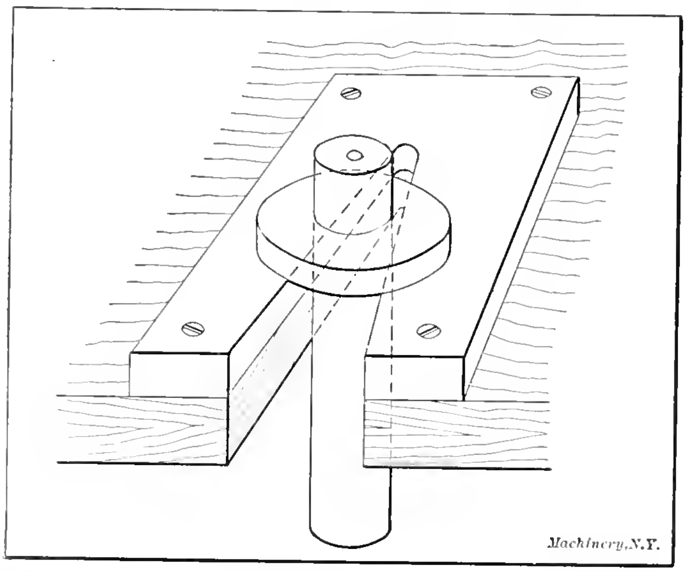


Fig.1 Fig 2

screws. An iron ball is cast on one end of the machine steel stud *B* to prevent the end of the rod from dropping out of the socket when it is assembled. The cup-shaped casting *C* is secured to the ceiling by four No. 14 wood screws. W. H. K.

A MANDREL PLATE

The engraving shows a handy mandrel plate that is intended to be screwed to the bench, close to the lathe. It has a tapered slot, and a similar one is cut in the bench for the mandrels to pass down through. The mandrel is slid inward until it

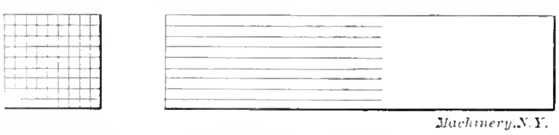


lightly touches the sides of the slot, when the work will be supported in the best manner for resisting the driving in or out. The plate may be of wrought iron, or of cast iron, if made thicker. FRED HORNER

Bath, England.

ERASER FOR CLEANING DRAWINGS

To make a cleaning eraser that will remove dirt and pencil marks from drawings, and that will not readily touch the ink marks, procure a common soft rubber pencil eraser and cut

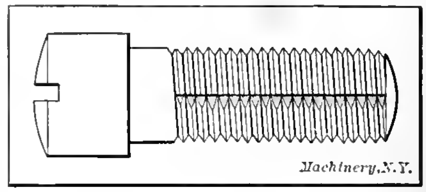


a lot of slits along the length of it, as shown in the illustration. These slits make the end flexible and this serves to keep it from removing ink marks when cleaning up a finished drawing. HOWARD M. NICHOLS

Kenyon, R. I.

IMPROVISED TAP

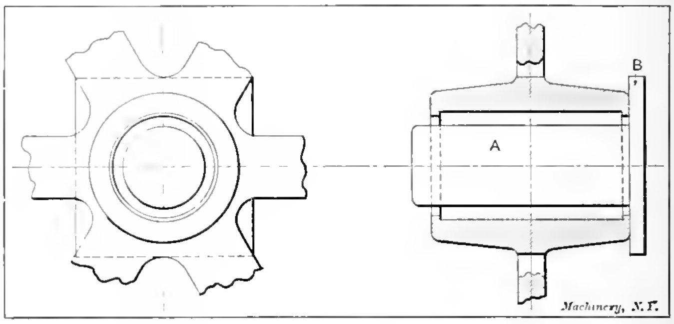
In re-assembling a machine which had been taken down for repairs, it was found that in a couple of threaded holes the threads had been, in some way or other, damaged so badly that the screws could not be replaced. These threads were of small diameter and a special pitch, and no taps were kept in stock for them. Accordingly one of the screws was annealed and three grooves were filed



in the threads lengthwise (see engraving) with a three-cornered file, thus, in reality, converting it into a tap. After being hardened, the screw was run into the holes, clearing up the threads enough to allow the screws to go back into place. F. W. B.

A LOOSE PULLEY BEARING

To bush a loose pulley, first bore it out as shown in the illustration. Then make a wooden arbor *A* somewhat smaller



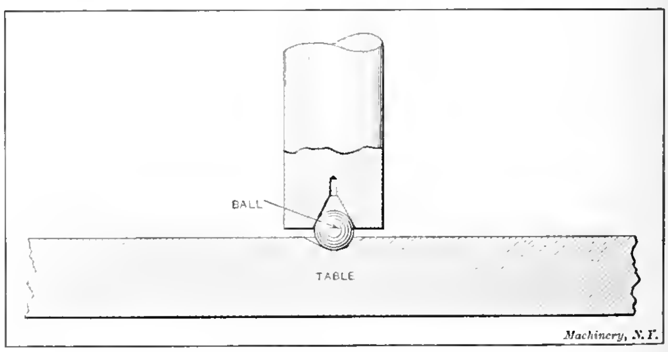
than the size of the shaft. To one end of this arbor nail a board *B*, and lay the pulley on the board with the arbor in the bore of the pulley. Adjust the pulley on the board until the arbor is central, as shown. Then get some brass chips that are well curled and fill the space between the arbor and the bore of the pulley. The hub of the pulley should then be heated and babbitt metal poured in. After this lining is bored to fit the shaft, there will be a bushing of brass and babbitt that will wear well. D. H. S.

SUPPORT FOR CENTERED WORK ON THE DRILL PRESS

A 5-16-inch steel bearing ball makes a good lower center for a drill press when handling centered work thereon. The ball is placed on a spot where a drill has marked the table, as shown in the engraving. CHARLES E. BURNS

Beverly, Mass.

[When an old drill mark is used, as described, it will

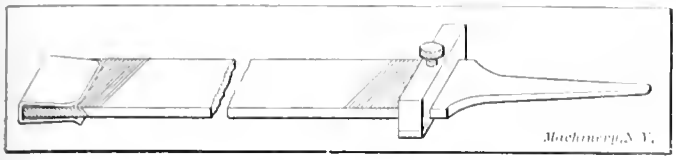


be necessary to align it with the drill spindle, assuming that the table has been shifted since the mark was made. This will, doubtless, take more time than would be required to strap a scrap piece to the table and make a new mark. Of course a competent mechanic would not deliberately mark his drill table with the drill point in order to support the work in the manner described.—EDITOR.]

EMERY CLOTH CLAMPS

The accompanying illustration shows a set of emery cloth clamps that will doubtless be appreciated by any one who has

occasion to use emery cloth on a file. The cloth is held tighter than it can be held by hand, and the hands are left free so that they may be used in a natural way. Filing may be done with the clear side of the file and the tool turned over when work is to be polished; or if desired, two grades of emery cloth

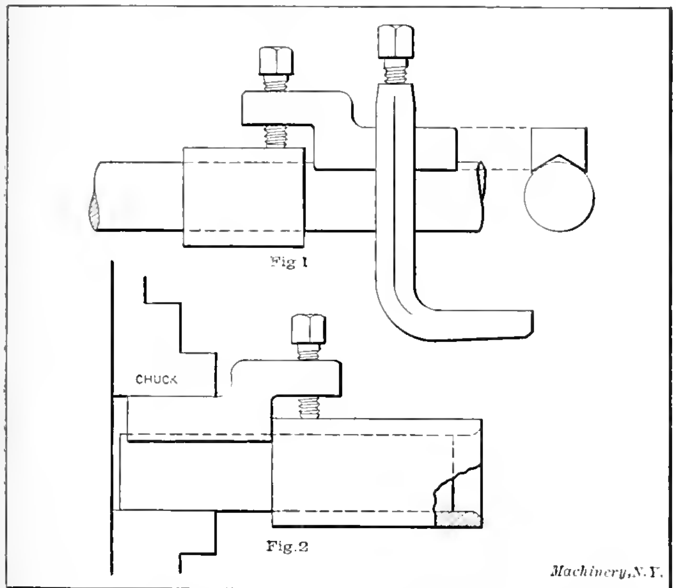


may be used, one on each side of the file. The strip of emery cloth is given a simple fold over the end of the file, the spring clip shown is pressed over it, and the other end is brought back under the clamp next to the handle; then the emery cloth may be drawn as tight as desired.

TOOLMAKER AND DESIGNER

COLLAR CLAMP

With all the paraphernalia that lies about the machine shop, often there is nothing handy that can be used to locate and clamp a cam or collar on its shaft while drilling it for a pin or spotting it for a set-screw. After many inefficient makeshifts, I made a clamp as shown in Fig. 1, and clamped



it to the shaft with a lathe dog. It worked satisfactorily. I also used it in an independent lathe chuck, as shown in Fig. 2, with a piece of cold-rolled shafting as an arbor, to face bushings to length or to round their inside corners, or any light turning where it is desired to have the work overhang the arbor.

CHARLES E. BURNS

Beverly, Mass.

WEDGE POINT FOR HERMAPHRODITE CALIPERS

Everyone who uses hermaphrodite calipers knows that the point soon loses its sharpness and makes "heavy" lines. The dulling of the point is, of course, hastened when the work on which the calipers are used is hard and rough. A style of point that will keep sharp much longer and make better lines than the conical point, is shown in the accompanying

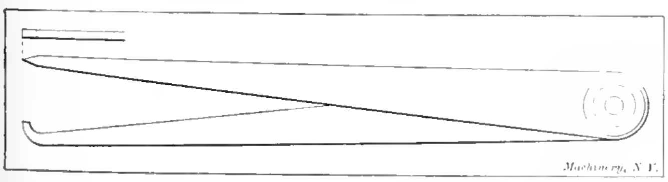


illustration. It is, in reality, an edge instead of a point, and consequently, will remain sharp for some time. It is simply an adaptation of the point a draftsman puts on his pencil for drawing lines, and practically all the work for which hermaphrodite calipers are used can be performed with this wedge-shaped end.

DONALD A. HAMPSON

Middletown, N. Y.

CASTING HOLLOW FIGURES

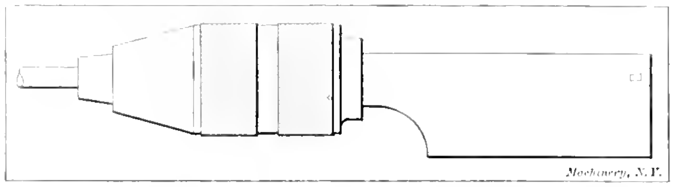
Hollow pewter figures are made by pouring them in a metal (generally cast iron) mold, where they are allowed to remain a few minutes, or until they are cooled sufficiently to form a thin outer shell of pewter. The mold is then inverted, and the molten metal in the center allowed to run out, leaving the figures hollow.

HERMAN JONSON

New York City.

BORING TOOL HOLDER FOR SMALL WORK

The accompanying sketch shows an old style of tool-holder used in possibly a new connection. The tool-holder proper is, as will be readily observed, a regular three-jawed drill-chuck. This chuck will admit any diameter of stock up to and includ-



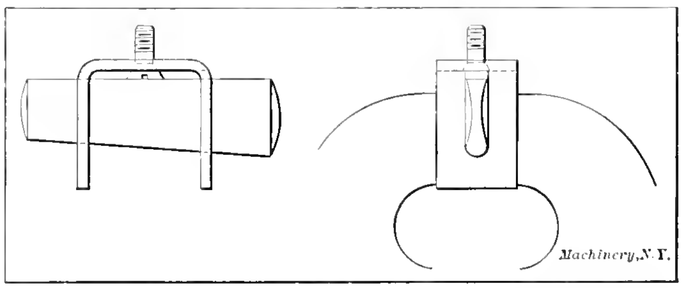
ing a half-inch, and it has a special shank fitted to it which may be clamped in the lathe toolpost. The range of work within the capacity of this tool-holder is unusually extensive, and at the same time its utility as a drill-chuck for lathe purposes is not impaired, since it may be removed from the toolpost and the shank held on the tailstock center, the center having been left in the shank for that purpose.

J. PRICE

Stamford, Conn.

METHOD OF HOLDING SMALL SCREWS

While making volume XV. of MACHINERY ready for the bindery, I noticed a method of holding small screws when filing off the ends, in the Shop Kinks page of the February, 1909, number. The arrangement shown in the accompanying sketch is successfully used for the same purpose. A suitable scrap of wrought iron is drilled, countersunk, bent and slotted for the introduction of a flat taper key straight on one face.

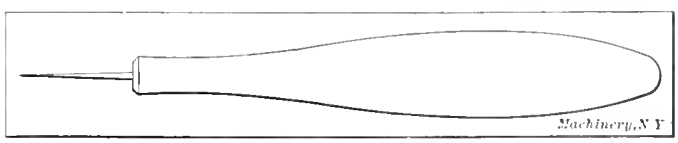


With several holes in the top of the stirrup, screws of a great variety of sizes may be held with great rigidity while being operated on, without marring them.

Holyoke, Mass. HARRY BAILEY

HANDY TOOL FOR DRAFTSMEN

A convenient tool for draftsmen's use is shown in the accompanying sketch. It is simply a burnisher made from a toothbrush handle. One end is finished with a file and fitted with a needle point, thus making a fine punch for close accurate lay-outs. The original shape of the toothbrush handle is such that the tool will not roll off the drawing-board when



it is laid aside. Any part of the handle may be used as a burnisher to polish the drawing paper after erasing part of a sketch. It is often necessary to do considerable erasing in a certain part of the drawing, and then the work does not look neat and gets soiled easily. In such cases, the paper may be given a smooth clean polish with this burnisher, which will not leave a mark on the paper or soil it.

JIG AND TOOL DESIGNER

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

BELTING ON PULLEYS WITH AXES AT AN ANGLE

C. J. N.—How can the belt be kept on the pulley steps on the line-shaft and on the machine in the following case? A line-shaft has a three-step cone-pulley over which a belt runs on another three-step cone-pulley on a hand screw machine. The machine is not directly under the line-shaft, but about two feet in front of it. Furthermore, it is not in line with the line-shaft, but makes an angle of about ten degrees with it. I have had trouble keeping a belt on the pulleys, and would like to know how to do it without the use of idlers, and without changing the relative position of the machine with the line-shaft.

A.—The first suggestion in reply to this question would be to provide the steps of both cone-pulleys with considerable crown. The crowning would tend to keep the belt in position on the cone-pulley steps, provided the center distance between the cone-pulleys is reasonably large and the belt not too wide. The usual rule for setting pulleys which are at an angle, which was given in the May, 1909, issue of MACHINERY in the "How and Why" department, does not, of course, apply to three-step cone-pulleys, as it is impossible to set more than the middle steps in accordance with those directions; and even this rule is applicable only when the drive is in one direction. In the case of a hand screw machine, the spindle would be reversed, so that if the machine were directly beneath the line-shaft, it would be necessary to set the middle step of the cone-pulley on the machine directly beneath the middle step of the cone-pulley on the line-shaft. In this way when the center distance between the cone-pulleys is not too short, placing the belt on the outside steps on either side of the middle steps would not be likely to cause any trouble. When the machine is moved in relation to the line-shaft either forward or backward, if the same relationship between the pulleys is maintained as that which exists when one cone-pulley is directly beneath the other, the belts should run as well on the pulleys in this case as in the former. In order to maintain this relationship, however, the machine would have to be tipped at a slight angle, that end of the machine being elevated, which is further away from the line-shaft after the machine has been moved. To illustrate this and also to find the means for calculating the amount that the machine would have to be tipped from the horizontal plane, the accompanying diagram has been drawn. In the upper part of the diagram, line KL is the center line of the line-shaft and line AB indicates the axis of the machine when its cone-pulley is placed directly beneath a cone-pulley on the line-shaft. In the lower part of the diagram is shown an elevation where H is the line-shaft, and CD the projection of the axis AB of the machine. Now, when we move the machine in front of the line-shaft, in order to maintain the same relation between the pulley on the machine and the pulley on the line-shaft, we must conceive of the lower cone and shaft as swung like a pendulum to a position in front of the line-shaft so that line HM occupies the position HN. This, however, will throw the axis of the machine at an angle with the horizontal plane, the angle being such that the line CD will occupy the position EF. To calculate the amount that the tailstock end would have to be raised in this case, assume that α is the angle which the axis of the machine makes with the axis of the line-shaft. In the diagram this angle is shown exaggerated, in order to more plainly illustrate the principle involved. Let b be the distance between the line-shaft and the center of the cone-pulleys on the machine, a the distance which the machine is moved forward in relation to the line-shaft, and l the length of the bed of the machine.

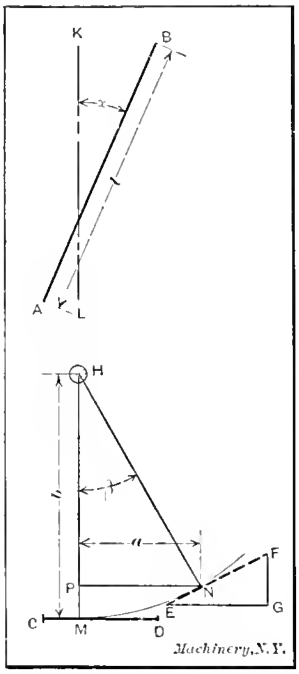


Diagram for Belt Problem

Now the length CD or the projected length of the bed of the machine equals $l \times \sin\alpha$. Further $\sin\beta = \frac{a}{b}$.

Line FE, of course, equals line CD, both being projections of the length of the machine bed on the same plane. Thus $FE = l \times \sin\alpha$. Line FG indicates the amount that the tailstock end of the machine should be raised relative to the headstock end in order to preserve the relative position of the cone-pulleys. Angle $FEG = \beta$.

$$\text{Hence, } FG = FE \times \sin\beta = l \times \sin\alpha \times \frac{a}{b} = \frac{a \times l \times \sin\alpha}{b}$$

Hence, if the distance between the line-shaft and the pulley on the machine, the distance that the machine is moved in front of the line-shaft, the length of the machine bed, and the angle between the axis of the machine and the line-shaft, are known, the formula above gives us the amount to raise one end of the machine to preserve the relationship between the cone-pulleys. If the belt runs properly when the machine is set directly beneath the line-shaft, it should run as satisfactorily when the machine is set in the manner described in front of the line-shaft.

As an example, assume that $a = 2$ feet, $b = 8$ feet, $l = 6$ feet, and $\alpha = 10$ degrees. Then:

$$FG = \frac{2 \times 6 \times \sin 10^\circ}{8} = 1.5 \times \sin 10^\circ = 0.261 \text{ foot, or}$$

$0.261 \times 12 = 3\frac{1}{8}$ inches, about. This is the amount that, in this case, the tailstock end of the machine should be elevated above the headstock end.

* * *

NEW GERMAN TARIFF RATES ON MACHINERY

According to the new agreement between Germany and the United States, American metal and wood-working machinery may be imported into Germany at a considerably lower rate of duty than heretofore. Instead of the general or maximum rate being imposed, the minimum rates will apply. The old rate of duty on machines or tools weighing 550 pounds (250 kilograms) or less, was \$4.76 (20 marks) per each 220 pounds (100 kilograms). The new rate is \$2.86 (12 marks). For weights over 550 pounds, and up to 2,200 pounds the old rate was \$2.86 (12 marks) per 220 pounds. The new rate is \$1.91 (8 marks). When over 2,200 pounds, up to 6,600 pounds, the old rate per 220 pounds was \$1.91 (8 marks), and the new rate is \$1.43 (6 marks). For weights between 6,600 and 22,000 pounds the old rate was \$1.43, while the new rate is \$1.19. For machinery heavier than 22,000 pounds the old rate of \$0.95 per 220 pounds is unchanged.

* * *

The Swedish Institution *Järnkontoret*, representing the Association of Swedish Iron Manufacturers, has decided to build an electric blast furnace at Trollhättan for experimental purposes. An electric blast furnace has been in use for some time at Grängesberg in Sweden, but the efficiency of this furnace with electricity generated by a hydro-electric plant has so far reached only 58 per cent, while in the ordinary blast furnace the efficiency can be raised to 80 per cent. It is expected, however, that the new furnace will materially reduce the loss through various alterations in the construction. Should the experimental working prove successful, a considerable portion of the water power owned by the government in the northern part of the country, in the vicinity of the large iron deposits, might be exploited in the production of pig iron by the electric process. As a matter of fact, the possibilities of developing a large iron industry in the northern part of Sweden is entirely dependent upon the success of the electric process, as this eliminates the coal otherwise required.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

LE BLOND HEAVY DUTY MANUFACTURING LATHE

In the September, 1909, number of MACHINERY, we illustrated and described a heavy duty engine lathe, designed and built on original lines by the R. K. Le Blond Machine Tool Co., 4609 Eastern Ave., Cincinnati, O. We herewith illustrate a further modification of this design of lathe, especially adapted to manufacturing operations. The special features in this case are a geared headstock of unusually direct and durable construction, and a multiple stop arrangement for both cross and longitudinal feeds. The accompanying engravings illustrate these mechanisms very clearly.

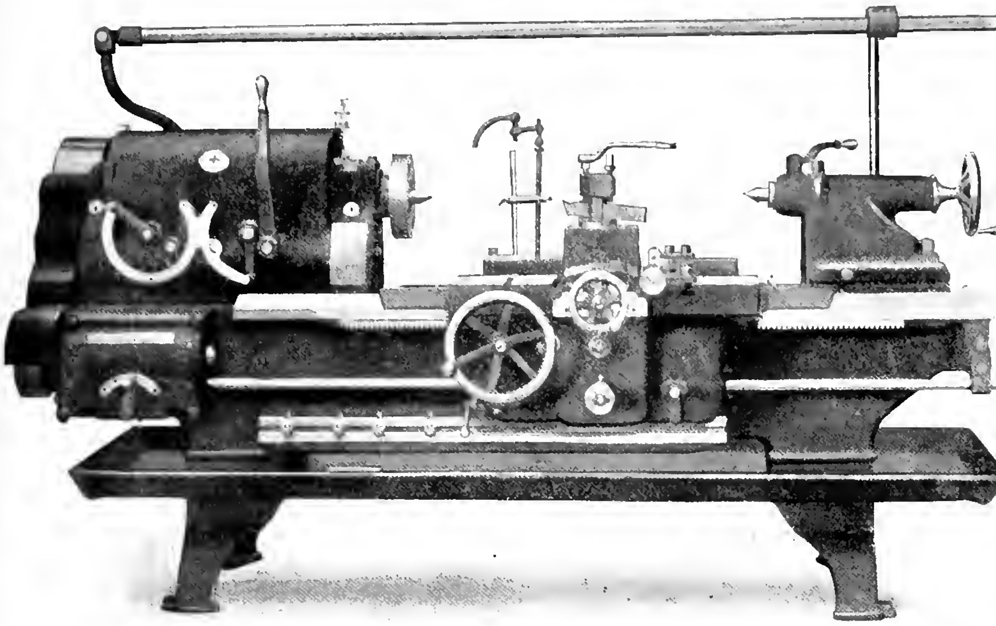


Fig. 1. The LeBlond Heavy Duty Lathe, with Geared Head and Multiple Cross and Longitudinal Stops

Fig. 1 shows a general view of a 21-inch lathe of this type, fitted with oil pan, pump, plain rest and plain geared feed. The ruggedness of the machine is plainly shown. The convenience of the hand levers for controlling the speeds and feeds, and the complete guarding of the gear mechanism, should also be noted. Fig. 2 shows an end view of the headstock, while Fig. 3 is from a photograph taken looking directly down into the mechanism, with the cover removed. This latter engraving shows the drive to the best advantage.

Driving pulley *A* runs at constant speed, and may be directly belted to the countershaft if desired, as it is connected with the driving shaft through a powerful friction clutch. This is controlled by lever *B*, and operated by the shifting rod shown extending over the machine in Figs. 1 and 2, an arrangement which has become deservedly popular for geared head lathes. This clutch for connecting and disconnecting the driving pulley *A*, is also provided with a brake mechanism which goes into operation when the power is thrown off, thus bringing the lathe spindle instantly to a stop and avoiding loss of time in taking measurements or changing work.

Gears *D* and *E* on shaft *C* are mounted on a sleeve, which may be shifted longitudinally so that *D* meshes with gear *H*, or *E* with gear *F* as shown in Fig. 3. *F* and *H* are keyed to intermediate shaft *G*, which carries a second sliding sleeve on which gears *M*, *N* and *O* are mounted. This sleeve may be shifted to three positions, so that *M* may engage with gear *P* as in the case shown, *N* with *S*, or *O* with *T*. Gears *P*, *S* and *T*, as well as *Z*, are mounted on a third sleeve which revolves loosely on the spindle *R* of the lathe, but has no end movement. Gear *Z* is connected under the spindle through back-gearing with main driving gear *Y*, one back gear being shown at *Q*. The spindle may be clutched to either *T* or *Y* by means of clutch *X*, which furnishes a friction back-gear control.

These combinations, it will be seen, give twelve changes of speed—two by the shifting of *D* and *E*, multiplied to six by the shifting of *M*, *N* and *O*, and again doubled to make twelve by the operation of the back gears. The controlling levers for these twelve changes are shown at *U*, *K* and *W*. Lever *U*, through the operation of segment gears and rockshaft *V* shifts *M*, *N* and *O*; lever *K*, also through segment gears and rockshaft *L*, shifts *D* and *E*; while lever *W* controls the friction back-gear clutch at *X*.

The headstock casting itself will be seen to be of closed box construction, braced with cross-ribs. It forms a reservoir for a bath of oil in which the gears run constantly, with obvious advantages in the way of reduction of wear. Oil gages are provided for determining the height of the oil. The makers call attention to the simplicity and durability of this geared head. The changes are all made through sliding gears, and the drive in every case is in straight lines. The number of parts has been reduced to a minimum. The twelve speed changes are carefully calculated, and cover the proper range for which each size of lathe is designed. Each gear is made of the material suited to its peculiar requirements, and in no case are two soft steel gears run together. The sliding gears have rounded teeth, permitting easy engagement.

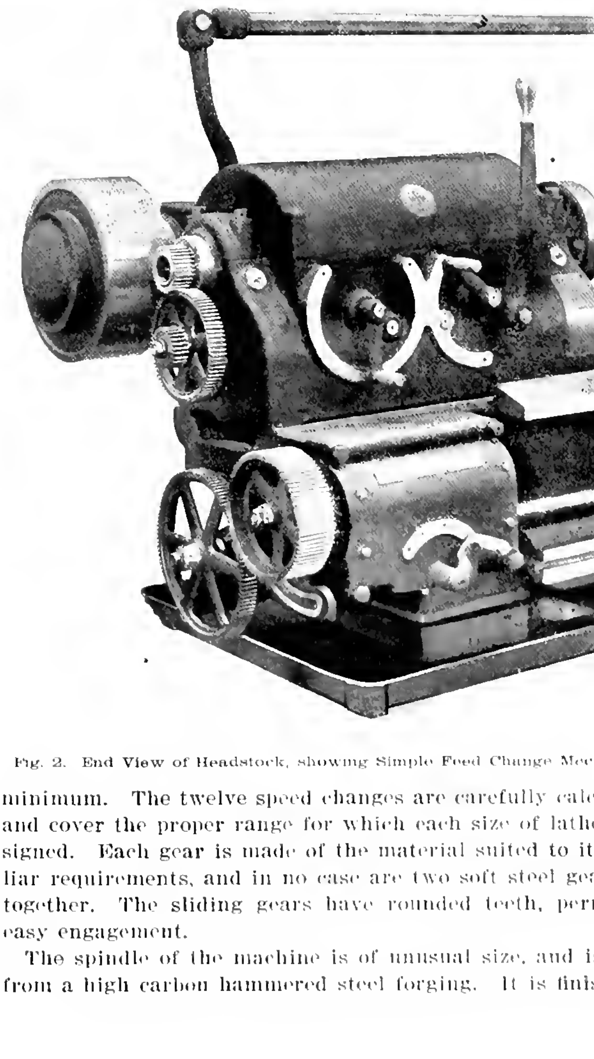


Fig. 2. End View of Headstock, showing Simple Feed Change Mechanism

The spindle of the machine is of unusual size, and is made from a high carbon hammered steel forging. It is finished to

size by grinding, great care being taken to bring it close to standard gage. The front spindle bearing is hardened and ground, and runs in a cast-iron box of special close-grained material. The particular design is somewhat expensive, but has been found to give the best results under severe strains at high speeds—these being the conditions under which the lathe is expected to operate when using tools of modern steels. This combination of materials for the main bearings should not be confused with the more common combination of soft steel spindles running on cast iron. The bearing is lubricated by generous oil wells, through felt pads which filter the oil and supply it slowly but continuously to the wearing surfaces.

Besides the provision of a quickly changed, powerful and simple drive, as just described, the machine has been specially adapted to manufacturing by the provision of an elaborate but simple system of stops, for both cross and longitudinal feeds. The cross-feed stops are of the positive type and are best seen in Fig. 4. A four-faced stop bar is used, as shown, extending across the carriage from front to back. On each face of this stop bar is adjustably mounted a stop, as shown; these stops may be set to give different depths of cut for different diameters. The bar is rotated to bring one stop after another in line with the abutment on the tool-slide, by means of the knurled handle shown at the front. The stop-bar could doubtless be provided with more than four faces, if required for complicated work.

The longitudinal stops, as shown best in Fig. 1, are adjustably mounted in a T-slot in a long cast-iron bracket, rigidly mounted on the bed. When the trip lever on the apron strikes one of these longitudinal stop dogs, a square tooth clutch on the feed drive of the apron is disengaged, thus stopping the feed. Raising the trip lever, re-engages the clutch and the feed is automatically thrown back into action again, until the next stop is reached. This operation may be repeated as many times as there are shoulders on the work at hand. These rigidly-mounted dogs also form positive stops, permitting the duplication of shoulder distances with great accuracy. The

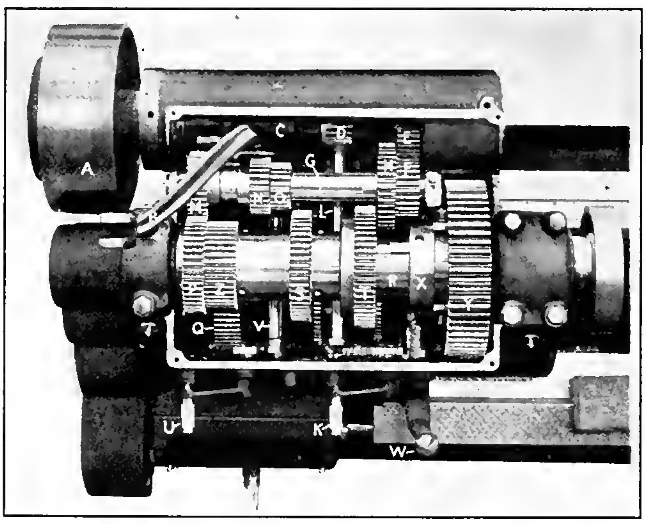


Fig 3. Top View of Headstock with Cover Removed, showing Speed Change Connections

trip lever is of such shape that it rides over the dogs when the carriage is being returned, making it unnecessary for the operator to give the mechanism any further attention.

The usefulness of this combination of cross and longitudinal stops will be readily appreciated. With four dogs for each movement it is possible, for instance, to rough out with a single tool a lot of similar pieces, each of which has four different shoulders to be turned to the proper diameter and length of cut. The tool is set to the diameter indicated by the first cross-slide stop, is fed up to the first longitudinal dog, and stops. The tool is drawn back, the cross feed stop bar is turned, and the tool is fed down to the second stop for the second diameter. The feed lever on the apron is raised, allowing the carriage to feed forward to the next longitudinal stop and so on. Overhanging parts are avoided, so that diameters can be duplicated with great surety. The whole construction is very rigid. The mechanisms are simple in construction, and when not required, can be quickly set so that they do not interfere in any way with the movements of the lathe. These features should be appreciated in manufacturing work.

The other improvements in this design of lathe were described in connection with the article of September, 1909. They included a novel design of ways, intended to give the advantages offered by both the English and American types; a double-walled apron; and an improved quick-change gear-feed device, which will also be furnished with these manufacturer's lathes if desired. The arrangement shown provides eight changes of feed, ranging from 0.0045 to 0.100 inch per revolution of the spindle. Of these, four changes are obtained by gearing in the feed-box, while a further fast and slow change

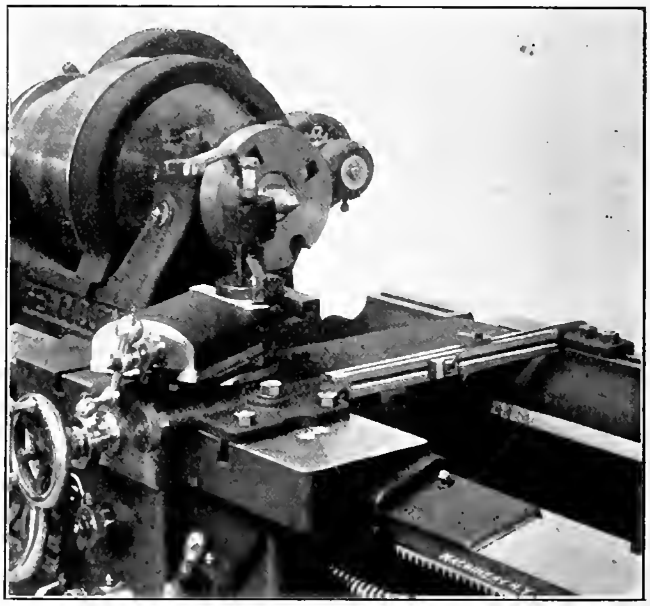


Fig. 4. Multiple Cross Feed Stops mounted on Carriaga

is given by shifting the intermediate gear shown in Fig. 2, from the large gear to the pinion shown on the headstock stud.

In connection with this design, it will also be remembered that the headstock is set two inches back of the center line of the bed, making it possible to turn the full swing of the lathe without any overhang of the tools beyond the ways. The stiff construction of the tailstock, as well as of the other structural members of the machine should also be noticed.

This manufacturer's lathe is built in seven sizes, 17, 19, 21, 25, 27, 30 and 33 inches swing, respectively. It should be especially useful for the duplication of shafts and other work having one or more shoulders.

IMPROVED TABLE SUPPORT AND FEED FOR QUEEN CITY SHAPERS

In Fig. 1 is shown an example of the line of shapers made by the Queen City Machine Tool Co., Cincinnati, O. This design incorporates two improvements which are plainly shown in the engraving. One of these is outboard support for the table, which controls the table rigidly, yet permits it to feed with the utmost freedom even when the base of the machine is distorted in clamping to the floor. The other improvement relates to the feed, and provides unusual conveniences in the matter of the making of changes in rate and direction while the machine is in operation.

The outer edge of the table is supported, as shown, by a projecting lip, which bears in a horizontal gibbed slide, vertically adjustable on the standard bolted to the base. This vertical adjustment covers the full vertical movement of the table, so that the support may be used at all times. The slide is provided with a gib, so that the bearing of the table will be at all times closely controlled, and yet be free to feed horizontally. Owing to the length of the slide the bearing surface on the lip is at all times protected from chips, giving a durable surface which does not require to be constantly cleaned. This length of slide also furnishes full support at extreme adjustment in either direction.

The same wrench that loosens the straps for binding the cross-rail to the face of the column, loosens the slide support in the standard at the front of the table, allowing the slide to move freely with the vertical adjustment. Since only two screws are used for the clamping of the slide to the bracket, this adjustment is self-aligning. Even though the base of the machine may be badly twisted out of shape from being clamped down unevenly, the slide will always be true with the lip on the edge of the table, as its alignment is determined entirely by that lip.

The improved feed is shown in a close on view in Fig. 2, and in detail in Fig. 3. The cross-rail is at A and the cross-feed screw at B. This latter is connected by gearing, as shown, with sleeve F, which revolves loosely on stud C. The power feed, is received from the crankshaft by a mechanism which operates in the usual manner, on ratchet-wheel D. One of the points of improvement is the provision of a friction washer E between D and the collar on F, to permit this ratchet to slip on the sleeve whenever excessive resistance is met with in the feeding of the table on the cross-rail. This makes the feed fool-proof, providing enough power for legitimate purposes, but not enough to break any of the parts in case the workman feeds during the cut or allows the saddle nut to strike against the rail at either end. It is preferable

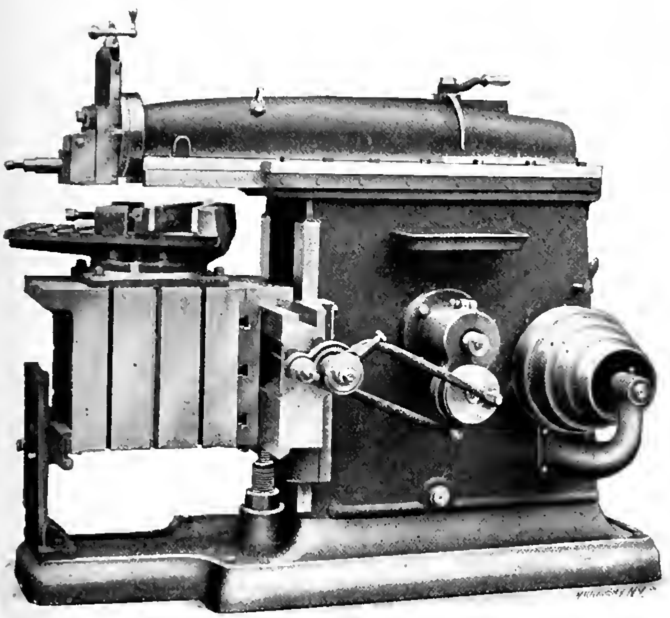


Fig. 1. A Shaper with Self-aligning Outward Support for Table, and Quick-change Feed Mechanism

to the design in which the friction is placed on the feed rod itself, because it is not affected by the vertical adjustment of the rail, and is entirely automatic.

The control of the feed change is unusual. In place of the regulation slotted adjustable crank disk, a simple revolving plate is used, shown at M, which is geared with the main shaft O of the shaper. This is mounted in a swinging case which is connected with the cross-rail by distance rod H, so that the mechanism is unaffected by the vertical adjustment of the work-table. Feed-rod K is pivoted to the revolving plate M, by a latch whose lever is shown at L. By raising this latch the pin is withdrawn from the hole in revolving disk M, though it is still supported by a loose outer cover disk mounted on the same center. The continuous revolution of M brings a second pivot hole N under the latch, which then drops in. This evidently causes the feed to take place on the opposite end of the stroke. Thus, whenever it is desired to change the time of feeding from one end of the stroke to the other, the latch L is quickly pressed and released, when the pin will automatically change its position from one side of the disk M to the other, producing the desired effect.

Feed-rod K, as shown, operates a swinging arm carrying latch J, which may be turned to face in one direction or the other, depending on which direction it is desired to feed the table. A new method of varying the rate of feed is employed. Instead of doing this by varying the arc through which latch J swings, the movement of this part remains unchanged, but it is allowed to pick up more or less teeth of the ratchet through the action of cam G. This is cut away for part of its length, as shown, to permit the latch to engage with the ratchet. It may be so adjusted, however, that it will raise the latch for a less or greater number of teeth, or indeed for the entire portion of the stroke, through the action of its cam surfaces on the pin shown projecting from the side of the latch, and most plainly seen in Fig. 2. Thus,

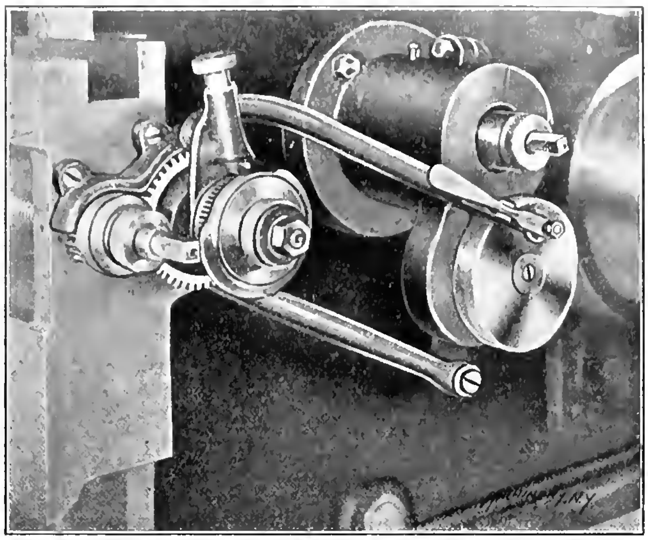


Fig. 2. Near View of Feed Mechanism

by adjusting this cam to different angular positions, it is possible to have from 1 to 16 teeth of movement at each stroke of the ram. When adjusted, it may be locked by means of the nut shown.

This teed mechanism gives 16 changes, varying from 1/64 to ¼ inch stroke on the 24-inch machine, which is here shown. Thus from zero to full feed or reverse, or to and from any number of notches in either direction, can be made instantly

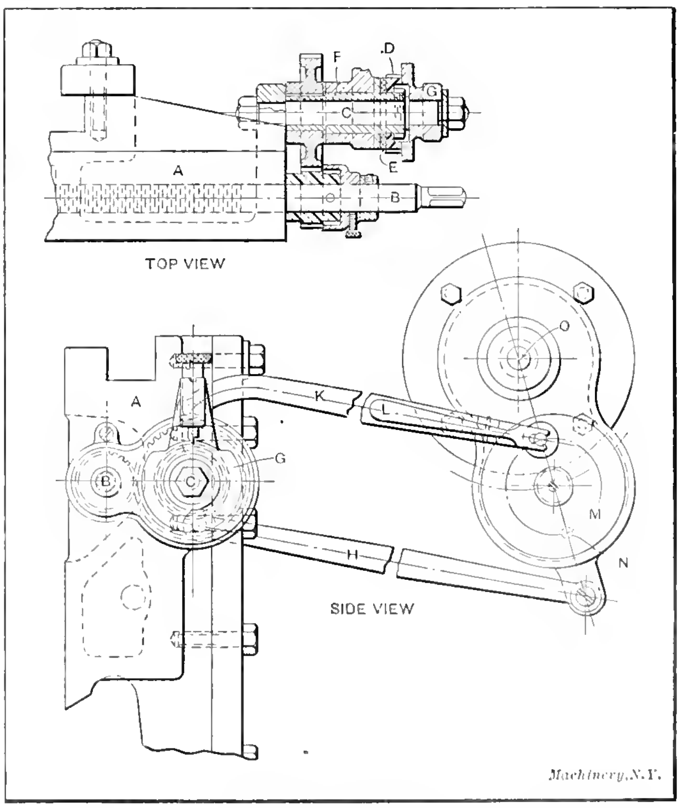


Fig. 3. Details of Arrangement for quickly altering Rate, Direction and Time of Feeding

and with precision while the machine is running. It is the makers' statement that changes can be made on the average in one-fifth of the time required with the ordinary design of feed change, without the danger to the fingers often met with in using the slotted disk arrangement

BEAMAN & SMITH VERTICAL TWO-SPINDLE CYLINDER BORING MACHINE

The accompanying illustrations show a two-spindle vertical boring machine built by the Beaman & Smith Co., of Providence, R. I. It is designed particularly for boring automobile cylinders and is provided with special facilities for

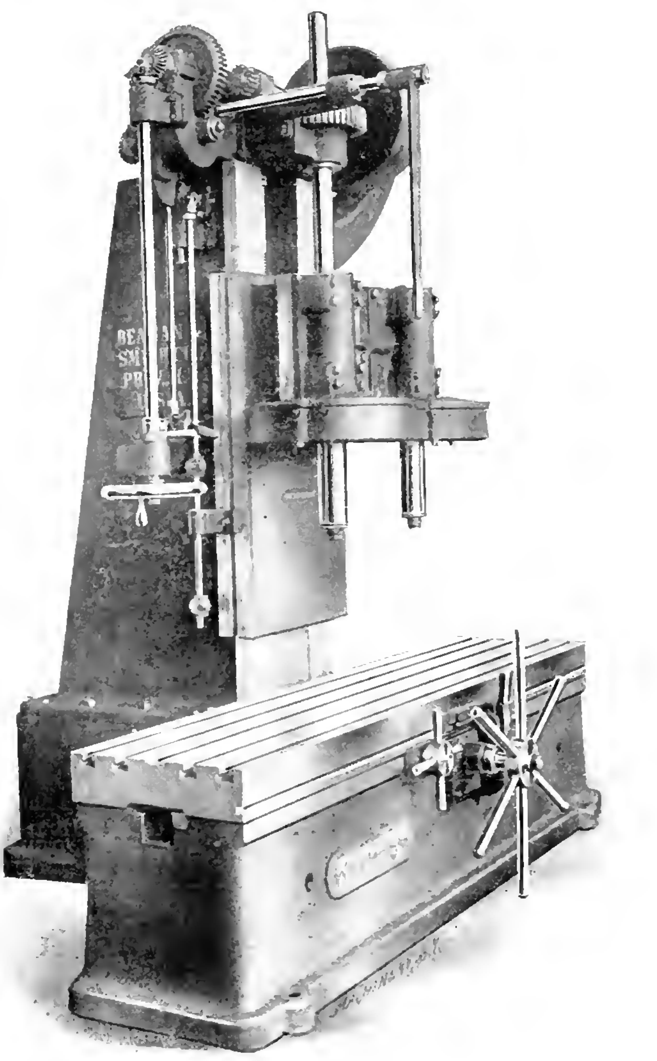


Fig. 1. A Vertical Boring Machine, having a Novel and Effective Spindle Construction

that work, though it will, of course, prove useful for similar operations on other work.

An examination of Fig. 1 gives the impression of simplicity, rigidity and convenience of arrangement; but in addition to these features there are certain important improvements which do not appear on casual examination. One of these is the table adjustment, which facilitates the setting up of the work at one end of the table while the boring is in progress at the other. It also furnishes means for shifting the table to either of two positions at each end, as it is intended that two cylinders of a block of four shall be bored at a time, whether those four be in a single casting or in two double castings. The convenience of the automatic feed and the power quick return, each of which is provided with automatic stop, should also be noted. Special attention is called, however, to the construction of the spindle and the spindle drive, which is entirely new so far as we know. This improved design gives promise of unusual effectiveness in the work for which it is intended.

First, as to the general construction of the machine: The base is of T-shape with long ways in front, along which the work table is adjusted to bring the work into position under the spindle. To the rear extension of the base is bolted a heavy column, on the face of which the double spindle-head is gibbed for its vertical feed. This head has the spindles set to a fixed center distance, but changes in this center distance could doubtless be made, if required, without radical alterations in the rest of the machine. Such a change, of course, would only need to be made for more than two cylinders cast *en bloc*. For single or double cylinder castings, the work itself is adjusted on the table.

In regard to the construction of the spindle head and spindle, it will be seen, first, that a principle used on all similar machines of the same make has been followed—namely, that of extending the sliding surfaces of the head forward (or downward in the case of a vertical machine like this) to or beyond the cutting edges on the spindle. We have referred to this previously; see, for instance, the description of the duplex horizontal boring machine in the October, 1908, number of MACHINERY. This arrangement gives a stiffness of support to the cutting edges which would otherwise be impossible. To express it in colloquial language, the cutting edges have no "leverage" on the slide, and the freedom necessary for the oil between the sliding surfaces is not multiplied so as to permit destructive vibration at the tool point. The cutting edges have a support on the face of the column directly in back of them on a vertical machine, or directly under them on a horizontal machine. This also avoids excessive wear at the forward end of the slide.

This same idea of directness of support has been still further carried out in this machine in an important improvement clearly shown in Fig. 2. Instead of having the spindle solid, revolving in bearings in the sliding head, it is made in the form of a hollow sleeve as shown at *A*, provided with bronze liners *BB*, and revolving on a stationary spindle stud *C*, which is firmly clamped into the bearing head as shown in Fig. 1.

The spindle sleeve *A* is held from dropping off by its attachment to driving gear *D*. This latter is supported by a ball thrust bearing *E*, resting on the shield or gear guard *F*, seen also in Fig. 1. The thrust of the cut is taken directly between the nose of the spindle *H* and the end of stud *C*, through the ball bearing *G*. Adjustment for removing the end play is made by drawing up gear guard *F* by screws provided for the purpose as shown in Fig. 3. This raises driving gear *D* and with it spindle sleeve *A*, leaving the proper

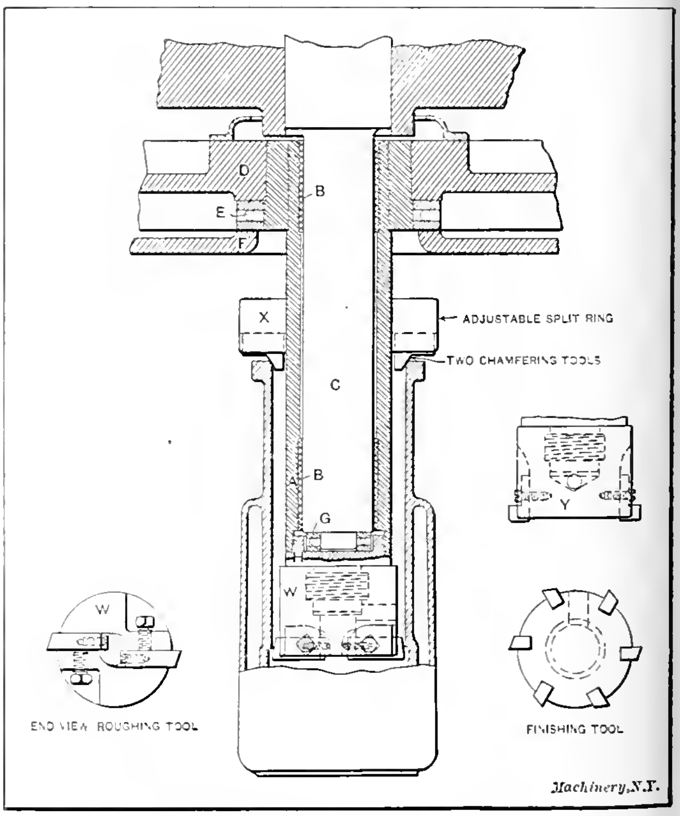


Fig. 2. Sectional View of Spindle Sleeve on Stationary Stem; also shows Cutter Heads used for Cylinder Boring

amount of play for thrust bearing *G*. The two spindles have each their separate driving gears *D*, and are each driven from the same pinion on the lower end of shaft *J*, which is connected by the gearing shown, with the three-step driving cone *K*.

The advantages of this spindle design, for which patent is pending, are obvious. It permits boring with an overhanging spindle which has no overhang to speak paradoxically. By making it in the form of a sleeve, and giving it an internal bearing, this bearing is brought close up to the cutting point, so that the necessary freedom for lubrication is not multiplied at the cutting point, thus carrying out the advantages of the extended slide construction previously described. It would be difficult to imagine a more satisfactory construction for work of this kind. It should also be noted

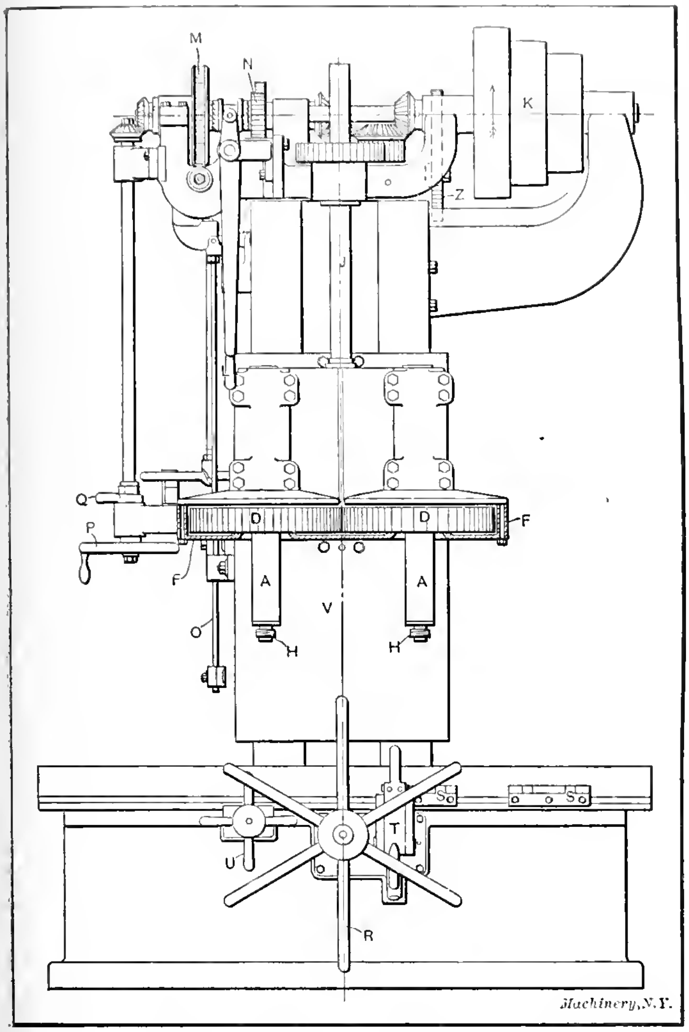


Fig. 3. Front Elevation, showing Feed and Drive Connections, and Arrangement of Table Setting for Changing Work while Machine is in Operation

that the arrangement permits the use of driving gears of large diameter, connected with the spindle close up to the work, so that the power is led to the cutting point by the most rigid and direct means.

As stated, power down feed and power quick return for the spindle head are provided. These movements are controlled by lever *L* (see Fig. 3), which operates a clutch connecting either slow feed worm-wheel *M* or rapid traverse gear *N* with the feed screw driving shaft. Rod *O* is provided with dogs operating automatic stops for both the upward and downward movements. Handwheel *P* may be thrown in or out of engagement by means of lever *Q* for giving a fine hand movement for facing, etc. Thirteen changes of speed are provided, controlled by a change gear box not plainly shown in any of the engravings. The boring head is counterbalanced, making hand and power manipulation easy.

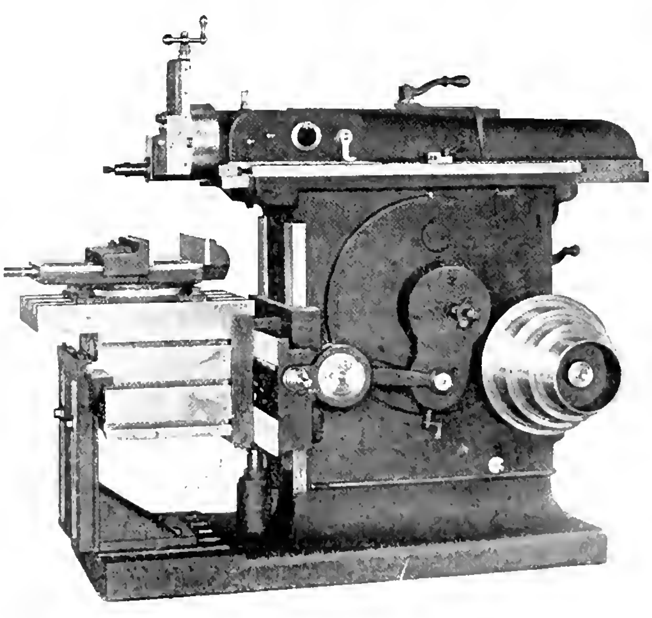
The work-table is shifted to different positions along the bed by the large pilot wheel *R*, which operates a rack and pinion movement. The various positions for lining up the boring spindles with the work are located by templets *SS*, having slots which fit a tongue on latch *T*. By this means, as explained, the table is shifted and located when moving from one pair of a set of four cylinders to the other, or when shifting the table for nearly its full length in moving from a complete set of cylinders to one newly clamped in place. These arrangements permit the changes to be made accurately without measuring, thus reducing the idle period of the machine to a minimum, keeping it constantly employed in actual cutting. Small pilot wheel *U* operates a clamp for locking the table, when it has been located by the pilot wheel and latch.

Fig. 2, besides showing the construction of the spindle, illustrates the style of tools used and the order of operations. The roughing tool is shown in two views at *WW*, mounted in place in the spindle and in an end view. It will be seen to have two boring blades held in place by set-screws, and provided with adjustable abutment screws at the back for setting them out to the right diameter. The head in which they are held is screwed onto the end of the spindle nose *H*, on a 1½-inch lead, triple, right-hand U. S. standard thread, and is provided with a hole for inserting a bar to permit its ready removal in changing tools. On the exterior of sleeve *A* is clamped the split ring *X* (which may be adjusted to any required position on the sleeve), which carries blades for chamfering the outer end of the cylinder as shown. Finishing head *Y* carries six inserted blades held in place by screws and mounted in a body similar to that provided for tool *W*, and held on spindle *H* by the same means.

The work table is 20 inches wide and 6 feet long. The spindles will be spaced to any distance required for special work, and the improved construction readily allows the spindles and spindle studs to be made of a size which will best suit the work in hand.

TWENTY-FOUR INCH STOCKBRIDGE SHAPER

The accompanying half-tone illustration shows a new design of the 24-inch shaper built by the Stockbridge Machine Co., Worcester, Mass. In general, the previous designs of the Stockbridge shapers have been followed, but some important changes have been made in the construction, with an idea of making the machine simpler and stronger, and thus increasing the capacity of the machine. The new shaper is more powerful than the previous designs, which can be judged from the back-gear ratio, which is 30 to 1. Although intended for high duty, the high standard of accuracy of former designs has not been sacrificed, but this feature is combined with that of increased power. The most important improvements are described in detail in the following.



Twenty-four Inch Shaper built by the Stockbridge Machine Co., Worcester, Mass

In previous designs a taper packing was used to take up the wear of the side thrust of the ram, but in the new design a solid gib is used. This gib is bolted to the column. It presents a solid working face for taking the side pressure of the ram when taking a cut, any wear of the gib being taken up by adjusting screws so arranged that they do not interfere with the gib being solidly bolted to the column.

The cross-feed mechanism has been simplified and strengthened. The feed rod is automatically adjusted to any position

of the bar, and without changing its position, the table can be fed in either direction and can be automatically stopped at either end of the required feed.

The method of supporting the driving cone gives exceptional rigidity. The cone is carried on a sleeve which is supported by a large self-oiling bearing, which takes the strain of the driving cone off the driving shaft, and permits the use of a very large bearing. This, in connection with the self-oiling feature, eliminates the probability of the box becoming heated, and the consequent troubles arising.

The direct drive is in the ratio of 6 to 1, and with the back-gears in, the ratio is 30 to 1, as mentioned. The cone drive provides for eight changes of speed to the ram, and the range in strokes obtainable is from 8 to 90 per minute. The change gears are all made of steel, and the driving shafts are carried through on both sides of the machine, having a bearing at both ends. If a gear-box and single-pulley drive is preferred instead of the cone drive shown on the machine illustrated, it can be supplied and attached without difficulty, the parts being interchangeable. In common with all the shapers built by the Stockbridge Machine Co. the machine is equipped with the company's patented two-piece crank motion, which provides for a uniform cutting speed the entire length of the cut, as well as a quick return motion.

Some of the principal dimensions of the new 24-inch shaper are as follows: maximum length of stroke, 24¾ inches; vertical traverse of table, 15 inches; horizontal traverse of table, 30 inches; size of top of table, 16 × 24 inches; length of ram bearing in column, 36 inches; width of ram bearing in column, 12 inches. The countershaft for the machine runs at 300 revolutions per minute, the floor space required is 102 × 52 inches, and the net weight 4400 pounds.

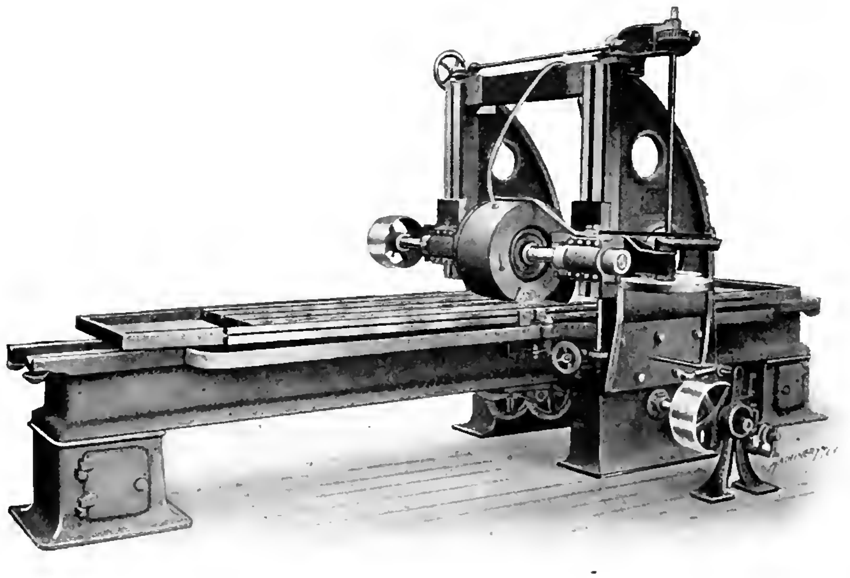


Fig. 1. Oscillating Surface Grinder for Rapid Reduction

TWO STYLES OF SPRINGFIELD SURFACE GRINDERS

The engravings illustrate two new designs of surface grinders, of styles that have been built for some time by the maker (the Springfield Mfg. Co., Bridgeport, Conn.), but which have recently been re-designed throughout to bring them in line with modern requirements for surface work with the emery wheel. The first of these, shown in Fig. 1, is of the "oscillating" type. The second is a motor-driven machine built on the lines of the standard metal planer.

The oscillating surface grinder is the No. 3 automatic size, having a reversing mechanism and other parts similar to the metal planer, with table driven by rack and gearing. It is also made with a screw driven table if the customer prefers. The oscillating feature of the machine will be readily understood from Fig. 1. The wheel, which is 20 inches in diameter by 12 inches wide, is carried on a large and substantial spindle, mounted in two phosphor-lined boxes which oscillate in slides mounted on the cross rail. The oscillation is continuous, and is effected by the crank shown, which receives its power through worm gearing from a shaft on the upright, belted to the countershaft. The crank is slotted so that the width of oscillation can be adjusted to suit the width of work. It will be seen that, as the work table reciprocates back and forth under the wheel, the latter is moved back and forth over the work, cutting a zig-zag path. As the work continues to reciprocate, these zig-zag paths overlap, covering the entire surface in a manner which removes the stock at a very rapid rate. The down feed is effected by a hand-wheel.

The machine is arranged to take care satisfactorily of the cooling compound used for such work. This compound is supplied by a centrifugal pump, shown on the floor in the rear of the driving pulley. Guards, return spouts, settling tanks, etc., are provided, as required. This machine grinds up to 24 inches wide, 18 inches high and 10 feet long. In the particular machine shown the height is special. The standard height takes but 9 inches under the wheel, but will be made to grind a width of from 15 to 30 inches and a length of from 4 to 12 feet.

The motor driven grinder shown in Fig. 2 is known by the makers as the No. 2 automatic planer surfacer. This machine, as may be seen, has the original feature of being entirely self-contained. The motor for driving the wheel is mounted directly above it on the saddle. Proper mechanical means are provided for keeping the belt under suitable working tension. The motor on top of the uprights drives the platen and feeds. This machine also is neatly arranged to take care of the cooling compound, having a centrifugal pump operated from the lower driving shaft. The water supply tube leads directly into the wheel case, so that it is used effectively and without splashing.

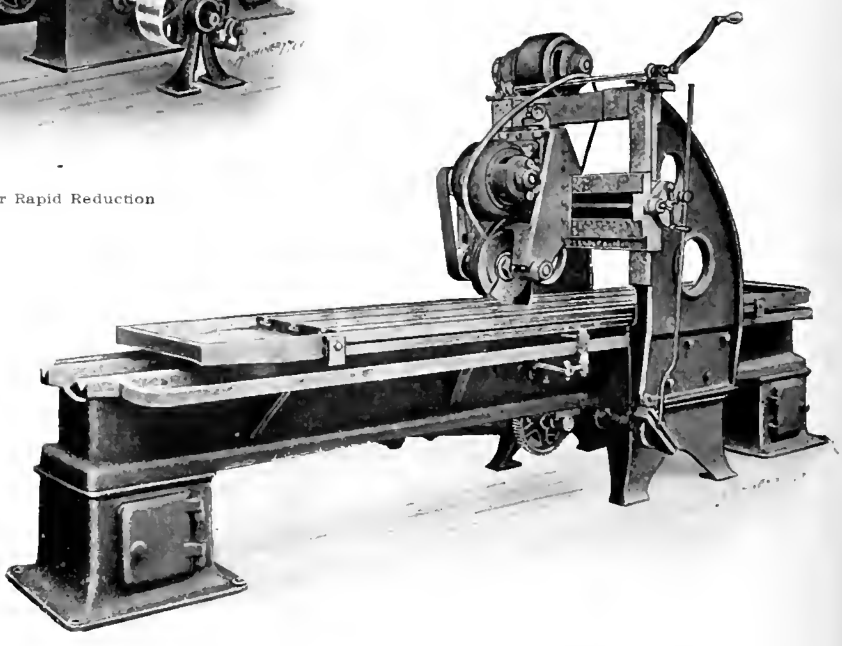


Fig. 2. Plain Type Surface Grinder with Self-contained Motor Drive

This machine, in the size shown, has a capacity for grinding work 8 feet long and 24 inches wide. It is also made in various other lengths, ranging as may be required from 4 to 12 feet. The motor driving the wheel is of 3 horsepower capacity, while that for operating the table mechanism is 2½ horsepower. Both are wired, in the case shown, for 230 volts. The emery wheel is 12 inches diameter, 2 inches face, and has a 2-inch hole.

WATSON-STILLMAN HYDRAULIC BENDING MACHINES

Two new hydraulic bending machines especially adapted for the bending of large pipe, structural sections, automobile parts, etc., have recently been brought out by the Watson-Stillman Co., 192 Fulton St., New York.

The smaller machine, shown in Fig. 1, is capable of exerting a power of 25 tons with a hydraulic operating pressure of 2,200 pounds per square inch. The table of this machine is 2 feet by 3 feet 4 inches, and is provided with 18 round holes staggered in rows as indicated, but systematically placed with regard to the ram. Round pins of 3½ inches diameter can be placed in the holes, and the work to be bent may be further held by bolts set in any of the T-slots provided on the top and sides of the table. Modifications of the table may be made when necessary for special requirements. The ram of the machine has a travel of 8 inches, and is brought back to the starting position by the counterweight shown. The center line of the cylinder is 2¼ inches above the table, but the bending block can be raised higher above the table if required. By making the ram travel in guides, its center line may also be brought below the table. The cylinder head is removable and provided with air passages for removing entrapped air or draining, if required in cold weather. The ram is controlled by a stop and release valve on the side of the cylinder. The frames and cylinders of both this and the larger machine are of cast iron and the cylinders copper-lined. The rams and bending pins are of machine steel, and a positive stop is provided for preventing the ram from passing out beyond the safe limit.

The machine shown in Fig. 2 is capable of exerting a pressure of 30 tons. It is provided with a table 4 by 6 feet, and with two opposed 7-inch cylinders having a 12-inch stroke, arranged to operate in either direction with a double-headed ram extending between them. The table shown in the illustration has 21 holes on each side of the ram, staggered in six rows. The removable pins are 4½ inches in diameter. A large bending pin, shown in the center, is attached to the ram which works in machined guides and is covered, so as to prevent scale or dirt from reaching the contact surfaces. The cylinder heads are removable in this machine, the same

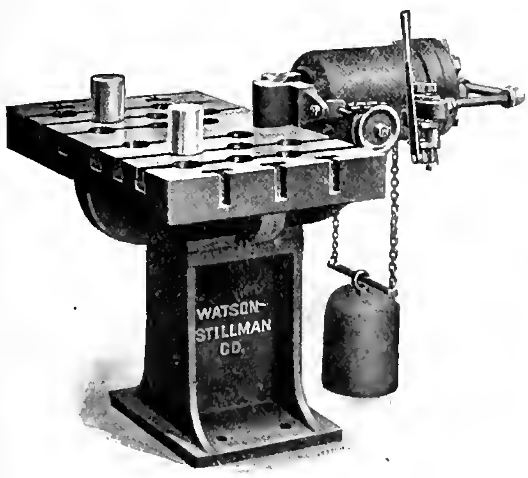


Fig. 1. Twenty-five Ton Watson-Stillman Hydraulic Bending Machine

as in the smaller one, and provided with air passages. The valves, which are all located in one place under the table as shown, may be operated by any of the four levers at the corners of the machine. The arrangement is automatic, so that the opening of the pressure or release valve for one cylinder opens the opposite valve in the other cylinder, the movement being stopped by removing the hand from the operating lever. If required, a pair of bending blocks with hardened steel faces can be substituted for the ram bending pin. The cylinders may be placed higher in relation to the surface of the table, if desirable. In such a case, the rams are usually made independent and single-acting, and returned by counterweights the same as in the smaller machine.

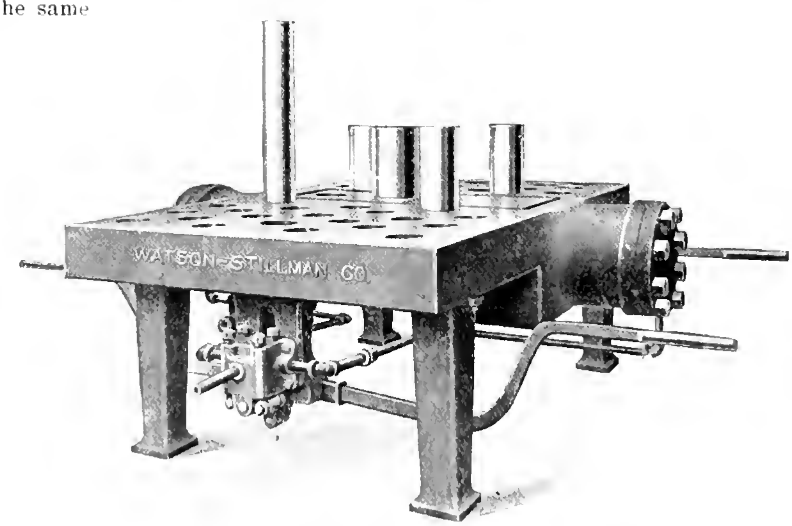
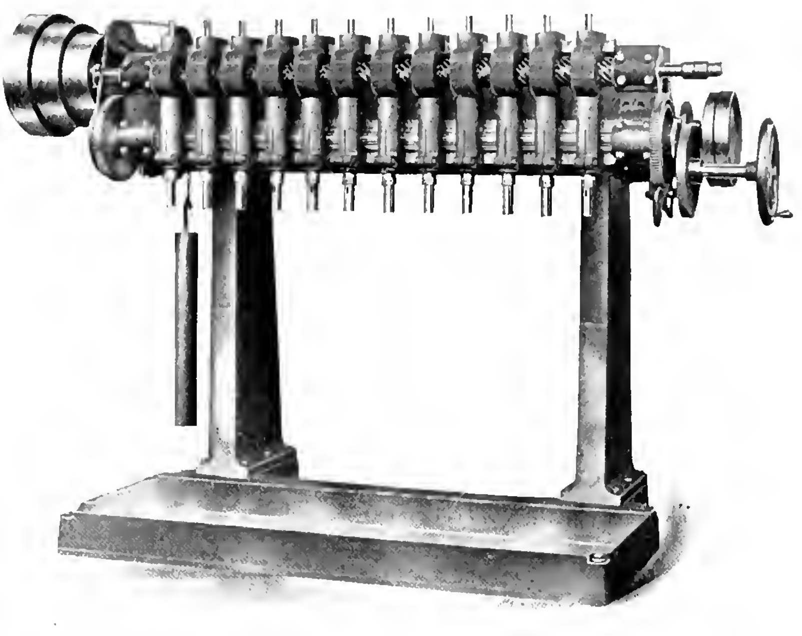


Fig. 2. Watson-Stillman Bending Machine of Larger Capacity than that shown in Fig. 1

MOLINE MULTIPLE SPINDLE DRILL WITH BASE PLATE AND SPINDLE FEED

The multiple spindle drill shown herewith is No. 31 of the line made by the Moline Tool Co., Moline, Ill. It employs the same driving principles as used on other machines of this line which we have previously illustrated (see, for instance, the two machines described in the department of New Machinery and Tools of the February, 1910, issue of MACHINERY) but differs from them in that no work-table is provided, requiring the feed to be applied to the spindles. The machine is, therefore, intended particularly for medium or large-sized work mounted on special fixtures, or clamped directly on the base-plate of the machine.



No. 31 Moline Multiple Spindle Drill, with Feed applied to Spindles

The spindles are carried in steel quills, bronze bushed, with feed racks cut in the solid metal. These racks mesh with a pinion extending the whole length of the cross-rail of the machine, permitting the spindle heads to be adjusted freely without disturbing the connections, in the same way that the helical driving gears for the spindle are shifted to any position on the long helical driving gear on the cross-rail. A feed of 6½ inches is provided for, and each spindle has an independent vertical adjustment of 2 inches, permitting the use of drills of various lengths in the various spindles.

A three-step cone drives the machine. A pair of two-step cones at the right of the machine operates the feed; the driving cone of the pair is of very small diameter, as shown, and is mounted on the right-hand extension of the driving shaft. The geared connections will be readily followed in the engraving. The long feed pinion is driven by gears at each end, to lessen the torsional deflection resulting from its great length. An automatic feed stop is provided, operated by a dog adjustably mounted in a circular groove, cut in the rim of the feed gear on the right end of the pinion shaft. This operates the levers shown, to throw out the feed clutch, when the desired depth of hole has been drilled.

The machine will be built in any reasonable width, with any number of heads. The greatest distance from the spindle to the base is 41 inches, and from the face of the column to the center of the spindle, 12½ inches. These spindles can be adjusted to within 3 inches of each other; the maximum length of layont in this particular case is 5 feet. The machine will drive any drill up to ⅝-inch diameter. It will be furnished with adjustable table when desired.

ADJUSTABLE SCREW CUTTING DIE

An improved design of adjustable screw cutting die has recently been brought out by the Remington Tool & Machine Co., Boston, Mass., the die being known as the "Perfection" screw cutting die. As shown in the accompanying illustration Fig. 1, the die is made in two sections, with a hinge formed integral with one of the parts. The adjustment is accomplished by means of a taper pin entering into a tapered hole, one half of which is located in each of the die halves as shown. The taper pin is placed on the end of the adjusting screw passing through the die holder shown in Fig. 2, so that the size of the die can thus be adjusted without removing it from the holder. When properly adjusted and clamped in the holders, shown in Figs. 2 and 3, it can be considered practically as a solid die.

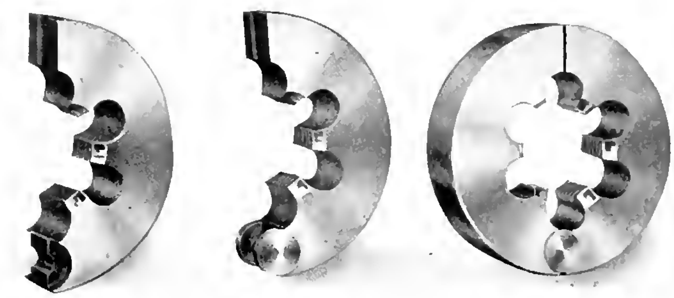


Fig. 1. The Remington Tool and Machine Co.'s Adjustable Threading Die

One of the most prominent features of the die is that it can be ground on the cutting edges after hardening, the teeth being easily accessible. There is ample clearance for an emery wheel or for lapping with diamond powder. In case particles of metal become lodged between the teeth of the die, it can also be easily cleaned. The advantage of being able to grind the cutting faces of the die adds both to its efficiency and economy. The tearing of the thread of the piece to be cut, which is an evidence of a dull die, is avoided when this die is kept in proper condition, and the life of the die is increased considerably by being able to sharpen it whenever dull. On account of its construction, breakage due to extreme adjustment is also impossible, and this loss thereby eliminated.

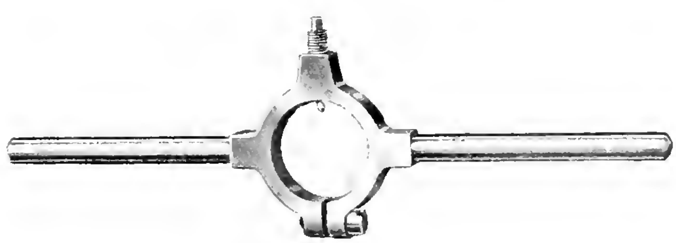


Fig. 2. The Remington Elastic Die Holder

Figs. 2 and 3 show two holders adapted for use with these dies. The dies can, of course, be used in ordinary standard die holders, but the so-called elastic holder shown in Fig. 2 is especially adapted for this die. A holder for use in the lathe, embodying the same features as this holder, is shown in Fig. 3.

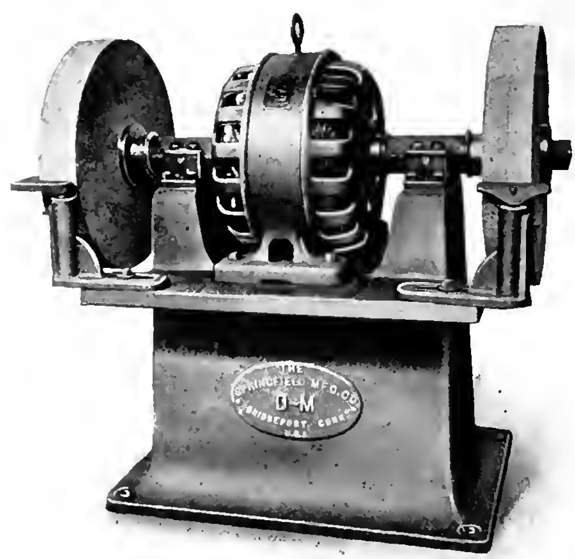
As an interesting example of the capacity of these dies, the makers state that one of them has been in daily use for over four years cutting the threads on over 6,000 chuck heads in that time, and this die is still performing satisfactory service.

Fig. 3. Die Holder for Use in the Lathe

THE SPRINGFIELD MOTOR-DRIVEN DRY GRINDER

The emery wheel stand shown herewith is an original design, developed by the Springfield Mfg. Co. of Bridgeport, Conn. The special feature is the arrangement which permits using a standard, stock motor with a regular armature, the only change being in the shaft. The shaft is mounted in self-oiling bearings, 2 inches diameter and 8 inches long.

The motor used is a Westinghouse alternating-current 5-horsepower machine ,of suitable speed for wheels 24 inches diameter and 4 inches face. It will be noted that an open type machine is used. This is possible only with the alternating motor, where there are no delicate parts such as commutators, etc., to give trouble from grit and dust. In cases where the purchaser prefers it, an entirely closed motor will be furnished, either of the alternating- or direct-current type. The makers of the particular motor shown claim that it does not require expensive starting apparatus, a regular knife-throw switch being all that is needed.



Electrically-driven Grinding Stand adapted for use of Stock Sizes of Alternating Motors

ROBBINS NEW MODEL 14-INCH ENGINE LATHE

Fig. 1 shows a new engine lathe made by the Robbins Machine Co., of Worcester, Mass. As may be seen, it is of plain, straightforward design, with simple lines, and is devoid of complicated mechanism. These features were intentionally followed, as it was the desire of the manufacturers to produce a lathe of the simplest possible construction, departing in no

important respects from designs whose value has been proved by time; along with this, however, it was desired to produce a lathe which should have a greater cutting capacity than any other machine of its size on the market. The manufacturers have been very well pleased with the results of their endeavor in this direction.

It is needless to say that great stiffness has been given to the main castings. The V's, centers, lead-screw and other parts are the same size as previously used on the makers' line of 18-inch standard engine lathes. It is strongly back-geared, and the proportions are such as to obviate chattering. The spindle is made from crucible steel, accurately ground and fitted to scraped bearings of the best phosphor-bronze. The tailstock also has a crucible steel spindle, and is cut away to permit using the compound rest parallel with the ways. The carriage is of rigid design with long bearings on the ways, and has the compound swivel and screw graduated for convenience in adjusting. The bed is of box design, heavily braced with cross-girders.

Coming down to the details of the mechanism, the provision of a geared feed of suitable range, with quick-change control, is an important point in keeping the machine up to its full output. As may be seen in Fig. 2, which shows the gear-box from the rear removed from the lathe, the mechanism is of the tumbler gear type, and provides for four changes of feed. The driving gear is mounted on the lead-screw driving shaft, so that the changes apply to the feed only. An automatic stop for the feed is furnished. An adjustable collar is mounted on the feed-rod. When the feed-rod bearing in the carriage strikes this collar, it moves it endwise, disengaging the clutch shown at the lower right-hand corner of the opening in Fig. 2. As may be seen in Fig. 1, the lead-screw may be disengaged from the feed box when using the rod feed. For setting up for screw cutting, the regular change gears are used, of course.

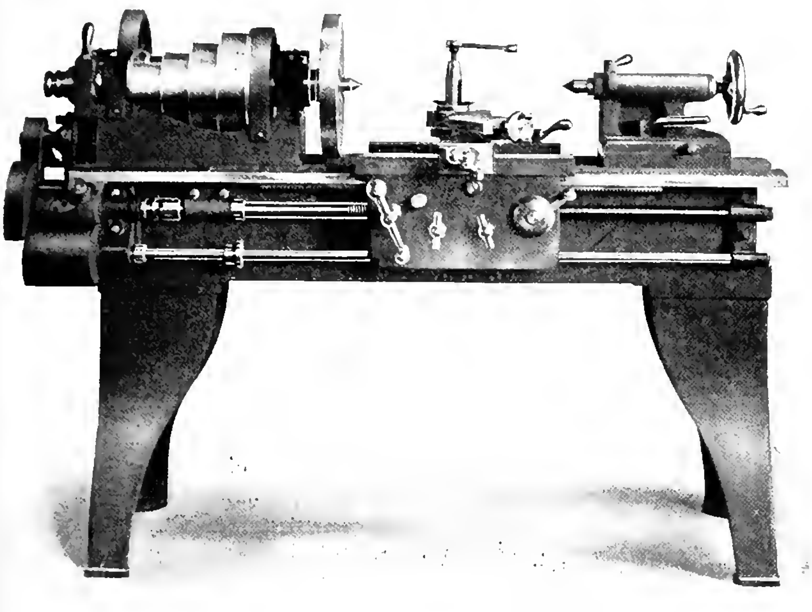


Fig. 1. An Engine Lathe of Standard Lines, designed for Rapid Reductions

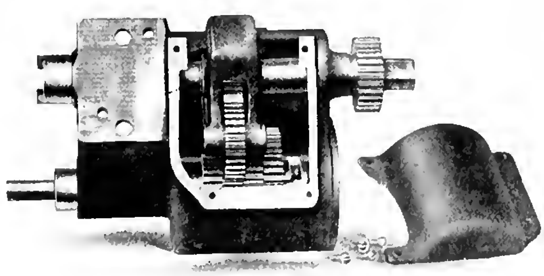


Fig. 2. The Quick-change Feed Box, which gives Four Ratios

This feed box has been so designed in its ratios as to give the range of feeds required for ordinary turning operations. Owing to the positive connections, these feeds are maintained in a way that is not possible with the ordinary belt drive. The feed changes can be easily operated while the lathe is in motion, and in the middle of a heavy cut. It is constructed in a substantial manner, using steel gears cut from solid stock.

Fig. 3 shows a rear view of the apron. The construction is noticeable for its simplicity. Separate worms are used for the carriage and cross-feeds, that for the latter being double-threaded. The construction of the feed frictions is plainly shown. The cams and fingers for expanding the friction rings are made of hardened steel. A screw is provided at the base of the expansion fingers for taking up the wear, or increasing the gripping power of the ring. The rack-pinion can be pulled out and disengaged when cutting screws. It will be noted that this pinion is supported in a double bearing, close to its point of engagement with the rack.

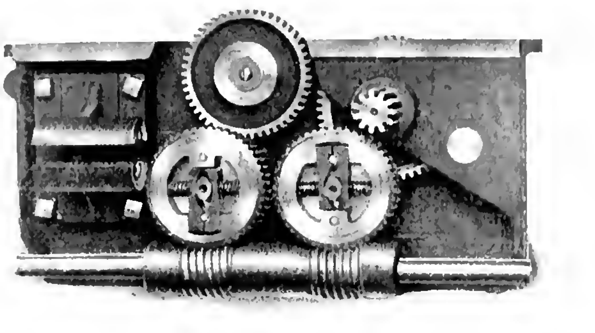


Fig. 3. Rear View of Apron, showing Simplicity and Directness of Mechanism

The headstocks will be furnished with a three-step cone if desired; in either case the speeds are arranged in geometric ratio. In the three-step design, the diameters on the cone pulley range from 5 to 9¼ inches; in the four-step design from 4 to 9⅝ inches, using 3½- or 2½-inch belts, respectively. The back-gearing ratio is 9 to 1. The front spindle bearing is 2¼ by 4¼ inches. The lathe has a 1 1/16-inch hole through the spindle, with a No. 4 Morse taper hole for the center. Change gears are provided to permit the cutting of threads from 3 to 30 per inch. The lathe with a 6-foot bed takes 36 inches between centers, and weighs complete 1600 pounds. This lathe swings 15 inches over the bed. It will also be furnished to swing 16 inches over the ways with an extra heavy headstock, tailstock and carriage, and with a four-step cone for a 3-inch belt.

The makers have found, after severe tests, that this tool has a reduction capacity great enough to use modern high-speed steels on cuts as great as the manufacturer can afford to use without wasting stock. The lathes are carefully tried out when completed, and are guaranteed in every respect.

CINCINNATI PORTABLE ELECTRIC RADIAL DRILL

The accompanying engraving shows a portable electric drill (made by the Cincinnati Electrical Tool Co., Cincinnati, O.), so mounted as to form a drilling machine of the "Scotch" radial type. When mounted in this way, it is evident that the machine is well adapted to portable use, on work up to the very largest size, to the top and sides of which it may be conveniently clamped by the slotted base in which the column is seated.

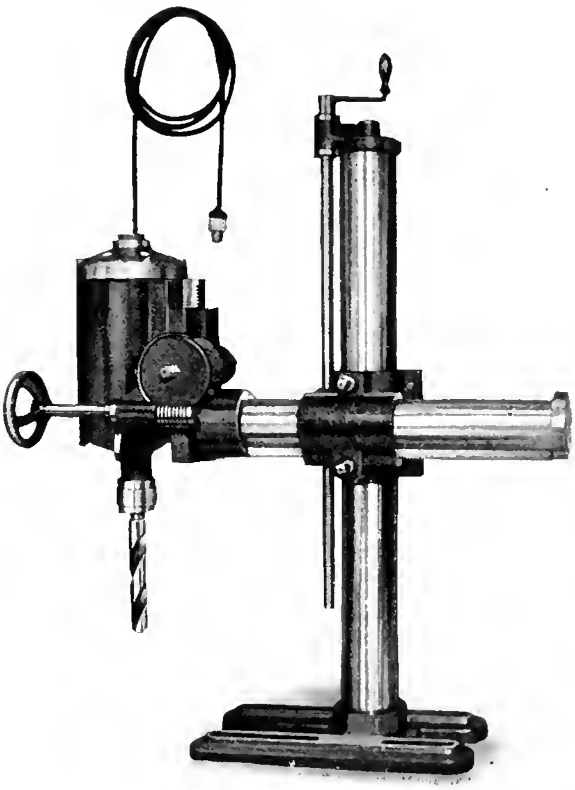
The arrangement consists essentially, as may be seen, of a standard design of geared electrical drill, mounted on a rack and pinion slide at the end of a horizontal arm, which is itself horizontally and vertically adjustable on the main column of the attachment. The columns are made of heavy seamless Shelby tubing, ground accurately to size, thus giving good fits and making the adjustments easy.

The vertical adjustment is effected by the screw shown which is suspended from a ball bearing bracket at the top,

which permits the whole drill to be swung around the central post in a way similar to the regulation radial machine. The in-and-out adjustment of the horizontal arm through the saddle is effected by a rack and pinion movement, as shown. The rack and pinion vertical feed of the machine at the end of the horizontal arm is controlled by a handwheel and worm connection, which permits a steady even feed. The worm gear-box swivels so that the handwheel may be set to any position throughout the circle, as may be most convenient for feeding. The worm may be thrown out of engagement at any time to permit the rapid adjustment of the drill.

The motor is shunt wound, and thoroughly ventilated by means of a self-contained fan mounted on the armature shaft. Ball bearings are used for the shaft, as the makers have found them to give results superior to bronze bushings in the matter of wear, the latter having been found to allow the armature and pole pieces to rub in a comparatively short time. The reduction gearing is made of hardened steel, and is enclosed in a gear box at the lower end of the machine. This is filled with lubricating grease, which reduces the friction and the wear on the machine to a minimum. A balanced internal gear drive is used, overcoming any cramping strains on the motor.

The machine can be quickly attached to a lamp socket by



A Portable Electric Drill of the "Scotch Radial" Type

means of the cable shown. It will be found useful particularly for bridge work, boiler shops, and all kinds of drilling and reaming on heavy work. It is made in three sizes, capable of driving 3/4, 1 1/4 and 2 1/4-inch drills, respectively. The illustration shows the 2 1/4-inch size. This machine has a vertical adjustment of 42 inches on the main column, a horizontal adjustment of 24 inches, and a feed of 4 1/2 inches.

OESTERLEIN NO. 25 UNIVERSAL MILLING MACHINE

We herewith illustrate and describe a new design of universal milling machine developed by the Oesterlein Machine Co., Cincinnati, Ohio. The machine has been changed in a number of particulars, principally as to the column, the quick change feed box, and the dividing head. Figs. 1 and 2 will serve, without extended explanation, to give an idea of the simplicity of the machine, the large proportions of all its main parts, and its rigidity. We can, therefore, pass to a description of the improvements in detail, without further preliminaries.

The feed box is on the right-hand side, back of the column, as shown in Fig. 2; the line engraving Fig. 3 gives details of the mechanism. It is connected with the spindle through a roller chain which drives sprocket wheel *A*. This in turn, drives, through shaft *B*, the sliding gears *C*, *D*, and *E*, which can be shifted axially as a whole to either of the three positions, so that *C* engages gear *F* on shaft *G*, or so that *D* engages *H*, or so that *E* engages pinion *J* on the same shaft. Three rates of speed are thus given to shaft *G*. These changes are effected by handle *K* on the front of the box which, through the rock shaft and lever shown, operates pin *L*, engaging a recess in the hub of pinion *C*. On shaft *G* are mounted four gears, *F*, *M*, *N*, and *O*, any one of which may be engaged by a sliding tumbler *P*, controlled by handle *Q* on the outside of the feed box. This transmits the motion to the telescopic shaft *R*, through which the feed is taken to the work table in the usual manner.

The three changes given by handle *K*, and the four by handle *Q* thus combine to give 12 rates of feed, any one of

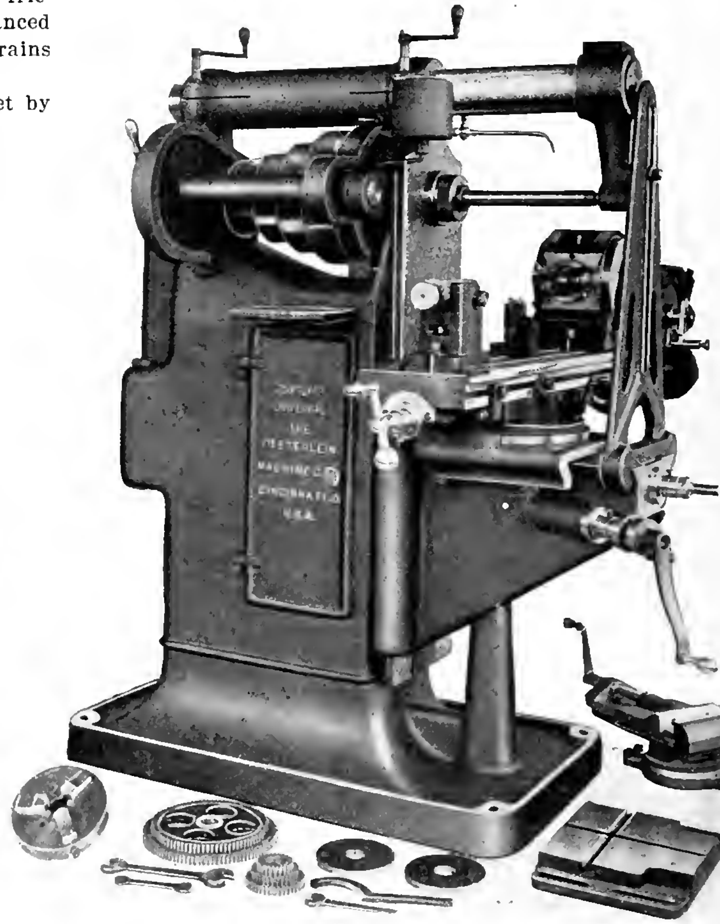


Fig. 1. No. 25 Oesterlein Universal Milling Machine

which is instantaneously obtainable. The gears in the feed box run in oil; provision is made to readily drain this oil when a clean supply becomes necessary. A direct reading index plate is attached to the feed box, from which the exact amount of feed per revolution of the spindle is read.

Fig. 4 shows the dividing head as arranged for plain indexing, without the spiral attachment. Fig. 5 shows a rear view of the head geared up for spiral cutting; a front view with the same setting is shown in Fig. 2. Fig. 6 is a sectional view of the head showing the internal mechanism. The design provides for dropping the worm out of contact with the wheel for direct indexing. It also provides for making adjustments between the worm and wheel for taking out the back lash. Means for clamping the work spindle in any desired position is also furnished. Suitable clamping arrangements for the index plate permit the use of either plain indexing or spiral cutting. The way in which these various features are provided for will be understood from the following description.

The main head casting or swivel block *S*, has a range of angular adjustments from 10 degrees below the horizontal

to 10 degrees beyond the perpendicular. It is clamped in any position between these two extremes by means of bolts T (the nuts for which are seen in Fig. 5), which engage V-blocks turned to fit the V's shown at a. These bolts are sufficiently far apart to hold the adjustments very rigidly.

The spindle U is of crucible steel, and has a taper bearing for its entire length except on the seat required for the dividing worm wheel V. It may be firmly clamped in any position by a wedge pin having a 60-degree angle milled on one end, to fit the sixty-degree groove in the spindle, shown at b. This wedge pin is operated by the small cross handle screw seen on a level with the axis of the swivel block in Fig. 5. The spindle is furnished with means for taking up wear in its journals.

The worm wheel V is made of bronze, and the worm shaft and worm W are made of tool steel, in one piece. The worm has a bearing at one end in trunnion X, which is hinged at c, while the inner end is supported by bearing Y. The latter rests in a suitable sliding support, hung to the pivot of engaging crank Z, which, as shown in Fig. 5, projects through the back side of the head, where it is provided with a cross-

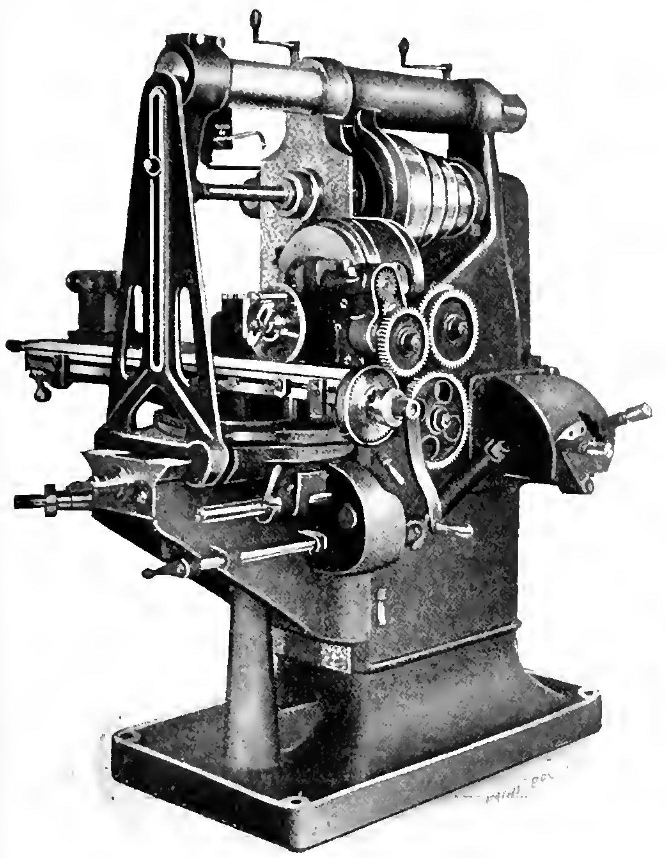


Fig. 2. Right-hand Side of Oesterlein Universal Milling Machine, showing the New Feed Box

pin for operating. By turning Z, worm W may be rocked about trunnion center c to bring it into engagement with wheel V, or dropped out of engagement so that V revolves freely.

The purpose of this is to permit direct indexing on worm wheel V, which is as shown, provided with a row of holes at d, which are in line with direct index pin A_1. This latter is entered into the holes or withdrawn from them by eccentric handle B_1, which projects through the top of the swivel block in front, as shown in Fig. 4. By using this, when worm W is thrown out of engagement, quick indexing is provided for 1, 2, 3, 4, 6, 8, 12, and 24 divisions. The front shoulder of spindle U has 24 graduations in plain view, corresponding with the small holes d on the worm wheel. Pin A_1 is hardened, and the point is tapered so that the indexing is done accurately and securely.

The engaging crank Z, for raising or dropping worm W, is itself fitted in an eccentric bushing C_1 which may be rocked slightly to take up any back lash between V and W, thus making allowance for wear as fast as it may occur. The adjustment raises the engaging crank, and consequently the worm, and brings it more closely into engagement with the wheel.

A point that should be noted in this dividing head is the

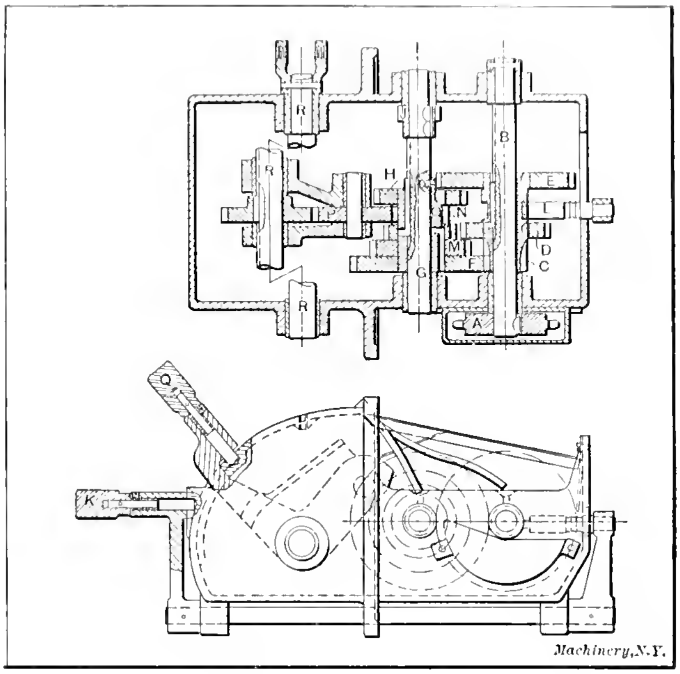


Fig. 3. The Mechanism of the Feed Box

fact that the index crank E is mounted directly on worm shaft W, instead of being connected through gearing, as is sometimes the case. This makes for accuracy in the indexing. Index plate F_1 is screwed firmly to sleeve G_1. Provision

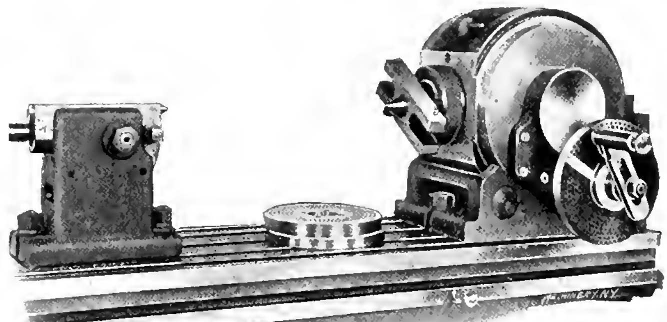


Fig. 4. Plain Dividing Head adapted for all Forms of Indexing Work except Spiral Cutting, and used on the Plain Milling Machine

is made for locking G_1 to trunnion X for direct indexing. When cutting spirals G_1 is, of course, free, being rotated through gears H_1, J_1, and the connections shown in Figs. 2 and 5. The change gear mechanism connecting with the

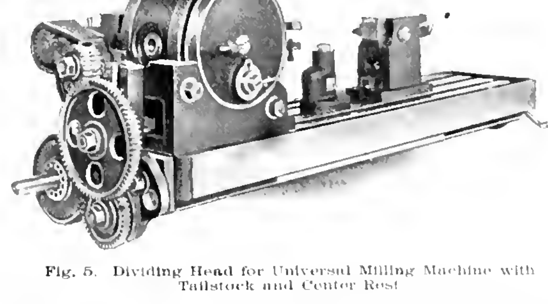


Fig. 5. Dividing Head for Universal Milling Machine with Tailstock and Center Rest

lead screw gives provision for compounding, and for reversing the motion as well in cutting right or left-hand spirals. The support for the gears is very rigid, as may be seen. This assists materially in taking substantial cuts on spiral work.

With this new design of dividing head is furnished a set

of change gears, three double dividing plates, a tailstock and a center rest. The three plates will index up to 100 on even divisions, and on those divisible by 5 up to 200, and many others besides. The tailstock is so arranged that it can be swiveled to any angle that may be required for milling tapered work. An efficient clamping device for the center is furnished.

REED 14-INCH EXTRA HEAVY LATHE

The F. E. Reed Co., of Worcester, Mass., has recently built an extra heavy 14-inch lathe, with plain rest and power cross-feed. This tool is shown herewith. It is particularly adapted to the rapid production of automobile, motor boat, engine and similar parts. The makers state that the construction throughout is the heaviest ever used for a lathe of this swing, and that it has all the power and stiffness of the commercial 20-inch lathe.

The head is back-geared and driven by a 3-step cone, having diameters, respectively, of $7\frac{1}{2}$, $9\frac{3}{4}$ and 12 inches, for a $3\frac{1}{4}$-inch belt. The back-gears are made with corresponding strength. The ratio is 3.62 to 1, which gives a range of spindle speed well adapted for the work to be done. The spindle itself is a crucible steel forging with a $1\frac{1}{8}$-inch hole bored through it. The spindle boxes are of cast iron, lined with genuine babbitt metal, firmly seated in dove-tail slots. The front bearing is $2\frac{3}{4}$ inches diameter by $6\frac{5}{8}$ inches long. All the bearings are provided with ample oiling facilities.

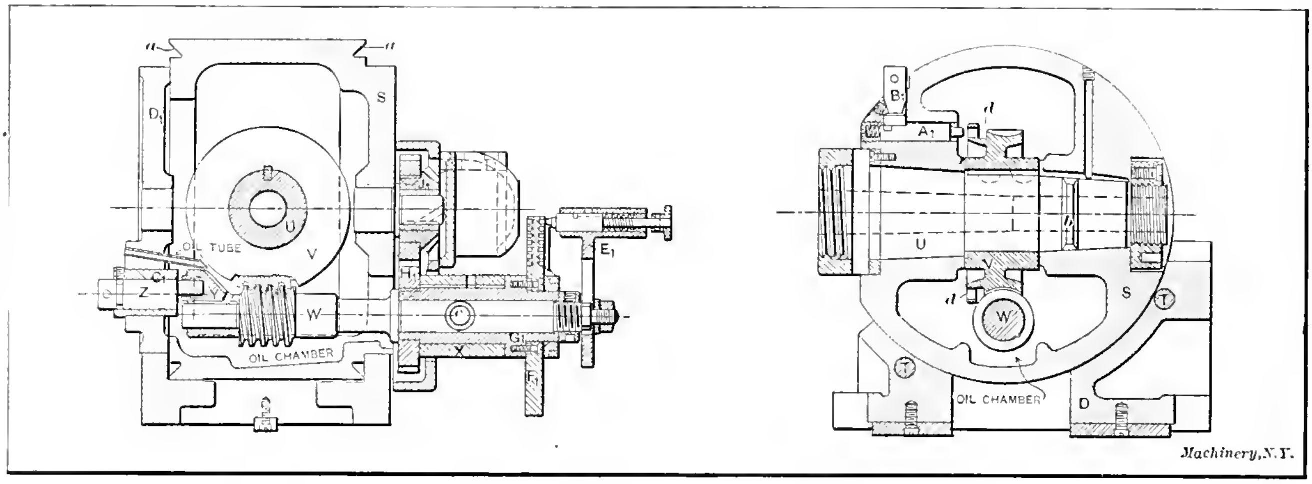
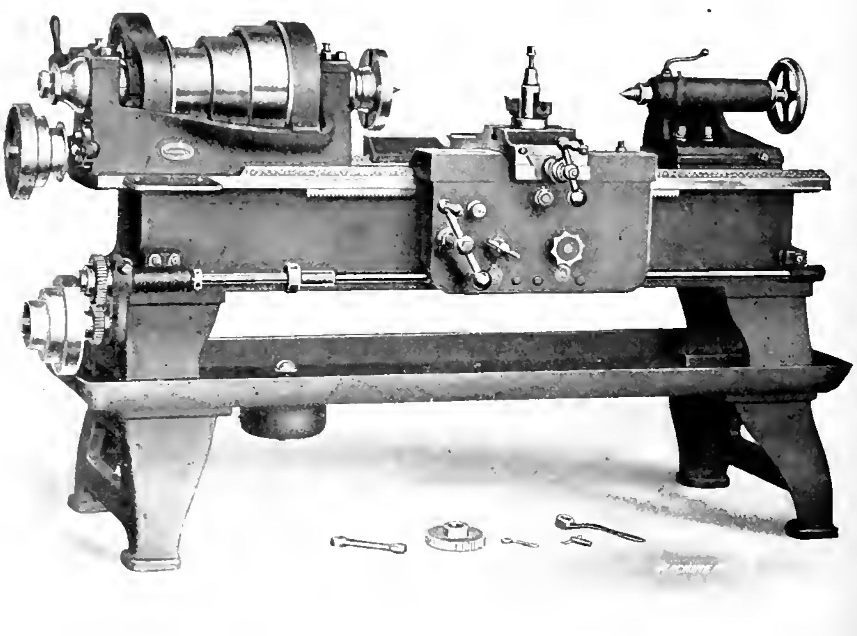


Fig. 6. Mechanism of the Dividing Head showing Direct Indexing Device, Worm Adjustment, etc.

The tailstock of this lathe is of the standard cut-away pattern, held to the bed by two heavy bolts. It can be set over for turning tapers. The tail spindle bearing is $2\frac{3}{8}$ inches diameter by 8 inches long. A special heavy plain rest is furnished on the carriage, having an unusually wide and deep dove-tail slide. The cross-feed screw is provided with a graduated dial. The carriage bears on the V's for its entire length, and is gibbed both inside and outside of the bed.



Special 14-inch Lathe of Unusual Weight, for Automobile and Similar Work

The feed is driven through 3-step cones of unusual diameter and belt capacity. This, in combination with the worm-gearing in the apron, allows ample power for the heaviest cuts. The lower feed cone is mounted on a swiveling arm as shown, so that it may be adjusted to maintain the proper belt tension. An extra feed gear gives six changes in all. The apron is deep and heavy, and is provided with the makers' patented integrally connected bearings for both feeds. As the tool is intended particularly for heavy turning and facing, it is not regularly made with a lead-screw, though this can be furnished at an extra charge if desired by the purchaser.

The lathe is supplied with a steel oil pan as shown, for which an extra charge is made, or it is mounted on regular legs without the oil pan. On the countershaft provided, the loose pulley can be oiled while running, and the hangers have self-oiling boxes. The lathes are made for tools having $\frac{5}{8}$-inch by $1\frac{1}{4}$-inch shanks.

BAKER TWO-CYLINDER AUTOMATIC CYLINDER BORING MACHINE

The tool herewith illustrated and described is for boring automobile and similar cylinders, and was designed and built by Baker Bros., Toledo, Ohio. The machine is of original design throughout, with many unusual features in the mechanism, structure, and materials employed. Among the most noticeable of these innovations may be mentioned the use of chrome vanadium gearing, oil-treated nickel steel shafting, and Hess-Bright ball bearings.

It might be a good plan in describing the machine to state first the particular points aimed at in the design. These points the maker enumerates as follows: General rigidity; powerful, smooth drive; adjustment for wear in spindle bearing, combined with substantial anti-friction thrust; screw feed for table; automatic operation; adjustable center distances for spindle, without sacrifice of rigidity; accuracy of alignment; efficiency of driving mechanism; economy of floor space; and adaptability to motor drive. In describing the machine we will take these points up in the order given.

To secure the desired rigidity, the frame has been made of heavy cored box sections, reinforced by internal ribbing, with broad gibbed surfaces for the table slide and for the heads. The side view in Fig. 2 shows plainly the massiveness of con-

struction. The weight of the complete machine is about 5000 pounds. This in itself gives evidence that weight has not been spared in the design.

The consideration of smoothness and power for the spindle drive is most important, and it is, as well, somewhat difficult of attainment where the spindles have to be set as closely together as in this case. In securing smoothness and power the first point determined on was the use of a single speed drive with a two-speed countershaft, allowing a direct connection through to the spindles. As the machine is expressly intended for manufacturing, it will be set up for one job and run on that for a year or more at a time, so there is no occasion for experimenting with speed changes. It is thus possible to drive the first spindle direct from the driving pulley through a worm and worm gear. The second spindle is driven in the same manner by a shaft parallel with the pulley shaft, driven from it by equal spur gears. The use of double driving shafts also allows the two driving worm gears on the spindles to be placed in different planes, overlapping each other so that larger diameters can be used than would otherwise be possible.

withstand pressure far beyond that ordinarily applied to balls of the size used.

To insure a smooth, uniform table feed, a screw is used for this motion in preference to a rack and pinion. This is clearly shown at A in the sectional drawing, Fig. 3. This screw is normally stationary, being fed by a nut B, revolved by bevel gear C for the power feed. It may be turned at will, however, by the hand-wheel shown to the right of the table, connected with it through helical gears D. These two connections are entirely independent, so that the hand feed may be used in either direction whether the power feed is engaged or not.

Three rates of feed are controlled by handle E. This, through the pinion on the lower end of the shaft on which it is mounted, operates sliding rods F and diving key G, which may be made to engage any one of the three gears H, H_1 and H_2, meshing with the corresponding gears J, J_1 and J_2 on feed driving shaft K. By this means feed shaft L is given three speeds, transmitted through bevel gear C to the revolving feed

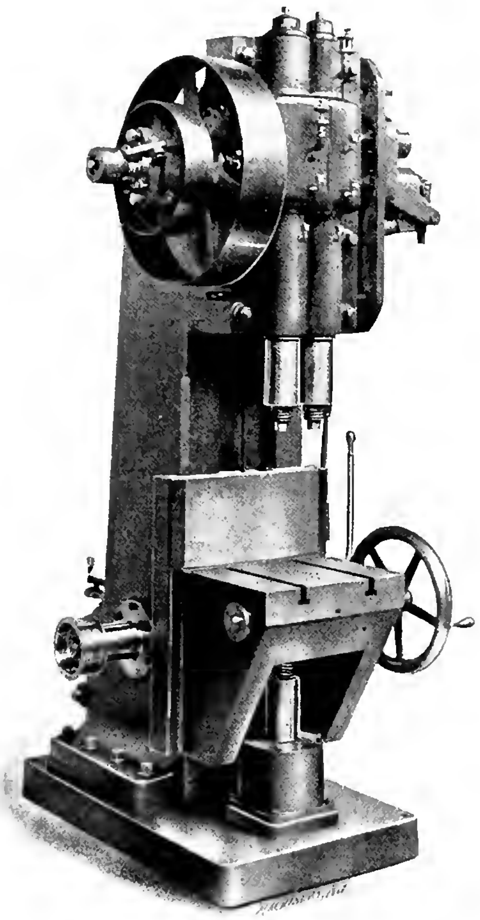


Fig 1. Baker Two-cylinder Automatic Cylinder Boring Machine

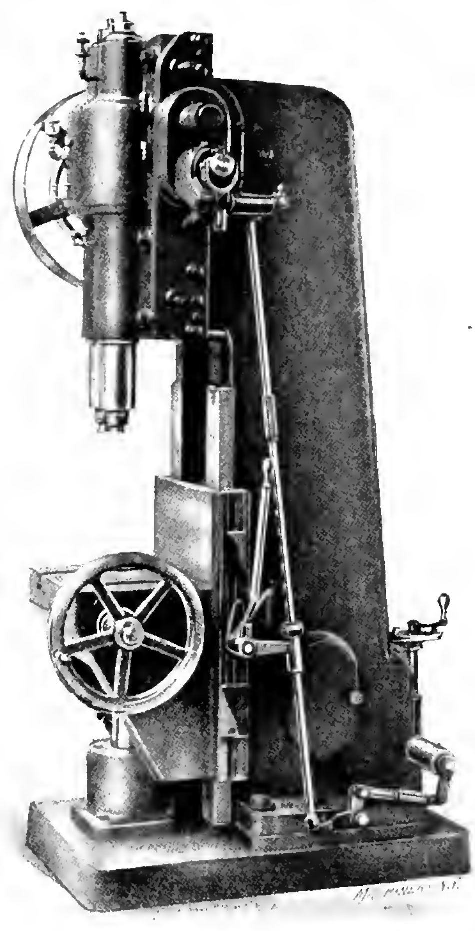


Fig. 2. Side View of Machine, showing Automatic Control for Spindle, Feed and Quick Return

The driving pulley is 24 inches in diameter for a 5-inch belt, and the reduction in the worm gears is eight to one. Particular attention has been given to so proportion the worm gearing as to give an efficient drive. The hardened steel worms have a two-inch lead, and the thrust is taken on ball bearings. The worm gears are of high-grade phosphor-bronze. The size of the worm gears, together with the simplicity of the drive, has given a very smooth, powerful and efficient transmission, which has shown its effect in the fine finish given the cylinders under rapid production.

The spindles have a ball thrust bearing, provided with an adjustment for end play at the upper end. The lower ends are supported in taper bearings, also permitting an adjustment. The spindles are of high carbon, hammered spindle steel, $2\frac{3}{4}$ inches in diameter, and are carefully ground. The ball thrust bearings are made from imported German balls, running in chrome nickel washers made by a special process, which insures great accuracy and gives at the same time ability to

nut as described. Nine feeds in all are provided, a further change of three ratios being given by means not plainly shown in the engraving. These feeds range from 0.03 to 0.20 inch per revolution of the spindle.

Fig. 3, in connection with Fig. 2, also shows some of the details of the automatic operation. In using the machine, the cylinder casting is placed on a fixture clamped to the table. Then the lever shown to the right of the machine in Fig. 2 is depressed. This, through the connections shown with the driving shaft, operates the clutch inside the driving pulley and starts the spindle revolving. At the same time it engages the feed, this being done through the connection of this lever with plunger M in Fig. 3, which enters the hole drilled in feed driving shaft K, and thus controls clutch N. This latter plays between the clutch teeth on worm gear O and those on helical gear T, the former of which gears gives a slow feed, and the latter a quick return, to the table movement.

The table feed having been thus set in motion, when the

proper depth of boring is reached, an adjustable cam on the side of the table drops the starting lever. This, through its connections with the driving pulley clutch, immediately stops the spindles, and at the same time throws in the quick reverse feed, clutch N in Fig. 3 being thrown to the right. This withdraws the work from the cutters. When these are clear, the feed is again automatically disengaged, so that after the cylinder casting has been removed and a new one chucked, the machine is ready for the same cycle over again. Only one movement of one lever is required from the operator, that for starting the machine.

The design of the spindles and heads is such as to admit of varying the center distances without in any way impairing the rigidity. The left-hand head is securely fastened to the frame by ample bolts and taper pins and is lined up with a well-fitted tongue and groove. The right-hand head is secured on the same surface by bolts from the front and back of the machine, and is provided with abutment screws sidewise, so that it is practically solid when set in position. This spindle is adjustable to give center distances ranging from $4\frac{1}{2}$ to $6\frac{1}{2}$ inches, effected by loosening the clamping screws, and then turning the micrometer abutment screws at the extreme top and bottom of the heads. In this way the distance between them is gaged in such a manner as to insure absolute parallelism. The adjustment is then clamped up again as solid as before.

The alignment of the table with the spindles and of the spindles with each other has been very carefully looked out for. Ample gibbed surfaces align the table with the frame. The length of table bearing is 30 inches, and the width $6\frac{1}{2}$ inches. This large ratio of length to width insures very accurate alignment, under free running conditions. The side adjustment is made by a taper gib. The distance from the center of the spindle to the face of the column is made as short as permissible considering the work for which the machine is to be used.

To further insure correct alignment, the heads are carefully roughed out and set aside to season. They are then bored, and afterwards re-planed on an arbor. As they are both clamped to the same surface on the frame, it is a comparatively simple matter to secure accuracy of the highest degree. As was previously explained, the parallelism of the spindles sidewise is maintained by micrometer screws, which permit the finest adjustments possible.

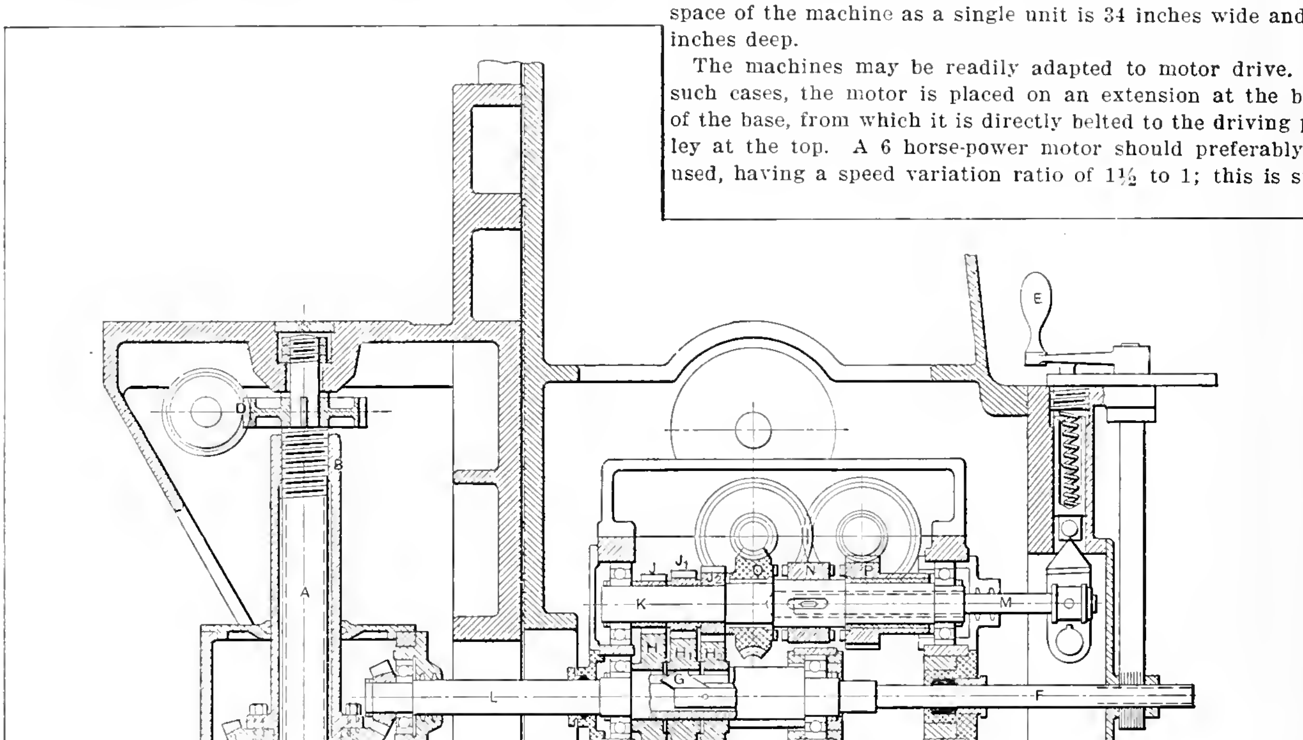


Fig. 3. Vertical Section through Base, showing Feed Change and Quick Return Mechanism

In the matter of efficiency in the mechanism as a whole, extraordinary measures have been resorted to. All the shaft bearings except those of the spindles are, as has been stated, fitted with Hess-Bright ball bearings. The gears are all made of hardened chrome-vanadium steel, and all the shafts are made from oil-treated alloy steel. A ball bearing is also provided to take the thrust of the table screw.

The floor space occupied is very small, being only 32 inches sidewise. That is to say, the machines may be placed in gangs with only this distance between the center lines. When ordered for arrangement in this way, suitable spreaders are provided for connecting the machines together, making a compact unit. This close spacing aids materially in getting from them the maximum possible output, as it reduces the useless moving about required by the operator. The regular floor space of the machine as a single unit is 34 inches wide and 48 inches deep.

The machines may be readily adapted to motor drive. In such cases, the motor is placed on an extension at the back of the base, from which it is directly belted to the driving pulley at the top. A 6 horse-power motor should preferably be used, having a speed variation ratio of $1\frac{1}{2}$ to 1; this is sufficient for the manufacturing work the machine is intended to perform.

This particular No. 3 cylinder boring machine is one of five sizes and types, intended for similar work. It is rated to bore cylinders up to 6 inches in diameter by 14 inches long, in double cylinder castings having from $4\frac{1}{2}$ to $6\frac{1}{2}$ inches between centers. It will also handle satisfactorily, in two operations, quadruple cylinders cast *en bloc*. The table surface is $14\frac{3}{4}$ by $18\frac{1}{2}$ inches, and the vertical feed is 18 inches. The table is counterweighted. The distance from the center of the spindle to the frame is $9\frac{1}{4}$ inches. This has been made as small as possible for reasons of rigidity, but it is great enough to accommodate all present makes of automobile cylinders.

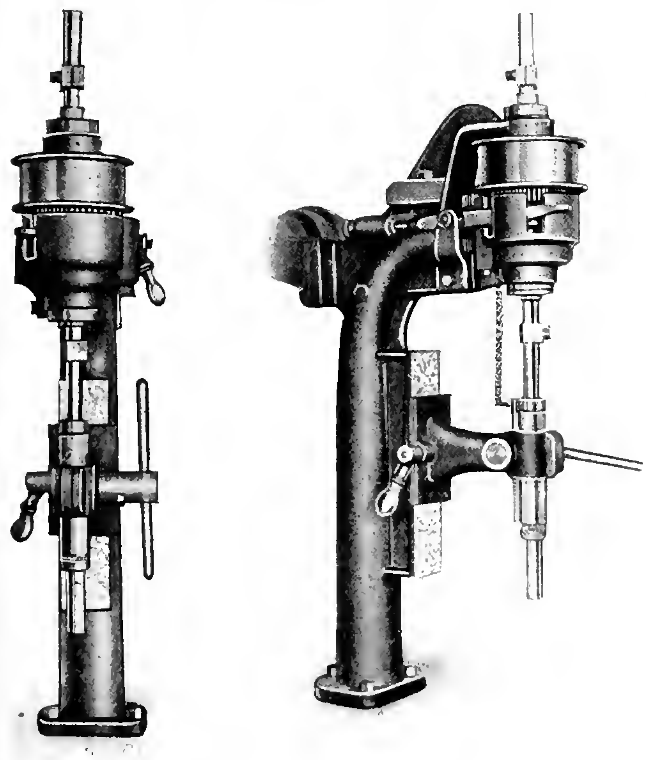
AUTOMATIC TAPPING ATTACHMENT FOR BARR DRILL PRESSES

In Figs. 1, 2 and 3 are shown, respectively, front and side views, and a sectional drawing, of a newly patented device for converting a drill press into a combination drilling and tapping

machine. This device is manufactured by H. G. Barr of Worcester, Mass., and is the result of much study in providing a machine which automatically reverses in both directions for tapping, without requiring any other motion than the regular movement of the lever as in drilling. This result is effected by simple means, which makes possible very rapid and accurate tapping on manufacturing work. It obviates the necessity for reversing "tapping chucks," and has many advantages over such devices, particularly in the fact that the tool is mounted directly on the regular, stiffly supported spindle of the machine.

The device illustrated is known as the "Style A Tapper," and is shown attached to one of the columns of a multiple spindle, style A drilling machine of the maker's line. The attachment itself consists of the post, spindle and pulley complete, and can be applied to any of the style A or B machines, using one or more as required, placing them on the proper spindle to be convenient for jig and manufacturing work.

Referring to Fig. 3, *A* is the driving pulley for the spindle. This revolves loosely in a lined bearing in the overhanging bracket *B*, as shown. It carries on its lower face a gear *C*, which is connected (by intermediate gearing not shown) with a lower gear *D*, which is thus caused to revolve in the direction opposite to *C*. *D* also revolves freely in a lined bearing, supported by the column *E* of the machine. Within gears *D* and *C* the quill *F* is free to revolve; this is provided with clutch pins *G* and *H*, and may be set to engage either the corresponding pins G_1 in gear *C*, or H_1 in gear *D*. Quill *F* is keyed to the spindle of the machine, *J*, which slides freely through it. Lever *K* is provided at one end with a roller entering the groove turned in the collar of the quill, while the other end has a V-point engaging a similar V-point on the spring plunger *M*. This arrangement will be recognized as



Figs. 1 and 2. Spindle of a Multiple Drill Press, equipped with a Barr Automatic Tapping Attachment

a commonly used device, for holding the quill *F* in either the upward or downward position, as it may have been set.

The operation of the attachment will now be intelligible. The spindle *J* of the machine is provided with two adjustable collars *N* and *O*, one below quill *F* and the other above it. With the lever *K* in the position shown, driving pulley *A* is connected with spindle *J* directly through pins G_1 and *G*, and quill *F*, rotating the spindle in the direction to drive the tap into the work. When the tap has entered to the required depth, adjustable collar *O* is set so as to strike and force down quill *F*, pushing pins *G* and G_1 out of engagement. Lever *K* then snaps over to the opposite position under the influence of spring plunger *M*, engaging pins *H* and H_1. The drive is now from driving pulley *A*, through gear *C* and the reversing gears (not shown) to gear *D*, thence through driving pins *H* and H_1 and quill *F*, to the spindle *J*. This reverses the spindle, giving a rapid backing-out movement, which continues until the tap is free of the work, when the natural movement of the hand lever, at the end of the upward stroke, brings collar *N* in contact with the lower end of *F*. By this means reversing lever *K* is snapped back again, re-engaging the spindle with the driving pulley *A* direct, ready for the next downward tapping motion.

Spring *M*, it should be mentioned, may be adjusted by means

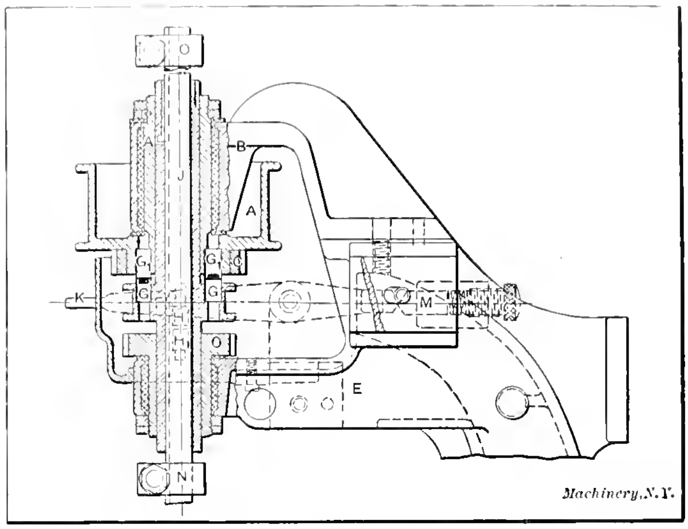


Fig. 3. Automatic Reversing Motion and Adjustable Stops of Barr Automatic Tapping Attachment

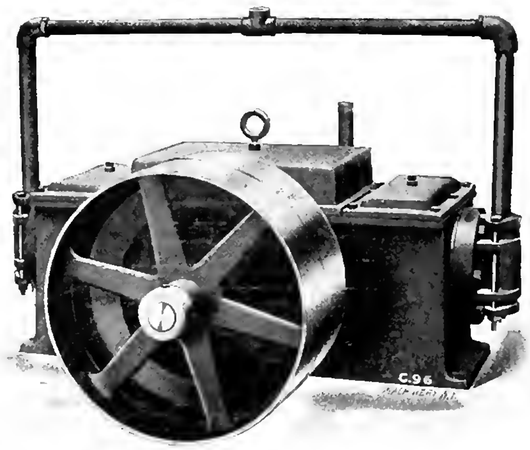
of the screw bushing shown to increase the tension. This may be required to support the "drag" on large taps. It may be as easily reduced, if required, for the more delicate taps. A binder handle is shown at the right of the attachment in the front view. This controls a slide which supports the reverse motion, connecting gears *C* and *D* in Fig. 3. When this slide is pushed back, all the parts are idle except the driving pulley, which may be directly connected with the spindle by pushing reverse lever *K* upward. When so adjusted, the set collars *N* and *O* are loosened on the spindle, and the regular stop attachment to the rack is used for getting the depth. Under these conditions, the spindle can be used for drilling in the same way as the others on the machine, with the added advantage of being quickly convertible into a reversing spindle when required. With this device any drill or "friction slip" chuck can be used for holding the tap. The alignment is as sure as when drilling. The action is rapid and positive; and there is no shock or jar in the mechanism. The style and size of attachment shown here will tap up to 3/8 inch diameter and drill up to 1/2 inch. Another style similar in design will be furnished for tapping up to 5/8 inch and drilling up to 3/4 inch. Other designs are being developed, for special purposes, incorporating the same principles. The style A attachment has been in use long enough to prove its effectiveness for tapping in connection with jig work, or for tapping large quantities of duplicate pieces on the drill press.

COMSTOCK AIR COMPRESSORS

The air compressor shown in the accompanying illustration is manufactured by George S. Comstock, Mechanicsburg, Pa. This air compressor is of the horizontal, center-crank type, and provided with two or more single-acting cylinders. The object in view in designing the machine has been to provide an air compressor which would give reliable service with little attention. The drive may be either through belting or gears, direct clutch or motor drive. The design includes several features not generally found in air compressors of this type. The moving parts are all completely enclosed and protected, and run in oil. The bearing surfaces are exceptionally large and the machines very compact for their capacity, the fly-wheel being placed in the center of the frame, so as not to take up any extra space. The frame is

made of a single casting, containing cylinders, water jackets and crank-case; the pistons are hollow, of coarse-grained gray iron, and are fitted with three rings each. These rings are lap-jointed, and fit tightly in the cylinders, which are reamed to size.

The drive from the crankshaft to the piston is by means of a special patented universal-joint transmission, ensuring an equally distributed pressure. The crankshaft is made of steel in one piece and is of ample dimensions. The valves are vertical, and can easily be taken out for examination or regrinding. The inlet valve is provided with a nickel steel head and carbon steel stem. The discharge valve is of steel



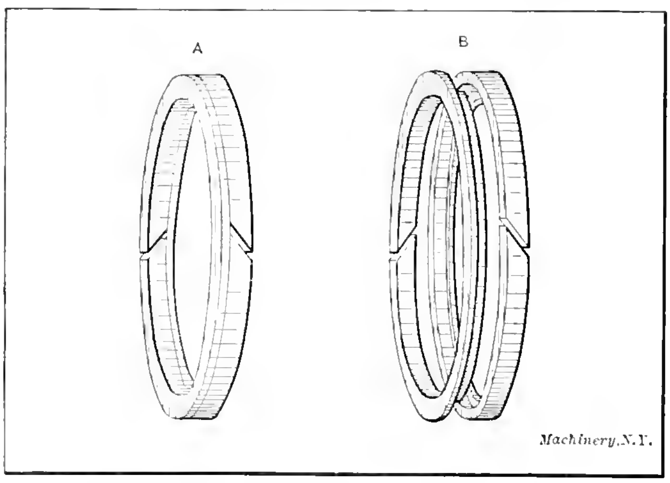
Simple and Compact Air Compressor made by Geo. S. Comstock, Mechanicsburg, Pa.

of a light but strong construction. The cooling is accomplished by large water jackets, and splash lubrication is employed for the moving parts.

The machines are built in eight sizes of a capacity for compressing from 6½ to 140 cubic feet of free air per minute, the horsepower required being from 2½ to 28, and the pressure obtainable 150 pounds for the smallest size and 100 pounds for the larger. The average weight of the air compressors varies from 250 pounds for the smallest to 4,200 for the largest size.

McQUAY-NORRIS "LEAK PROOF" PISTON RINGS

The McQuay-Norris Mfg. Co., 1500 Gaty Ave., E. St. Louis, Ill., has been trying out for several years past a new design of piston head packing ring, for use in gas engines, air compressors, pumps, etc. These experiments have been so satisfactory that the design has been patented, and is now being marketed



A Uniformly Elastic Piston Packing Ring, with Sealed Joints

under the appellation "Leak-Proof" as a trade name. As shown in the engraving, each set is composed of two separate rings, one male and the other female. Each ring carries a flange, outward on the male and inward on the female, as shown at *A* in the engraving. The rings are split diagonally. When the two are placed together in the proper position (that is, with the openings opposite as shown at *B*) each of these openings is overlapped by the other ring, thereby making a close joint and preventing the escape of the steam, gas, water, or other medium under compression in the cylinder.

These rings are made of the best grade of gray iron, giving a high degree of elasticity without the aid of springs or other artificial means. This increases the life of the ring proportionately. Owing to the fact that the points of expansion are opposite in the two rings, a more equal pressure results on the cylinder walls throughout the whole periphery, thus helping to make a tighter joint. In consequence of these conditions, the rings are able to retain their tightness through a very long life of usefulness. The makers have been very successful in replacing other designs of packing with these rings in engines, pumps and compressors.

IMPROVED CHICAGO DUPLEX HAND MILLER

In the August, 1909, issue of MACHINERY a complete description of the design of the new line of Chicago duplex hand milling machines, built by the Chicago Machine Tool Co., of Chicago, Ill., was given, accompanied by several illustrations of the general appearance and details of the machine. A new machine of the same general type, known as the No. 3A,

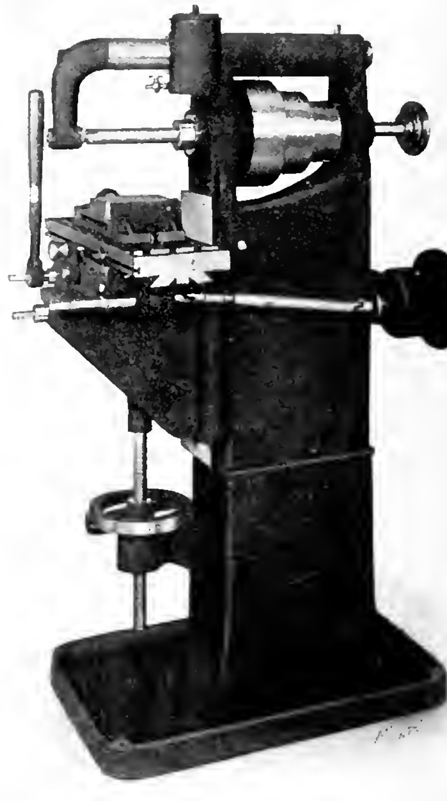


Fig. 1. No. 3A Chicago Duplex Hand Milling Machine

has just been brought out. This machine is shown in the accompanying half-tone, Fig. 1, and embodies some additional improvements. It will be noted that the oil pan regularly furnished on the machines previously illustrated, immediately beneath the knee, has been eliminated in order to facilitate the arrangement shown for the vertical screw adjustment of the knee. The base of the machine has instead been formed into a pan-shape for taking care of the oil or other lubricant used on the milling cutters.

The construction of the vertical screw adjustment for the knee makes it possible to obtain very accurate vertical movements. The elevating screw has four threads per inch, and the large hand-wheel for turning it has 250 divisions, so that the knee may be accurately adjusted up or down 0.001 inch, or even less if necessary. The indicator shown in the front of the hand-wheel is adjustable, so that it can be swung around to any desired position; thus, no matter where the zero point is located at the beginning of the movement, the indicator may be set to it, and it is possible to figure the movement from the zero point without having to add or sub-

tract the various readings, as is usually the case in arrangements of this kind.

In the previous description the design of the table power feed and the quick return of the table were referred to. A good illustration of this design is shown in Fig. 2. As will be remembered, the worm is fastened on the same shaft as the spiral gear which meshes directly with the gear on the universal joint shaft. This whole mechanism is held in a rocker which throws it in and out of mesh with the rack in the table. When the automatic feed is disengaged, the hand lever feed may be operated, and this provides for a quick return of the table when the cut has been taken.

The No. 3A Chicago duplex hand milling machine has an automatic table feed of 20 inches, a transverse feed of $5\frac{1}{2}$ inches, and a vertical screw adjustment of the knee of 10 inches. The machine is provided with micrometer adjustment for the longitudinal and transverse feeds, as well as for the vertical feed as already described.

The universal centers adapted for the No. 3A machine are of an improved construction having a number of features introduced with the aim in view of making them compact, rigid and accurate. As will be seen in Fig. 3, the wormwheel is placed at the front end of the spindle which makes it possible to make it larger in diameter than if it were placed in the interior of the head, where it, at best, could be no larger than the distance between the housings. Other things being equal, a larger diameter of the worm-wheel is conducive to accuracy, and the placing of the index plate and lever directly on the worm-shaft eliminates the inaccuracy which may arise through the introduction of gearing between the

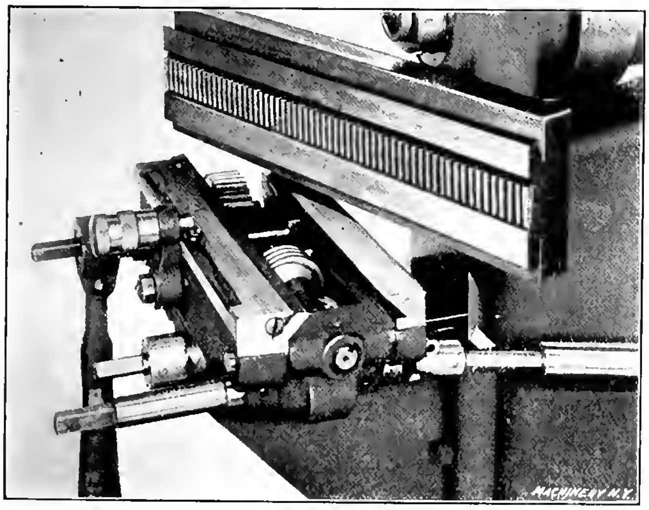


Fig. 2. Details of the Automatic Feed and Quick Hand Return Arrangement

worm-shaft and the index lever, which is necessary when the index plate is placed on a secondary shaft. In order to prevent the spindle from rising too high when turned to a vertical position, the center line of the spindle is placed considerably above the axis of the center block, so that the end

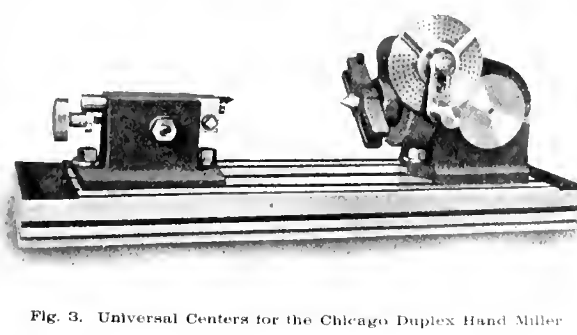


Fig. 3. Universal Centers for the Chicago Duplex Hand Miller

of the spindle, when it swings in an arc around this axis, reaches its highest position before it reaches the vertical direction. The spindle is bored to take a No. 9 Brown & Sharpe taper shank, the same as the main horizontal spindle of the machine. One index plate is furnished, having five circles of holes, the various circles having 33, 39, 42, 46, and 49 holes, respectively, which appears to be sufficient for ordinary work, but additional plates with different numbers of holes can be furnished if required. Hill, Clarke & Co., Inc., of Boston, Chicago, New York, Philadelphia and Cleveland are the selling agents for these machines.

WRIGHT QUICK-ADJUSTING PIPE WRENCH

A quick-adjusting wrench for general use, known as the Wright wrench, was illustrated and described in the May, 1909, issue of MACHINERY. Mr. J. F. Wright, of Canton, Ohio, the inventor of that wrench, has also recently patented a quick-adjusting pipe wrench as illustrated in the accompanying half-tone. This wrench can be adjusted instantly by a slight pressure of the thumb as indicated. To hold the adjustment, there is a toothed rack in the lower edge of the bar or handle, which engages with a toothed pawl in the sleeve. The rack in the bar is inserted so as to be fully protected, the main bar being slotted, and then the rack riveted in place. Should it be necessary to renew it, it can be easily done. The construction of the wrench eliminates any strain being placed on the rack and pawl, as the downward pull of the handle brings an equal strain over the entire length of the sleeve.

Quick-adjusting Pipe Wrench Patented by J. F. Wright, Canton, Ohio

The simple method of adjustment has several advantages. When under pressure or strain there is no rivet that can be pulled out if the wrench is subjected to a side pull, and as pipe wrenches are made to pull but one way, the screw in the sleeve acts as a pivot and the end of the sliding jaw (under the thumb) acts as a check, thereby distributing the strain over the whole length of the sleeve. The spring placed under the end of the sliding jaw as shown in the illustration only serves the purpose of making the adjustment convenient, but this is not depended upon for the working of the wrench, as it will operate either with or without the spring, and the action is entirely positive.

LANDIS AUTOMOBILE CAM GRINDING ATTACHMENTS

The Landis Tool Co., of Waynesboro, Pa., has developed two forms of cam grinding attachments for use on its regular line of universal and plain grinders. The first of these attachments, shown in Figs. 1 and 2, is for detachable cams; the other, shown in Fig. 3, is for those of the integral type, the machine being intended to finish these surfaces complete from the forging, without lathe work or milling.

The first attachment is a self-contained arrangement whose frame, as shown at *A*, is mounted directly on the table of a regular grinding machine. It is connected by a driving arm *B* with the regular driver on the faceplate of the work-spindle, as is clearly shown in both views. It is constructed on the swinging principle, the spindle bearing *C* being suspended from a hinge or pivot directly above it. The work is mounted at *D* on one end of this supplementary spindle, while the master cam is shown at *E*. As this spindle is revolved, the pressure of a spring, not shown, which keeps bearing *C* pressed outward and holds master cam *E* against shoe-plate *F*, will cause the cam outline to be reproduced on the work *D*.

An important feature of the attachment is the fact that it grinds its own master cams, which are copied from full-sized model cams identical with those to be ground. In making the master cam, it is fastened in the place of *D* in Fig. 2, while the model cam is mounted in the place of *E*. The op-

eration is exactly the same as for grinding the work from the master, and the method evidently insures making an exact copy of the model in the finished work. Owing to the fact that the master cam is of enlarged size, the least radius being never less than $1\frac{1}{2}$ inch, the outline is reproduced very accurately on the work, the reduction in the majority of cases being more than 2 to 1.

As in all accurate cam grinding devices, the designer has had to make provision for overcoming the change in the form of the work produced by the decreased diameter of the wheel, as it wears away. Allowance is here made for this by providing a series of shoe-plates *F* as a regular part of the equipment. These plates have a curved working surface corresponding to the diameter of the wheel being used. The number of plates in a set is determined by the size of the machine in which the attachment is to be used; that is, by the difference between the diameter of the grinding wheel at full size and smallest diameter at which it can be used. A plate is furnished for each inch of wheel diameter reduction allowed.

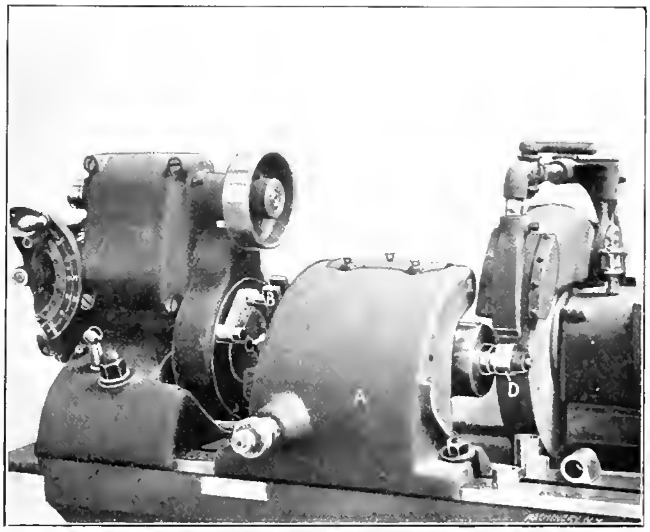


Fig 1. Self-contained Attachment for Grinding Detachable Automobile Cams

In grinding the master cam, a shoe-plate and wheel of equal radii are used, producing, of course, a standard copy of the model cam form. If the cam is placed in its proper position at the other end of the spindle, replacing the model cam and using the same wheel and shoe-plate, an exact copy of the model or work would result. The same thing would follow if any size of wheel and a plate of radius equal to it were used. Without this multiplicity of plates, the tendency would be, as the wheel wears down, for the cams to become slightly full.

In the inch of wheel reduction which each plate covers, this change of form is imperceptible. The master shoe-plates are arranged to distribute or divide this variation evenly. For instance, a shoe-plate of $6\frac{3}{4}$ inches radius is used on wheels from 7 down to $6\frac{1}{2}$ inches radius, or from 14 to 13 inches in diameter. In the same way a $6\frac{1}{4}$-inch radius plate is used on wheels from 13 down to 12 inches diameter, and these changes continue until the wheel is reduced to its minimum size. At no time, it will be seen, does the radius of the shoe differ from that of the wheel by more than $\frac{1}{4}$ inch, and as these extreme variations occur on each side of the middle or exact position, it is clear that the very slight variations in the contour of the cam will be divided equally on each side of the form.

Fig. 3 shows the back view of a standard grinding machine, furnished with an attachment for forming cams made integrally with the shaft. While designed especially for this work, detachable cams can be finished with equal facility, though in such work the master cam would be so made that a full set of either the inlet or exhaust cams could be placed on the arbor and ground together. The action of this machine is entirely different from the one previously described. The master cam and work are both stationary so far as lateral motion is concerned, this being given to the wheel-slide and wheel instead. The master or former cam is shown at *G*. As may be seen, it is of large diameter and stiff design, rigidly supported by bearings bolted to the main column of the bed. It is driven in unison with the work-spindle by a geared connection passing through the casing shown at *H*. The former roll, by whose action on the master cams the wheel-slide is reciprocated, is shown at *J*. This is mounted in bearings attached to the wheel-slide and thus transmits its motion to it, the movement being transmitted in turn from the wheel to the work to give the latter the form desired.

In the same way as in the previous case, the master cam shaft *G* is copied from an actual model cam shaft. In this copying process, the model shaft is supported rigidly between its cam surfaces over its entire length, in bearings provided for the master cam at the back of the machine. This is to overcome any possibility of its yielding or springing during the grinding operation on the master cams. The latter are ground in a solid piece held between the centers, in exactly the same way as the work itself. The cams are more than double the size of the work to be ground, insuring accuracy and freedom of movement in transmitting their motion to the wheel-slide.

Means have to be taken here also to allow for the wear of the wheel. A series of cam rolls *J* is provided, of various diameters, to agree with the diameter of wheel being used. There is one of these rolls for every change of inch in diameter, giving the same results in regard to accuracy as with the other attachment.

A portion of the cylindrical body of the master cam remains between the cam outlines in the form of a collar. When the grinding wheel is traversed along the work in passing from one cam to the next, the roller on the rear of the slide runs on these collars, by which action the grinding wheel is withdrawn clear from the work, and the wheel-slide is held from cross motion. When the wheel has been moved to the next cam to be ground, the roller passes beyond the collar of the master and engages the next corresponding cam surface. It will be seen that the wheel might even be traversed along the work automatically, just the same as in grinding plain work, since the reciprocating or cross motion of the wheel-slide only takes place when the roll is actually on the cam to be ground. The momentary resistance that the roll might suffer in being brought up against the shoulder of the cam is taken care of in either direction by the compression springs shown beneath the wheel-slide, at the left of the spindle on which roll *J* is mounted.

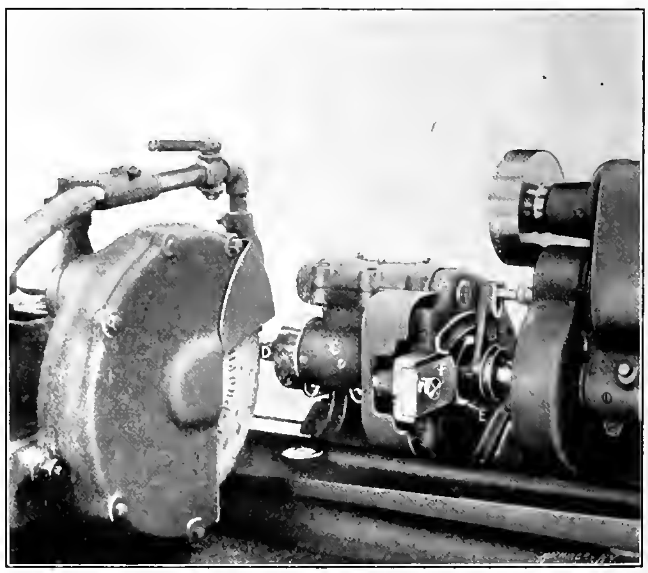


Fig. 2. Rear View of Cam Grinding Attachment, showing Construction

This fixture in no way interferes with plain straight grinding, and the machine can be used for finishing the cylindrical bearings of the shafts with the same facility as when the work is done in a regular plain grinder. To change the machine over to plain work, it is only necessary to slide the grinding wheel back, disengaging it from the master cam. This is effected by a screw operated by handwheel *K*.

Both of these machines and attachments are of rigid construction, especially designed for the rapid production of cam surfaces direct from the forging, without preliminary roughing of any kind. This has become the regular practice and

has resulted in doubling the output over the method previously followed of turning or milling, preparatory to finishing on the grinder. The machine illustrated is one of the maker's regular plain 10- by 30-inch machines.

"CONSOLIDATED" POWER PRESSES FOR AUTOMOBILE MANUFACTURING

The automobile has done a great deal in stimulating the development of the power press, and in widening its applica-

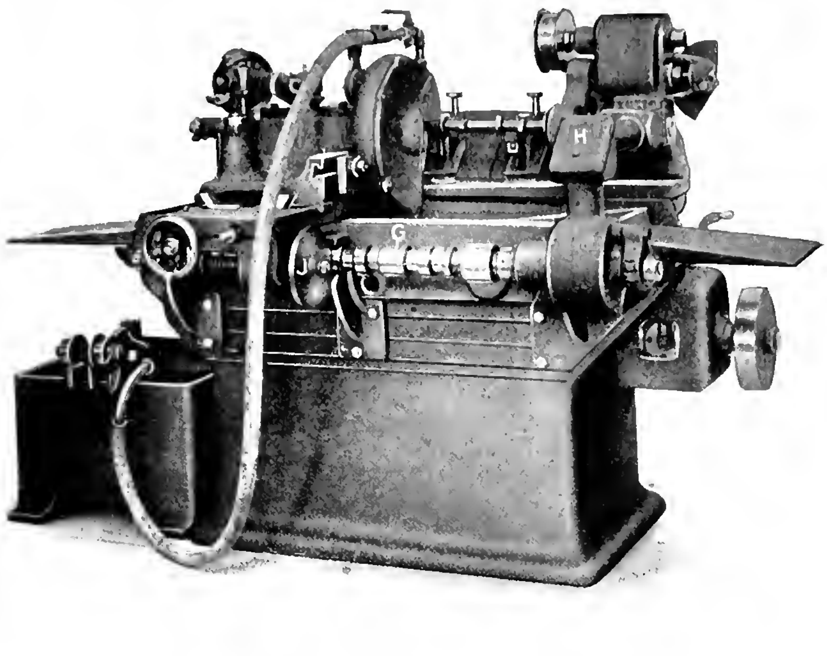


Fig. 3. Plain Grinder provided with Master Cam for Operating Wheel-slide, in Grinding Integral Cam Shafts

tions. The power press, in turn, has been of much assistance in cheapening the automobile, effecting at the same time an

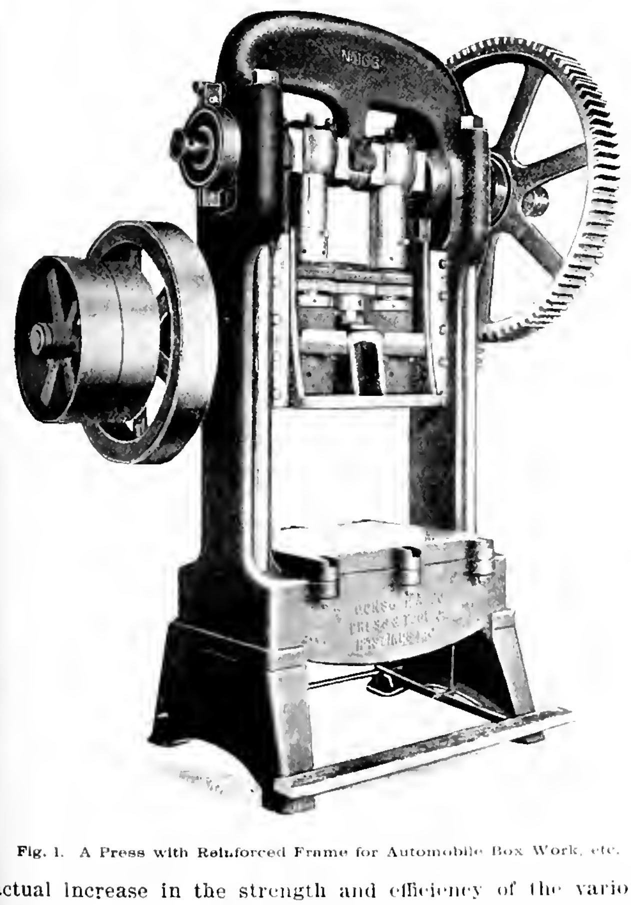


Fig. 1. A Press with Reinforced Frame for Automobile Box Work, etc.

actual increase in the strength and efficiency of the various parts. This has been done by making it possible to replace wooden parts and castings with steel stampings and forgings. The press is now the principal tool used in the making of frames, beds, hoods, radiators, brake drums and bands, rims, axles, etc., and many other parts. In making crankshafts, about all that is needed at the present time is a drop hammer, a trimming press and a grinder. The accompanying illustrations show two forms of press developed by the Consolidated Press & Tool Co., Ford Building, Detroit, Mich., especialy adapted to this important field of automobile manufacture.

The press illustrated in Fig. 1 is especially adapted to making tool boxes and similar parts. On this class of work the strain on the frame, at times, is excessive, and to guard against possible accident each housing is reinforced with two steel rods. These rods are put in hot, and the nuts on the underside of the frame are tightened up and pinned, so that when the rods cool, the strain is equally distributed between the cast-iron frame and the steel rods. It is claimed by the manufacturers that it is practically impossible to break a frame constructed in this manner, and as the life of a press is usually determined by the life of the main frame, the advantage of this type of construction becomes at once apparent.

The distance from the bed to the slide on the press illustrated is 22 inches, which gives ample room for operating the heavy dies used in redrawing, forming and bending the different parts for which it is intended. Some of the other principal dimensions are: distance between uprights, 40 inches; width of bed front to back, 32 inches; height from floor to center of shaft, 94 inches; ratio of gearing, 8 : 1; total weight, 17,000 pounds. This press is built in six sizes and twenty-four different styles, with a varying width between the uprights to suit any class of work.

The press illustrated in Fig. 2 was designed especially for

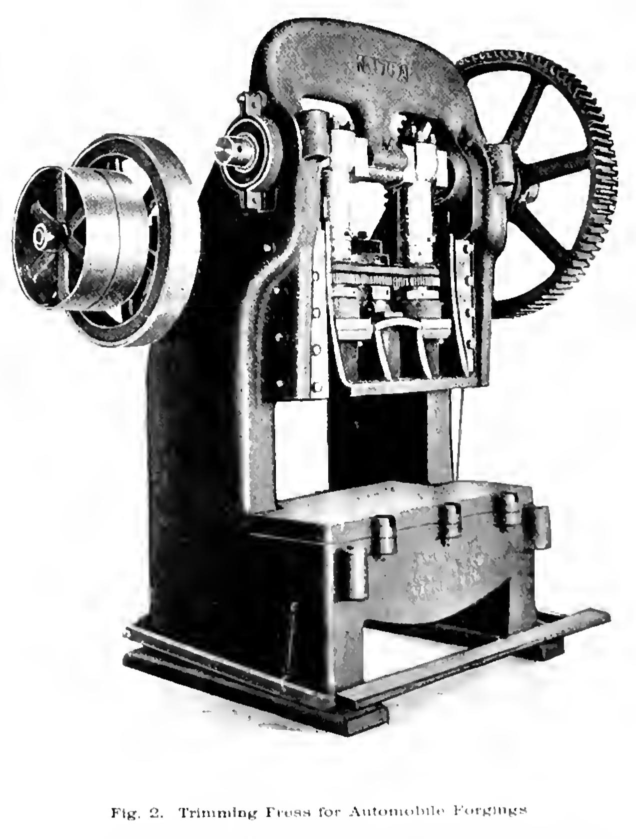


Fig. 2. Trimming Press for Automobile Forgings

trimming the special shapes of forgings used in the automobile industry. While the frame is of the overhanging type, the depth of the throat is not as great as on similar presses intended for working sheets cold, consequently the spring in the frame on heavy work, always so noticeable in machines

of this type when the throat is deep, is entirely overcome. The main frame is cast in one piece instead of in sections, the bed is heavily ribbed underneath, and the crown is exceptionally deep and thick. The section of the housings is made similar to that of a planer housing, instead of following the usual form heretofore used in power-press construction when the frame is cast in one piece. Some of the principal dimensions are: width of bed right and left, 60 inches; distance from bed to slide, 22 inches; ratio of gearing, 8 : 1; total weight, 28,000 pounds. This type of press is built in six sizes classified as to power, and 18 sizes classified by weight, the distance between the uprights being made to suit the work to be performed.

"CISCO" 14-INCH ENGINE LATHE

The accompanying illustration Fig. 1, shows a new 14-inch lathe placed on the market by the Machinery and Equipment Department of the Cincinnati Iron and Steel Co., Cincinnati, Ohio. This lathe is known as the "Cisco" 14-inch quick-change gear engine lathe, and the particular features of the machine are the simplicity of the quick-change gear device, and the exceptionally powerful drive in the apron.

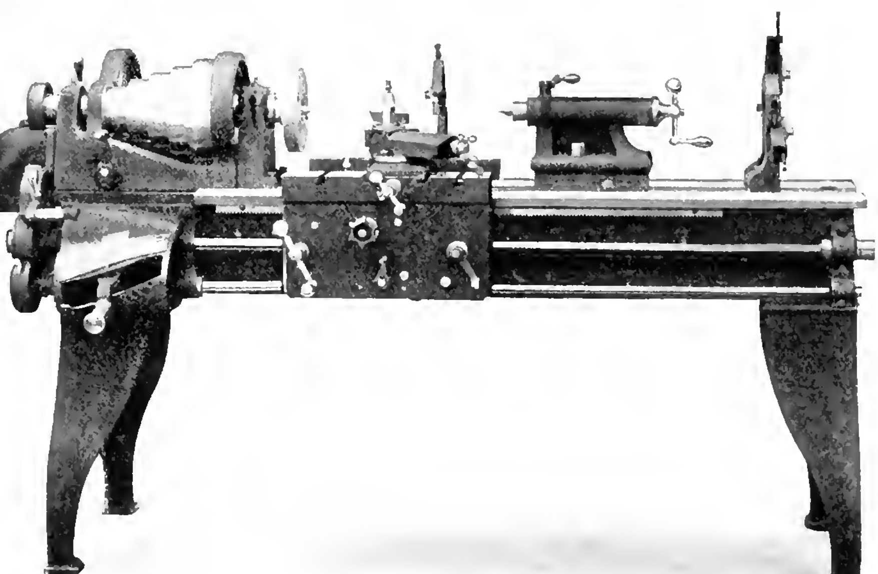


Fig. 1. Fourteen-inch Engine Lathe placed on the Market by The Cincinnati Iron & Steel Co., Cincinnati, Ohio

A view from the end of the headstock is shown in Fig. 2 and a view of the inside of the apron in Fig. 3. This latter illustration indicates the massive construction of this part of the machine. The apron mechanism is worm driven, and provided with a safety device to prevent interference between the lead-screw and the feed-rod drive so that it is impossible to engage the feed rod and lead-screw at the same time. All shafts and studs in the apron are supported at both ends by ample bearings.

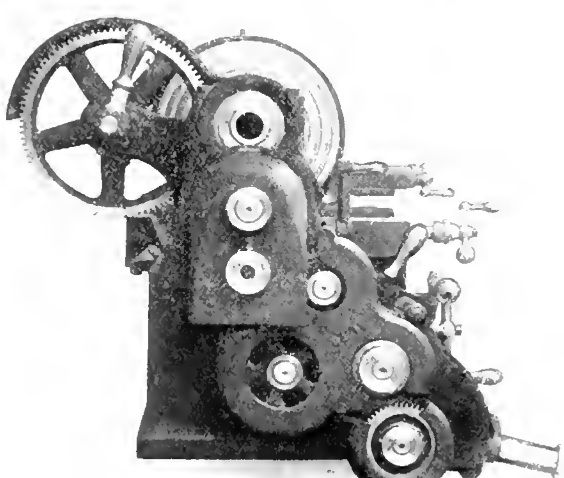


Fig. 2. End View of the Headstock

As will be seen in the illustrations, two levers are used for operating the quick-change gear device by means of which threads from 3 to 32 per inch may be cut. The feed changes possible are 33, varying from 18 to 192 per inch. A positive locking device is provided which makes it impossible to engage two gears at the same time. It will be seen by referring to the illustrations Figs. 1 and 2, that all gears have been very carefully covered in a manner to give the machine a neat and pleasing appearance. Ample oiling facilities and oil pockets have been provided wherever necessary. While the machine is not regularly furnished with the taper attachment, it can be provided with such an attachment at any time, as the carriage has been jig drilled for this purpose, and the application of the taper attachment is a simple matter.

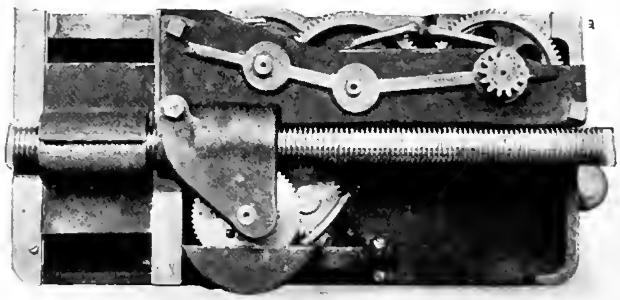


Fig. 3. Construction of the Apron of the "Cisco" Lathe

The headstock is of massive construction. In Fig. 1 the head cone is provided with five steps, but a head cone with four steps can be furnished instead, if required. While the nominal swing of the lathe is 14 inches, the actual swing is 15⅝ inches. A hole is provided through the spindle for stock up to 1 5/16 inch diameter. The bearings are of phosphor-bronze and made amply large, and all the proportions of the machine, including those of the bed and legs, have been made massive and heavy so as to make the machine suitable for the advantageous use of high-speed steel tools. The countershaft provided is equipped with the Nugent friction clutch.

An interesting feature in the lathe is that all studs, screws and nuts have been so selected and their heads milled to such standard dimensions that only two wrenches are required for the entire lathe. This is a great advantage, as considerable time is lost in the ordinary shop in hunting for suitable wrenches for the variety of sizes of nuts and bolt heads frequently found on many machine tools.

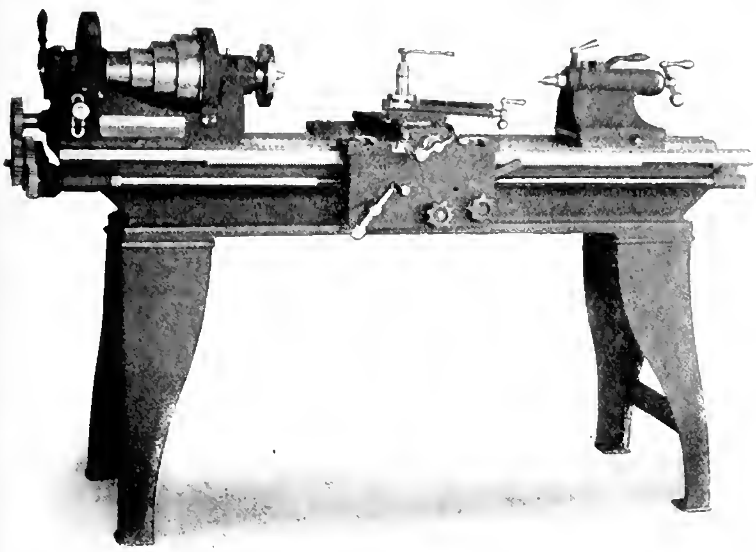
THIRTEEN-INCH "STAR" SCREW CUTTING LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has added a 13-inch lathe to the regular line of machines manufactured. This lathe, shown in the accompanying engraving, is known as the No. 65-E "Star" lathe, and is of the same general design and construction as the 9- and 11-inch sizes built by this company, which were illustrated and described in the September, 1909, issue of MACHINERY.

The actual swing of the lathe is 14⅛ inches over the bed. The length of the bed is 6 feet. The head spindle is made of 60-65-point carbon steel and revolves in large ring-oiling bearings. It is provided with a 1¼-inch hole, and may be fitted with a draw-in chuck with split collets for work from 1/16 to 3/4 inch diameter. The carriage is provide with T-

slots as indicated, and the cross-feed screw is equipped with a micrometer collar to read in thousandths of an inch. All the carriages are arranged for taper attachment, which may be supplied at any time. The plain and compound rests are easily interchangeable, and the same binding device as used on the smaller sizes is employed. The automatic cross and longitudinal feeds are also of the same design as described in the September, 1909, issue. The machine will cut all standard threads from 3 to 72 per inch, including 11½ and 27. When equipped with metric translating gears it will cut international standard metric threads from 0.5 to 8 millimeters lead.

The countershaft is of the same type as supplied with the smaller sizes of "Star" lathes, and all other advantageous features in the smaller sizes are retained. Screws, nuts and small parts liable to become burred or bruised are case-hardened, and ample facilities have been provided to compensate for wear. An additional feature which will be appreciated particularly in shops with limited equipment is the provision of a set of blocking, three inches high, by means of which the head- and tail-stock and the plain, compound and center rests may be raised up to increase the swing of the lathe to 20½ inches.



Thirteen-inch Screw Cutting Lathe, built by the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

CLEVELAND SODA AND POTASH KETTLE

The Cleveland Machine Specialty Co., 202-204 St. Clair Ave., N. E., Cleveland, Ohio, has recently placed on the market a new type of soda and potash kettle for cleaning the parts of disassembled machines. This kettle, which is shown in the accompanying illustration, is heated by gas. The convenience of gas as a fuel will be readily appreciated. The burners are arranged in a fixed position with relation to the kettle, and either natural or artificial gas can be used. The bottoms of the pots are constructed so as to break up the flame in order to distribute the heat rapidly to the solution, thus effecting a greater economy in the consumption of gas necessary to keep the solution boiling. Eye-bolts are attached to the flange of the kettle proper to facilitate handling it when this is necessary.

Cleveland Machine Specialty Co.'s Gas-heated Soda and Potash Kettle

These kettles are made in two sizes, the smallest having a capacity of 10 gallons and the largest 30 gallons. They are meeting with considerable favor among manufacturers of all kinds, according to the makers, which can doubtless be attributed to the convenience of connecting them to the gas supply and also to their economy of operation. Dipping baskets of various sizes are furnished for use in connection with the washing of machine parts.

DIAMOND MACHINE CO.'S POLISHING MACHINE

The Diamond Machine Co. of Providence, R. I., has recently developed a new type of polishing lathe which we illustrate herewith. This machine has been designed to meet the growing demand for a polisher that can be driven by a belt from the floor below, thus doing away with an overhead countershaft and unnecessary belting. The column of this machine is entirely enclosed, as shown, thus giving a rigid construction and at the same time avoiding the danger of interference with the driving belt. The pulleys on the spindle are protected by a cover bolted to the column, which, if desired, can be removed, if for any reason the machine is to be driven from an overhead countershaft. The distance that the polishing wheels project from the column on either side, adapts the machine to a wide range of work. The bearings are long and rigidly supported, as the engraving indicates. A removable cover on the side of the column opposite to that illustrated, provides access to the belt when this is desired, either for inspection or repairs. A removable taper point which may be attached to one end of the spindle is furnished with the machine. The small handle shown projecting from the front of the column, provides convenient means for starting and stopping the spindle. The height of the spindle above the floor is 38 inches, and the total floor space required is 33½ by 54 inches. Polishing wheels up to and including 16 inches in diameter can be easily swung.

Diamond Machine Co.'s New Polishing Lathe which is designed to be driven from the Floor Below

SLOTTING ATTACHMENT FOR MILWAUKEE MILLING MACHINE

The new Milwaukee milling machine, made by the Kearney & Trecker Co., Milwaukee, Wis. (of which the No. 2B plain design was illustrated in the February, 1910, number of MACHINERY), has been provided with an improved form of slotting attachment, herewith illustrated in Figs. 1 and 2. An attachment of this kind may be used to great advantage on the milling machine, particularly in toolroom work, where it will take cuts in boring bars, dies, wrenches, internal gears, key seats, etc., which cannot be done with the milling cutter. The special features of the new design are the simplicity of mechanism, the adjustable stroke, the rectangular ram, the improved tool clamping arrangement, and the adjustable setting of the head to any angle through the whole 360 degrees. The

construction will best be understood from Fig. 2.

The base of the machine K is clamped to the front face of the knee-slide being set down over the dovetail from above, and lined up as shown by the engagement of the top of the recess with the overhanging arm of the machine, which is allowed to project slightly. When thus located, it is clamped in place by gibs in a way similar to that by which the knee is gibbed to the same surface. This arrangement makes the

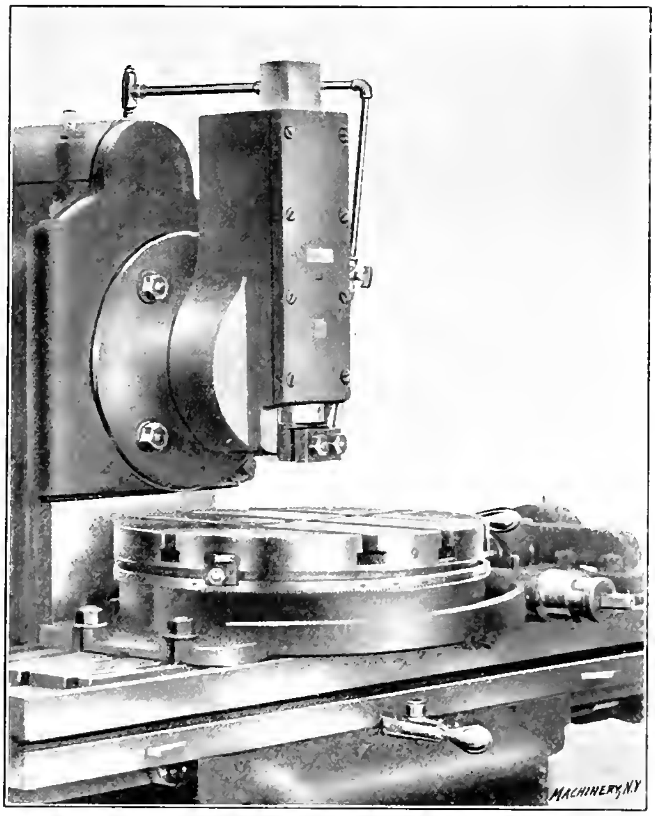


Fig. 1. Slotting Attachment with Adjustable Stroke and Quick Return, for Milwaukee Millers

base of the attachment practically solid with the base of the machine, and thus gives it great rigidity. The extension of the dovetailed knee bearing, on which the attachment is fastened, was designed for the specific purpose of firmly holding this and other similar appliances.

Collar J is fitted directly to the main spindle of the machine. It carries a pivot on which is supported bronze block H, fitting a groove cut in the face of the driving plug E. Plug E and the spindle of the machine are eccentric by a considerable amount, as shown, so that E receives from the spindle a quick return movement of about two to one, in accordance with the principle of the well-known Whitworth

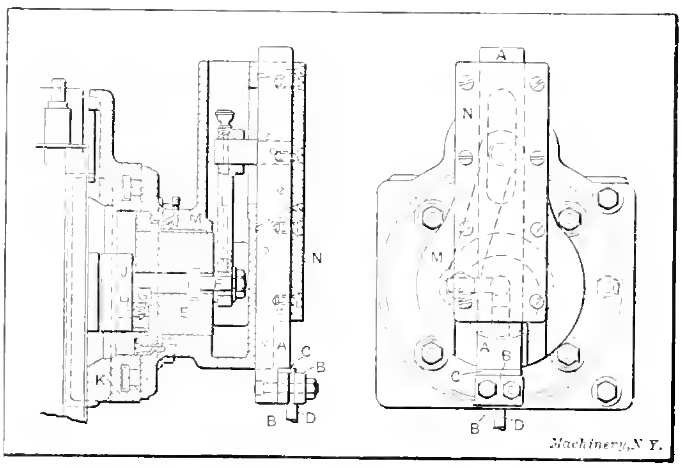


Fig. 2. Section and Face View of Slotting Attachment, showing Construction

quick-return mechanism. The front face of E is slotted for the crank pin F. This is adjusted to or from the center to give a less or greater stroke, being reached with the wrench through an opening in the right side of the attachment. It operates the ram A through the connecting-rod L as shown. The ram A is a rectangular steel bar. This form gives a long bearing in proportion to the width, insuring stiffness and a better alignment. The lower end of the bar is provided with V-blocks BB, and has a hardened piece C to back up the tool.

A convenient improvement in the machine is the provision made for swinging the entire head around a full circle on base K. This adjustment is read from angular graduations, making it possible to set the ram accurately to any position. In the vertical position it may be used in connection with the rotary table for any work requiring slotting and indexing, such as internal gears. When swiveled to the horizontal position, it may be used in connection with the indexing head for similar work, when the rotary table is not available. It is also then useful for work held in the chuck, such as hex or socket wrenches, dies, etc.

The machine is made in three sizes, giving 10½, 11 and 11¾ inches respectively from the center of the tool to the face of the column. The tools used can be of any size from ¼ to ¾ inch diameter, and of any shape, rough or finished. The adjustment of the stroke for all sizes is from 0 to 4 inches. The net weight of the device is 195, 220, and 262 pounds, respectively, for the three sizes.

S. M. HILDRETH CO.'S COLLAPSIBLE STEEL HORSE

A patented collapsible steel horse or trestle has been placed on the market by the S. M. Hildreth Co., 2 Rector St., New York. This horse, which is illustrated herewith, will be found very convenient in a machine shop or, in fact, anywhere that a device of this kind is used. It is light in weight but very strong and rigid, being constructed of steel angles throughout. The steel construction precludes any chance of breakage, even under heavy weights, and insures a long life. The collapsible feature of this trestle, makes it very convenient for handling and transporting, and the very

A Collapsible Steel Trestle, or Horse, Folded and Ready for Use

small amount of space which it occupies when not in use is undoubtedly its most valuable feature. The upper engraving shows how compact the trestle is when folded ready for storing. Anyone who has had experience with trestles of the rigid type, will readily appreciate the compactness of this new design. Obviously, these trestles may, if desired, be checked out from the tool or stock-room the same as with other tools. These horses are manufactured in various sizes to adapt them for any purpose required. The manufacturers also intend to bring out a type which may be raised or lowered to various heights.

ROCKFORD HAND MILLER AND ATTACHMENTS

The Rockford hand milling machine, herewith illustrated and described, is made by the National Machine Tool Works, of Rockford, Ill. The machine itself is of interest in a number of ways, particularly in the combination lever and screw feed provided. Its interest and usefulness are increased, however, by the line of attachments furnished. Two of these, the slotting and vertical milling attachments, are here illustrated.

In Fig. 1 the machine itself is shown; it is of the familiar column and knee type, set on a substantial base with a tool cupboard. Adjustable micrometer stops are provided for the vertical movement of the knee on the column. This movement is effected by a lever, keyed to a rack and pinion for quick operation. The longitudinal motion of the work-table is also provided with stops, which bring up solidly against a post attached to the saddle. The combination screw and lever feed for the table is plainly shown in the engraving. It consists of a worm-gear keyed to the shaft on which the hand lever is mounted, meshing with the feed-screw of the table. Means are provided for clamping this worm-wheel fast, in which case the feed-screw may be run out and in over it the same as through the usual stationary feed nuts. When it is desired to handle the table with the lever, the worm-wheel is unclamped. Under those conditions it operates as a gear, meshing with the double thread screw as though the latter were a rack, thus making provision for quick operation of the longitudinal feed.

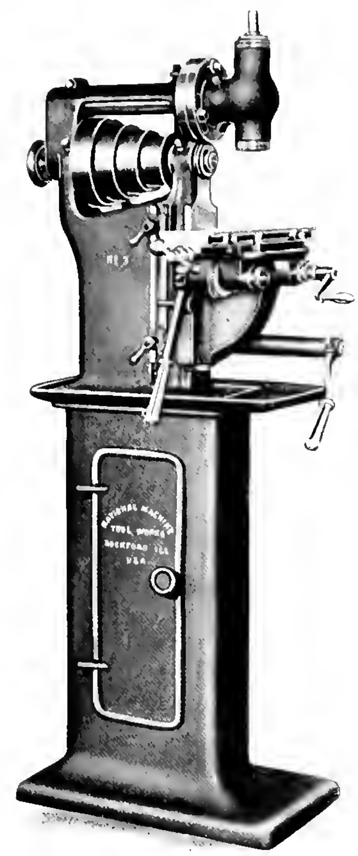


Fig. 1. Hand Miller with Combination Screw and Lever Feed; Vertical Attachment shown in Place.

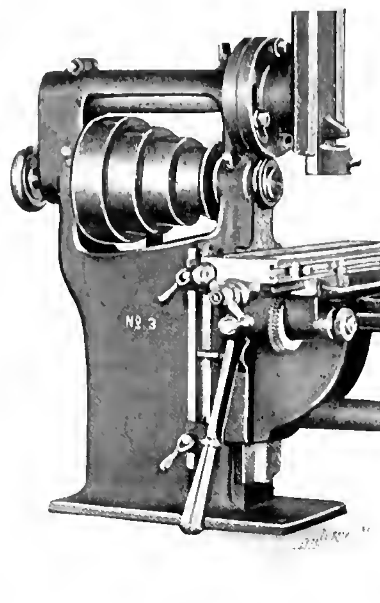


Fig. 2. Stiffening Flange for Overhanging Arm, Clamped to Attachment Flange on Column

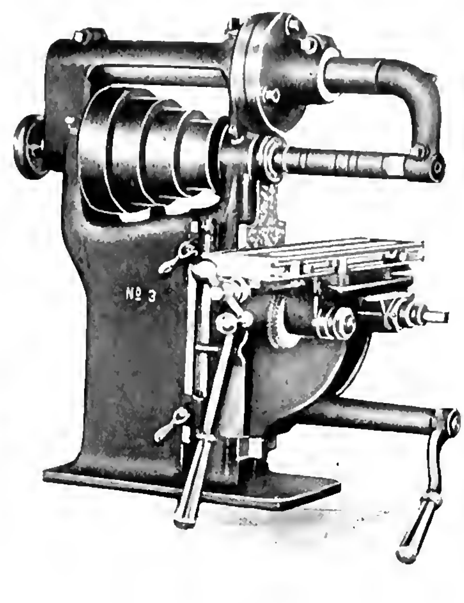


Fig. 3 Rockford Hand Miller, fitted with Slotting Attachment

The spindle of the machine is provided with a draw-in tube for collets of any size up to ¾-inch hole. A collet is also furnished bored to the No. 7 Brown & Sharpe taper, for holding end mills, drill chucks, etc. The overhanging arm, as shown in Fig. 2, has a stiffened flange or plate mounted on it, and screwed fast to a corresponding flange cast solid with the machine. This extends out 3½ inches on the overhanging arm, and serves to support it more thoroughly.

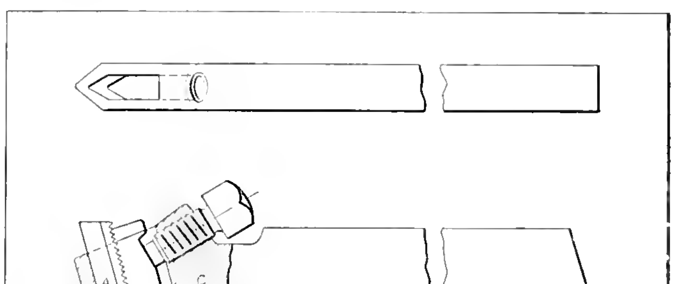
While this flange on the column serves, when clamped to the plate, to stiffen the the outboard arbor support, it was not primarily designed for this purpose. As shown in Figs. 1 and 3, its regular function is to serve as a base for the vertical and slotting attachments. The vertical attachment is shown mounted in Fig. 1. The spindle of this is driven by bevel gears from a horizontal shaft, extending to the back of the machine through a sleeve in the seat for the overhanging arm. Here it is connected with spur gears for the rear end of the spindle. This sleeve is made so that it can be slipped out from the back end in an instant. It is held in place by the rear clamping screw, which tightens the overhanging arm.

The advantage of this construction is that a very rigid support for the vertical spindle is furnished, and at the same time it is set high enough so as not to materially lessen the vertical capacity of the machine. The flange of the base is graduated in degrees, so that the head may be set to any position desired for angular cuts, by loosening the three clamping screws and adjusting as required. The same draw-in collets and taper socket are furnished as for the main spindle of the machine. The spindle thus holds end mills, drill chucks, etc. It is possible on some work, indeed, to use both the horizontal and vertical spindles simultaneously. The attachment has been found well adapted to jig work, as both the cross and longitudinal feeds of the table are accurately graduated to thousandths of an inch.

The slotting or shaping attachment shown in Fig. 3 has been found useful for cutting keyways, planing out dies, etc. It is clamped to the column in the same way as the vertical milling attachment in Fig. 1. It has a 2-inch stroke, and takes tools with ½-inch round shanks. These may be set with the cutting edge on any side, and the whole attachment may be swiveled round to any angle. The device should be especially useful for die sinking and similar work, as it permits cutting to a line scribed on the top of the work where it is always in sight, and so runs no risk of being under cut and destroyed. The same connection with the rear end of the main spindle of the machine is made as in Fig. 1.

"READY" STRAIGHT THREADING TOOL

The accompanying illustration shows an improved threading tool, which is being placed on the market by the Ready Tool Co., of New Haven, Conn. As may be seen, it is of the inserted blade type, and is very simple in construction, there



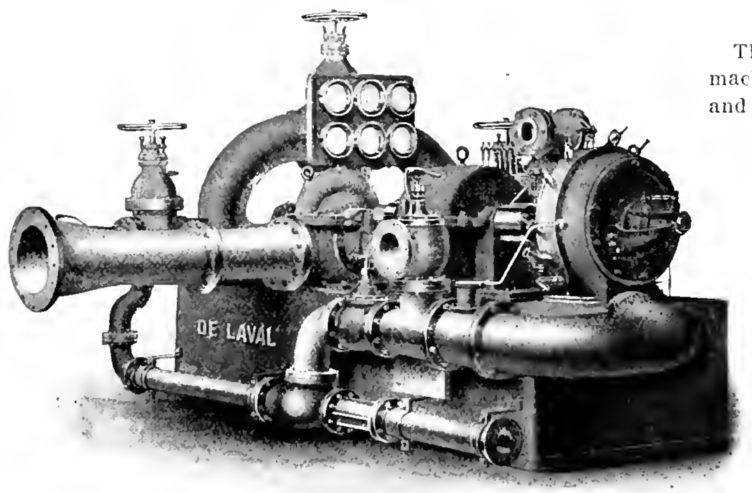
Thread Tool Holder with Improved T-Head Clamping Block

being but three parts to it besides the blade. The holder is straight and flush on both sides with no projections, presenting a very neat appearance. The blade *A* is adjustable, being provided with ratchet teeth on its rear face which engage corresponding teeth in the face of clamping block *B*, which thus serves to lock it under the pressure of the screw *C*. The clamping block is held in position by its T-head (not clearly shown in the engraving, which keeps it from dropping

through the slot, and thus in turn supports the blade against the pressure of the cut. The screw holds the V of the blade wedged in the V-slot broached out in the holder to receive it, thus binding the blade and holder firmly together. The tool will also be furnished with the offset form of shank if required.

SELF-CONTAINED TURBINE PUMPING ENGINE

The improvements made in centrifugal pumps and steam turbines during recent years have made possible a very efficient combination of both, which compares favorably as to size, cost, simplicity and steam consumption with reciprocating pumps. This combination also has an advantage over the reciprocating unit in cases where a pump is required to work against different pressures, which requirement is easily met with good steam economy by a turbine-driven multi-stage centrifugal pump, properly arranged for series and parallel



DeLaval Self-contained Pumping Engine

operation. A pump of this type is shown in the accompanying half-tone illustration. It consists of two 10-inch De Laval double suction centrifugal pumps, driven by a De Laval steam turbine, and arranged so that the pumps can be operated either in parallel or series, thus covering a range of operation from a normal delivery of 7,550 gallons per minute against a 50-foot head, to 2100 gallons per minute against a 175-foot head. The pumps are operated in parallel up to a head of 80 feet, and for higher heads in series.

As will be seen from the illustration the pump, turbine, condenser, and accessories are mounted compactly on a box-shaped bed-plate of moderate size. The condenser is of the ejector type, receiving the injection water under considerable head from the first pump, so that a good vacuum is possible with simple and inexpensive apparatus. If it is desired to shut off the condenser at any time the unit can be operated non-condensing by closing the water check valve in the exhaust pipe, so that the steam escapes through the exhaust relief valve.

The exhaust pipe contains a speed limiting device which prevents the turbine from running away in case of failure of the main governing valve. This emergency speed-limiting device consists of a butterfly valve in the exhaust pipe normally held open by a spring, but controlled by a piston. If the turbine exceeds a certain speed, a governor on one of the gear shafts will open a valve admitting air behind the piston, which will then turn the butterfly valve to a position athwart the exhaust steam pipe. As soon as the speed is checked, the air will leak from the cylinder into the exhaust pipe, so that the valve will resume its normal position.

As will be seen, all gages have been brought together upon a gage board attached to the piping connecting the two pumps. The six gages show the steam pressure on the turbine throttle, the steam pressure above the nozzle, the water pressure in the pipe lines, the suction lift, the water pressure in the injection pipe to the condenser, and the vacuum.

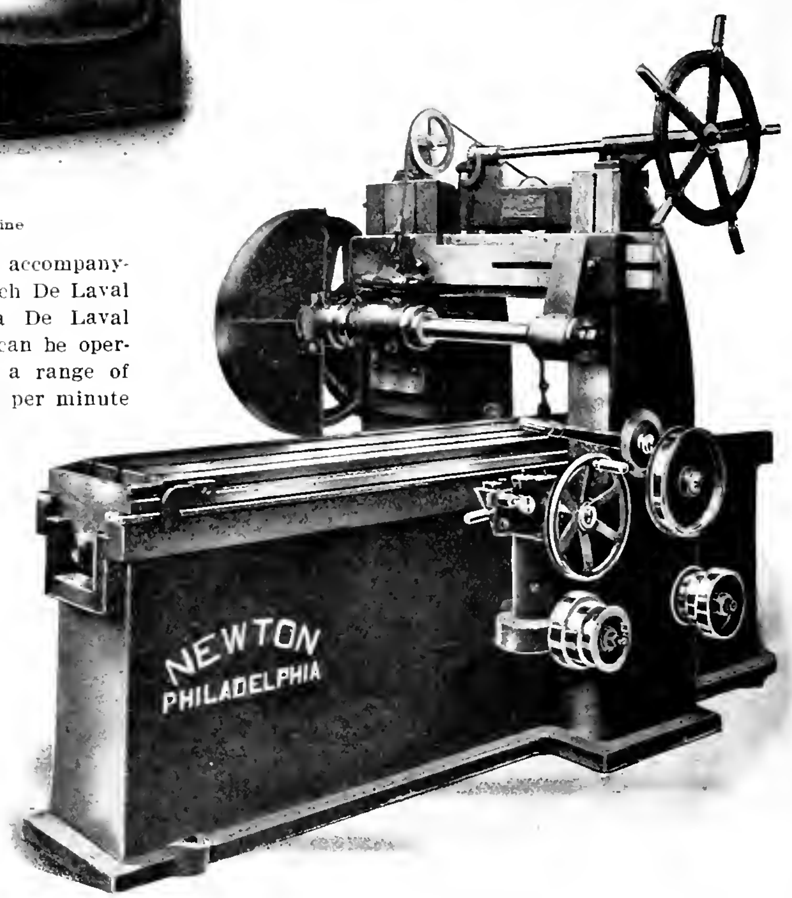
The lubrication is furnished from a central multiple oiler mounted on the gear case of the turbine, the oil from this lubricator being used for the high-speed bearings, gears, and governor pins. All oil from these points is carried to a common reservoir in the bed-plate and from there pumped to a filter from which it flows back to the central multiple oiler.

The unit, which is built by the De Laval Steam Turbine Co., Trenton, N. J., is very compact and is self-contained so that it is only necessary to connect it with the steam and water piping and place it on a suitable foundation, which latter need not be very heavy, due to the fact that there is practically no vibration.

NO. 1 NEWTON HORIZONTAL MILLING MACHINE

The accompanying engraving shows a horizontal milling machine, made by the Newton Machine Tool Works Inc., 24th and Vine Sts., Philadelphia, Pa. This design is provided with an improved spindle bearing which gives the cutters an axial adjustment, which can be accurately gaged by a screw control. The bearing is mounted for this purpose, as shown, in an auxiliary slide.

The machine is strongly built, and is intended for the rapid milling of small duplicate parts. The spindle, saddle, and cross-rail form an integral casting, giving the machine advantages in this respect



A Horizontal Milling Machine for Manufacturing Operations

over the column type with which it is offered in competition. Provision is made for supporting the outer end of the arbor by a saddle fitting the cross-rail, insuring accurate alignment at all times. The outboard support has a bearing with parallel internal and taper external surfaces, with adjusting nuts to compensate for wear.

There are six changes of belt feed for the table, with automatic release, hand adjustment and power quick return; the latter is controlled by the friction disks and operating lever shown at the front side of the machine. The spindle is 3½ inches in diameter, with a maximum capacity for cutters up

to 7 inches in diameter. The work table is 14 inches wide, with an extra inch between the uprights. The maximum distance from the center of the spindle to the top of the table is 15 inches. The table is long enough to take cuts 48 inches long, and is entirely surrounded by an oil tank.

The builders have found a wide demand for this machine on work which had previously been done on the standard column and knee type miller.

GARVIN VERTICAL MILLING ATTACHMENT

The accompanying halftone and line engravings illustrate a vertical milling attachment, made by the Garvin Machine Co., New York City. It is shown in Fig. 1 applied to the maker's No. 2 universal milling machine. This attachment is unusual,

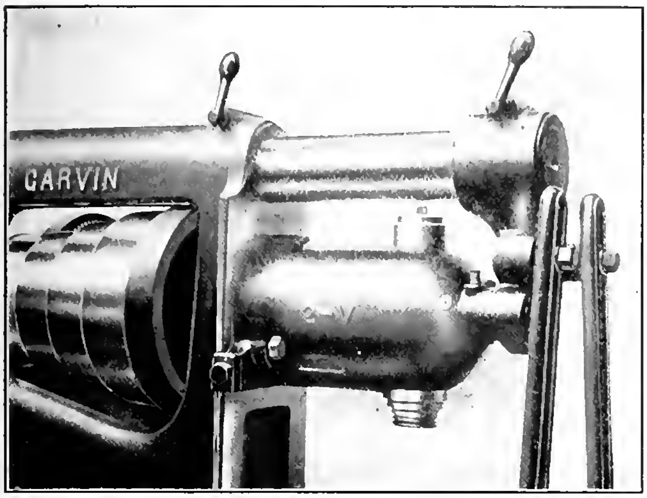


Fig. 1. Rugged Attachment for Vertical Milling Exclusively

in that no provision is made for swiveling the vertical spindle about the horizontal axis of the machine. This adjustment was dispensed with because it is seldom required. Its abandonment has resulted in giving this attachment much greater rigidity and capacity, as it makes possible a substantial decrease in the number of joints and connections necessary.

Referring to the reference letters in Fig. 2, in connection with Fig. 1, it will be seen that the casing of the attachment and the support on the face of the milling machine column, are made in one piece, shown at *A*. This casting is clamped to the column by the three bolts *B*, and is supported at its outer end by a pivot closely fitting the regular outboard support of the machine. While this, as explained, does not regularly provide

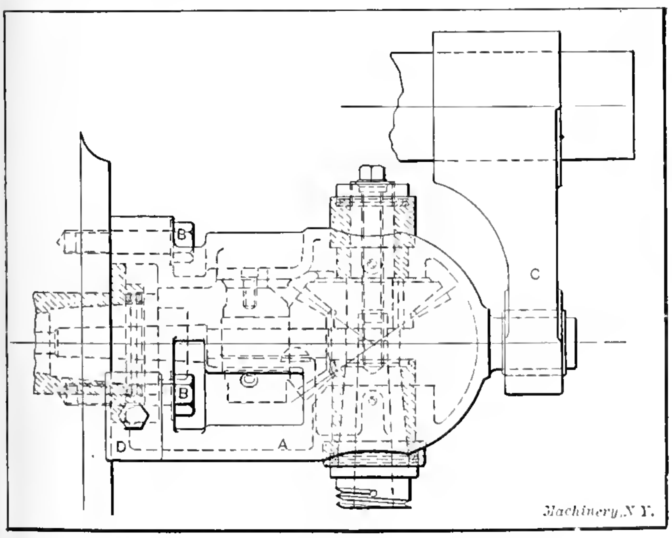


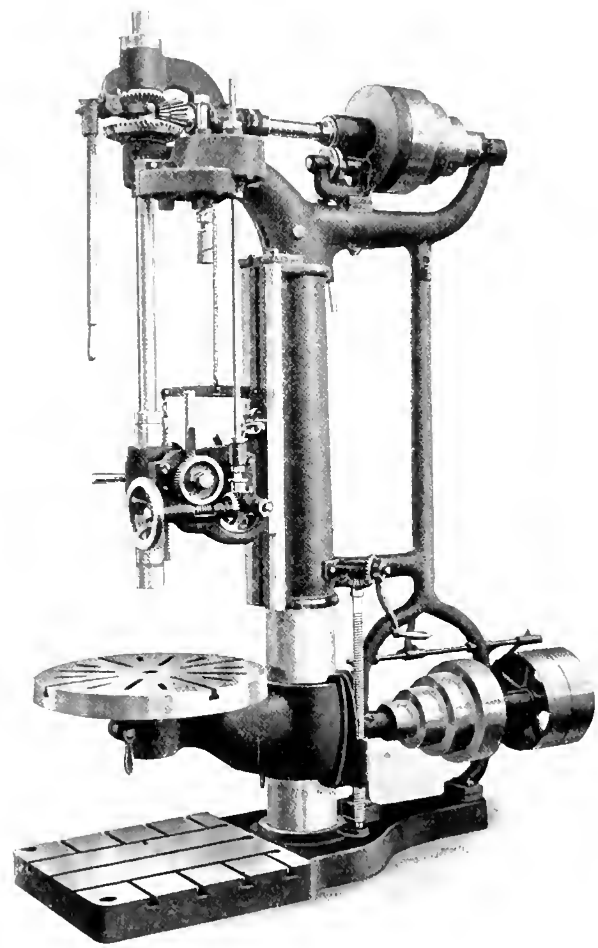
Fig. 2. Section of Garvin Vertical Milling Attachment

for swiveling the spindle away from the vertical, provision is nevertheless made for tipping the spindle very slightly in other direction, to prevent dragging of the cutting edges on the back side of the cutter. Bolts *B* are a little loose in their holes, permitting the spindle to be rocked slightly to the right or left. This rocking adjustment is controlled by clamps *D*, which engage the V's on either side of the front face of the column, and swing the attachment slightly one way or the other, depending on which side is screwed down. It should be noted that the body *A* of the device is made cylindrical, with spherical end, so as to give the operator an unobstructed view of his work.

This attachment is driven by miter gears, having a coarse pitch and strong teeth. The spindle is ground, having a No. 10 Brown & Sharpe taper hole for the arbor or cutter shank; it is provided with a draw-in rod for holding the cutters in place. The lower bearing is taper, running in a solid self-oiling bronze box. The upper bearing is straight, running in an adjustable bronze box, provided with a take-up nut for end motion. The nose of the spindle is threaded to the standard $2\frac{1}{2}$ inch diameter, four pitch, left-hand V-thread. The attachment is made in two sizes, and may be applied to many sizes or styles of the makers' milling machines.

MECHANIC'S MACHINE CO.'S NO. 32 UPRIGHT DRILL

The accompanying illustration shows a new No. 32 upright drill, made by the Mechanic's Machine Co., of Rockford, Ill. The tool, as may be seen, is of the sliding head design, and is



An Upright Drill with a Simple Design of Tapping Attachment and Geared Feed

notable for the simplicity of the tapping attachment and the provision of geared feed changes. A back-gear device of the internal type is also furnished.

Referring to the engraving, the construction of the tapping attachment will be plainly understood. Its construction is the most direct possible, as only two gears are used in addition to the ordinary crown gear and pinion; these two are simply an additional crown gear and pinion for the reverse movement, the ratio of which is such as to give the desired return. The reverse crown gear is made from steel, and is provided with a large hub, bored out to sufficient size to furnish a bearing for the clutch sleeve in it. This gives a chance to use a very long and durable clutch sleeve, and one which will not be cramped under any conditions. This sleeve is

made from steel, but is surfaced on the outside with hard bronze to give a good bearing in the steel gear.

The enclosed gear feed mechanism gives the eight changes, varying from 0.005 to 0.062 inch per revolution of the spindle.

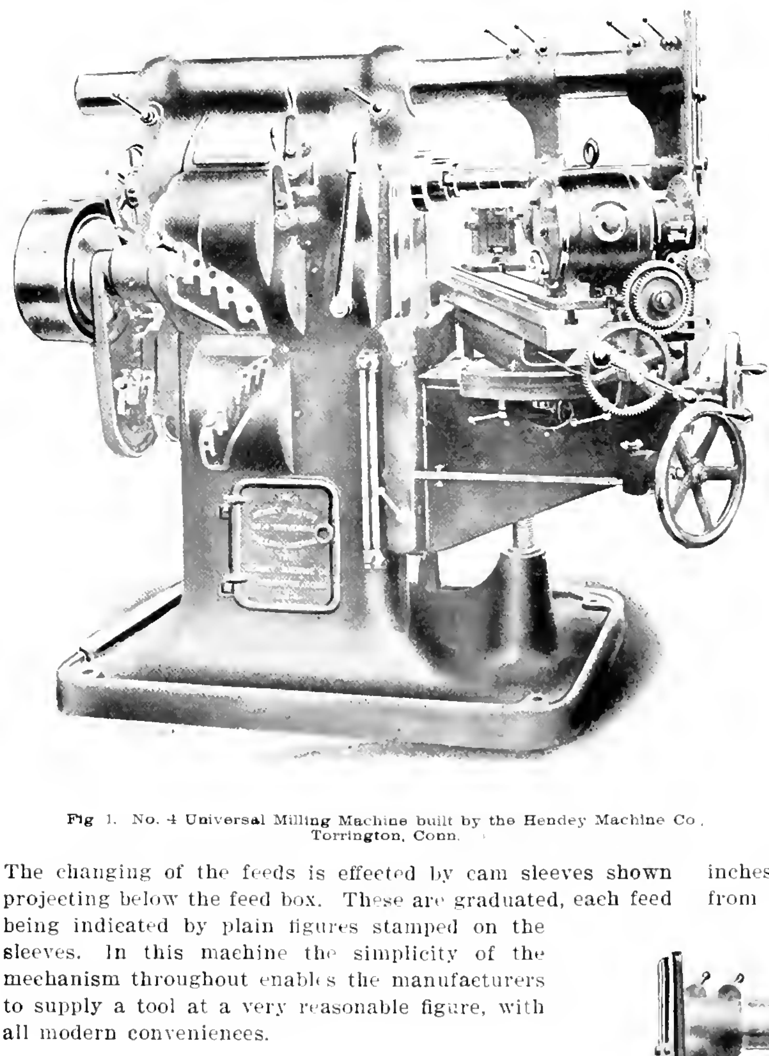


Fig. 1. No. 4 Universal Milling Machine built by the Hendey Machine Co., Torrington, Conn.

The changing of the feeds is effected by cam sleeves shown projecting below the feed box. These are graduated, each feed being indicated by plain figures stamped on the sleeves. In this machine the simplicity of the mechanism throughout enables the manufacturers to supply a tool at a very reasonable figure, with all modern conveniences.

HENDEY NO. 4 UNIVERSAL MILLING MACHINE

A universal milling machine, known as the No. 4 G.-S. type has recently been brought out by the Hendey Machine Co., Torrington, Conn. The right and left sides of the machine are shown in the accompanying illustrations. In designing this machine the same general construction has been followed as is employed in the No. 4 plain gear-driven milling machine built by the same company, which was mentioned in a note in the July, 1909, issue of MACHINERY. The object aimed at in designing this machine has been to provide ample power and a wide range of spindle speeds and feeds, and at the same time produce a machine of simple construction. There are but few and easily understood movements required for the various feed changes, the gearing for which is arranged according to the same system as has been applied so successfully on the Hendey-Norton lathes. The number of spindle speeds obtainable are 15, and the range of spindle speeds obtainable through the back-gears is from 12 to 106 revolutions per minute, while the range obtainable through the geared cone is from 134 to 350 revolutions per minute. The feeds are positive and obtained through chain and sprockets. There are 21 feed changes, ranging from ¼ to 25 inches of table travel per minute. The feeds are all automatic and can be operated simultaneously, and reversed while the machine is in motion. The longitudinal travel of the table is 35 inches, the transverse travel 12 inches, and the vertical travel 20 inches. All feeds are provided with safety trips. The total dimensions of the table are 60½ by 15 inches, the working surface being 55½ by 15 inches. The table is provided with three ¾-inch T-slots.

The dividing head is of very heavy construction. The frame furnishes annular bearings for side plates which, in turn, serve as trunnions for carrying the center block of the head; the spindle is provided with taper journals on both ends. The nose of the spindle is made with a clutch driving collar, and furnished with a draw-in bolt. The swing of the index centers is 15 inches, the maximum distance between the centers being 31 inches. The front plate on the index head, intended for direct indexing, has three rows of holes, with 24, 30 and 36 holes, respectively. The plunger pin for these holes is carried on an eccentric shaft graduated to indicate the row of holes engaged with. Only one side plate for the wormwheel indexing is required, this plate being reversible and having nine circles of holes on each side, running from 15 to 49 holes per row, the intermediate numbers being according to the usual system. The indexing crank rotates on its pin when marking spacings, and is provided with a snap catch which holds it free from the plate when indexing. The worm in the index head runs in an oil bath, and an adjustable stop is provided to regulate the proper engagement between the worm and wormwheel.

The general dimensions of the machine are as follows: The taper hole in the end of the spindle is a No. 12 Brown & Sharpe taper; the straight hole through the spindle is 1⅜ inch, and the diameter of the nose of the spindle 3½ inches, with three triple left-hand threads per inch. The width of the driving belt is 5 inches, the diameter of the driving pulley 16 inches, and its speed 350 revolutions per minute. The distance from the center of the spindle to the overhanging arm is 8⅜ inches, and the distance from the end of the spindle to the center in the arbor support is 28 inches. The floor space required is 108 by 117 inches and the net weight is 6900 pounds.

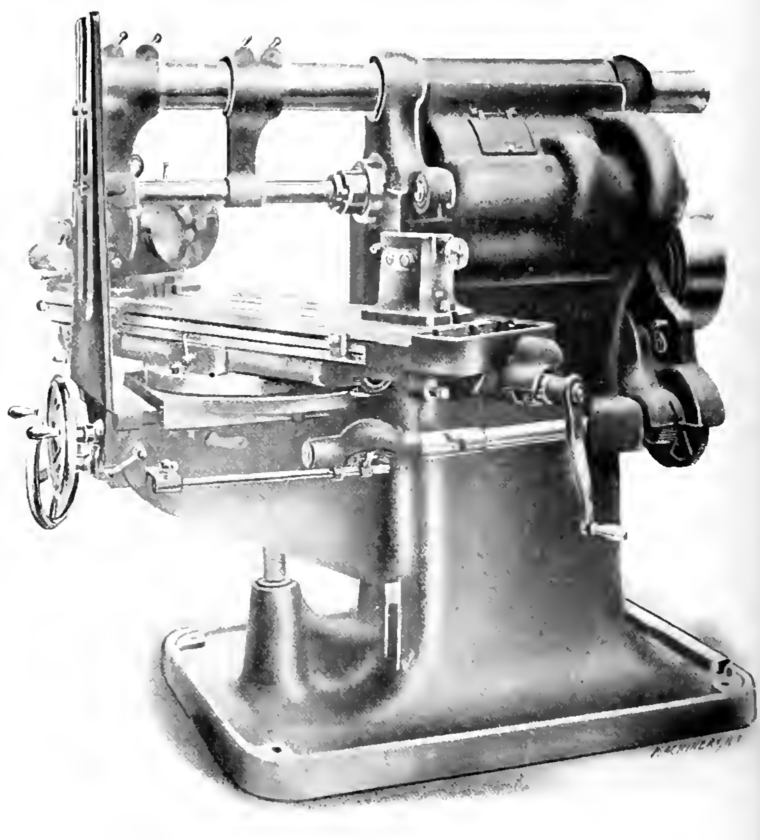


Fig. 2. View of Universal Milling Machine showing General Arrangement of Feed Mechanism

IMPROVEMENTS IN THE WOODS UNIVERSAL TOOL AND CUTTER GRINDER

In the March, 1908, number of MACHINERY, we illustrated and described a very complete tool and cutter grinder made by the Woods Engineering Co., Alliance, Ohio. This machine has since been improved in a number of particulars, resulting in the new design herewith described and illustrated.

Fig. 1. Improved Design of Woods Universal Tool and Cutter Grinder

The principal change consists in providing for the angular adjustment between the wheel and work, by swiveling the wheel-head instead of the work-table. This results in a marked increase of rigidity, as the column can now be made solid instead of having the split sleeve construction previously required. Less floor space is needed as well, the work-table being always in the same position. For the same reason it is now at all times directly under the countershaft, to which it can always be belted for driving the work in cylindrical grinding.

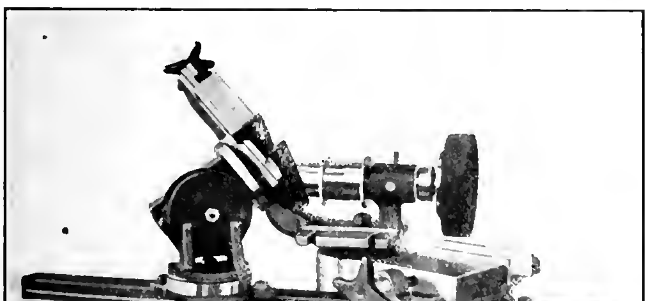


Fig. 2. Three-swivel Mounting for Vise, permitting Universal Adjustment

Another improvement relates to the vise, which is now made to fit on the headstock. This is shown most plainly in Fig. 2, where it will be seen that the new arrangement gives the vise three swivels, making it strictly universal and capable of holding work in any conceivable position. The vise also fits the base of the headstock, bringing it close to the table for surface work. The other attachments have been simplified and at the same time improved so as to give them a wider range of action and more varied uses.

As seen in Fig. 1, handwheels have been supplied for all the movements. They are placed so that the operator can control them all without shifting from his natural position. All the working parts are easily accessible for cleaning, and adjustments are provided throughout for wear, allowing the original accuracy of the machine to be preserved for a long period of time. In other points the good features of the original design have been preserved.

The longitudinal travel of the machine is 22 inches, and the cross-feed is 7½ inches. The vertical adjustment is 9 inches. It will take 22 inches between centers and swings 9 inches over the table. A full outfit of wrenches, dogs, tool-rests and attachments is provided, together with wheels suitable for the work of the machine. The weight without countershaft is about 700 pounds.

GENERAL ELECTRIC ALTERNATING CURRENT GRINDING AND BUFFING EQUIPMENT

The General Electric Co., Schenectady, New York, has brought out improved types of alternating-current buffing and grinding equipments designed for use in wood-working shops, machine and repair shops, foundries, etc., where alternating current is available.

The grinding equipment, as shown in Fig. 1, consists of an alternating-current motor with substantial supports, fitted with tool-rests and water attachments. These latter accessories are rigidly clamped to the bearing brackets, and can be easily removed if required. Each end of the extended shaft is provided with two steel flanges, two leather washers and one nut for clamping the emery wheels securely in position. The motor is absolutely enclosed, so as to be thoroughly dust-proof, and the shafts, bearings and attachments have been designed with a view of making the device able to withstand hard and constant usage.

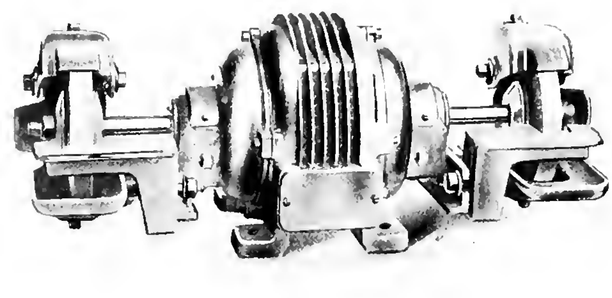


Fig. 1. Motor-driven Grinding Equipment built by the General Electric Co, Schenectady, N. Y.

The self-contained buffing equipment shown in Fig. 2 provides a very efficient polishing device, similar in construction to the grinding outfit, with the exception that the tool-rests and water attachments are omitted. The shaft is also made longer, and each end is tapered and threaded for receiving the buffs. The bearing brackets are circular and so designed that they may be turned through 90 degrees to admit of side wall installation.

The motors can be furnished for operation on either single-, two-, or three-phase circuits of 110 or 220 volts. The single-phase motors are of ¾, 1, 2 and 3 horsepower capacities, and the polyphase motors of ¾, 1, 2, 3, 5 and 7½ horsepower capacities.

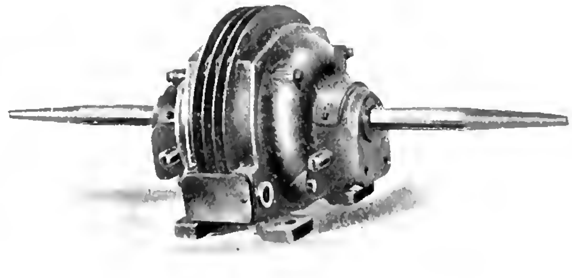
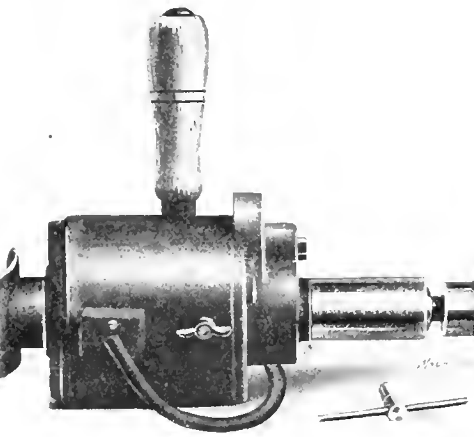


Fig. 2. Buffing Equipment of the same General Design as the Grinding Equipment in Fig. 1

WILLEY PORTABLE ELECTRIC BREAST DRILL

The portable breast drill shown in the accompanying engraving, made by the Willey Machine Co. of Jeffersonville, Ind., is of the same general type, but of an improved design,

as compared with the drill made by the same company and illustrated and described in the November, 1908, issue of MACHINERY. Instead of having the power transmitted by only two gears as in the previous design, four gears are used, this construction being more advantageous. The gears are all cut from a solid steel bar. A system of air ducts in the frame provide for ventilation and cool running of the motor.



Improved Portable Electric Breast Drill built by the Willey Machine Co., Jeffersonville, Ind.

The tool is made in three sizes, having a maximum capacity for drilling 3/8, 1/2 and 3/4-inch holes in steel. The motors, as mentioned in the previous description referred to, are wound for either direct or alternating current and for any voltage up to 250.

* * *

NEW MACHINERY AND TOOLS NOTES

MACHINIST'S HAND-SCREW OR CLAMP: Tower & Lyon Co., 95 Chambers St., New York City. This is a clamp designed on the familiar lines of the wood-worker's hand-screw, but made of sheet steel pressed to shape, with steel screws. The construction is stiff and durable.

CORUNDUM OILSTONES: American Emery Wheel Works, Providence, R. I. This line of oilstones is made in five different sizes (4, 5, 6, 7 and 8 inches long, respectively), and in three grades, coarse, medium and fine. The stones are impregnated with vaseline, so that they are practically self-lubricating.

"CORUBIN," A NEW ABRASIVE: Goldschmidt Thermit Co., 90 West St., New York City. This is a material which has been extensively used abroad as an abrasive, but has only recently been introduced in this country. It is a by-product formed in the manufacture of chromium by the thermit process. It is supplied in three grades, coarse, medium and fine.

DUPLEX MILLING MACHINE FOR PISTON RINGS: Ackley & Abbey Machine Co., Battle Creek, Mich. This tool is designed for milling lap joints in piston rings used for automobile and other engines. Both sides of the ring are cut and jointed in one operation. Pneumatic devices are provided for clamping the work, making the operation of the tool exceedingly rapid. It will cut and joint 4-inch rings, 5/16 inch wide, at the rate of 400 per hour.

"COLUMBIA" VERNIER CALIPER WITH DEPTH GAGE ATTACHMENT: E. G. Smith Co., Columbia, Pa. A recent addition to this line of calipers provides jaws for inside measuring, agreeing with the setting of the regular jaws, and provides also a depth gage connected with the sliding jaw and read to the same graduations. Outside, inside and depth measurements can thus be taken simultaneously at the same reading. This tool is furnished with a number of different styles of graduations.

SPECIAL MILLING MACHINE FOR ANGLE SLOTS IN PISTON RINGS: Ackley & Abbey Machine Co., Battle Creek, Mich. This special miller is provided with a work-table, set at an angle of 45 degrees, and provided with an air clamp for rapidly grasping or releasing the work. Rings up to 8 inches in diameter may be cut. These are located by suitable plugs on the angular table. The machine is operated by two hand levers, which make possible rapid manipulation and consequent high output.

INTERCHANGEABLE BLADE SCREW-DRIVER: Tower & Lyon Co., 95 Chambers St., New York City. This screw-driver has a wooden handle, reinforced with a steel shank, and provided with a spring pin for retaining the various screw-driver blades furnished with the set. These are of two kinds, round and square, and of two diameters for each style. Various lengths are furnished from 1 to 36 inches, for work under a wider variety of conditions. The square shanks of the blades adapt them to be used in bit braces also.

ARBOR PRESS: Cleveland Machine Specialty Co., Cleveland, O. This arbor press is of improved design, particularly in the matter of the shape of the main casting, which is of box section, giving great strength for the weight. The No. 3 machine has a capacity for arbors up to 1 1/2 inch diameter and work up to 12 inches diameter by 12 inches high. It will exert the pressure of three tons with ordinary effort, and has a net weight of 108 pounds. It can be mounted on the lathe or bench, or can be provided with a special pedestal.

OIL AND GAS FURNACES: Strong, Carlisle & Hammond Co., Cleveland, O. These furnaces are furnished in a wide variety of styles, adapted for all metal working purposes, both for regular and special work. They are made to be fired with either natural gas or oil. Two convenient designs for general use are a heating, annealing and tempering furnace with a pre-heating oven; and an oil tempering furnace with an oil burner. These furnaces are especially noteworthy for their very convenient arrangement and attention to detail in design.

DRAW-IN CHUCK ATTACHMENT FOR LATHES: Cleveland Chuck Co., Cleveland, O. This is a draw-in attachment of the adjustable jaw type, adapted to be applied to existing screw machine and turret lathes, or to engine and speed lathes provided with hollow spindles. The working parts are hardened and ground. The device will be furnished with either three or four jaws, or with stepped or special jaws for special work. Its wide adjustability gives it a great advantage over the usual construction of spring collets of one size each and limited adjustment.

BALL TURNING DEVICE FOR LIBBY TURRET LATHE: International Machine Tool Co., Indianapolis, Ind. This device is adapted to be used in place of the regular cross-slide tool-post on the Libby turret lathe, and is connected with the regular power cross-feed without alterations. The tool-post is mounted on a swivel table, which may be rotated by hand or power to turn balls from 2 to 12 inches in diameter. Stops are provided for locating so that the axis of the swivel motion will coincide with the center line of the spindle. The tool-post is of the turret type and can be locked in two positions, one for roughing and one for finishing.

IMPROVED HANDLE FOR HACK-SAW FRAMES: Simonds Mfg. Co., Fitchburg, Mass. This firm's line of straight cut hack-saw frames for blades from 8 to 12 inches inclusive, is now furnished with a gutta percha handle in shape resembling a regular saw handle, reaching from the frame proper down to the saw itself. The sides are checkered to make the grasp surer. Brass screws are used to connect the handle and the frame. The metal parts are polished with nickel, and the blades may be used in any one of four directions. This improved handle gives a firm steady grasp, and results in corresponding efficiency in the use of the tool.

MOTOR-DRIVEN MANUAL TRAINING LATHE: F. E. Reed Co., Worcester, Mass. This lathe is driven by a one-half horsepower motor, mounted in a cabinet leg beneath the bed. It is so supported that the tension of the belt can be easily adjusted. The headstock is mounted on an overhang of the bed, permitting a direct cone pulley drive from the armature spindle. A faceplate is provided at the back end of the lathe spindle for turning large diameters. A shelf beneath the bed and one at the back, furnished with the lathe, afford place for work and tools. The lathe swings 12 inches and, with a 4 foot bed, will take 24 inches between centers.

DUENKEL RECIPROCATING METER: Mechanical Instrument Co., 120 Liberty St., New York City. This instrument positively measures the number of linear feet traversed by any reciprocating machine member, and can thus be used to check the working life of such parts as piston rings, rods, packings, pump valves, elevator cables, etc. In its application to pumps, it would evidently be useful, in addition, in giving an indication of the number of gallons of water delivered. The recording dial is driven by reversing and clutch mechanism, which operates the hand continuously in one direction, both on the forward and on the back stroke of the reciprocating parts.

MOTOR-DRIVEN DIE SLOTTER: Garvin Machine Co., Spring and Varick Sts., New York City. The slotter has a motor bolted to the side of the column and directly belted to the regular driving pulley, so that practically no change is required in the machine itself. Cross, longitudinal and vertical adjustments of the table are provided and a rotary table is furnished as well, adapting the machine especially to working out the shapes found in die cutting. The head may be adjusted to the proper angle for the draft or clearance. The stroke is 2 1/2 inches, and the machine runs from 29 to 87 strokes per minute. The weight of the machine is 1,480 pounds.

"SHARPEN EZY" COLD CHISEL: H. D. Smith & Co., Plantsville, Conn. This chisel is drop forged to special shape. The body of the tool is fluted, allowing a comfortable grip and preventing the tool from slipping in the hand. The head, of course, is solid. The blade is shaped so as to be easily sharpened and is tempered for its full length instead of only for about one-half inch from the point as with the ordinary hand-made tool. It does not then have to be redressed from time

to time, and as it can be used clear up to the body, its life is a long one. Each tool is tried under a sledge hammer test before marketing. It comes in four sizes with blades from 3/8 to 3/4 inch wide.

Punching and Shearing Machines: Carpenter-Kerlin Gear & Machine Co., 77 White St., New York City. This line of machinery is built in different forms—either as a shear for angles, squares and rounds alone, or combined with a plate shear or with a punch. It is built in several sizes, the largest of which will punch a 2-inch hole in a 1 9/16-inch plate, shear rounds up to 3 inches diameter, angles up to 7 by 3/4 inch, and other sections in proportion. High grade material is used, steel castings being employed throughout with shafts of tempered steel, running in phosphor-bronze or cast iron bearings, depending on the service. A motor drive may be easily applied to this machine.

Knight Beam Compass: Sherwoode Tool & Instrument Co., Westtown, Pa. This compass is intended both for the drafting-room, and for shop use in laying out work. Adjustment of the sliding head is made by graduations which permit it to be quickly set to approximately the position desired. The fine adjustment is then made by turning the pivot point, which is set eccentrically with its shank for the purpose. The sliding holder is clamped by a nut which permits vertical as well as horizontal adjustment. It will hold either a pencil or drawing-pen as desired, or a scriber for metal work. Beams up to six feet in length will be furnished, reinforced with wood to give the proper stiffness.

Lane's Ratchet Screw-driver and Wrench: J. C. McCarty & Co., 21 Murray St., New York City. This wrench is provided with a variety of screw-driver blades and sockets, which may be quickly changed by unscrewing a knurled nut. The ratchet mechanism is automatic in action and may be instantly changed from right to left or *vice versa* by the movement of a convenient lever. The knurled clamping nut may be employed for rapidly twirling off the nut or screw after it has been loosened, thus saving considerable time. The tool is 7 inches long over all, and drop-forged from the steel that is best suited to the work each part has to do. This wrench should be very useful in working in confined places, in assembling automobile work, and for similar applications.

Pipe Attachment for Automobile Wrench: Charles E. Hall Co., Buffalo, N. Y. This firm is the maker of a steel wrench particularly suited to the automobilist's use. For the Nos. 18 and 20 of this line, which are respectively 9½ and 11½ inches over all, an attachment has been provided which immediately converts the tools into a pipe wrench. This attachment consists of a separate jaw with the usual ratchet teeth cut in it, which may be slipped in place in the wrench and quickly locked by a spring clip. In addition to the convenience afforded by this attachment, the handle of the wrench is so shaped as to be serviceable in removing pneumatic tires from wheel-rims, and is available as well for general leverage in the many emergencies occurring in connection with automobile work.

Reversing Tapping Chuck: Pawtucket Tool Co., Pawtucket, R. I. In the department of New Machinery and Tools in the December, 1909, number of Machinery, was published a note descriptive of a new tapping chuck made by the above firm. This was of the pull-off type, on which the tap is released when the proper depth of thread has been cut. The new design is provided with self-contained reversing gears and automatic clutch mechanism, which stops the tap at the bottom of the hole and reverses it by the operation of the regular feed lever of the drill press. It is, therefore, adapted particularly to presses not provided with a special reversing attachment. It is of very compact and of rugged design, with a friction device graduated to suit the size of tap used, making it very simple to set.

Motor Drive for No. 00 Screw Machine: Garvin Machine Co., Spring and Varick Sts., New York City. In this application to a small screw machine, the motor is mounted on a base attached to the legs of the machine on the back side, and connected with the spindle by a pair of round belts, one of which is crossed. A hand-operated lever is provided for shifting the belts on and off of the grooved driving pulley on the spindle, for reversing. The driving pulley is made of larger diameter than the loose pulleys, so that the belt not in use is released from tension. This machine has a capacity for stock up to ¼ inch diameter. It may be used for anything from this down to the very finest of rod work. The machine is very quickly handled, making high production possible. It weighs about 500 pounds, including the motor.

"Utility" Machine Vise: Jackson Vise & Tool Co., 85 Beekman St., New York City. This is a strongly constructed tool, covering a large range of work both as to size and shape, without the use of attachments. This is made possible by the fact that the fixed jaw is four-sided, and may be swiveled to bring any one of its four sides in line with the movable jaw. All the sides of this jaw are machined. One has a steel face, while another is shaped to answer the purpose of an angle-plate. A third side has a V-groove extending its full depth, admitting rounds, squares, etc., to be held vertically. A similar horizontal groove is provided on the fourth side. The vise gives an opening of 6½ inches high and 8½ inches extreme distance between the jaws. By the use of supplementary jaws, a still wider adjustment is provided for.

Carr Combination Tool-holders: Henry G. Thompson & Son Co., New Haven, Conn. In the November, 1907 and 1908 issues of Machinery, we described various members of the line of Carr combination tool-holders. The manufacture of these has now been undertaken by the firm above mentioned, and the line has been materially added to. It consists at present of a tool-holder body adapted to be clamped onto the tool-rest by the use of the regular tool-post of the lathe. This is done in a way, however, that holds it much more solidly than any tool held in the tool-post. In this holder may be clamped any one of a series of tools, comprising turning tools, boring tools of various sizes, threading tools, etc. One form of the holder permits rocking the blade so as to give an adjustment for the height of the center. This is particularly adapted to the use of cutting-off tools. Blades clamped in these holders are held with unusual firmness, having a support directly down onto the tool-rest of the lathe.

Combined Vertical Milling and Drilling Machine: W. B. Knight Machinery Co., St. Louis, Mo. This machine resembles a drill press somewhat in its general lines, but is built with an exceedingly stiff column and with adjustable work tables which adapt it to milling operations. In place of the usual rotary work-table and swinging arm, a knee is provided with a milling machine saddle and table, giving adjustments in two directions. This knee is supported on a pivot, so that it may be tilted to any angle, and it may also be swung about the column of the machine, making it universal. The vertical adjustment for the mill, 12 inches, is obtained from the sliding spindle head. The feed of the spindle in the head is 4½ inches. Positive geared changes are provided for the speed and feed. The latter has 10 rates varying from 0.008 to 0.76 inch per revolution, and may be applied to either the longitudinal or the cross-feed of the work-table. A swiveled vise is provided with a graduated base. The machine weighs about 2,000 pounds.

Cincinnati Special Forge Planer: Cincinnati Planer Co., Cincinnati, O. This tool is intended for severe duty, especially where the sideheads are called upon to do a large share of the work. For this reason the faces of the housings have been made very wide (18 inches on the 56-inch machine) and the heads have been gibbed to them in such a way as to give them great rigidity. Owing to the weight of these heads, they have been furnished with a power rapid traverse under immediate control of the operator. Besides this special attention to the sideheads, another important feature has been incorporated in the design—namely, the use of double driving and reverse belts, with a separate driving shaft for the latter, so as to eliminate cross belts entirely. The forward and reverse shafts on top of the housings are connected positively by gearing in the proper ratio. The narrow straight belts used with this arrangement, while transmitting great power, can still be shifted quickly and easily, giving instant and accurate control to the reversing motion.

Blevney Tube Polishing Machine: John C. Blevney, 216 High St., Newark, N. J. This machine employs the same principles of construction as the one illustrated in the department of New Machinery and Tools of the May, 1909, issue of Machinery. The polishing member is a belt of emery cloth, supported and driven by a leather belt whose surface is formed into ridges which keep the emery cloth spread out flat, and at the same time give it a ribbed surface which greatly increases its cutting capacity. This particular design of machine is provided with a special table carrying rubber-covered roller shafts for supporting the tubes as they pass through the machine. The tubes are carried through by the friction between them and the surface of the abrasive belt. As they pass at a slight angle the tubes are revolving automatically, so that their whole surface is ground; the table is also automatically shifted during the grinding to distribute the wear over the full area of the belt. For tubing of rectangular section the work is carried through on a feed belt.

Fuel Oil Burning Process: Gilbert & Barker Mfg. Co., Springfield, Mass. This firm has developed a system of fuel oil which has proved to be economical, convenient, efficient and safe to a high degree. The supply tank or tanks are located underground outside the building. The oil is drawn from them and forced into the nozzle by means of a power pump connected with a release valve which maintains a pressure of five pounds in the system. A series of baffle plates in the vent pipe of the storage tank prevent the entrance of fire through this opening. The air is furnished by a positive rotary blower at a working pressure of about two pounds. The air and oil are combined at the nozzle in portions regulated by suitable valves. The fuel is sprayed in the form of a fine mist, which is as easily regulated and burns as freely as a gaseous fuel. As an ingenious safety provision, the fuel pump is belted to the blower, so that if the latter should fail from the breaking of a belt, burning out of a motor or otherwise, the supply of oil would also cease at once. This system is adapted to anything from large forges, to small bench furnaces for light hardening, tempering, etc.

TOOL OUTFIT FOR MACHINING FLY-WHEELS ON THE BORING MILL: Colburn Machine Tool Co., Franklin, Pa. This firm is furnishing an outfit of tools for gas engine fly-wheels which has proved very successful. The boring mill used is provided with two regular tool-heads and a central boring spindle. The latter is revolved independently of the table, so as to give the proper cutting speed to the tools which finish the bore at the same time that the rim is being machined. In the first operation a tool in one of the heads turns the outside diameter of the rim. Simultaneously a box tool held in the other head faces both edges of the rim, the wheel being mounted in a special fixture which holds it firmly, but allows these cuts to be taken simultaneously. At the same time also, the central boring spindle is roughing out the bore with an inserted blade boring-bar. By the time the operations on the rim are finished a roughing and finishing boring cut has been taken in the hub and the reaming is in progress. For the reaming, the floating holder described in the New Tools Department of the December, 1909, issue of MACHINERY is used. The final operation consists in facing the hub with an inserted blade holder, steadied by a pilot in the bore, and chamfering all four edges of the rim inside and out. With this outfit of tools the following rate of production has been found practicable: 22-inch wheels, 15 minutes complete; 26-inch wheels, 18 minutes; 30-inch wheels, 20 minutes; 36-inch wheels, 23 minutes; 42-inch wheels, 25 minutes apiece.

* * *

UNITED STATES TRADE REPORTS BOBS UP AGAIN

The following interesting correspondence, which speaks for itself, may be read with profit by manufacturers unacquainted with the game. It has been played for several years with profit, and although exposed many times it seems to flourish still:

Industrial Press,
New York, N. Y.

MOLINE, ILL., 2/12/'10.

Gentlemen:—We enclose herewith letter which we recently received from a Cincinnati concern. . . . We received exactly the same letter from them about a year and one-half ago and are enclosing herewith copy of our reply to them at that time, and also to the last letter received from them. These parties were shown up in the trade publication a few years ago but are evidently getting busy again and believe that it would be well to warn the trade against them. The point of the matter is the fact that we are the sole and only and exclusive builders of screw driving machines in this or any other country, to the best of our knowledge and belief. The writer is easy and falls for a good many advertising schemes, but this one is too raw. Very possibly, however, others new in the business would be taken in by such a scheme and we believe that it would be well to post the trade through your publication.

Very truly yours,
REYNOLDS MACHINE CO.

CINCINNATI, 1/20/'10.

Reynolds Machine Co., Rock Island, Ills.

Gentlemen: The enclosed article is an editorial prepared on the subject of Screw Driving Machines, which we intend to publish in our columns.

Our policy of furnishing reports on any commercial matter about which our readers may request information brings numerous inquiries on all subjects pertaining to trade. This editorial gives facts that are needed and will be appreciated by a large number. As we have highly indorsed your machine, we ask that you add to or alter same as you may think best and return as soon as possible. If you have any cuts that will illustrate the subject, kindly loan them to us and we will return them promptly.

As this is an editorial of course there is no charge for publication and in addition if you can use any extra copies of the issue in which it will appear, we will be pleased to make you the following special reduced rates as we are desirous that you should get as much benefit out of it as possible.

The price of the United States Trade Reports is 15c. per copy, but we can supply you with 100 at 12c. per copy, 250 at 10c. per copy, 500 at 9c. per copy, 1,000 or over at 8c. per copy, shipped to you or if you will send us a list of the names of those whom you wish to reach, we will mail marked copies to such without any extra charge to you for the postage, wrapping, addressing or marking.

Although the publication does not depend on an order for copies, such an order will be appreciated by us.

Awaiting an early reply with corrected copy, we remain

Yours truly,
UNITED STATES TRADE REPORTS.

Following is the article headed "Disinterested Advice" that was to be published in the U. S. Trade Reports—if "approved":

DISINTERESTED ADVICE

It is often a very difficult matter for the average person to determine the "best" in this or that line and especially so where every producer heralds his own particular product as the acme of perfection. The many points to be taken into consideration in determining the superiority must all be given careful thought, and even if one had the time and energy to devote to a careful research, there are still many obstacles to overcome.

It is perhaps a realization of these facts combined with the knowledge that this paper has better facilities for such examinations and researches than any individual that induces the numerous inquiries we receive in which we are asked the merits or advantages of this or that commodity where they have not the means of ascertaining for themselves.

One of the chief facters, however, in arriving at a satisfactory solution of this question must always be the reliability of the firm you contemplate dealings with. Knowing the firm you deal with so as to be able to place perfect reliance in their integrity is by far the best test.

On the subject of Screw Driving Machines and where can be obtained the best make we beg to draw attention to the valuable products of the Reynolds Machine Co. of Rock Island, Ills.

We are convinced that this machine is superior to all others that has come under our observation because the manufacturers use every endeavor to make their products perfect.

This company enjoys an enviable reputation for the high standard of excellence and their products are used in preference to all others wherever they have been introduced. They are of the highest commercial standing and any representations they may make can always be relied upon.

Those interested may esteem this our reply and a communication addressed to them direct will elicit information and details which would be out of place in an editorial like this.

January 25, 1910.

U. S. Trade Reports,
414 Home Street,
Cincinnati, Ohio.

Gentlemen: Replying to yours of the 20th inst., in regard to proposed editorial for your publication, we call your attention to our letter of June 20th, '8, in reply to a similar communication.

We expressed our opinion of you and yours at that time and have had no reason since to change it.

Very truly yours,
REYNOLDS MACHINE CO.

U. S. Trade Reports,
Cincinnati, O.

June 20, 1908.

Gentlemen: We are in receipt of your favor of the 17th inst. on the subject of editorial you propose to publish in regard to our Screw Driving Machine.

Beg leave to advise you that while we are new in manufacturing, we have been in the mechanical line long enough to know your reputation in the mechanical world.

We would think it would be necessary or at least advisable for you to make greater change in your proposed editorials than to merely change the name of the machine recommended and its manufacturers.

While we of course have not committed your letter to memory, it has a very familiar sound and believe it is exactly the same as you are in the habit of sending out to manufacturers in all lines.

You might at least pay us the compliment of making some little change in the wording in your proposed editorial.

Beg leave to advise you in conclusion that your proposed editorial if published would be of no earthly benefit to us and on the contrary we believe if published by you would be good grounds for damage suit against you. You will therefore oblige us by taking no further steps in the matter.

Yours truly,
REYNOLDS MACHINE CO.

* * *

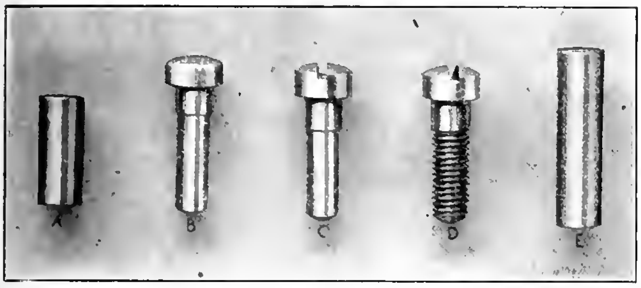
According to the *Industritidningen Norden*, rotary files are used to a great extent in a prominent German machine shop. The files are placed in special machines similar to small grinding machines. They are made of a diameter of from 3/8 to 1 inch and are rotated at a velocity of 2,000 revolutions per minute for working iron and steel, and at a velocity of from 2,500 to 3,000 revolutions per minute for brass and softer metals. The files are used for a number of different purposes, such as the removal of burrs, the rough finishing of holes and hollow portions in castings, etc. It is stated that in many cases from 20 to 50 per cent of the time can be saved in this manner, as compared with other methods of performing the same work.

NEW METHODS OF MANUFACTURING MACHINE SCREWS

The International Machine & Screw Co., Springfield, Mass., has recently brought out machine and wood screws made by an entirely new process, invented and patented by Mr. George T. Warwick. In this process there is no waste of material, the product is stronger than that made by ordinary methods, is very uniform and of high finish, and long screws are made as rapidly as short ones.

The machines for making this product are entirely automatic. Two methods are in use. One method is by a single machine that makes the screw complete; this is known as the combination machine. This machine takes wire of the size of the screw head from the reel (the stock being coiled, instead of in straight bars) straightens it, cuts off the blank to the required length, swages and elongates the screw body, heads, slots, threads and delivers a finished screw with no waste of stock and with great speed.

By the other method a unit of three machines is required to make the complete screw. The first machine in the set is the blanking machine. This machine takes the wire of the size of the screw head from the reel, straightens it, and cuts



Progressive Stages of the Manufacture of Screws by a New Method

it to the required length by shearing. Then the piece is taken by a gripping chuck and passed to elongating dies where it is reduced to the proper sizes for the shank and thread parts, and thence to dies that finish the head and point and deliver it to a receiving box. The appearance of the blank is as shown at *B* in the half-tone.

The second machine in the set is the slotting machine. The blanks are put in a hopper from where they are fed automatically to the dies that press the slots in the heads; the slotted blanks are then fed to a receiving box, their appearance being as shown at *C*.

The third machine in the set is the threading machine. The slotted blanks are put in the hopper from which they are fed automatically to the dies that roll the threads on them. In the threading process a slight burr is raised at the point where the thread begins; this burr is removed while in the threading machine by a revolving tool. This completes the screw, as shown at *D*. Fillister head screws are shown in the illustration, but all other regular and special shapes are as readily made. By the processes mentioned it takes but slightly more than one-half the stock to make a screw than is used by ordinary methods. This saving of stock varies in the different sizes and lengths, the longer screws saving more stock in proportion than the shorter ones. As an example, the stock used by the new process is shown at *A*, while that used by ordinary methods is shown at *E*. In a recent test for speed and stock on a 3/16 by 5/8-inch size screw, the International Machine & Screw Co.'s combination machine made 100 screws in a little less than three minutes. For a given number of screws made by regular methods, the stock weighed 20 ounces; for the same number and size of screws made on the International Machine & Screw Co.'s automatic machine the stock weighed 11½ ounces.

Tests for strength made at Columbia University on these screws show an average of 17 per cent greater tensile strength of thread and 5 per cent greater bending strength for the new process.

The machines themselves will not for the present be sold or leased, but the company will build them for its own needs, and will place upon the market a complete line of screws and like products.

ENGINES AT THE MOTOR BOAT SHOW

The exhibition of gasoline engines recently held at Madison Square Garden, New York, in connection with the sixth annual National Motor Boat Show, was impressive, partly because of the improvements embodied in many of the designs and also because of the size and power of many of the units exhibited. A large number of engines of both the two- and four-cycle types were shown, the power of which ranged from 1 to 250 horsepower. The engines intended for driving the high-speed motor boats, which have recently become so popular, formed one of the most interesting features of the exhibition. These were of both the two- and four-cycle types and were equipped with four, six or even eight cylinders. There was also an unusually large exhibit of two-cycle engines having one or two cylinders.

These motors were, of course, practically all of the marine type, having been designed to develop a maximum of power in a minimum of space. The weight per horsepower of many of the motors shown, particularly those of the high-speed type, has been reduced considerably by the use of aluminum in the construction of such parts as beds, crank-cases, cylinder heads, exhaust manifolds and other parts not directly subject to wear. The weight has been further reduced on some of the highly developed motors of the racing type, by the use of copper water-jackets. A careful inspection of the engines of all classes, showed that much attention has been given by the manufacturers to the matter of lubrication and ignition. A great many of the motors shown were equipped with mechanical oiling devices, and the engines of the multi-cylinder high-speed type were in many instances fitted with gear-driven magnetos, supplemented by batteries on the larger engines, for starting.

One of the high-speed engines which attracted considerable attention was exhibited by the Jencick Motor Co., Port Chester, N. Y. This engine, which develops a maximum of 250 horsepower, has eight gun metal cylinders which are cast separately. These are furnished with cooling water by four pumps, each pump supplying a set of two cylinders. The ignition system is of the double, high-tension type, a Bosch magneto being used. An automobile type of steering wheel is attached to the rear of the engine and on this are mounted the controlling levers. This motor is to be installed in a 40-foot flyer.

Another interesting motor of the eight-cylinder type was shown in the exhibit of the Dean Mfg. Co., Newport, Ky. It was this particular engine that drove *Brer Fox II.* on her record-breaking trip from Cincinnati to New Orleans, a distance of 1554 miles, at an average speed of 29.08 miles per hour, thus establishing a world's endurance record. The motors now being built by this firm are equipped with a new arrangement to which much of their power and reliability is attributed by the makers. This is known as an "accelerator" and is, in reality, a fourth port through which a small amount of pure air is admitted to the cylinder, in advance of the gas mixture for the purpose of expelling the burnt gases.

An interesting line of high-speed motors of the two-cycle type was shown by the B. F. Brown Gas Engine Co., Syracuse, N. Y. The bases of these engines are of aluminum and those intended for racing have, in addition, aluminum cylinder heads, inlet and exhaust manifolds, etc. These manifolds are water-cooled, the water being pumped through the exhaust manifolds into the cylinder jackets. The motors built by this firm are of the three-port type, the ports being proportioned for a maximum of efficiency at high speeds. The Bosch magneto is used in connection with the ignition system. The largest engine in this exhibit had six cylinders and developed approximately 80 horsepower on the brake, while the smallest with one cylinder, known as the "Brownie," was rated at a single horsepower.

The largest motor in the show in point of size was a mammoth 100 horsepower, four-cylinder, kerosene oil motor, the product of Mietz & Weiss of New York. This engine embodies many novel and interesting features. It is air starting and reversing, by the movement of a single lever, which also controls both the air and fuel supply to the cylinders. The engine operates on the two cycle principle, and the cylinders

are of the three-port type. The fuel is forced directly into the cylinders on the compression stroke, by means of a pump which is actuated by the governor. The compressor which supplies the air for starting, is self-contained and is driven by an eccentric which also drives the circulating pump. Lubrication is supplied to thirty-two different places by a mechanical lubricator. The hot-tube system of ignition is employed.

The Thrall Motor Co., Detroit, Mich., showed a number of heavy-duty two-cycle engines and also an interesting design of light high-speed motor. The last type referred to has, in addition to the regular third port, a fourth port in each cylinder which might be properly called an auxiliary third port. This auxiliary set of ports is used for high speeds in order to get a sufficient supply of gas into the compression base. Each set of third or intake ports is connected to a carburetor by separate manifolds so that the carburetors may be used independently. For speeds below 800 or 900 revolutions per minute, one carburetor only is used, but for higher speeds both carburetors are brought into action, thus giving a double amount of gas and increasing the power. These high-speed motors, which have bases and other parts of aluminum, give one horsepower for each ten pounds of weight. The forced-feed system of lubrication is used, the crank-case compression being utilized for this purpose. The oil for the cylinders is fed from an oil cup above the carburetor through the intake manifold.

The Standard Motor Construction Co., of Jersey City, exhibited a complete line of high-power motors, among which was a 100-horsepower engine of the type and size used by the Russian government in its submarine boats. This engine has six cylinders and is air starting and reversing. A six-cylinder, 60-horsepower motor of the auto-marine type, which is also self-starting and reversing, attracted considerable attention. In addition, there was a line of heavy-duty motors exhibited, ranging from 12 to 60 horsepower. The engines of the heavy-duty type are all equipped with automatic governing devices which are contained in the fly-wheel.

In the motor exhibit of the Fay & Bowen Engine Co., of Geneva, N. Y., there was a 30-horsepower combination kerosene and gasoline engine which the makers claim has proved very successful. This type of motor is intended for use in countries where gasoline is either difficult to obtain or too expensive. When the motor is first started, a small amount of gasoline is used; this is fed into the crank-case through a mixing device which, when the engine is using kerosene, becomes an inlet for pure air. The kerosene is vaporized before passing into the crank-case, where it is mixed with the air, by being forced into a chamber surrounding the exhaust.

The Charles L. Seabury Gas Engine & Power Co., New York, had in addition to a large boat exhibit, a complete line of four-cycle motors of various sizes. A six-cylinder engine in this exhibit, of the air starting and reversing type, contained many interesting features in its design. The cylinders are cast separately and are cooled by a circulating pump of the gear-driven type, which operates in either direction. The intake and exhaust valves, which are actuated by two camshafts, are located on the same side of the cylinder. When the engine is to be run in a reverse direction, the position of the cams with relation to the crank is changed by means of a spiral gear. The air used for starting is admitted to the cylinders on the explosion stroke by a special camshaft. Two magnetos are used in the ignition system, one for each direction of rotation.

In addition to the motor exhibits which have been briefly referred to in the foregoing, there were, of course, many others worthy of note, and also an interesting line of motor accessories. The entire exhibit showed in a striking way the wonderful progress that has been made in the development of the gasoline engine, and those who have been regular attendants at this annual exhibition could not have failed to observe the progress which has been made by the manufacturers in bringing the internal combustion engine up to its present state of simplicity, reliability and efficiency.

* * *

During 1909 the new main line railroad track built in the United States amounted to 3,748 miles.

AMERICAN EXPOSITION IN BERLIN ABANDONED

The American exposition of American products, which was to be held in Berlin, Germany, June 1 to August 31, has been abandoned because of the fierce opposition of German officials and manufacturers to the project. A storm of protest was raised because of the exclusiveness of the exposition, it being the original plan to show only American machinery and products. A compromise was proposed under which the exposition would include both German and American machinery and products, but the plan was rejected as was also the plan to postpone it until the summer of 1911. The real animus seems to have been dislike of Americans and American goods. The incident at one time threatened to develop international complications, and as it was it caused some painful embarassment to the diplomatic representatives of the two countries.

The project originated with some Berlin capitalists owning a fine exhibition hall in Berlin, who cast about for a paying exhibition enterprise for the summer of 1910, and the proposed American show was the outcome. The following bearing on German hostility is quoted from a resumé of the affair printed in the New York *Times*:

By far the most significant aspect of the whole incident is the light it has thrown on the latent hostility to American industrial competition with which the entire German business world is honeycombed. The blunt, brutal truth is that the German manufacturers' dread of their American competitors borders on jealous hatred. While clamoring for the widest possible privileges for themselves in the American market, German manufacturers resist by every means at their command the extension of fresh privileges to American manufacturers in the German market. Every sale of an American typewriter, cash register, shoe machine, or harvesting machine in Germany is regarded as an act of war by the average Teuton manufacturer. He bars the doors of his factories to American visitors and regards our consular officials as spies. It was in this spirit of blind unreasoning hostility that influential German Chambers of Commerce petitioned their government to boycott the proposed American exhibition, and it was to mollify the influential industrial community that Secretary Delbrück made his celebrated break. When the history of this latest German-American incident comes to be written, one statement will require to be underlined, namely, that the entire exhibition scheme and the resultant squabble were exclusively made in Germany. America throughout has played the role of the innocent bystander.

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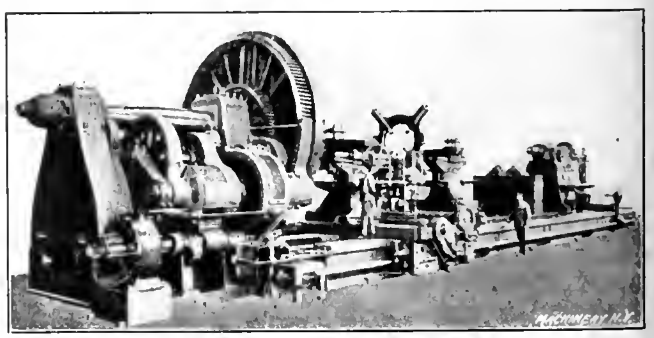
LARGE GERMAN LATHE

The accompanying illustration shows a large lathe built by the German Niles Works at Oberschöneweide. It is the largest lathe of this type ever built in Germany, and so far as we know, it is the largest lathe of its kind built anywhere. The maximum distance between the centers is 52½ feet, and the maximum diameter of work that can be turned in the lathe is 17 feet 2 inches. The total length of the machine is about 85 feet, and its weight is 385 tons. The



Large Lathe built by the German Niles Works, Oberschöneweide

lathe was built for the dock-yards at Kiel, and will be used especially for the turning of the rotating parts for steam turbines. The maximum speed of the faceplate is 30 revolutions per minute, which means a maximum speed at the periphery of the faceplate of 1,600 feet per minute. The machine is driven by an 80 horsepower motor, and by means of the variable speed in the motor and the gearing, 60 speeds are obtainable.

COMPLETE DIMENSIONS OF ACME STANDARD THREAD PARTS

Most hand books and catalogues give rather meager, and sometimes misleading, information in regard to the Acme standard thread. The writer has compiled the accompanying table giving not only the dimensions for the screw parts, which nearly all tables refer to, but also the data required

Table of Acme Thread Parts.

Dimension Required	Class of Thread	Symbol on Drawing	Formula	Example: Nominal Diam., 2 inches, 4 Threads per inch
Outside Diameter	Tap	A	Nominal size* + 0.020 inch	2.000 + 0.020 = 2.020
	Nut	B	Nominal size + 0.020 inch	2.000 + 0.020 = 2.020
	Screw and Die Tap	C	Nominal size	2.000
	Die	D	Nominal size	2.000
Root Diameter	Tap	E	$\text{Nominal size} - \left(\frac{1}{\text{No. of thds per inch}} + 0.020\right)$	$2.000 - (\frac{1}{4} + 0.020) = 1.730$
	Nut	F	$\text{Nominal size} - \left(\frac{1}{\text{No. of threads per inch}}\right)$	2.000 − 0.250 = 1.750
	Screw and Die Tap	G	$\text{Nominal size} - \left(\frac{1}{\text{No. of thds per inch}} + 0.020\right)$	$2.000 - (\frac{1}{4} + 0.020) = 1.730$
	Die	H	$\text{Nominal size} - \left(\frac{1}{\text{No. of thds per inch}} + 0.020\right)$	$2.000 - (\frac{1}{4} + 0.020) = 1.730$
Width of Flat on Top of Thread	Tap	J	$\frac{0.3707}{\text{No. of threads per inch}} - 0.0052$	$\frac{0.3707}{4} - 0.0052 = 0.0875$
	Nut	K	$\frac{0.3707}{\text{No. of threads per inch}}$	$\frac{0.3707}{4} = 0.0927$
	Screw and Die Tap	L	$\frac{0.3707}{\text{No. of threads per inch}}$	$\frac{0.3707}{4} = 0.0927$
	Die	M	$\frac{0.3707}{\text{No. of threads per inch}} - 0.0052$	$\frac{0.3707}{4} - 0.0052 = 0.0875$
Width of Flat at Bottom of Thread	Tap	N	$\frac{0.3707}{\text{No. of threads per inch}} - 0.0052$	$\frac{0.3707}{4} - 0.0052 = 0.0875$
	Nut	P	$\frac{0.3707}{\text{No. of threads per inch}} - 0.0052$	$\frac{0.3707}{4} - 0.0052 = 0.0875$
	Screw and Die Tap	R	$\frac{0.3707}{\text{No. of threads per inch}} - 0.0052$	$\frac{0.3707}{4} - 0.0052 = 0.0875$
	Die	S	$\frac{0.3707}{\text{No. of threads per inch}}$	$\frac{0.3707}{4} = 0.0927$

*Nominal size is the actual outside diameter of the Acme thread screw

in connection with taps, die taps, and dies. This table will perhaps clear up a great deal of misunderstanding and misinterpretation of existing tables. In order to make the formulas clear, an example has been given, in which the nominal diameter of the screw thread is two inches, there being four single threads per inch. A.

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PERSONALS

Herbert M. Wilcox, chemical engineer, experienced in various industries, has joined the staff of Walter B. Snow, publicity engineer, Boston, Mass.

J. J. Voelcker, an occasional contributor to MACHINERY, has taken the position of machine shop foreman with the H. Mueller Mfg. Co., Decatur, Ill.

Benjamin Baker, formerly of the *Boston Transcript*, and late editor of *The Navy*, has joined the staff of Walter B. Snow, publicity engineer, Boston, Mass.

Henry Smith, who has represented the *Iron Age* and associated publications for the past thirty-seven years, twenty-seven of which have been spent in Cincinnati, has resigned.

Andrew Rogers, until recently foreman of Foundry No. 1, Eddystone plant, Baldwin Locomotive Works, has taken charge of the foundry of the Lima Locomotive and Machine Co., Lima, Ohio.

George Ahrens, of Spokane, Wash., who has been president of the Moline Tool Co., Moline, Ill., for several years, but not actively connected with the business, assumed charge of the sales department of the company March 1.

H. E. Strohm, formerly of the Lodge & Shipley Machine Tool Co.'s sales department, has taken a position as salesman with the W. R. Colcord Machinery Co., St. Louis, Mo., and will cover the Illinois territory lying south of Quincy.

Frank E. Bocorselski, superintendent of the Baush Machine Tool Co., Springfield, Mass., for the past ten years, has resigned to take the position of assistant supervisor of plants with the American Locomotive Co., at Richmond, Va.

Harry Hoover, a well-known foundry foreman, has taken a position with the S. Obermayer Co., Cincinnati, Ohio, manufacturer of foundry supplies and equipment. He will look after the company's interests in Buffalo and Dunkirk, N. Y.

W. A. Sabin, inspector at the United States Armory, Springfield, Mass., has been promoted to the position of foreman of the Ordnance Department at Manila. Mr. Sabin is now on his way to the Philippines.

George U. Poole, manager of the Boston branch of the Dodge Mfg. Co., Mishawaka, Ind., lectured before the mechanical and electrical association of the University of Maine, February 26th, on the manufacturing of pulleys and castings and methods of power transmission.

Douglas T. Hamilton, die-sinker, toolmaker, designer of automatic screw machines, tools, etc., and author of "Formulas for Machine Screw Button or Split Dies," "Knurls and Knurling Operations," "Circular Form and Cut-Off Tools," etc., has joined the editorial staff of MACHINERY.

C. W. Werst, a member of long standing in the American Society of Mechanical Engineers, and for eleven years with the Baldwin Locomotive Works, Philadelphia (where he was one of the general foremen) has assumed the position of assistant superintendent and general foreman of the Lima Locomotive and Machine Co., Lima, Ohio.

* * *

OBITUARIES

Robert J. Hancock died at his home in Springfield, Mass., February 26, aged 70 years. Mr. Hancock had recently resigned the position of superintendent of the Blair Mfg. Co., makers of lawn mowers.

Jonathan Bailey died in Providence, R. I., March 4, aged 74 years. Mr. Bailey was for several years superintendent of the Providence Tool Co., and was at one time foreman of the Brown & Sharpe Mfg. Co.

Thomas H. Dodge died at his home in Worcester, Mass., February 12, aged 87 years. Mr. Dodge was a noted inventor and patent lawyer. The cylinder printing press is probably the most notable of his inventions.

Andrew Gale, president of the Belcher & Taylor Agricultural Co., died February 8 while presiding at a meeting of the company's directors, aged 74 years. Mr. Gale was the inventor and patentee of many agricultural appliances.

George W. Sunderland, head instructor of machine work, McKinley Manual Training School, Washington, D. C., died March 9. Mr. Sunderland contributed the article on the McKinley Manual Training School, in the January, 1910, number of MACHINERY.

Thomas C. Page, of Chicopee Falls, Mass., died in New York, February 5, following an operation, aged 61 years. Mr. Page was prominent in manufacturing circles, having been at the head of the Lamb Knitting Co. for several years. In the bicycle days he was manager of one of the large plants of the American Bicycle Co. In recent years he was assistant treasurer of the Stevens Arms & Tool Co. and of the Stevens-Duryea Co., and also a director in several companies.

CHARLES F. AARON

Charles F. Aaron, general manager of the New York Leather Belting Company and one of the best known belting manufacturers in the United States, died at his home in Plainfield, N. J., on March 4, aged forty-three years, following an operation for hernia.

Mr. Aaron had for many years been closely identified with the largest machinery and supply manufacturing interests of the United States. He was, from its organization, prominently identified with the American Supply and Machinery Manufacturers' Association, whose membership represents more than half a billion dollars' worth of American factories. He was president of this association from May, 1908, to May, 1909, and prior to that time had for several years been the vice-president and chairman of its executive committee. He is best known for his work in this association and outside of it in connection with his efforts for higher standards of production among American manufacturers.

It was largely his inspiration and suggestion that prompted the American Supply and Machinery Manufacturers' Association in convention at Pittsburg last May to adopt what was known as its Declaration of Principles. This document, which was unanimously adopted, put all members of that association on record as pledging themselves and their factories to higher qualities in the goods they produced and it condemned the practice of substituting inferior goods as first qualities. The document referred to caused much discussion and favorable comment in the daily and trade press of this country as well as abroad as being an advance step among American manufacturers for higher qualities and fitting condemnation of the manufacturer of low-grade American products.

Mr. Aaron is perhaps even better known in connection with a campaign he was making up to the time of his death for raising to a higher plane the standards of manufacture of leather belting. He was promoting a plan for general adoption by belting manufacturers of standardizing the specifications upon which all leather belting of first quality should be built. His plan entailed the national adoption by all manu-

Charles F. Aaron

facturers, dealers and consumers, of rigid belting specifications, a national stamp or trade mark which should go upon all such goods by whomever manufactured, and a severe penalty to the manufacturer who put out supposedly first quality goods bearing this stamp which did not fulfill specifications. Several of the largest of the Supply Dealers' Associations now have his plan under advisement of committees, who will report upon it in connection with like reforms in other lines at conventions to be held this spring.

He was a man who had brought himself to the front among American manufacturers by sheer hard work. He started at the very bottom of the ladder, spending several years in the leather belting factory of his father, mastering every technical detail as to the methods of manufacturing followed by his company. Following his apprenticeship in the factory he made suggestions for the improvement of qualities in the belting put out by his concern. The result was that his company was able to put out goods of superior quality that have won a fine reputation.

Mr. Aaron also is author of the first book ever published in this country describing the whole system of manufacturing leather belting from the time the hide is taken from the steer until it is ready for installation on pulleys. This book is used in several colleges as an authority on the most improved method of manufacturing leather belting. He traveled most of the time in later years and was known to almost every mill supply dealer in the United States as well as by the operative heads of almost every manufacturing plant of size in the United States. He was prominently connected with the Masonic order, was a Knight Templar, and a Shriner, belonging to Kismet Temple A. A. O. N. M. S., and a member of the Elks. He was also a member of the Machinery Club, and the Crescent Athletic Club of Brooklyn. He leaves a wife and three children.

* * *

COMING EVENTS

April 5-7.—Joint convention of the Southern Supply and Machinery Dealers' Association, and American Supply and Machinery Manufacturers' Association, Jacksonville, Fla., Seminole Hotel, headquarters. Alvin M. Smith, secretary and treasurer of the Southern Supply and Machinery Dealers' Association, Richmond, Va.

April 13-14.—Annual convention of the National Metal Trades Association at the Hotel Astor, New York. Robert Wuest, commissioner, 605 New England Building, Cleveland, Ohio.

April 27-28.—Annual meeting of the National Association of Cotton Manufacturers in the Mechanics' Fair Building on Huntington Ave., Boston, Mass. An exhibition of textile machinery will be held in the same building by the Textile Exhibitors Association. C. J. H. Woodbury, secretary and treasurer, 45 Milk St., Boston, Mass.

May 4-5.—Annual meeting of the Iron and Steel Institute at the institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 10-13.—Seventeenth annual convention of the Air Brake Association, Indianapolis, Ind., Dennisson Hotel, headquarters. An interesting program has been prepared on air brake construction, air pumping, piping inspection and cleaning, triple valves and brake cylinders, recommended practice, etc. F. M. Nellis, secretary, 53 State St., Boston, Mass.

May 11-13.—Joint convention of the American Supply and Machinery Manufacturers' Association and the National Supply and Machinery Dealers' Association at Atlantic City, N. J. F. D. Mitchell, 309 Broadway, New York, secretary-treasurer, American Supply and Machinery Manufacturers' Association.

May 16-18.—Fifteenth annual convention of the National Association of Manufacturers, Waldorf-Astoria Hotel, New York. George S. Budinot, secretary, 170 Broadway, New York.

May 24-25.—Spring convention of the National Machine Tool Builders' Association at Rochester, N. Y., Hotel Seneca, headquarters. Charles E. Hildreth, secretary, Worcester, Mass.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich. C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 15-17.—Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building will be erected and used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

SOCIETIES AND COLLEGES

Columbia University, New York, has announced that beginning with next September it will conduct an important extension of its work. The new undertaking is an outgrowth of the success of the summer session of the university which has been established for ten years and which in 1909 attracted more than two thousand students from all parts of the United States. It is now proposed to extend the operation of the principles of the summer session so as to provide class and laboratory work in the evening at the university and both in the evening and during the day in other parts of the city as well as in north New Jersey and Westchester County for the benefit of those who are not able to avail themselves of the course of instruction at the university.

National Gas and Gasoline Engine Trades Association.—The first meeting of the National Gas and Gasoline Engine Trades Association was held in Chicago, December 8, 1908. The constitution adopted at that time stated that the purpose of the organization was as follows: "The object of the association shall be to protect, promote, further and advance the interest of the trade; also for the purpose of holding national conventions once a year of interest to the parties. The purpose of such conventions shall be for the promotion of education and sociability among the members of the association." Since the initial meeting there have been held three conventions and at the Chicago convention in December, 1909, there were over 200 present. The next meeting will be in Cincinnati, June 13, 14, 15, and 16. Indications point to a very large attendance. Provisions are made at all meetings for the exhibition of gas engines and accessories. No charge is made for space. The entertainment feature, while of high class, has been entirely subordinated and there are few bodies in which the entire conventions maintain so high a degree of interest in the technical features of the programs offered. The dues for membership are $5 per year and an initial fee of $10 has been suspended, as it was found that the dues provided sufficient funds to maintain an ample surplus in the treasury. The officers of the association are as follows: M. A. Loeb, Cincinnati, Ohio, president; C. O. Hamilton, Elyria, Ohio, vice-president; Otto M. Knoblock, South Bend, Ind., treasurer; Albert Stritmatter, Cincinnati, Ohio, secretary.

NEW BOOKS AND PAMPHLETS

Northwestern University Bulletin. Annual catalogue 1909-1910. 371 pages, 6 x 9 inches. Published by the Northwestern University, Evanston and Chicago, Ill.

The Vermont Bulletin. Catalogue 1909-1910. 173 pages, 5¼ x 7½ inches. Published by the University of Vermont and State Agricultural College, Burlington, Vermont.

A Study of Base and Bearing Plates for Columns and Beams. By N. Clifford Ricker. Bulletin No. 35. 36 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

The Thermal Conductivity of Fire-Clay at High Temperatures. By J. K. Clement and W. L. Egy. Bulletin No. 36. 32 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

Twenty-third Annual Report of the Commissioner of Labor for the Year 1908: Workmen's Insurance and Benefit Funds in the United States. 810 pages, 6 x 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

Ballistic Electro Dynamometer Method of Measuring Hysteresis Loss in Iron. By Martin E. Rice and Burton McCollum. 23 pages, 6 x 9 inches. Published by the University of Kansas, Engineering Experiment Station, Lawrence, Kansas.

Proceedings of the Nineteenth Annual Convention of the American Railway Bridge Building Association Held in Jacksonville, Fla., October 19-21, 1909. 340 pages, 6 x 9 inches. Published by the association, C. A. Lichty, secretary, Chicago & Northwestern Ry., Chicago, Ill.

American Water Works Association Proceedings, 1909. 796 pages, 6 x 9 inches. Numerous illustrations and folding plates. Published by the Secretary, 14 George St., Charlestown, S. C.

This volume contains the papers presented before the twenty-ninth annual convention of the association, held at Milwaukee, Wis., June 7-12, 1909. About forty papers were presented, all of which are included.

The Second Law of Thermodynamics. Its Basis in Intuition and Common Sense. By W. S. Franklin. 18 pages, 6 x 9 inches. Reprinted from the *Popular Science Monthly*, March, 1910.

This interesting and popularly written treatise on the second law of thermodynamics is intended to form a part of a book on "Elementary Theory of Heat" now in preparation. The author, who is a professor at the Lehigh University, possesses an unusual ability of making scientific matters clear and simple to the lay mind, and he frequently uses illustrations from everyday life to make scientific truths plain.

Record of Transportation Lines Owned and Operated by and Associated in Interest With the Pennsylvania Railroad for Year Ending December 31, 1909. 40 pages, 9 x 12 inches, and folding map. Published by the Pennsylvania Railroad Co., Philadelphia, Pa.

The Pennsylvania Railroad system has 11,234.36 miles of lines of which 6,294.32 lie east of Pittsburg and Erie, Pa., and 4,940.04 lie west of Pittsburg. These lines run through fourteen states in which live more than 45,000,000 people. The book gives statistics of all the constituent lines of the system.

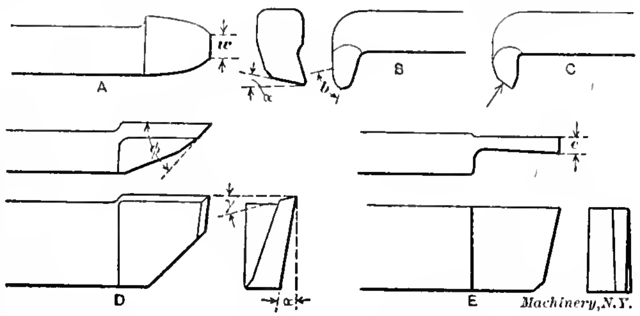
Exporters' Encyclopedia. Sixth (1910) edition. 776 pages, 5½ x 8¼ inches. Published by the Exporters' Encyclopedia Co., New York. Price $5.

Supplement to MACHINERY, May, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Tool Grinding"—II

SHOP OPERATION SHEET NO. 133

Franklin D. Jones MACHINERY, May, 1910



Grinding Lathe Tools—I

NOTE.—A number of lathe tools of different types are illustrated on this and the two following sheets. As these tools are intended for different purposes, the shapes vary widely and there are certain points in connection with the grinding of each, which should be observed.

1. At A is shown a plan view of a tool that, because of its broad flat nose, is used for finishing cuts when a wide feed may be taken. When such a tool is used, the cut taken is very light and the feed is slightly less than the width w. This tool is, however, only adapted to rigid work, for if a broad-nosed tool is used on slender and flexible pieces, chattering will occur, which will cause the finished surface to be rough. Consequently, for slender work the width of the cutting edge and the feed must be reduced, the reduction depending upon the rigidity of the work. As a finishing tool cuts only on the point, it should be ground without side slope. The angle of back slope should be about 12 or 15 degrees.

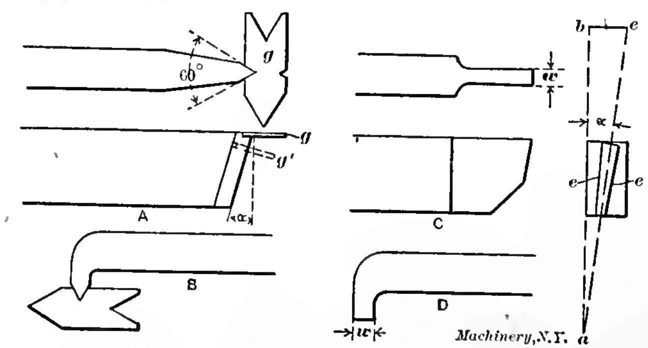
2. The top view of a well-shaped boring tool is shown at B, and at C the same tool is shown improperly ground. When the cutting edge is beveled off as at C, the pressure of the cut acts in the direction of the arrow and tends to deflect the tool from the work. For the same reason, a broad-nosed boring tool is not adapted to finishing cuts, as the spring of the tool at right angles to its shank causes chattering, except when the shank is unusually rigid or the tool is being used in a heavy boring-bar. The clearance angle a of a boring tool should be great enough so that the cutting point of the tool can be set to the same height or slightly below the center of the work. A boring tool that is used for roughing cuts should have more side slope than back slope, as the cutting is done along the edge b.

3. Three views of a right side-tool are shown at D. This type of tool is used for facing the ends of work, beveling corners, etc. It should have a clearance angle a of 10 or 12 degrees, and a side slope γ of 12 or 14 degrees. The end of the tool should be ground to an angle ϕ of about 45 degrees so that it will clear the lathe center when facing. The end should also slope backward to an angle of 4 or 5 degrees.

4. A parting or cutting off tool is shown at E. This tool is also used for cutting grooves, etc. The cutting edge e has a slight amount of clearance, both backward and downward. This tool is usually ground on the top without slope.

SHOP OPERATION SHEET NO. 134

Franklin D. Jones MACHINERY, May, 1910



Grinding Lathe Tools—II

1. A tool used for cutting V-threads is shown at A. The top of the tool is ground without slope and the end is given an included angle of 60 degrees, as shown in the plan view. This angle may be tested by holding a thread gage g against the tool. The gage should be held parallel with the top, and not inclined as illustrated by the dotted lines at g^1. If the tool is ground to a gage held as at g^1, the angle between the cutting edges at the top will be less than 60 degrees. A tool of this type should have a clearance angle a of about 15 degrees. When grinding a thread tool it should be pressed lightly against the stone to avoid "burning" or drawing the temper of the cutting edge. A grindstone is preferable to an emery wheel for grinding a thread tool as a finer edge may be obtained. The stone should, of course, have a copious supply of water.

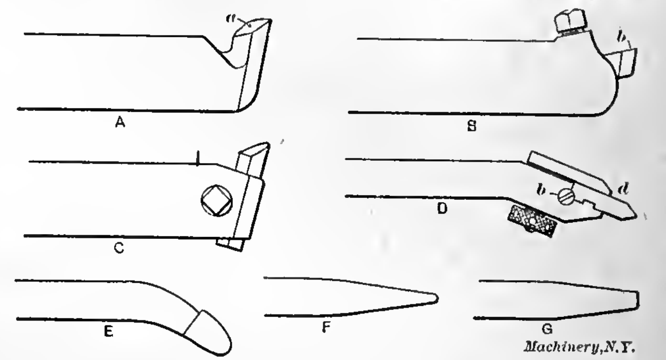
2. The thread tool, a plan view of which is shown at B, is for inside work, that is for cutting a V-thread in a hole. The cutting point of this tool is shaped like the point of the outside thread tool. When the gage is held against the point, as shown, it should be practically parallel with the shank of the tool. If the tool were ground so that the gage was at a considerable angle with the tool shank, the latter might strike against the end of the hole, when properly set, before the tool could traverse the full length of the part to be threaded.

3. A square thread tool is shown at C. This tool is similar to a parting tool, except that the cutting end is at an angle with the shank. This angle a depends on the diameter of the screw and the pitch of the thread; it may be determined graphically by laying off a line a—b equal to the circumference of the screw to be cut, and a line b—c at right angles to the first and equal to the lead of the thread. The angle a, between the lines a—b and a—c will be required angle. The tool illustrated is for cutting a right-hand thread. If it were intended for a left-hand thread, the cutting end would, of course, incline to the left. The sides e of the tool should be ground with a clearance of 4 or 5 degrees, and the width w be made equal to one-half of the pitch of the thread.

4. A tool for cutting an inside square thread is shown at D. The cutting end is shaped practically the same as the tool at C. If a tap is to follow the threading tool, the width w may be made 0.002 or 0.003-inch less than the width of the tap teeth.

SHOP OPERATION SHEET NO. 135

Franklin D. Jones MACHINERY, May, 1910



Grinding Lathe Tools—III

1. The tool shown at A is known as a diamond point; this type is much used for outside turning, particularly on comparatively light work. It should be given a clearance of 8 or 10 degrees. The slope of the lip surface a and its direction will depend upon the work for which the tool is intended. If it is to be used for roughing cuts, a back slope of 8 degrees and a side slope of 14 degrees will be about right for general work. If for finishing cuts, there should be little or no side slope, and a back slope of 12 or 14 degrees.

2. A tool-holder with an inserted cutter is shown at B. As the cutter b is held in a fixed position by the set-screw shown, it can be sharpened by simply grinding the end, except when it is desired to give the cutter a different slope from that due to its angular position.

3. Another type of inserted-cutter turning tool is shown at C. With a holder of this type, it is the clearance of the tool that is fixed, and the sharpening is done by grinding the top of the tool to the proper slope.

4. A plan view of a thread tool of the holder type is shown at D. The angle of the blade d is accurately ground by the manufacturers, so that the tool is sharpened by simply grinding it flat on top. As the top is ground away, the tool is raised by turning the screw b, which can also be used for setting the tool to the proper height.

5. A bent round nose turning tool is shown at E. This tool, as far as clearance and slope is concerned, is ground practically the same as the diamond point referred to in paragraph 1. By having the ends of the various-shaped tools used for turning or planing, bent either to the right or left, they are adapted to work for which they could not otherwise be used.

6. The plan view of a tool for turning brass is shown at F. Brass tools, which are intended for general work, are drawn out quite thin, and they are given a comparatively narrow point, which is flattened or rounded. The top of a brass tool is usually ground flat or without slope, as otherwise it tends to gouge into the work, if the latter be at all flexible. The clearance should be from 12 to 14 degrees.

7. A brass tool suitable for finishing cuts on comparatively large and rigid work, such as brass pump linings, etc., is shown at F. The cutting edge is made wide and the tool is used with a coarse feed.

LOADS FOR ECCENTRICALLY LOADED RIVET GROUPS—IV

Four Vertical Rows of Rivets.

Body of Table Gives Total Load in Thousands of Pounds
Vertical Spacing of Rivets, 3"—Size of Rivets, ¾".

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group												
	0"	1½"				3"				6"			
	Horizontal Distance between Outside Rivet Rows												
	Any	9	12	15	18	9	12	15	18	9	12	15	18
4	17	11	12	13	13	8.0	9.2	10	11	5.2	6.3	7.2	8.0
8	35	23	25	26	27	17	19	21	22	11	13	15	16
12	52	37	35	40	43	28	30	32	34	18	21	23	25
16	70	52	54	55	56	41	43	45	46	28	30	32	34
20	88	69	70	71	72	55	57	58	60	38	40	42	45
24	105	86	86	87	88	71	72	73	74	50	52	54	56
28	123	104	104	104	105	87	87	88	89	63	65	66	68
32	140	122	122	122	122	104	104	105	105	77	78	79	80
36	158	139	139	139	139	122	122	122	122	92	93	94	95
40	176	157	157	157	157	139	139	139	139	108	108	109	110
44	193	175	175	175	175	156	156	156	156	124	124	124	125
48	211	193	193	193	193	174	174	174	174	140	140	140	141

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group											
	9"				12"				15"			
	Horizontal Distance between Outside Rivet Rows											
	9	12	15	18	9	12	15	18	9	12	15	18
4	3.8	4.7	5.5	6.3	3.0	3.8	4.5	5.2	2.5	3.2	3.8	4.4
8	8.5	10	11	12	6.7	8.2	9.4	10	5.6	6.9	8.0	9.0
12	14	16	18	20	11	13	14	16	9.4	11	12	14
16	21	23	25	27	17	19	21	23	14	15	17	19
20	29	31	33	35	23	25	27	29	19	21	23	25
24	38	40	42	44	31	33	35	37	25	27	29	31
28	48	50	52	55	39	41	43	45	32	34	36	39
32	60	62	63	65	48	50	52	54	40	42	44	46
36	70	73	75	77	58	60	62	65	49	51	53	55
40	86	86	87	88	70	71	73	75	59	60	62	64
44	100	100	101	102	82	83	84	86	69	70	71	73
48	114	114	115	116	94	95	96	98	80	81	83	85

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group											
	18"				21"				24"			
	Horizontal Distance between Outside Rivet Rows											
	9	12	15	18	9	12	15	18	9	12	15	18
4	2.1	2.7	3.3	3.8	1.9	2.4	2.9	3.4	1.7	2.1	2.6	3.0
8	4.8	5.9	6.9	7.9	4.2	5.2	6.1	7.0	3.7	4.6	5.4	6.2
12	8.0	9.1	10	12	7.0	8.3	9.6	10	6.2	7.4	8.5	9.7
16	12	13	15	17	10	12	13	15	9.4	10	12	13
20	16	18	20	22	14	16	17	19	13	14	16	17
24	22	24	25	27	19	20	22	24	17	18	20	22
28	28	30	32	34	24	26	28	30	21	23	25	27
32	34	36	38	40	30	32	34	36	27	29	30	32
36	42	44	46	48	37	39	41	43	33	35	36	38
40	51	52	54	56	44	46	48	50	40	41	43	45
44	60	61	62	64	51	53	55	57	48	49	50	52
48	69	71	72	74	61	63	64	66	55	56	57	59

Contributed by Harry Gwinner

LOADS FOR ECCENTRICALLY LOADED RIVET GROUPS—III

Three Vertical Rows of Rivets.

Body of Table Gives Total Load in Thousands of Pounds
Vertical Spacing of Rivets, 3"—Size of Rivets, ¾".

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group												
	0"	1½"				3"				6"			
	Horizontal Distance between Outside Rivet Rows												
	Any	6	8	10	12	6	8	10	12	6	8	10	12
3	13	7.5	8.4	9.1	9.6	5.7	6.2	6.9	7.5	3.3	4.0	4.7	5.3
6	26	16	17	18	19	12	13	14	15	7.8	9.0	10	11
9	39	28	28	29	30	20	21	23	24	13	14	16	17
12	52	39	40	40	41	30	31	32	33	20	21	23	24
15	66	52	52	53	53	41	42	43	44	28	29	30	32
18	79	66	66	66	66	53	53	54	55	37	38	39	40
21	97	79	79	79	79	66	66	67	67	47	48	49	50
24	105	92	92	92	92	79	79	79	79	58	58	59	60
27	118	106	106	106	106	92	92	92	92	69	69	70	71
30	132	119	119	119	119	106	106	106	106	82	82	82	83
33	145	132	132	132	132	119	119	119	119	94	94	94	95
36	158	146	146	146	146	133	133	133	133	107	107	107	107

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group											
	9"				12"				15"			
	Horizontal Distance between Outside Rivet Rows											
	6	8	10	12	6	8	10	12	6	8	10	12
3	2.4	3.1	3.5	4.0	1.9	2.4	2.8	3.3	1.5	2.0	2.4	2.8
6	5.8	6.7	7.6	8.5	4.5	5.4	6.1	6.9	3.7	4.5	5.1	5.4
9	10	11	12	13	7.9	8.9	9.9	11	6.6	7.4	8.0	9.4
12	15	16	17	19	12	13	14	15	10	11	12	13
15	21	22	23	25	16	17	19	20	14	15	16	17
18	28	29	30	32	22	23	24	26	18	19	20	22
21	36	37	38	39	29	30	31	32	24	25	26	27
24	45	45	46	47	36	37	38	39	30	31	32	33
27	55	55	56	56	44	44	45	46	36	37	38	39
30	65	65	65	66	53	53	54	55	44	45	46	47
33	76	76	76	77	62	62	63	64	52	52	53	54
36	87	87	87	87	72	72	72	73	60	61	62	62

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group											
	18"				21"				24"			
	Horizontal Distance between Outside Rivet Rows											
	6	8	10	12	6	8	10	12	6	8	10	12
3	1.3	1.7	2.0	2.4	1.1	1.5	1.8	2.1	1.0	1.3	1.6	1.9
6	3.2	3.8	4.4	5.0	2.8	3.3	3.9	4.4	2.5	3.0	3.4	3.9
9	5.6	6.3	7.2	7.9	4.9	5.5	6.3	7.0	4.3	4.9	5.6	6.2
12	8.4	9.3	10	11	7.2	8.1	9.0	10	6.5	7.2	8.0	8.9
15	11	12	13	14	10	11	12	13	9.1	9.9	10	11
18	16	17	18	19	14	14	15	16	12	13	14	15
21	20	21	22	23	17	18	19	20	15	16	17	18
24	25	26	27	28	22	23	24	25	19	20	21	22
27	31	32	33	34	27	28	29	30	24	25	26	27
30	38	38	39	40	33	34	35	36	29	30	31	32
33	45	45	46	47	39	39	40	41	35	35	36	37
36	52	53	54	54	46	46	47	48	40	41	42	42

Contributed by Harry Gwinner

LOADS FOR ECCENTRICALLY LOADED RIVET GROUPS—II

Contributed by Harry Gwinner

Two Vertical Rows of Rivets.

Body of Table Gives Total Load in Thousands of Pounds
Vertical Spacing of Rivets, 3"— Size of Rivets, 3/4".

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group															
	0"	1½"					3"					6"				
	Horizontal Distance between Rivet Rows															
	Any	3	6	9	12	15	3	6	9	12	15	3	6	9	12	15
2	8.8	4.4	5.8	6.6	7.1	7.3	2.9	4.4	5.2	5.8	6.3	1.7	2.9	3.7	4.4	4.9
4	17	11	12	13	14	14	7.9	9.5	10	11	12	4.9	6.5	7.5	9.1	9.9
6	26	19	19	20	21	22	13	15	16	18	19	8.6	10	12	14	15
8	35	27	27	28	29	29	20	22	23	24	25	13	15	17	19	20
10	44	37	36	36	37	37	29	29	30	31	32	19	20	22	24	26
12	52	46	44	44	44	45	38	37	38	39	40	25	26	28	30	32
14	61	55	53	53	54	54	46	45	46	46	47	31	33	34	36	38
16	70	64	61	61	62	62	56	54	54	55	56	39	40	41	42	44
18	79	73	71	71	71	71	65	63	63	63	63	48	48	49	50	51
20	88	82	80	80	80	80	74	72	72	72	72	57	56	56	57	59
22	96	92	88	88	88	88	83	80	80	80	81	65	64	64	65	66
24	105	101	97	97	97	97	93	89	89	89	89	75	73	73	73	74

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group														
	9"					12"					15"				
	Horizontal Distance between Rivet Rows														
	3	6	9	12	15	3	6	9	12	15	3	6	9	12	15
2	1.2	2.2	2.9	3.5	4.0	1.0	1.7	2.4	2.9	3.4	0.8	1.4	2.0	2.5	2.9
4	3.5	4.8	6.1	7.2	8.1	2.7	3.9	5.0	6.0	6.9	2.2	3.2	4.3	5.2	5.9
6	6.2	8.0	9.5	10	12	4.8	6.3	7.9	9.2	10	3.9	5.3	6.6	7.9	9.1
8	9.6	11	13	15	16	7.4	9.1	10	12	14	6.0	7.6	9.2	10	12
10	14	15	17	19	21	11	12	14	16	18	9.0	10	12	14	16
12	19	20	22	24	26	15	16	18	20	22	12	13	15	17	19
14	24	25	27	29	31	19	20	22	24	26	15	17	18	20	23
16	30	31	32	35	37	24	25	27	29	31	20	21	23	25	27
18	37	37	39	41	43	30	30	32	34	36	24	25	27	29	31
20	44	44	45	47	49	36	36	37	39	42	29	30	31	33	36
22	52	51	52	53	55	42	42	43	45	47	35	35	37	39	41
24	60	59	59	60	62	49	49	50	51	53	41	41	42	44	46

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group														
	18"					21"					24"				
	Horizontal Distance between Rivet Rows														
	3	6	9	12	15	3	6	9	12	15	3	6	9	12	15
2	0.7	1.2	1.7	2.2	2.6	0.6	1.1	1.5	1.9	2.3	0.5	1.0	1.4	1.7	2.1
4	1.9	2.8	3.7	4.5	5.3	1.6	2.4	3.3	4.0	4.7	1.4	2.1	2.9	3.6	4.2
6	3.3	4.5	5.7	6.9	8.1	2.9	3.9	5.0	6.2	7.2	2.5	3.5	4.5	5.6	6.5
8	5.1	6.5	8.0	9.4	10	4.4	5.6	7.0	8.3	9.7	3.9	5.0	6.3	7.5	8.8
10	7.6	8.8	10	12	14	6.6	7.6	9.1	10	12	5.8	6.8	8.1	9.7	11
12	10	11	13	15	17	9.1	10	11	13	15	8.0	8.9	10	11	13
14	13	14	16	18	20	11	12	14	16	18	10	11	12	14	16
16	17	18	19	21	23	14	15	17	19	21	13	13	15	17	19
18	21	21	23	25	27	18	18	20	22	24	16	16	18	20	22
20	25	26	27	29	31	22	23	24	26	28	20	20	21	23	25
22	30	30	32	34	36	26	26	28	30	32	23	23	25	27	29
24	35	35	36	38	40	31	31	32	34	36	27	27	28	30	33

LOADS FOR ECCENTRICALLY LOADED RIVET GROUPS—I

Contributed by Harry Gwinner

Directions for Using Tables.

The following tables facilitate the finding of the number of rivets to support eccentric loads.

All the tables are calculated for a vertical spacing of rivets of three inches; size of rivets, 3/4-inch; and maximum stress per square inch, 10,000 pounds.

To use the tables, decide on the number of vertical rows of rivets, and the distance between the outside rows, if more than one row is used. Then, in the table for the number of rows adopted, find the number of rivets required for the given load.

Example:— Find number of rivets required for supporting a load of 5000 pounds applied 18 inches from the center of the rivet group. Three vertical rows of rivets will be used; distance between outside rows, 6 inches. (See illustration below).

In Table III, giving the number of rivets for three vertical rows, find the distance (18 inches) between the load and center of rivet group; then in the section headed "18 inches" and in the column headed "6 inches" (horizontal distance between the outside rivet rows), find the figure nearest to the given load. This figure is 5.6, which, being in thousands of pounds, is equivalent to a load of 5600 pounds. Now follow the horizontal line from 5.6 to the left where the number of rivets for the given case is found to be 9.

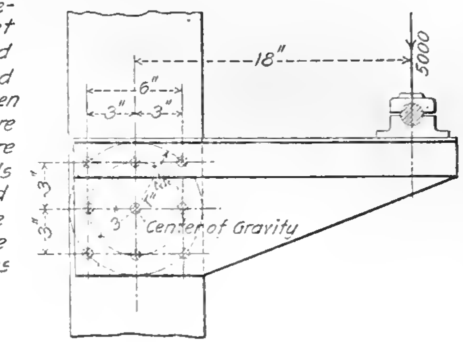


Table of Number of Rivets for Eccentric Loads
One Vertical Row of Rivets.

Body of Table Gives Total Load in Thousands of Pounds
Vertical Spacing of Rivets, 3"— Size of Rivets, 3/4".

Number of Rivets	Horizontal Distance between Load and Center of Rivet Group									
	0"	1½"	3"	6"	9"	12"	15"	18"	21"	24"
1	4.4	—	—	—	—	—	—	—	—	—
2	8.8	6.2	3.9	2.1	1.4	1.1	0.9	0.7	0.6	0.5
3	13	10	7.3	4.1	2.8	2.1	1.7	1.4	1.2	1.1
4	17	15	11	6.7	4.7	3.6	2.9	2.4	2.1	1.8
5	22	19	15	9.8	6.9	5.3	4.3	3.6	3.1	2.7
6	26	24	20	13	9.5	7.4	6.0	5.0	4.3	3.8
7	30	28	24	17	12	9.8	7.9	6.7	5.8	5.1
8	35	33	29	21	15	12	10	8.5	7.4	6.4
9	39	37	33	25	19	15	12	10	9.2	8.1
10	44	42	38	29	22	18	15	12	11	9.8
11	48	46	43	34	26	21	18	15	13	11
12	52	51	47	38	30	25	20	18	15	13

MACHINERY

May, 1910

LAYING OUT STEERING GEARS FOR AUTOMOBILES

By JOHN L. BARRA*

IN designing automobiles, the steering gear probably receives less consideration than any other equally important part of the entire car. As it is one of the most important parts of the automobile, it should, however, be theoretically investigated in order to secure the best possible results. Before entering upon this investigation, it should be thoroughly understood that the meaning of the expression "steering gear" here is not the worm and wheel with their attachments, but the parts to which the first-mentioned is connected by means of a system of levers, that is the so-called "knuckles," which are rigidly fastened to the front wheels, and the link which joins these knuckles. This link will be called the connecting-rod.

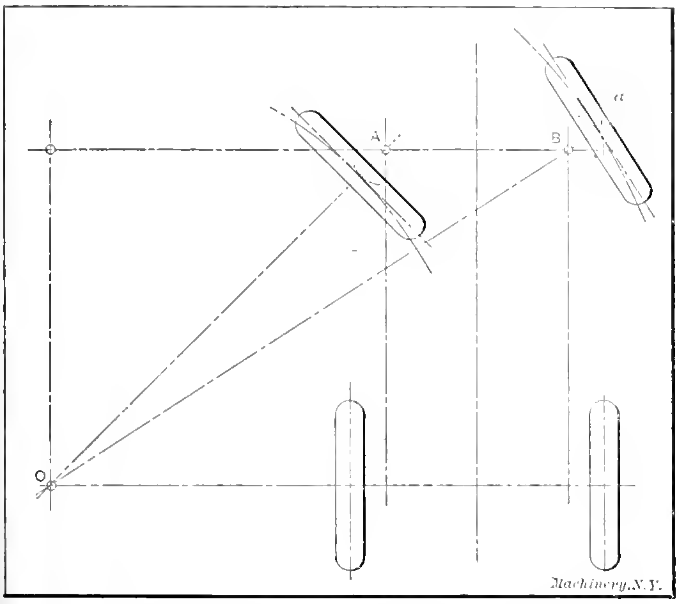


Fig. 1. Diagram showing Action of Car Wheels when turning a Curve

This system of levers and knuckles, when not properly designed, will result in a stiff-steering car, and will also cause undue and excessive wear on the front tires. This comes about in the following manner:

By referring to Fig. 1, it is seen that the center of the curve or circle through which the automobile is turning is at a point O on the center line of the rear axle produced. The location of point O depends on the radius of the curve. In reality there are two concentric circles, one of radius OA, and the other of radius OB. At any point of the curve through which the car is turning, as at a, the outer wheel must be perpendicular to its radius OB to insure perfect rolling action of the wheel over the road; the inner wheel must also be perpendicular to its radius OA at the corresponding point in its path. If the wheels are not perpendicular to their corresponding radii, never-ending trouble will result. It is easily understood how sliding of either the inner or outer tire will occur with an incorrectly designed system of levers, and it is still easier to compare a sliding tire on a sandy road to one rubbing against an emery wheel.

Referring to Fig. 3, let the arms or links bc and de be called the right and left steering knuckles, respectively, and the cross-link ce, the connecting-rod. The knuckles can be made of any length desirable, usually from 5 to 8 inches between centers. Some designers contend that the point f at which the center lines of the knuckles produced intersect the center line of the car should be at the center of the rear axle. On the contrary, so simple a rule cannot be formulated.

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Fig. 2 shows the layout for the derivation of the formulas to be used. Throughout the rest of this discussion we shall observe the following notation:

W = wheel base,

T = distance between centers of swivel joints about which the front wheels turn,

m = the angle of the inner wheel,

n = the angle of the outer wheel.

P (Fig. 3) = the angle made by bc and de with the center line of the front axle.

The following relation exists between the angles m and n (see Fig. 2):

$$\cot m = \frac{AC}{CO}; \quad \cot n = \frac{BC}{CO} \qquad (1)$$

But $BC = AC + AB$, and $AB = T$. Hence $BC = AC + T$. Substituting this value of BC in equation (1) we have:

$$\cot n = \frac{AC + T}{CO} = \frac{AC}{CO} + \frac{T}{CO}.$$

Since $CO = W$, the wheel base, we have:

$$\cot n = \frac{AC}{W} + \frac{T}{W} \text{ and } \frac{AC}{W} = \cot n - \frac{T}{W}$$

But

$$\frac{AC}{W} = \cot m$$

Therefore,

$$\cot m = \cot n - \frac{T}{W} \text{ and } \cot n = \cot m + \frac{T}{W} \qquad (2)$$

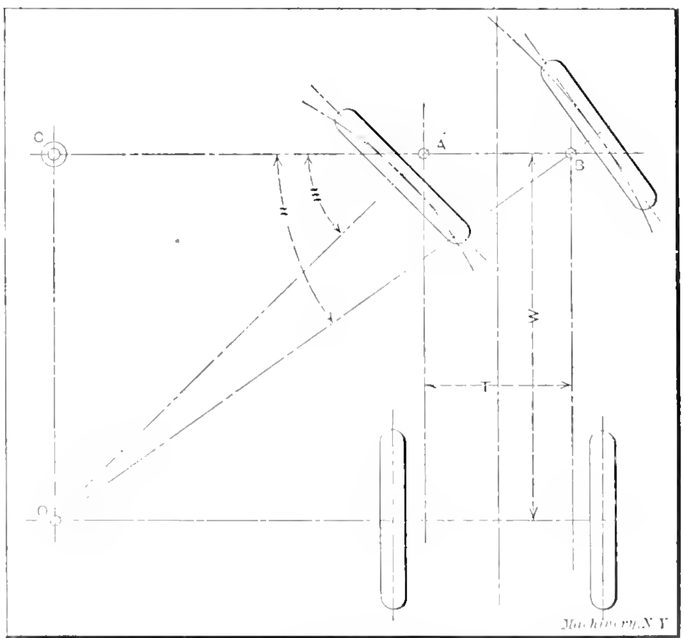

Fig. 2. Diagram giving Notation used in Formulas

From Fig. 3 we find,

$$\cot P = \frac{\frac{T}{2}}{h} = \frac{T}{2h} \qquad (3)$$

Now assume a value for h about 90 per cent of W and by equation (3) obtain the angle P. Having found P, lay out, full size, the points A and B, as indicated in Fig. 4, representing the centers of the swivel joints about which the front wheels swing, and also the angle P of the steering knuckles. Then with any convenient radius, describe two arcs from A

and B as centers and divide the left-hand arc of what will be called the inner wheel, into about nine 5-degree spaces, representing the conditions found in actual service. The length of the connecting-rod or cross-link will be DE.

With a beam compass set to the length DE and with a, b, c, etc., as successive centers, mark the points 1, 2, 3, etc., on the arc through E. Connect the points 1, 2, 3, etc., with the center B and using a protractor, scale the angles $EB1$, $EB2$, $EB3$, etc., and tabulate them under the heading "Angle of Outer Wheel by Trial" in the table, Fig. 6.

It is now necessary to see how nearly correct these trial angles are. The theoretical values of the correct angles of

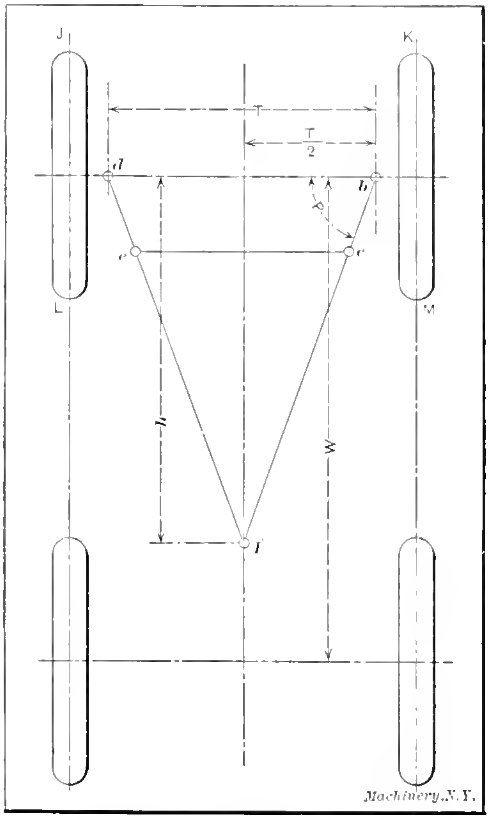

Fig. 3. Diagram for the Deduction of Formulas for Steering Gear

the outer wheel are obtained by equation (2). The values of the cotangents of m the angle of the inner wheel are obtained from a table of natural cotangents. These values are tabulated in Column 2 of Fig. 6. The value of $\frac{T}{W}$ (using

1	2	3	4	5	6
Angle of Inner Wheel Degrees	Angle of Inner Wheel Cotangent	Values to be Added to those in Column 2	$\text{Cot. } m + \frac{T}{W}$	Angle of Outer Wheel, Theoretical	Angle of Outer Wheel, by Trial
5	11.4301	$\frac{T}{W}$	....	....	....
10	5.6713	$\frac{T}{W}$	....	....	....
15	3.7321	$\frac{T}{W}$	....	....	....
20	2.7475	$\frac{T}{W}$	....	....	....
25	2.1445	$\frac{T}{W}$	....	....	....
30	1.7321	$\frac{T}{W}$	....	....	....
35	1.4282	$\frac{T}{W}$	....	....	....
40	1.1918	$\frac{T}{W}$	....	....	....
45	1.0000	$\frac{T}{W}$	....	....	....

Fig. 6. Table for comparing Tentative with Theoretically Correct Results

numerical values for T and W) is to be added to the cotangents of m as per equation (2). This sum is then tabulated under the heading cot $m + \frac{T}{W}$.

The angles having the value in Column 4 for cotangents are now found in a table of natural functions, and placed in Column 5.

On comparing the angles by trial with the theoretical (Column 5) angles, they will not be found to agree to any considerable extent. If the difference between the trial and the theoretical angles is very large, say from 3 to 5 degrees, it will be necessary to assume a new position of f and make a new calculation for the angle P and a new full-size lay-out. This calculation and construction is to be repeated until angles of the outer wheel are found which show a difference of not more than 2½ or 3 degrees with the theoretical angles.

When a set of angles has thus been found agreeing closely with the theoretical values, a curve can be plotted on

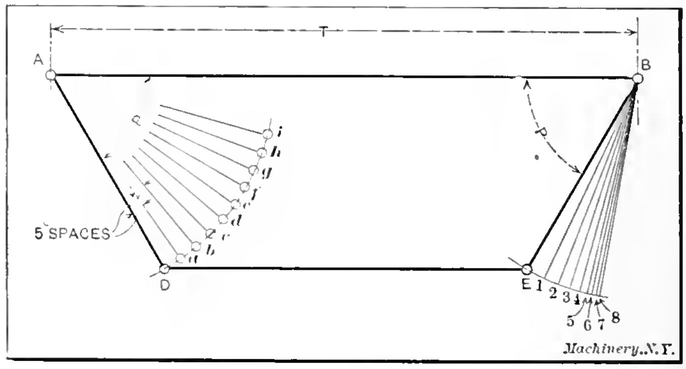

Fig. 4. Tentative Lay-out of Steering Gear Links

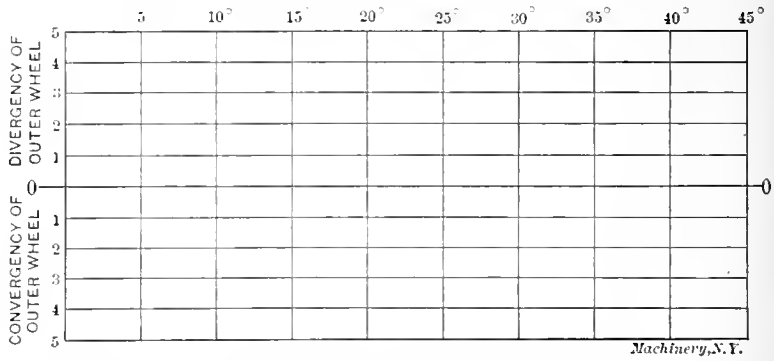

Fig. 5. Drawing-paper ruled for Laying Out Curve showing graphically Comparison between Tentative and Theoretical Angles

the curve sheet Fig. 5. The curve which would give a perfect rolling to both tires is the straight line 0-0, since this line is one of no difference between the trial and theoretical angles. It is impossible ever to attain this degree of perfection in actual practice. The best that can be asked for is that the angle difference does not exceed 2½ or 3 degrees anywhere between the 0 and the 45-degree point.

The horizontal spacing shows the different angles of the inner wheel, and the vertical spacing the difference between the trial and the theoretical angles. These differences for every 5 degrees are to be plotted above the base line 0-0 if the trial angles are less than the corresponding theoretical angles, and below if they are greater. If the trial angles are greater than the calculated angles, it is at once known that JK, Fig. 3, is less than the distance LM and the front wheels are convergent; on the other hand, if the trial angles are less than the calculated angles, the distance JK is greater than the distance LM, and the front wheels are divergent. In either case there will not be a perfect rolling action which will result in the car steering stiffly and cause excessive wearing of the tires.

The joints c and e should lie on the lines bf and df, respectively, and may be either ahead of the front axle or behind it.

The safest place for the knuckles and connecting-rod is just back of the front axle if it is possible to place them there. When they are placed back of the axle they are protected by the axle against accidents due to hitting rocks and stumps.

Having obtained a value of P which gives good results for the angles of the outer wheel, it now remains to design the steering knuckles and connecting rods by the methods laid down in mechanics, bearing in mind the fact that the parts are subject to quite severe shocks due to rocks and irregularities in the road, making it necessary to use a large factor of safety.

FORGING IN OLD FRANCE

By JOSEPH G. HORNER*

A smith's shop previous to 1771, taken from a French encyclopedia of that date, is shown by Plate I. It is termed the workshop of a master smith. At *d* bellows, and the rod by which they are operated, are shown. At *e* a blacksmith is urging the fire with bellows and heating the iron at the forge. The hood and chimney of the forge at *f* will be noticed. At *g* a man is occupied in filing a piece of work in the vise. Another vise is seen at *h*, both being tail vises fastened to the bench *i* exactly as they would appear to-day.

The anvils are not of exactly the same patterns as ours, and they rest on wooden blocks. There is a water bosh in front of the double forge. There is plenty of ventilation to the shop, as there are no glass windows, but hinged shutters hooked up to the ceiling which can be let down. The iron storage is seen outside. It is illustrated separately in Plate II. The bars are tied up in bundles *b* and laid against the wall, and a large pair of scales suspended from a wooden tripod has bars in one pan being weighted by the two workmen. One man is passing bars into the shop, which are being taken charge of by another workman within.

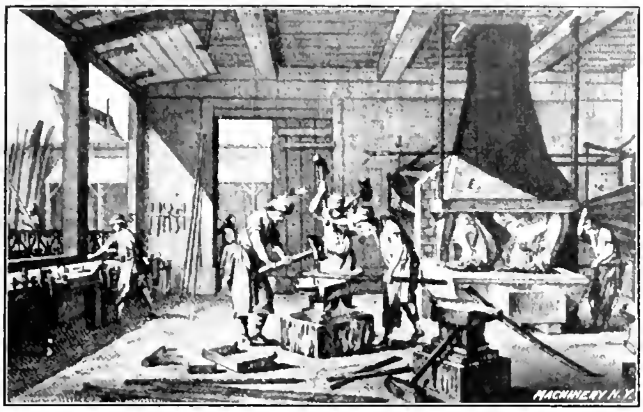

Plate I. A French Blacksmith Shop about 1770

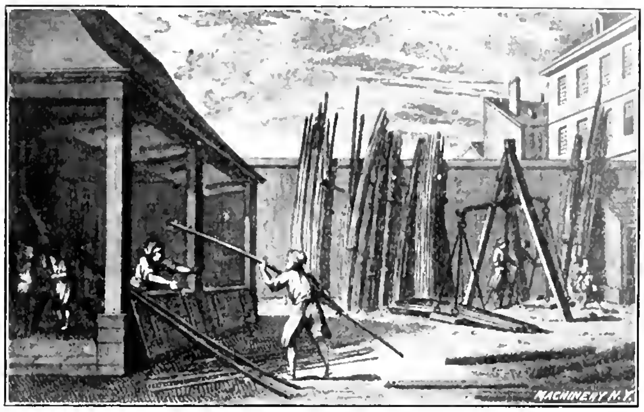

Plate II Stock Storage and Scales for Weighing the Material

Plate III shows trusses or bundles of iron bars tied up by iron rods *A*. Figs. 3, 4 and 5 show round, flat and square bars as used by the blacksmith of that time, and Figs. 6 and 7 show forged bars. In Plate IV are shown a packet of sheet iron and a coil of iron wire. A curious bar gage is seen in Fig. 10, similar to a modern wire gage with notches terminating in round holes down both sides of the gage. Another gage, Fig. 11, is formed by bending a bar in S fashion, which is suggestive of a spring. Illustrations are given in this plate of forgings termed anchors, apparently used for building purposes; Fig. 12 is a "straight" anchor, Fig. 13 a "finished" anchor. Fig. 14 is a drawing strap, *C* being the anchor. Fig. 15 is a forging with a forked end.

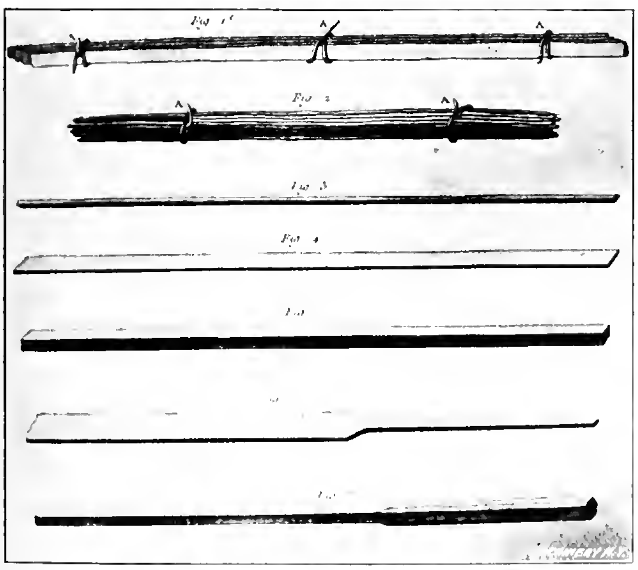

Plate III. Rough Stock and Forged Bars used in Blacksmithing 150 years ago

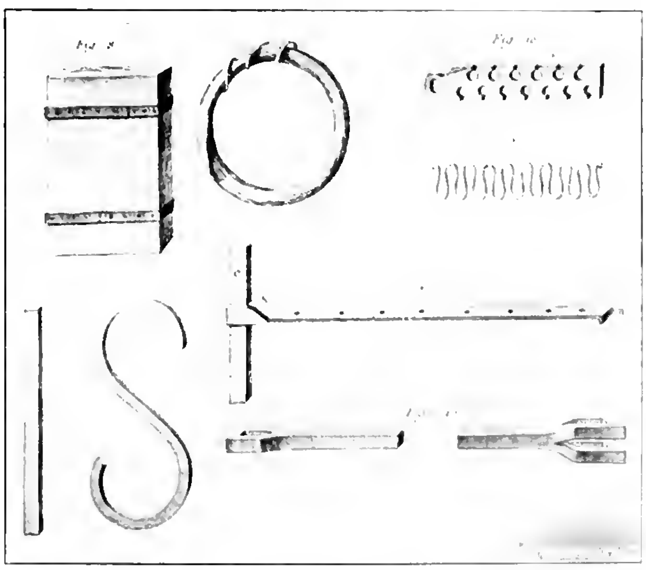

Plate IV Materials and Tools used in Early Blacksmithing

In Plate V another smith's shop is shown with several workmen engaged on various operations. At *a* a man is urging the forge bellows; at *b* another is manipulating a forging on an anvil, turning, and turning it about on the four faces; the one at *c* is placing a piece on for welding, on which the men at *d* and *e* are hammering. The man at *f* is cutting a file.

In Plate VI, Fig. 1 is the "mass" from which the body of the anvil is to be made, seen again at *A* in Fig. 2. Into a square hole in it a bar *B* is fitted, to be manipulated by the cylinder of wood *C*, shown again separately in Fig. 4, and bonded at *A* with iron hoops. Holes at *B* receive the handle bar, Fig. 5, by which it is turned about. Fig. 6 shows at *A* the piece to be welded, *B* being its porter bar. In Fig. 7 the top *B* is seen welded on the body *A*. Fig. 8 shows a beak *A* prepared for welding with a porter bar *B*, and Fig. 9 is the same in place. In Fig. 10 both beaks are welded on. Figs. 11 and 12 show the steel face and the body of the anvil separately, and Fig. 14 is the finished article.

In Plate VII the making of a stake is shown, beginning with Fig. 1. In Fig. 2 the collar *B* is fitted, shown separately in Fig. 3, and welded in Fig. 5; the end *B* is then upset. In Fig. 6 one of the horns in Fig. 7 has been welded on. Fig. 8 is the steel face with its porter. In Fig. 9 the stake is complete. Figs. 10 to 17 represent the stakes in the making of a hammer, Figs. 11 and 14 being the steel jaws hatched up for welding. The next group of Figs., 18 to 20, illustrate the making of a billhook. Figs. 21 to 32 are other examples of forging.

Die forging was practiced in the eighteenth century in a small way, and the practice was the forerunner of the die forging applied to the manufacture of pistols in America, and of locks in the Black Country. Several dies are illustrated in Plate VIII for the work of making sliding bolts for doors and other purposes, which figured more largely then than they do in these days of cheap locks. The stamps were laid upon

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the anvil and held securely. Fig. 1 is a die for imparting a truly cylindrical form to round rods for window bolts, A being the stamps, and B the horns or ears. One of molded section is seen in Fig. 2, and the same is clamped to the anvil in Fig. 3. It is secured with a bridle and key. The bridle holds in the ears B of Fig. 2 and is shown separately in Fig. 4, and its key in Fig. 5. Figs. 6, 7 and 8 are other forms of dies; Fig. 6 is for a collar; Fig. 7 combines two recesses, one for plain bar, the other as in Fig. 8 for a molding. Fig. 9 is another kind of stamp for forging the portion A in Fig. 10. Figs. 12 and 13 are two stages of nail making for window bolts, Fig. 12 showing the nail blank ready for stamping, and

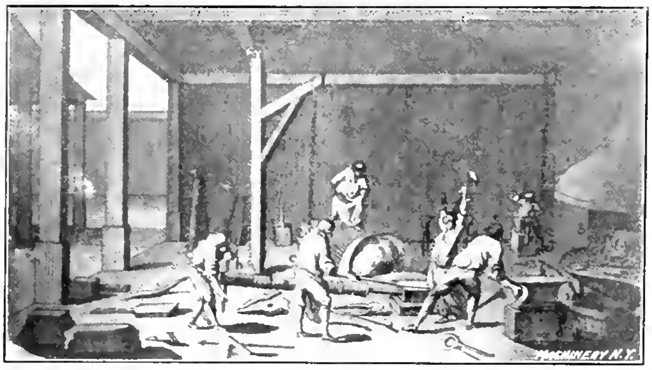

Plate V. Another Early Blacksmith Shop

Fig. 13 being the same taken out finished from the stamp in Fig. 14. Fig. 15 is a key for turning the nuts of bolts, A being the fork and B the handle. Fig. 16 is a tool for stamping nuts, and Fig. 17 is the same reversed showing the end by which the stamping is done. Half a dozen nuts are shown being stamped from a piece of flat bar in Fig. 18. Figs. 19, 20 and 21 are top stamps with handles. They are of the same type as those used in any smithy to-day.

Figs. 22 to 26 show separate stages in a piece of work. Fig. 22 is the first heat taken on the bar A, in which rings 23 or 24 are welded round a plain bar. In Fig. 25 a groove has been fullered round at A, and in Fig. 26 the molded sections at A have been finished in a third heat. In Fig. 27 a piece A for the ward of a key is welded on a shank, the piece being seen at Fig. 28. At a second heat the ward is flattened as in Fig. 29 at A. In Fig. 31 a wrist or boss A has been welded to the rod B. The wrist is seen in Fig. 30, and horns A are

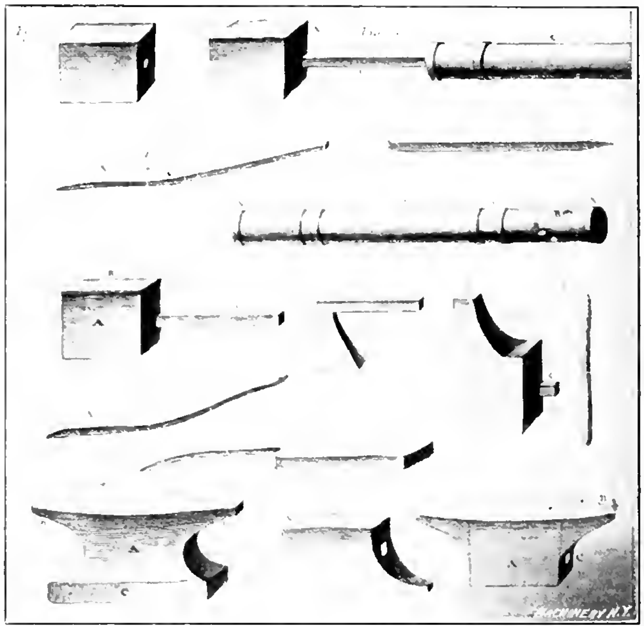

Plate VI. Successive Stages in the Forging of an Anvil

shown to enable it to hold during the welding. In Fig. 32 a piece of drawing down is shown, the drawn-down portion being afterwards bent to form the elbow A in Fig. 33.

How microscopic are the differences between the tools shown in Plate IX and those of a modern smithy! There is

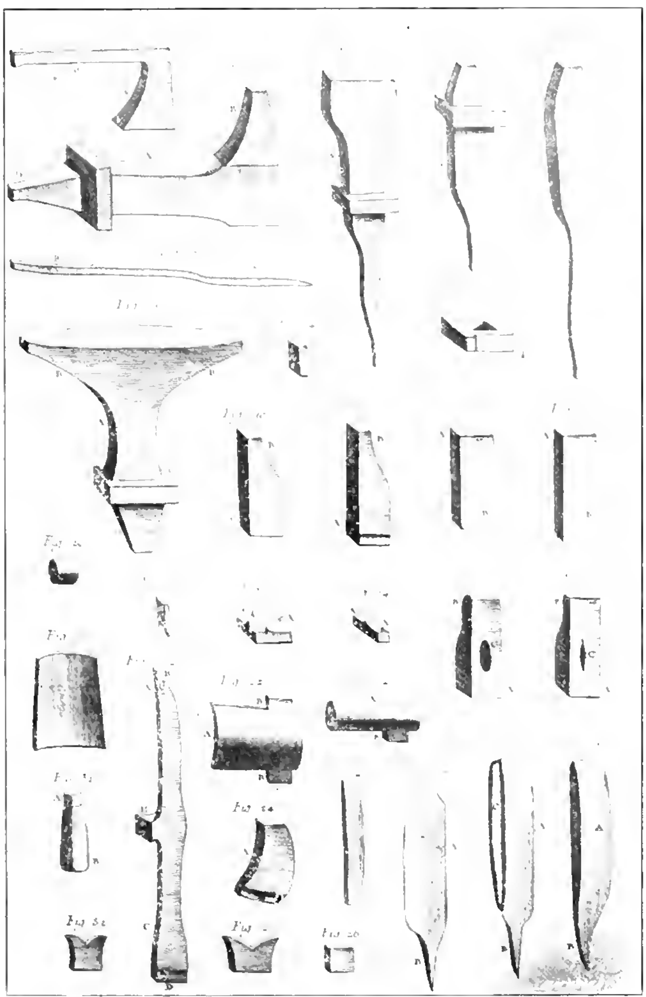

Plate VII. Examples of Forging Methods in Early Days

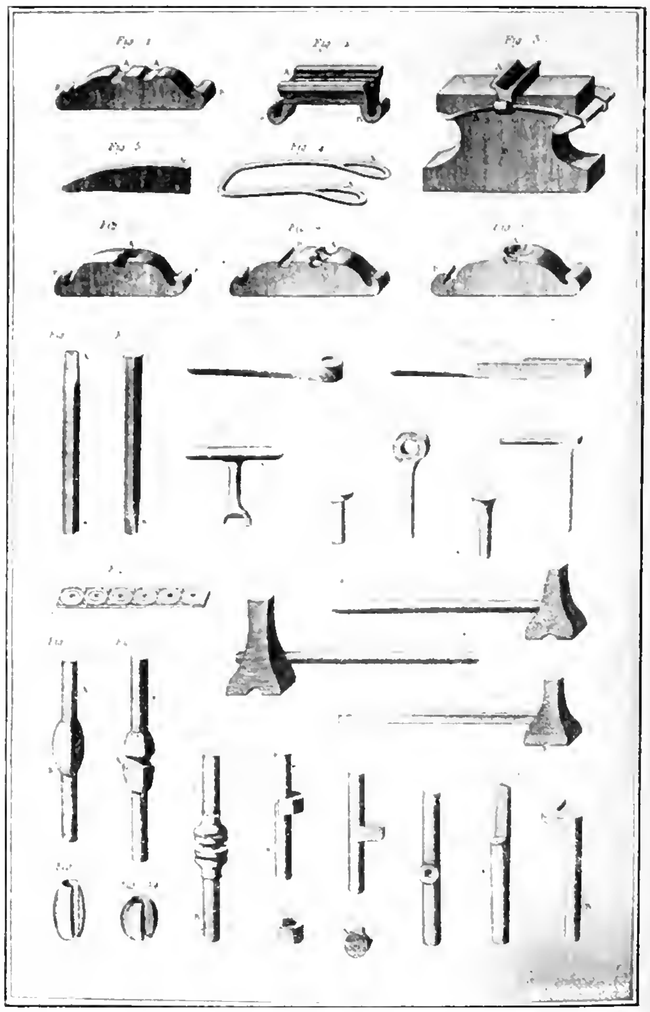

Plate VIII Early Die Forging Tools and Methods

little need to particularize. The poker, the brush, the anvils and stakes, are nearly identical. The foot of the anvil, Fig. 4, looks rather odd, being shaped into steps, and so do the grooves at the side. A stake or little anvil is shown in Fig. 5, *B* being the round beak and *C* the square one, placed on a block or billet of wood *E*, bonded at *F*. Fig. 6 is another small stake. Fig. 7 is a scroll, finished, and lying on a block of wood. An anvil stake is seen in Fig. 10, and hot and cold

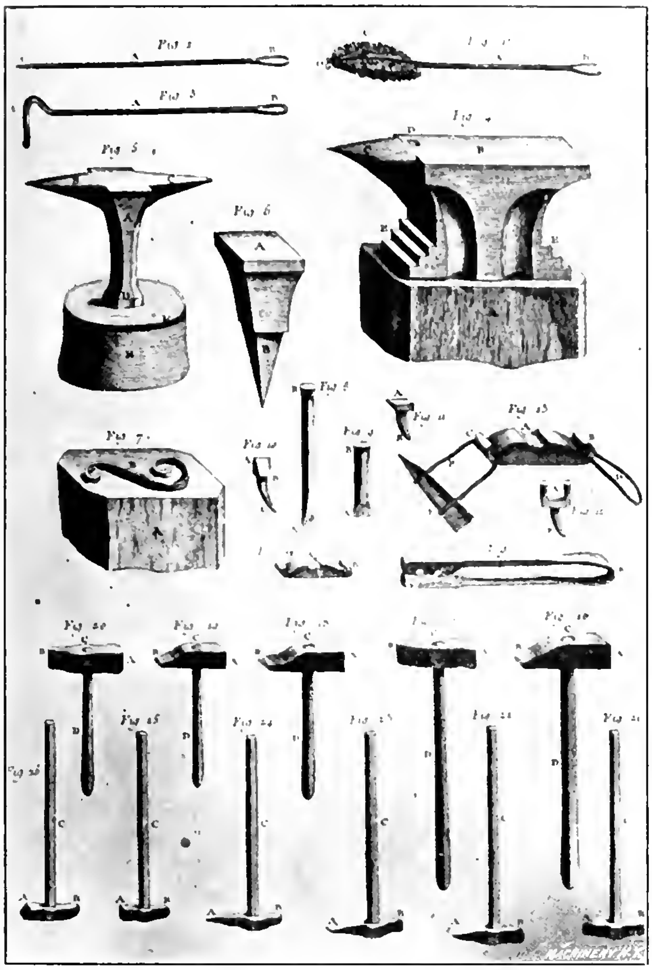

Plate IX. Blacksmith Tools of a Century and a Half ago

chisels in Figs. 8 and 9. Fig. 12 is termed a claw for a vise, probably for bending bars. Figs. 13 and 14 show more bottom dies, and Fig. 15 a spring swage. The group of hammers and sets call for no comment, being identical in form and in function with modern types.

There are some interesting examples of forged work on tools in Plate X. Fig. 1 is termed a simple anvil, and Fig. 2 an anvil with beaks; one, *A*, round, the other, *B*, square. Fig. 3 is simply a plate or block of iron. Figs. 5 and 17 are small and large gimlets respectively. Figs. 4 and 6 are instruments for working slate, 4 being for cutting, while 6 is a slate hammer. Fig. 7 is a cutting hammer. Next follows a succession of hammers, Figs. 8 to 16, the forms of most of which are familiar. Figs. 18 and 19 are chisels for file cutting. Figs. 20 and 21 show other forms of chisels, and Fig. 22 a gouge. Fig. 23 is an auger. Fig. 24 is evidently the parent of our center bit, but it is termed a *percoir a vin*, apparently meaning that it was used for boring wine casks. Next is the brace, Fig. 25. Then we come to a group of vises, jaws, or clamps, Figs. 26 to 29, the last two being for wire. Figs. 30 to 33 are smith's tongs, the forms of which are familiar.

* * *

The Krupp Works at Essen in Germany are constantly increasing in size. The number of men employed by the company at its works in Essen and elsewhere increased during 1909 by nearly 4,000, so that at the end of 1909 about 67,000 men were in the employ of the company. At the Essen works a total horsepower of over 73,000 is used, this power operating over 7,000 separate machine tools, over 900 cranes, 187 trip hammers, and 81 hydraulic presses.

FRICTION OF WATER IN PIPES

A writer in *Power and the Engineer* gives the following formula for the loss of head in water pipes, due to friction:

$$H = \frac{LQ^2}{1{,}000{,}000\,KD}$$

in which H = frictional head (or loss of head by friction) in feet,

Q = gallons of water per hour,

L = length of pipe in feet,

D = diameter of pipe in inches,

K = a variable coefficient, tabulated below for various diameters.

D	K	D	K
0.5	1.27	4	3.05
0.75	1.63	6	3.26
1.0	1.90	8	3.38
2.0	2.57	10	3.46
2.0	2.85	12	3.51

These coefficients apply specifically to new cast-iron pipes.

* * *

The first regular air navigation service in Europe will be begun May 15. Regular trips will be made from Munich, Bavaria, alternately to Starnberg and Oberammergau. A dirigible balloon of the Parseval type, having a gas capacity of 6,700 cubic meters and driven by two motors of 100 horsepower each, will be used. The aerial carriage will accommo-

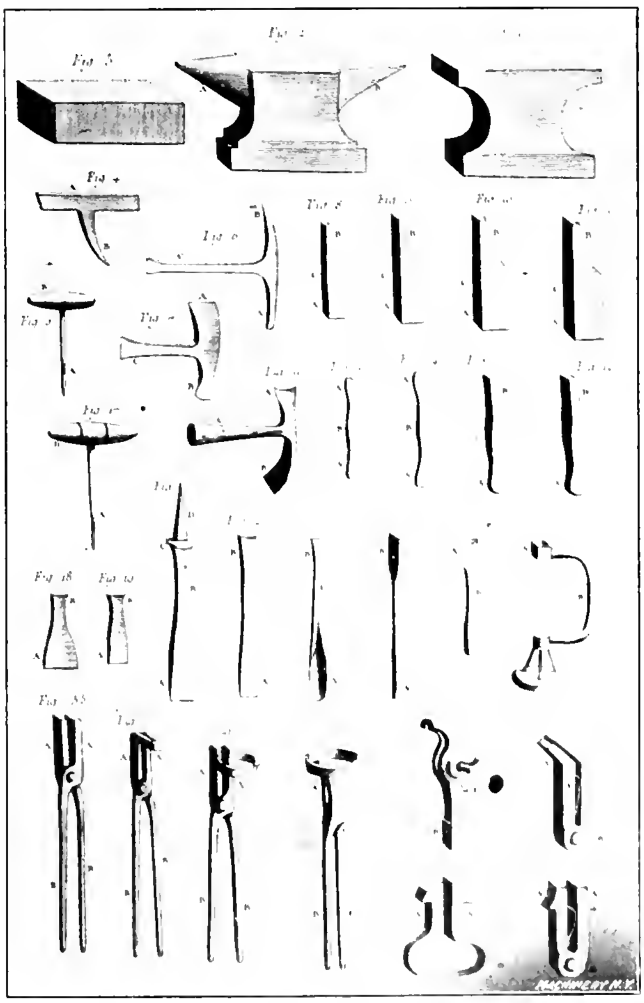

Plate X Another Selection of Early Blacksmith's and other Tools

date twelve passengers besides the crew. The fare for the round trip to Starnberg will be \$55, and for the round trip to Oberammergau \$175. The regular service will close for the season September 1. An officer from the German Aeronautic Corps has been detailed to serve as captain of the dirigible.

REORGANIZING A RUN-DOWN ASSEMBLING DEPARTMENT*—1

By ALFRED SPANGENBERG†

The present-day enthusiasm for increasing production by the use of ultra high-speed steels and by methods for "cutting time between cuts," has resulted in a disproportionate amount of attention being given to the problem of machine work in comparison with the no less important problem of assembling. Yet an investigation of the conditions existing in many manufacturing establishments will reveal that obsolete methods and processes in the assembling department nullify, to a large extent, the savings thus made in machining. The adoption of up-to-date methods of assembling may easily be expected to increase the efficiency of the average assembling department from 100 to 150 per cent, and if the department is in a run-down condition, even greater savings may be anticipated. Of course, to expect such large increases in all cases would be unreasonable, but there are many instances where such results are possible.

RECEIVED OF

________________ Foreman.

on Machine ________ Lot ________ S. O.

No. Pieces	Name of Piece	Piece No.	Sent to	Date	Punch Here Insp.	Punch Here Dept.

Fig. 1. Transfer Card

While the need for system in the assembling department is becoming more widely recognized, there are many manufacturers to whom the word "system" is indissolubly linked with "red tape." "Organization" is not their idea of economical management, because it means additional "non-producers"; and the leaks continue unchecked until some well-organized competitor forces the condition to their startled attention. This condition, however, is generally due to lack of sufficient experience or data enabling a concern to determine, with any degree of accuracy, whether or not economical results are secured from foremen, workmen, or processes.

It should be fully understood that there is no infallible system which will fit all cases alike; methods must be suited to the circumstances under consideration, since the first thought in regard to any plan must relate to its adaptability to existing needs. The reorganizer can rely but to a small extent upon any established system, and his initiative and common sense must bring a working result from a mass of conflicting conditions. With these facts in mind, the author will not attempt to describe any particular system, but will only consider certain fundamental principles.

Necessity for Analysis of Existing Conditions

Before introducing innovations in a department, it is necessary to analyze existing conditions and methods with regard to the men in the present organization, for invariably a certain amount of ignorance, prejudice, false pride, and stubbornness must be met and overcome. To win success, all plans must recognize, primarily, the human element of the men affected; methods should be instituted that are likely to elicit the support, develop the latent ability, and bring out the best that is in the workers. The best system in existence will not bring complete success without securing the support of the foremen and workmen. If these points are ignored, the tendency of the workers to gradually abandon methods with which they are not altogether familiar, will cause a partial failure of the system.

The most arduous and discouraging task, next to training the old men, is that of progressing along new lines and at the same time not interfering with the regular output. This can only be accomplished gradually; any attempt to suddenly rip up existing methods will not be effective. The old systems possess a momentum not easily overcome, and it therefore will take a long time to reorganize. However, when once a general line of procedure is mapped out and progress begun, there must be no lessening of effort. Everyone must be impressed with the idea that *every day* must show *some progress*, however slight.

The machine and the assembly departments are so closely connected that the introduction of new methods of assembling must begin with an investigation of the production conditions in the machine departments. This investigation will include the quality and quantity of work, whether or not provisions are made for inspection in the machine departments, methods of routing the work, what delays are encountered in getting work to the assemblers, whether the work is sent directly to the assembling department or duplicated in large quantities and kept in a store, etc. It is apparent that any defects in the processes just enumerated will have an immediate effect on the efficiency of the assembling department.

In the assembling department itself may be found faulty judgment regarding assembling methods, lost time in looking up work, hunting for tools, and running after drawings or to the stock-room for screws and pins, mistakes due to oversight, lack of proper instructions to the workmen, etc. The faults in organization and methods mentioned in this brief outline must be eradicated before any effective improvement can result.

The Stock-tracing System

Where there is constant trouble in getting out machines or repairs in a reasonable time, it usually will be found that some one or two departments are responsible for practically all of it. The first step to remedy the trouble, then, is to locate it. The assembling department usually is blamed, but an investigation will generally reveal that the difficulty lies in not getting work promptly to the assemblers. Many manufacturers are so accustomed to delays in getting finished parts to the assemblers that they regard the matter as unavoidable, even though the consequent losses show clearly that a remedy is imperative. A well-organized stock-tracing system is an important factor in overcoming this defect, and is so necessary that a brief outline of it is deemed advisable.

INSPECTOR'S REPORT TO CHIEF INSPECTOR

ON DEFECTIVE WORK AND MATERIAL

Supplementary to Report No. Date ________ 19__

Quantity ________ Inspector ________

Article ________ No. ____

Pattern or Forging No. ________ Dwg. No. & Part ______ Mat'l ______

From ________ Recd. on Req. No. ______

Location ________ Dept. For Ship. on Req. No. ______

Defects, etc. ________

Oper. Done ________ Date Corrected ______ 19__

Fault of ________ Employed in ________ Dept

Fig. 2. Inspector's Report from which the Monthly Report is made

The functions of a stock-tracing system are: Directing the transportation of all parts in the factory; pushing the work through the foundry and machine departments in such a manner as to prevent delays to the assemblers; keeping up records that will show the location of parts in the foundry and shop, the time required by the various departments, the labor cost, and all losses, with proper explanations. The sole authority and responsibility for this work should be vested in the head of the stock-tracing department. It is obvious to the experienced shop manager that such duties cannot be left to

* For additional information on the subject of assembling, see MACHINERY, February, 1910, "Laying Out and Aligning Operations on Machine Tools," and other articles there referred to. See also MACHINERY'S Reference Series, Nos. 50 and 51, "Principles and Practice of Assembling Machine Tools."

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the department foremen if the shop is to be run advantageously. The foremen's attention should be concentrated solely upon improving their methods and their output, and their duties should be confined strictly to their own departments.

Experience has demonstrated that it is necessary to give the stock tracer *absolute control* of all parts in the process of manufacture; in addition, he should be given such authority that the foremen will understand that his requests for stock must be complied with under all circumstances, and he alone should have authority to secure parts from any department in the factory, either for any foreman, or for the assembling department. Having under his charge all the records for stock in the course of manufacture will enable him to locate all stock with certainty and dispatch. Another advantage is that the superintendent always knows where to get any information regarding the location of work in the factory, and the time it may be expected to reach the assembling department.

If the work is allowed to remain in any department after

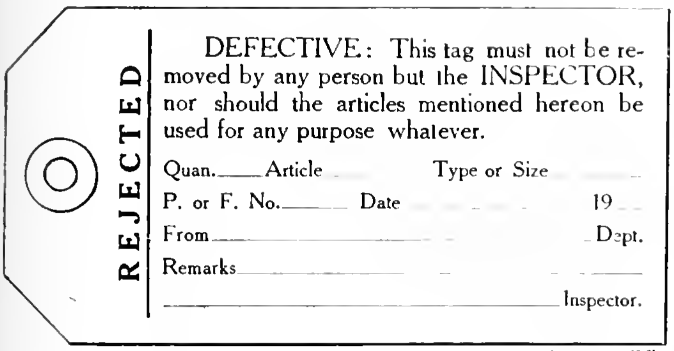

Fig. 3. Card or Tag for Rejected Work or Material

it is finished, it is apt to be forgotten, and is hard to find when wanted. Therefore, the advantages of having the work placed in central depots as soon as finished by each department, will amply compensate for the time consumed in hauling the work to one of the depots, putting it on a platform, checking it up and then taking it to the next department. This plan is especially advantageous where any system of inspection is followed; no stock can be lost; each foreman can see at a glance how much work there is ahead of him; and it aids the superintendent in getting a conception of the conditions of the work. The central depots can be located at any number of points and should contain suitable platforms for the storage of stock. These remarks apply, of course, to the smaller parts; it would not be practicable to carry out this scheme in the case of large work.

Transfer cards showing delivery of work from one department to another form a ready record which shows the date on which the articles have been received, the length of time they were retained, and the date they were passed on to the next department. A glance over this record shows if the work is pushed through with all the promptness possible. The question of giving certain orders priority over others is one upon which the stock tracer will need to exercise his best judgment. If any work is behind time, the card made out when the order was first sent to the shop is called in and replaced by a similar card of bright red color containing exactly the same information, and also the required date of delivery. An order with the red card always has precedence over those with cards of the ordinary color. Care must be taken, however, not to use these "rush" cards to such an extent that they become so familiar as to be ignored. A transfer card and the information it should contain is shown in Fig. 1.

Instead of allowing each foreman to have his own gang of truckers, the trucking force throughout the factory should be centralized and placed under the supervision of the stock tracer. This force of men will deliver work to all departments in the factory as it is called for, and upon their returning to the respective depots they will bring in the work that is on the machine room floors already finished. The fact that this work is finished is indicated by "Move It" cards, which are placed in the boxes by the workmen. These remarks apply to the handling of small parts; in handling large work, cranes are almost universally used.

Inspection

In a previous article appearing in the September, 1909, issue of MACHINERY, the writer emphasized the necessity for inspection of work in the machine departments in order to secure economical assembling. This is one of the essential preliminary steps in the revival of a run down assembling department; yet it is difficult to convince the average manufacturer that it will pay to employ a number of high-priced men to do nothing but inspect the work done by other men. The idea is prevalent that the payroll for these inspectors, who are non-producers, is but a constant expense, and it is hard to realize the very large economies which their work, if efficient, will bring. The advantages to be gained by an efficient inspection department may be given thus:

1. Imperfect parts are eliminated before the work reaches the assemblers. If the parts come to the assemblers properly inspected, so that they can be put together without unnecessary filing and fitting, the saving of time in assembling easily may reach from 60 to 75 per cent.
2. The fact that the parts are interchangeable will result not only in ease of assembling, but in case of repairs the parts can be sent out with the assurance that they will fit properly without adjustment. The last-named feature is important in that it is a splendid advertisement to any concern.
3. It instills into the minds of the workmen the fact that the work they produce must be up to a high standard, and that if it be otherwise it will be thrown out, at their loss. This one feature will result in marked improvement in the quality of the work.
4. The workmen receive pay for good work only and are charged with that which is defective, so that an inspection system provides protection to the company.
5. The elimination of defective parts by an inspector, important as it is, is only of minor significance when compared to the general effect. It would astonish the average manufacturer to find how soon his workmen will come up to any standard set by the inspection department, and how small the loss will be, no matter how close the limits are held.

Any system of inspection must be thorough, and the limits given to the work must be adhered to uncompromisingly. Weakness on the part of the inspector will immediately be noted by the workmen. The inspector's authority to reject work should be unquestioned, and the superintendent should never, unless when absolutely necessary, reverse his decision. An inspector should be placed upon as high a plane as any of the foremen in the factory, and to be successful, he should possess good judgment, firmness of character, and familiarity with the business.

A thorough system of inspection effects large economies in every direction, but principally in the assembling department. The parts can be assembled more quickly and accurately, and the saving in this department alone will pay for the cost of inspection. Besides, the machines built will be much more accurate. In many cases it is not necessary to establish a very elaborate system.

There is another phase of this question which is important from an economic standpoint; this relates to fair and consistent inspection—*commercial* inspection. Unless an inspector has sufficient intelligence to discriminate between vital and unimportant dimensions, and unless he possesses enough judgment to know when a job is commercially satisfactory, he causes a waste of time and imposes unnecessary hardships on the men who do the work. Good judgment in inspection is a vital factor, and it will pay to employ first-class men on this work. The best workmen and machines sometimes make a slip as to size, and to ruthlessly reject work which is commercially satisfactory is an abuse of the inspector's authority. An inspector is apt to forget that on the large majority of work there is often no necessity for anything closer than a few thousandths inch. Therefore, it is advisable, in many instances, to have limit gages with as wide limits as the character of the work will permit, and to have rejected work looked over by a chief inspector whose decision is final.

Reports should be made by the inspectors at least once a month, showing the amount of work scrapped by each department, together with the reasons. The effect of this upon the foremen is marked; when they realize that they are liable to censure for the excessive amount of scrap coming from their departments, they will soon give the matter their per-

sonal attention. Fig. 2 shows a blank report of this character, while Fig. 3 shows a card or tag which is placed on all defective work by the inspector. A simple system of this kind, tried for a few weeks, will prove to any manufacturer that the unnecessary waste in his factory is astonishing.

Having thus analyzed general factory conditions, attention will now be given to the methods for increasing the efficiency of a run-down assembling department. The causes of loss should be clearly recognized and logically grouped for study. This will enable us to easily see what must be done (and what *must not be done*) to secure improvements. The sources of waste already referred to may be classified as follows:

1. Defects of departmental organization—of the foremen, the job bosses, and the usual methods of management.
2. Defects of assembling systems.

1. DEFECTS OF DEPARTMENTAL ORGANIZATION

The Foreman

The first and the absolute requirement for an efficient assembling department is an efficient man to run it. No half-baked "graduate" of the existing department will bring proper results; this department calls for a man of a high type. This cannot be emphasized too strongly, for it is foolish to plan a campaign of improvement with any expectation of success unless this first step is taken. The mistakes and shortcomings of the low-priced foreman are too costly; a well paid, progressive man is the cheapest in the end. He should have a thorough knowledge of the most economical methods and of the special labor-saving devices, jigs, etc., best adapted to the work he handles, and, last but not least, the ability to handle men tactfully.

In selecting the foreman, it should always be remembered that he is to the workmen the direct representative of the firm, and that the men base their opinion of the company largely upon their opinion of the foreman; hence, the personality of the foreman affects the workmen more directly than any other factor in the shop organization, and has a direct effect upon their efficiency and disposition toward the company. The foreman must be invested with absolute authority over his men, and he should be given "his chance," which with most men means increased ability to handle the problems submitted to them. Of course, the foreman of a department should consult frequently with the superintendent regarding any important problems that arise, for it is well to observe the principle that, nine times out of ten, the joint advice of several men is superior to any plan developed from one man's brain. It frequently happens, however, that a superintendent makes the serious mistake of ignoring the vital points just mentioned, and instead of entrusting the details of the work to his foreman, gives orders directly to the workmen; in this way the workmen gradually lose respect for their foreman, and the latter becomes a mere figure-head, without any authority except in minor details.

Owing to the weakness of the ordinary foreman, the majority of up-to-date concerns have adopted the broad policy of instituting a rate-making department, and jig-designing and jig-making departments, entirely independent of the foremen. The principal reason for the adoption of this plan, however, is the fact that a foreman seldom has time to set piece-work rates, design jigs, etc., and attend to the other important duties that demand his attention. As has already been pointed out, the foreman's entire energies should be concentrated, as far as possible, upon the important duties of supervising the work and devising ways and means for increasing the efficiency of his department.

The Job Bosses and Workmen

It is evident that a foreman cannot properly oversee his entire department without assistance and still devote his attention to the larger and more important details of his work. The usual method of procedure in order that each man or group of men may receive the proper amount of attention, is to appoint the more efficient members of the working force to the position of "job bosses." Each job boss is invested with a limited degree of authority over a small group of men, and, by performing his share of the work in addition, receives a slight increase in pay. These men should be carefully selected, since they usually are next in line for advancement to assistant foremanship.

When the department is sufficiently large, the foreman should be relieved of all clerical labor such as making out time-cards, writing sub-contracts, checking up parts received, etc.; and this, of course, presupposes the employment of one or more clerks.

As a general proposition, first-class, well-paid machinists are the cheapest in the end on assembling work. This is especially true where the work varies in character. The amount of work that will be turned out by a highly skilled assembler, when compared to that of a cheap man, is astounding. An important feature to consider is also the fact that the workmen's pay is only one part of the total cost, because a largely increased production per square foot of floor area decreases the proportion of overhead cost per piece.

Where work is duplicated in large quantities, so that there are constant repetitive processes, it is possible to so train the cheaper and less experienced workmen that they in time become expert on their particular class of work. It is advisable to provide for a rigid subdivision of labor. Thus, the more particular work at the vise or bench is handled by special men who do no other class of work. These high-priced mechanics perform no work that can be done by cheaper men or apprentices, and in this way, the average rate is kept normal.

Systems of Pay and their Effect Upon the Workmen

The system of pay is one of the most important elements to be considered in the case of a run-down assembling department, because assembling work is progressing only when the workman is busy. In order, then, to stimulate production, it is absolutely necessary to offer a reward for extra efforts on the part of both the foreman and workmen. To give the foreman all the gains is manifestly unfair, and leads to dissatisfaction on the part of the workmen; in fact, an inequitable system of pay invariably causes a lack of proper results and seriously affects the cost of assembling.

The piece-work system is the one usually in vogue, but its chief evil lies in the universal practice of cutting rates when the men begin to earn large wages. This trouble is very largely caused by the practice of setting "original prices," or "original times" not based upon data mathematically determined, but either upon best previous records, an ordinary "try-out," or, worst of all, on the cost department's estimate. The workmen find that their only protection from reduction in prices lies in the strict adherence to a certain limited rate of earnings and hence of production, with the result that the firm suffers unconsciously through excessive costs and limited output and the men are discontented and determined to "get even" for unfair treatment.

It is clear that it is to the advantage of the manufacturer to get the hours down to the points determined upon. When the work of determining "standard times" is accurately done, as, for instance, in shops where an expert tester is employed who analyzes the assembling operations to the last degree, the figures obtained will be so far below the results previously secured in existing shop practice, that the workmen, in all sincerity, will refuse to believe that it is possible to attain such rates of production. A flat piece rate based upon these "times" would lead to trouble, because of the lack of stimulus. It is advisable, therefore, to offer an extra reward to the workman attaining standard time, with the guarantee that no reduction will be made unless methods be changed.

The attainment of standard time, however advantageous, will never be realized unless the assembling department is so arranged and equipped that the same conditions prevail in everyday manufacture that existed when the expert tests were made. This is a point that is often overlooked. The particular benefits derived from having an expert tester, lie not only in the accuracy with which prices can be determined, but also in that the firm is enabled to show the workmen, by actual demonstration, that the work *can be accomplished* in the time set for it.

The systems of pay in general use are as follows:

The Day Work Plan.—This plan is decidedly inefficient unless the men are rigidly supervised, or under special conditions where the work is intricate and exacting.

Piece-work.—By this the workman receives a certain amount of pay per piece. One of the greatest objections to this plan, as already stated, is that it is so often coupled with the practice of cutting rates when the men begin to earn large wages.

The Premium Plan.—This is a very efficient system of pay on many classes of work. The determination of "standard times," however, should be made carefully, for if the rates are set by incorrect methods, it is easy to imagine the results that will follow. In fact, the determination of "standard times" on assembling work is a particularly difficult proposition, since the skilled assembler can and will deceive anyone not of the highest order of expertness concerning his possible rate of production, particularly when he has worked for years on repetitive processes and thereby has gained marvelous skill. Consequently, in order to secure an extra output, the possibility of which lies concealed within the workman's skill, it is absolutely necessary that the premium be sufficiently large to stimulate his ambition.

The Bonus Plan.—This is a system of task work combined with the use of instruction cards for the workmen and a bonus for accomplishing the task within the time set for it. This plan readily lends itself to adoption in case the men already are working on the day work basis. It also has the advantage of being introduced with little opposition, because it is easily understood by the workmen; and, besides, it is adaptable in some form to almost any other system of pay already in existence in the shop. To be effective, however, it should be combined with methods that accurately determine the shortest time in which a job can be accomplished; and it also should include provision for the job bosses and foreman securing bonuses in case all the men under them earn bonuses. This will compel the foreman to immediately give his close attention to the inefficient workman for his proper and speedy training or his discharge.

This bonus system of pay has always appealed to the writer as the most effective of all systems yet devised for assembling work. But it should be remembered by anyone contemplating the adoption of a piece-work or bonus system, that in addition, it is absolutely necessary to provide a check upon the workmen in the form of an inspection system, for if this point is neglected, the quality of the work will suffer.

THE BATEMAN PLANER DRIVE

By JOSEPH G HORNER*

During recent years some very excellent designs of planing machines with cushioned reversals to the table have been built in England. Messrs. Bateman's Machine Tool Co., Ltd., of Leeds, whose machines are in the front rank, have been introducing a separate self-contained driving apparatus to be fitted to old designs of machines, both for speeding them up and cushioning the reversals. They term it "plano-drive," and a cushioning device is introduced in the form of a spring wheel, which in effect corresponds with the sliding spring rack which is used on the firm's planing machine tables. The mechanism comprises driving pulleys carried at the head of a tall steel framing for belting from the countershaft and to the pulleys below which actuate the firm's flywheel drive, spring wheels, and a complete set of gears for operating the planer table. All the existing gears on the machine to be speeded up are taken out, connection being made directly from the "plano-drive" to the last driving

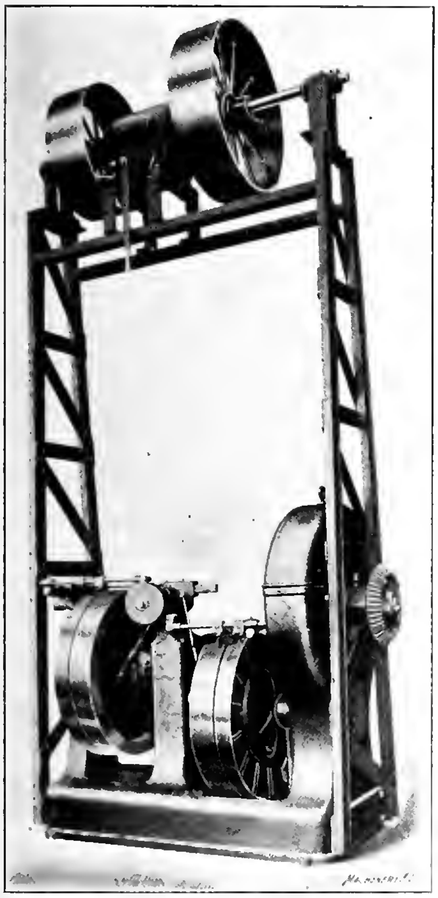

Fig. 1. Bateman's Planer Drive

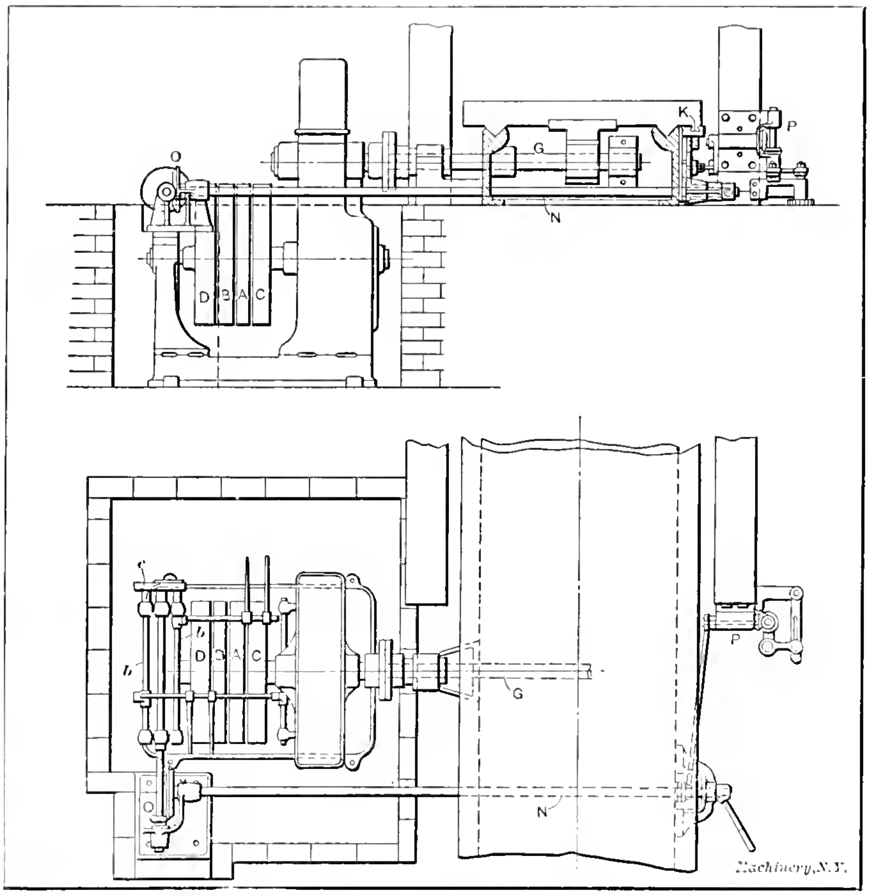

Fig. 2 The Bateman Planer Drive applied to a 4-foot, 6-inch Planer

shaft of the planer through a flanged coupling, or bevel gears. In some cases a motor is substituted for belt pulleys from the lineshaft, in which case it is coupled direct to the countershaft, special frames being fitted to the sides of the plano-drive to carry it. Several firms who have had their planers speeded up have taken the opportunity also to electrify them. In many cases the cutting capacity of the machines has been much more than doubled by the adoption of this drive.

Figs. 2 and 3 illustrate the details of the plano-drive coupled to a 4-foot 6-inch planer. The plano-drive is placed in a pit beside the machine, coupling direct onto the bull pinion shaft, thus scrapping all the old gearing in the machine. The new gearing in the plano-drive replaces all the gearing that is taken out, and obviates all risk of breakage due to the higher speeds. Owing to the use of the spring wheel, the shock at reversal is actually less after the plano-drive is fitted than before.

In Fig. 3 the two fast pulleys for cut and return are

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marked respectively A and B, and their loose pulleys C and D. As the return stroke is always made at a constant speed, a pinion E is always in mesh with the large spur gear F, keyed on the short shaft that is connected by a flanged coupling to the bull pinion shaft G of the planing machine. The two cutting speeds are produced by change-speed gears mounted on two shafts H and J, these shafts being eccentric, and operated by a lever a, which, through lever connections and a rack and pinions, turns the eccentric shafts so as to bring one or the other pair of gears into engagement. Pinion E is thus driven in the reverse direction to that of pulley B.

The belt-shifting gear comprises a pair of forks for each set of pulleys, each pair being operated by a rod actuated from shafts B, Fig. 2, worked by a cam plate C, the part rotation of which has the effect of throwing the forks along in their proper relations for shifting the belts onto the fast pulleys for either cut or return. In Fig. 2 they are shown in the non-driving position, that is, both on the loose pulleys. The partial rotation of the shaft which carries C is effected by a lever d, Fig. 3, which is connected to the reversing mechanism of the planer.

The spring wheel is in course of modification, but the principle of action may be briefly described as follows: The large gear F is mounted loose upon its shaft. An oscillating lever is keyed on the shaft. Fitted inside the gear are spiral springs mounted in telescopic cases carried upon adjustable brackets; the projecting plungers butt against the end of the oscillating lever, and they are so arranged that when the machine is cutting, the thrust is taken against the solid metal of the spring case. When reversing, the shock is absorbed wholly by the springs. This spring wheel takes the place of the spring rack fitted in the tables of the firm's standard planing machine. (See description in MACHINERY, July, 1905). The standard flywheel pulley drive is also incorporated in the plano-drive, the flywheel pulley being at C in Fig. 3. Its endwise movement to throw it into engagement with the pulley A is effected by a lever c, worked by connections from the rods which carry the belt-forks. When the belt is shifted from C to A, C is also moved endwise to clutch it to A.

Fig. 2 shows the details of the relations of the plano-drive to the machine. In the top view the pinion and rack are shown. The reversing gear comprises two dogs, which alternately strike a "tumbler," which in turn rocks the shaft N passing through the bed. This shaft is coupled at the opposite end to bevel gears O, which operate the cam-shaft. The gear at P is for producing the automatic feeds to the planer heads, in the usual manner.

* * *

The extent to which the Walschaert valve gear, which was rarely seen in this country a few years ago, is now employed on American locomotives, is shown by the following figures: The total number of locomotives ordered during 1909 for which the Walschaert valve gear was specified was approximately 1,638; the number of those which were to be equipped with the Stephenson was 745; while the Baker-Pilliod gear was applied to about 65.

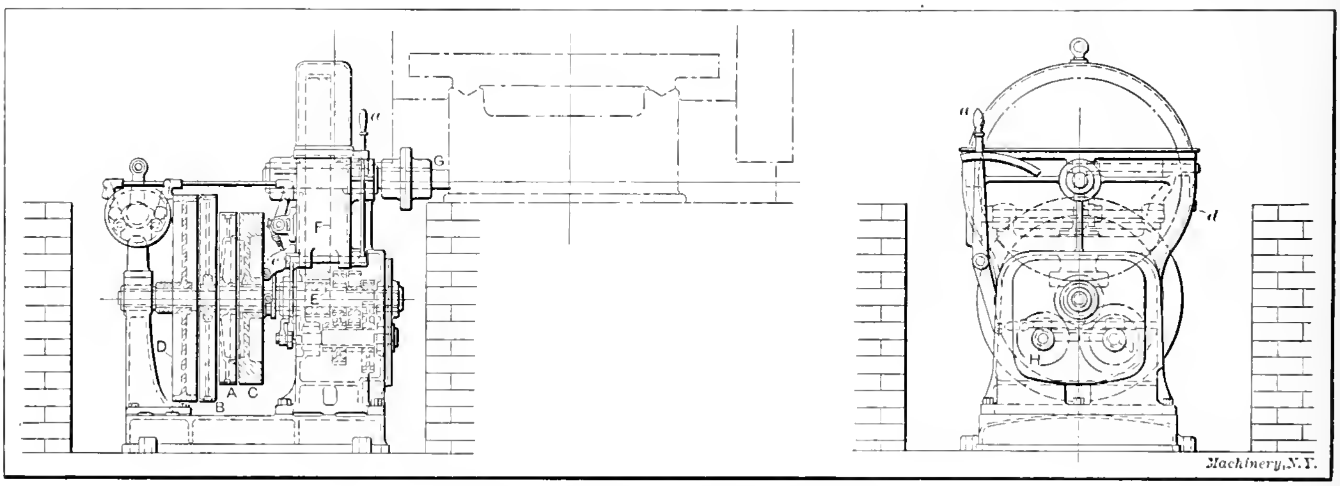

Fig. 3. General Design of the Bateman Planer Drive

METHOD OF APPLYING MOTORS TO MACHINE TOOLS

In a paper on the Economy of the Electric Drive in the Machine Shop, read at the April meeting of the American Society of Mechanical Engineers, Mr. A. L. De Leeuw reviewed the conditions which must be considered in connection with the equipment of a machine shop with electric drive. In conclusion he gave a general idea of the mode of application of motors to machine tools, the selection of motors for different classes of tools, and the lines along which economical results may be expected. The following abstract of these conclusions will undoubtedly be of interest to mechanics in general.

Bench and Speed Lathes

Bench lathes should be driven from a countershaft attached to the wall or bench and driven in turn by a motor. Any kind of motor except a series-wound or heavily compounded motor will do. The object of the motor drive is to get the machine in the best possible location without regard to the location of the lineshafting. A number of these machines may be driven by a common lineshaft, which in turn is driven by a motor.

Speed lathes should be driven from a countershaft located under the lathe, or by a direct-connected motor. In the latter case a variable-speed motor is to be preferred, if direct current is available. Motor drive is recommended when the machine is used in the assembling department, as the machines may then be placed where they are most needed; the crane service would also interfere with countershafts. There will be no material gain, if the machines are to be used for ordinary shop operations.

Engine Lathes

Various modes of driving engine lathes by motors are in use. Some makers furnish motor-driven engine lathes as standard equipment. Some have a headstock with a limited number of speeds, and depend on a variable-speed motor to fill out the speeds of the lathe. Others apply a constant-speed motor, or one with a limited amount of variation, to an all-geared headstock. In general, the use to which this class of machines is put in the shop would naturally lead to group drive. There is no material advantage in the individual motor drive, if the machines are used for regular manufacturing operations, except where the location demands individual drive.

Heavy Engine Lathes, Forge Lathes, etc.

Heavy engine lathes, and lathes of similar types should be driven by a direct-connected motor. The motor should be direct-current, as these machines are too heavy to permit a convenient all-gear drive. If no direct current is available and there is only one machine of its class in the shop, and this is used for an occasional job only, an alternating-current motor could be used, leaving a wide gap in the speeds. If these machines are used for manufacturing purposes, however, it will pay to install a small synchronous connector. The speed range in the motor does not need to exceed two to one, though a wider range is better if obtainable without complications or great expense. The position of the motor should be low, as the vibrations in the motor-support have a decided influence

on the capacity of the machine, as well as on the repair bill. The output of this class of machines may easily be increased from 20 to 25 per cent by motor drive. Further advantages of the motor drive are the possibility of placing the machine in the line of the routing of heavy work, and of placing it immediately under the traveling crane. This latter object may be reached with a belt-driven machine by placing the headstock under the gallery, if the construction of the shop lends itself to this arrangement, but the same convenience as that of the motor drive cannot be obtained.

Axle and Wheel Lathes

It is of the greatest importance that axle lathes and car and driving wheel lathes should have the highest possible efficiency, and the most convenient location. These machines are mostly used in locomotive and car repair shops, where time saved does not mean merely the saving of wages, but each day gained means an added day in the earning capacity of the engine or car. It is, therefore, important that these machines be motor-driven whenever installed in a railroad repair shop, though this does not mean that they should not be so driven if used for manufacturing. Direct current should be used. The economy of the motor drive should not be figured in increased output, but in reduction of time required to repair an engine or car.

Chucking Lathes

Generally speaking, there is little reason why a chucking lathe should be motor-driven. Most chucking lathes are provided with the necessary mechanism to shift speeds quickly. A few types handling large work may be motor-driven to advantage, though practically the only advantage lies in the fact that small gradations in speed can be thus obtained. Such machines, therefore, require a variable-speed motor.

Automatic Screw Machines

Small automatic screw machines are generally group-driven. Large machines may be individually motor-driven to good advantage. The larger sizes have generally one or two speeds for one piece of work, though these speeds may be varied when the machine is reset for a new piece of work. The speed given to the machine must naturally be proportional to the largest diameter to be turned, or in other words, to the size of stock used. This will reduce the speed for some of the operations such as drilling and reaming, far below the economical speed. The amount of time saved by the application of the variable-speed motor may be considerable. Where the construction of the machine permits, two motors, one for feed and one for speed, would give still better results. In all cases variable-speed motors should be used.

Drill Presses and Boring Machines

The only reason why the sensitive drill should be individually motor-driven is that it is often used in an assembling department, where height of ceiling and crane service would make a belt drive awkward or impossible. Most sensitive drills have, in themselves, all the speeds required for their work, so that any type of motor will be adaptable. The motor may either be directly applied to the machine or may drive a countershaft on a stand; or it may be placed on the floor by the side of the machine, in case the machine carries its own set of cones or other variable-speed device.

Generally speaking, the upright drill is used for manufacturing operations and does not require frequent changes of speed. There are, however, many exceptions, for instance, where upright drills are used to do all the operations on a piece by means of a jig. In this case frequent changes of tools, and, therefore, of speeds, are required, and an individual motor drive, whether direct-connected to the machine or operating on the countershaft, is of the greatest benefit. No great benefit can be derived from a constant-speed motor with this type of machine. Radial drills may be considered to present the same requirements as upright drills. There is an additional reason why radial drills should be motor-driven—they are often used in the neighborhood of the assembling floor.

Where the work for boring machines is specialized and the machines perform only one operation, there is no good reason why the motor drive be preferred to belt drive. Where, however, the machine is used for a multiplicity of operations, such as drilling, boring, reaming and facing, a motor drive is beneficial if a variable-speed motor is used. The range of speed of the motor should be as wide as possible, so that no gears may have to be shifted for the entire set of operations on a single hole. Especially where a boring machine is used for facing, this variable speed will be found highly economical.

Grinders

Grinders, in general, require so many various movements driven from countershafts that it is hardly possible to apply a single motor directly to the machine; the best that can be done is to attach the countershaft to the machine and drive the former from a motor standing on the floor or on a bracket attached to the machine. In isolated cases it would be well to have one or more motors, each controlling a single operation, attached directly to the machine.

Planers, Shapers, Slotters

Planers in general are not benefited by the application of a motor, as the motor only complicates the difficulties of a planer drive. However, large planers which must be placed under a crane give better results when motor-driven on account of the facility of handling the work. Another possible advantage when using a variable-speed motor and controlling the speed of the motor at the end of the stroke is that much higher return speeds can be obtained in connection with any desired cutting speed. What is true of planers is also true of shapers and slotters. Local conditions may make it advisable to drive them individually by motor, but generally speaking, there are no great advantages to be gained with this drive.

Milling Machines

The larger sizes of knee-and-column type machines, if motor-driven, will give the best results if the motor is of the variable-speed type, especially where these machines are used for gang work. This is due to the fact that the speed of the mills is dependent on the largest cutter in the gang, while the feed is dependent on the smallest cutter, not counting the limitations due to the nature of the work. It is therefore important that the speed should be as close to the permissible limit as possible. When applied to this type of milling machine, the motor should be as low down as possible, as vibrations in the machine have a marked effect on the quality of the finish. In practically all cases the planer-type of milling machine should be motor-driven, in order that it may be located under a crane. It is not so very important, however, whether the motor is of the constant-speed or variable-speed type.

Punches, Bending Rolls, Shears, etc.

This class of machinery, used largely for boiler, bridge, structural iron and ship-building work, is generally placed in high shops and under cranes, and in locations and directions most convenient for the routing of the work. The shops in which it is placed are generally large and contain a relatively small amount of machinery, so that the amount of transmission gearing required is large in proportion to the amount of machinery. It is for this reason advisable in almost all cases to drive this class of machinery by an electric motor, which, of course, does not need to be of the variable-speed type.

* * *

ANOTHER USE FOR MOVING PICTURES

We have alluded to the importance of the moving picture industry and the educational value of pictures showing mechanical processes, methods of work, etc. The players of the game of war, who are so expert on paper and never miss a chance to utilize, in theory at least, every improvement in mechanics that can possibly be twisted to destructive purposes, have seized on moving pictures as a means of improving marksmanship. The system is quite an elaborate one and has been tried with more or less success in the British army and those of other nations of Europe. By this, men are enabled to engage in practice under conditions which nearly duplicate those of real warfare. For instance, scouts in the picture are seen to come from cover and advance, fire at intervals and return to cover just as flesh and blood sharpshooters would act. The screen which is acting as a target is quite near the real marksman, but the effect is the same as practised at 600 yards. The hits are registered automatically and at the end of his practice he is shown at a glance the record made.

BRITISH TRAVERSING-HEAD SHAPERS

By JAMES VOSE*

The British machines illustrated in Figs. 1 and 2 have been patented by John H. Storey & Co., Hatcham, London, and are built by the same company. In designing the machines, the idea has been to combine the admitted handiness of the American pillar-type machine with the rigidity of the work-carrying members of the traversing-head or generic British tool. To a considerable extent the tool illustrated embodies the features which render the "open-side" or "side" planer adapted to the machining of pieces of unwieldy and heavy character. The freely T-slotted extended base, front of machine, and table sides, allow great latitude in this respect, work being easily and securely clamped, while the reciprocating and traversing portions of the machine can be kept within a reasonable size, being at the same time of great strength.

The machine is similar to the pillar style of shaper in that the whole of the driving gear and link and return motion is enclosed in the body, is carried directly under the saddle, and traverses simultaneously. Many ordinary British machines display a tendency to twist the ram owing to the side connection of the link motion, etc. In the Storey tool this objection is obviated by the driving gear being placed under the ram, giving a central thrust and drive. The rocking arm is also enabled to be of considerable length. Shafts, spindles, etc., can be passed through the body for keywaying purposes, and the back gear is thrown in or out by an eccentric lever which is always clear of the belt at any angle. The feed can be started, stopped, or reversed, while running, and breakage due to over-running of the saddle or other excessive strain is prevented by a slipping device. The stroke of the ram is adjusted by a screw, liability to slip being eliminated, and the adjustment can be made with the machine either running or stopped. The stroke index plate is level with the ram where it can easily be seen when making adjustments. The traversing screws are fitted with graduated collars reading to 0.001 inch, the tool heads are fitted with worm and worm-wheel motion for internal curves, and a circular motion in front of the bed may also be fitted if desired.

The machines are highly geared with a view to efficient use of the latest high-speed steels. If desired, a gear box drive can be substituted for the cone and countershaft, or the machines may be motor-driven. The machines are made in

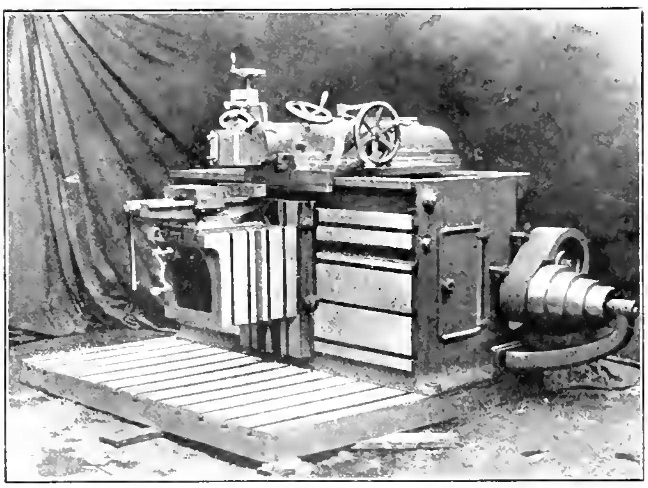

Fig. 1. Traversing-head Shaper of British Design

seven sizes from 8 to 36 inches stroke. The following details of the smallest and largest sizes of the machines will give a good idea of the capacity of the shapers generally. The 8- and 36- inch stroke machines have beds 4 and 14 feet long, respectively, the depths being 2 feet 9 inches and 4 feet. The tops of the tables are 10 x 15 and 30 x 48 inches, and the sizes of the extended bases are 4 x 2 feet and 14 feet x 4 feet 6 inches. The longitudinal traverse of the saddles is 2 feet and 10 feet. The widths of the ram bearings in the saddles are 7½ and 14 inches, and the lengths of the ram bearings are 18½ and 56 inches. The diameters of shafts which may be passed through the bodies of the 8-and 36-inch machines are 2 and 4½ inches, the number of speeds on the cone pulleys are 4 and 10, and the diameters and widths of the countershaft pulleys are 9 x 2¾ and 18 x 5 inches, the countershaft speeds being 200 and 350 in the respective machines. The horsepower required for the full duty the machines are capable of is 2½ and 20, and the weights of the machines—with fixed base and two tables—are 3,360 and 40,320 pounds, and the floor space needed 6 feet x 2 feet 6 inches and 20 x 12 feet.

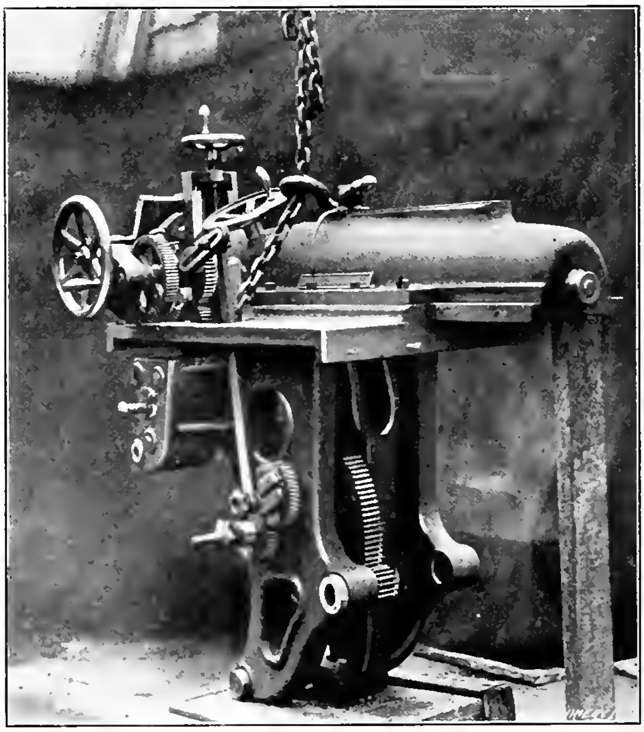

Fig. 2. Saddle, Ram and Driving Motion of British Traversing-head Shaper

It may be added that the machines are patented in various countries, and that, at the time of writing, the American and German patent rights are for disposal.

* Address: 328 Moss Lane East, Manchester, England—See biographical note in MACHINERY, August, 1907.

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CARBORUNDUM FOR ALUMINUM MOLDS

It is mentioned in the *Practical Engineer* (London) that carborundum on account of its remarkable thermal conductivity, has recently received an interesting application in the manufacture of molds for cooling aluminum so as to rapidly chill the cast metal. Aluminum becomes much denser when it is cast in a carborundum mold, because of this rapid cooling, and the metal surface becomes much finer. The molds, it is stated, are made in the following manner: fine carborundum powder is mixed with sugar and clay; to this mixture is then applied a sufficient amount of mortar to produce a plastic mass in which the desired mold is shaped. The mold is then baked and possesses the advantage of being permanent, lighter than metal molds and readily broken up, crushed and reduced to a fine powder, which can be used again for making new molds.

* * *

The *National Telephone Journal* gives an account of the number of telephones in the various European countries. From this it appears that on January 1, 1909, there were about 2,400,000 telephone apparatuses in use in Europe, more than one-third of which were in use in Germany. Sweden has more telephones in proportion to population than any other country in Europe, there being one telephone apparatus for each thirty-four inhabitants. Denmark, Norway, Switzerland and Germany come next on the list. It is not mentioned how many telephone apparatuses there are in the United States, but the number is estimated at about 2,000,000, which would be one apparatus for every forty or forty-five inhabitants. It is interesting to note that in Sweden, where, in proportion to the population, the telephone is most commonly used, public ownership of telephones and telegraphs is an established policy.

ACCURATE GAGE WORK IN THE BENCH LATHE

By A. L. MONRAD*

It was not very long ago that the making of a gage such as is illustrated at *A* in Fig. 1, by methods which would enable practically the exact duplication of any number, was not only very expensive but quite impracticable; but now with the improved tools and methods of the modern shop, skilled workmen can produce exceedingly accurate work, but not without care and perseverance. Three of these gages were required, one for manufacturing purposes, one for the inspector, and one as a master-gage. By the simplified method to be described, each of these gages can be finished ready for hardening with one setting on the master-plate, thus insuring great accuracy.

The old way of working to lines which have been laid out on the work, is fast being abolished, as accurate results cannot be obtained by this method. To work to the highest degree of excellence, each operation must be positively gaged so that it is certain when the work is finished that every step has been correctly performed. This article, which is a detailed description of the duplicate method of making the gages referred to, is intended not only for the inexperienced workman, but for the journeyman as well; therefore the writer has endeavored to start from the beginning and progress step by step so that each point will be absolutely clear.

Making the Master-plate

In order that the three gages be exact duplicates, it is first necessary to make a master-plate. The finished master-plate is shown at *C* in Fig. 1. This plate is made from tool steel, but is not hardened when finished. It can be rough turned in an engine lathe to within 0.020 inch and afterwards finished to the required size in a bench lathe. When the master-plate is ready for the bench lathe, the faceplate of the latter should be tested for accuracy by the use of a test indicator. After the master-plate is strapped to the lathe faceplate, one side should be faced off with a side tool *D*; the work is then reversed and the opposite face and outer half are machined. Both sides will then be perfectly parallel. The master-plate is now ready for the buttons which are used for locating it when boring the five holes shown. On a center line at right angles to the line *a—a*, the holes for the screws which are to hold the buttons in place are laid off to the required dimensions and drilled for a 1/8-inch tap. The depth of these holes should be about 1/4 inch. When the five holes are tapped so that the button retaining screws may be inserted in them, the center button is screwed in place and located in the center of the plate by using a depth gage. As all the buttons are hardened, ground and lapped on the outside to the same size, they may be set the correct distance apart by using as a gage

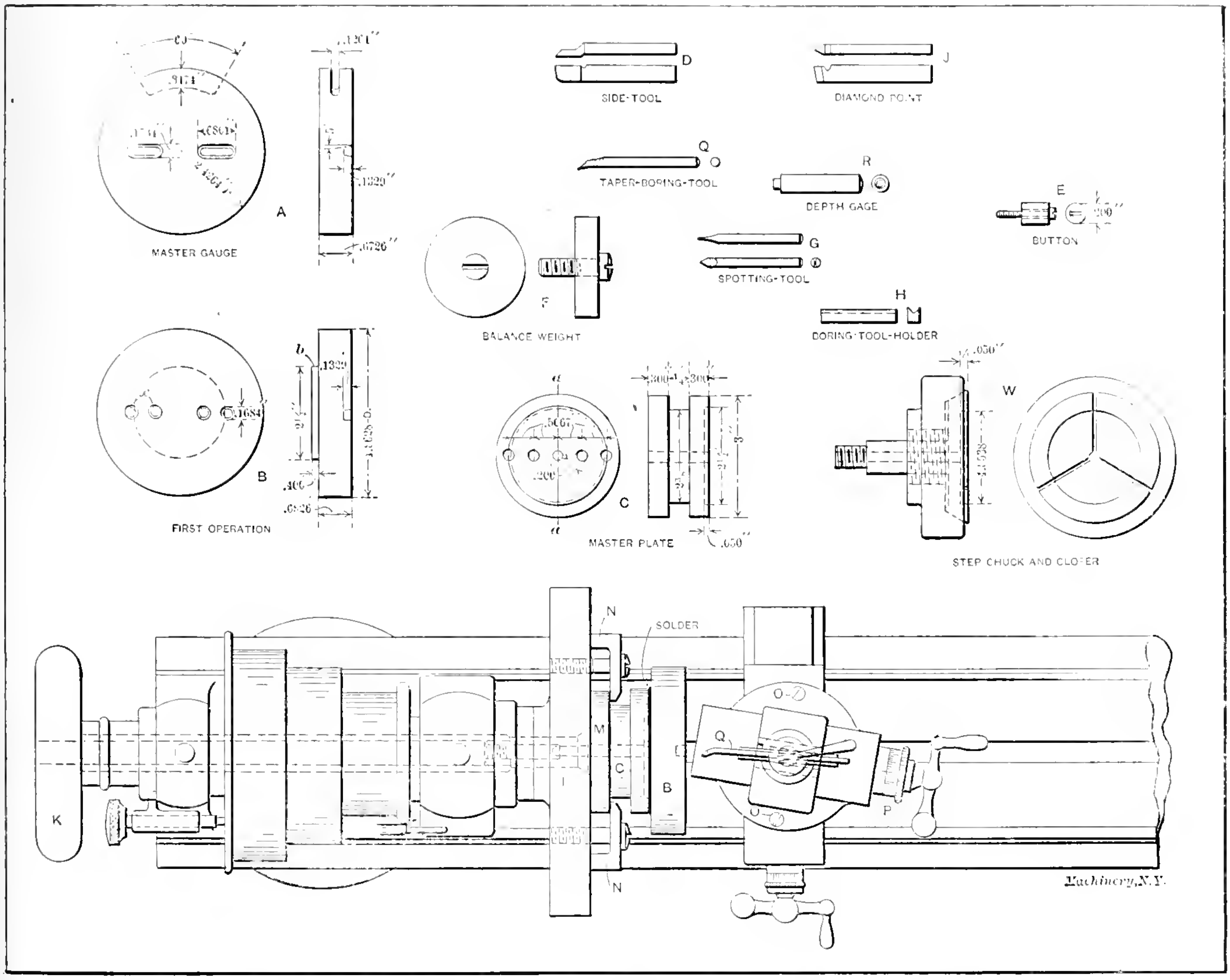

Fig. 1. Plan View of the Bench Lathe arranged for Boring the Tapered Holes in the Face of the Gage, and Miscellaneous Tools

a flat piece of steel having a thickness equal to the center-to-center distance minus the diameter of one button. The five buttons may be aligned by laying a straightedge across them.

The master-plate is now ready to be bored and reamed. After it is strapped to the faceplate, each of the holes is bored in its correct position by setting first one and then the other of the buttons true and then removing the button and boring the hole. The four outer holes should be bored first, the one in the center being machined last. Great care should be taken before boring a hole to set the button perfectly true. This is very important as the accuracy of the gages depends altogether on the accuracy of the master-plate. After a button has been set approximately true by the test indicator, balance weights *F*, which are made in different sizes, should be fastened to the faceplate to counterbalance the work which is, of course, offset with relation to the faceplate when boring the outer holes. This is essential because if the faceplate is not perfectly balanced, it will impair the accuracy of the hole

* Address: 58 Connecticut Boulevard, East Hartford, Conn.—See Biographical note in MACHINERY, September, 1901.

being bored. When testing the balance, the driving belt should be removed from the cone pulley. After a button is indicated, it is removed and a center is made by the use of a spotting tool *G*. A No. 15 drill, in this case, is fed through the master-plate after which the hole is bored out to 0.198 inch with a boring tool, which is followed by a 0.200-inch reamer, thus finishing the hole to the size indicated at *C*. In the same manner the other four holes are spotted, bored and reamed to the same size. After the central hole is finished, a recess 2.5 inches in diameter and 0.050 inch deep should be bored at the same setting of the work. A light cut should also be taken on the outer diameter with a diamond-point tool *J*.

Annealing the Gages

After the gages are roughed out in an engine lathe to within 0.020 inch, they should be annealed by being packed in charcoal in a cast iron box with a close-fitting cover luted with fire clay in order to exclude the air so that the gages will not change too much when they are hardened. The iron box should be placed in the furnace and given a very slow heat for about three hours, after which the heat is shut off and the box is left in the furnace over night. On removing the gages, they will be found very soft and easy to work.

First Operation in the Bench Lathe

The gages are now ready for the first operation in the bench lathe. First strap one of them to the faceplate with the boss *b* out, and face this end. Then machine the boss *b* to an accurate turning fit in the recess previously bored in the master-plate. The gage should then be removed and clamped to the master-plate with two C-clamps, so that the two may be soldered together. Before soldering all oil should be removed from the surfaces, which may be done by spraying a little benzine over them and afterward wiping it off with a piece of clean waste. When soldering the gage should be heated over a Bunsen burner until the solder will run freely. Plenty of solder should be used at the point indicated in the engraving. When the parts are cooled they will be securely attached to each other and the C-clamps can be removed.

The plug collet *I* is next placed in the lathe spindle and the handle *K* is tightened. A tool steel plug, *M*, tapered at one end, is then driven lightly into the collet. This plug is turned to 0.2003 inch in diameter or 0.0003 inch larger than the master-plate holes. Care should be taken to see that the shoulder on pin *M* is below the surface of the faceplate. The pin *M* is next polished with fine emery cloth until it is a turning fit in the holes in the master-plate. The latter is then fastened to the faceplate with four straps *N*, as shown in the engraving, the pin *M* being inserted in the central hole. If the spindle does not balance perfectly, a small weight should be attached to it. The gage is now faced to a thickness of 0.6826 inch and turned to a diameter of 4.8628 inch. The work is now removed and the faceplate cleaned thoroughly, after which the master-plate is again attached to the faceplate with the center plug *M* in any one of the four outer holes. The spotting tool is then used to cut a center for starting a No. 25 drill, which is sunk to a depth of 0.122 inch. The compound rest is then swung to an angle of 5 degrees, as shown, by the loosening of the screws *O*. When the point of the boring tool *Q* is in contact with the surface of the gage, the graduated sleeve *P* is set to zero and a taper hole is bored to a depth of 0.132 inch and to a diameter on the outside of 0.1684 inch. These dimensions can be obtained very accurately by using a tapered plug-gage *R* which is made with a clearance of about 0.005 inch for grinding. In the same manner, the three remaining holes which are to form the ends of the slots shown in the face of the gage at *A*, are bored. Care should be taken to balance the spindle each time the master-plate is shifted from one hole to another.

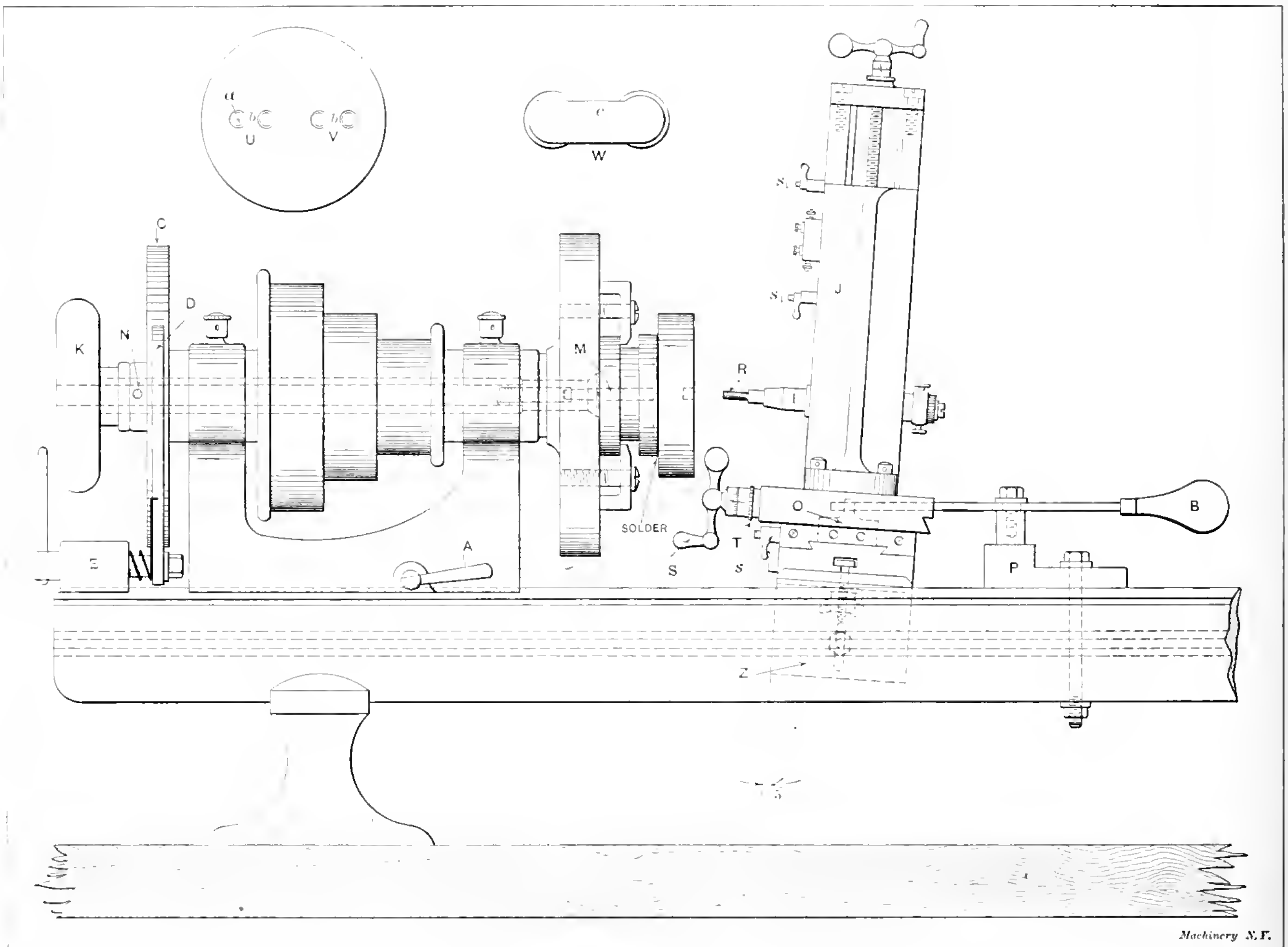

Fig. 2. Bench Lathe equipped with Indexing and Milling Attachments

Milling the Grooves

After the four tapered holes *U* and *V* (see Fig. 2) have been bored, as just described, the bridges *b* are milled away to form slots or grooves with tapering sides. The indexing attachment is first placed on the lathe headstock. The indexing plate *C* has 360 divisions. This is inserted by first removing the handle *K*. In order to make room for the block *E* with its indexing pawl *D*, the headstock is moved along the bed by

loosening handle A. Tapered plugs having outer ends which are parallel and of the same size should be placed in the two extreme holes in the gage. The master-plate (with gage still soldered to it) is then clamped to the faceplate with the plug M in the central hole. The pawl D should be inserted in the zero groove of the index-plate. An angle-iron Z is next fastened in the T-groove on the back of the lathe bed. On top of this angle-iron the milling attachment J is placed and adjusted so that the spindle will reach the two outer holes in the gage when it is moved to and fro by lever B, which is attached to stud O and fulcrumed on the stud of extension block P, which is fastened to the bed. To permit this movement of the slide by lever B, the cross-feed screw is removed. The plugs previously inserted in the end holes are now used to set the latter in a horizontal position or parallel with the movement of the cross-slide. This is done by inserting a test indicator away, the mill is fed downward until it just comes in contact with the bottom corner a of one of the holes. The movable stops s_1 on the vertical slide are now used to lock the mill against vertical movement. The mill is then fed across as before, machining the bottom of one slot as shown in the enlarged detail at W. The work is indexed 180 degrees and the milling operation described in the foregoing is repeated on the other pair of holes. Each slot would then appear as at W. In order that the sides c be cut away, the end mill is shifted so that it operates on the opposite side of the lathe center. The stops s on the horizontal slide are readjusted for this new position, the vertical stops remaining the same as before. After one side c has been milled, the work is again indexed 180 degrees and the milling operation is repeated.

The slots will now have tapering ends but straight sides.

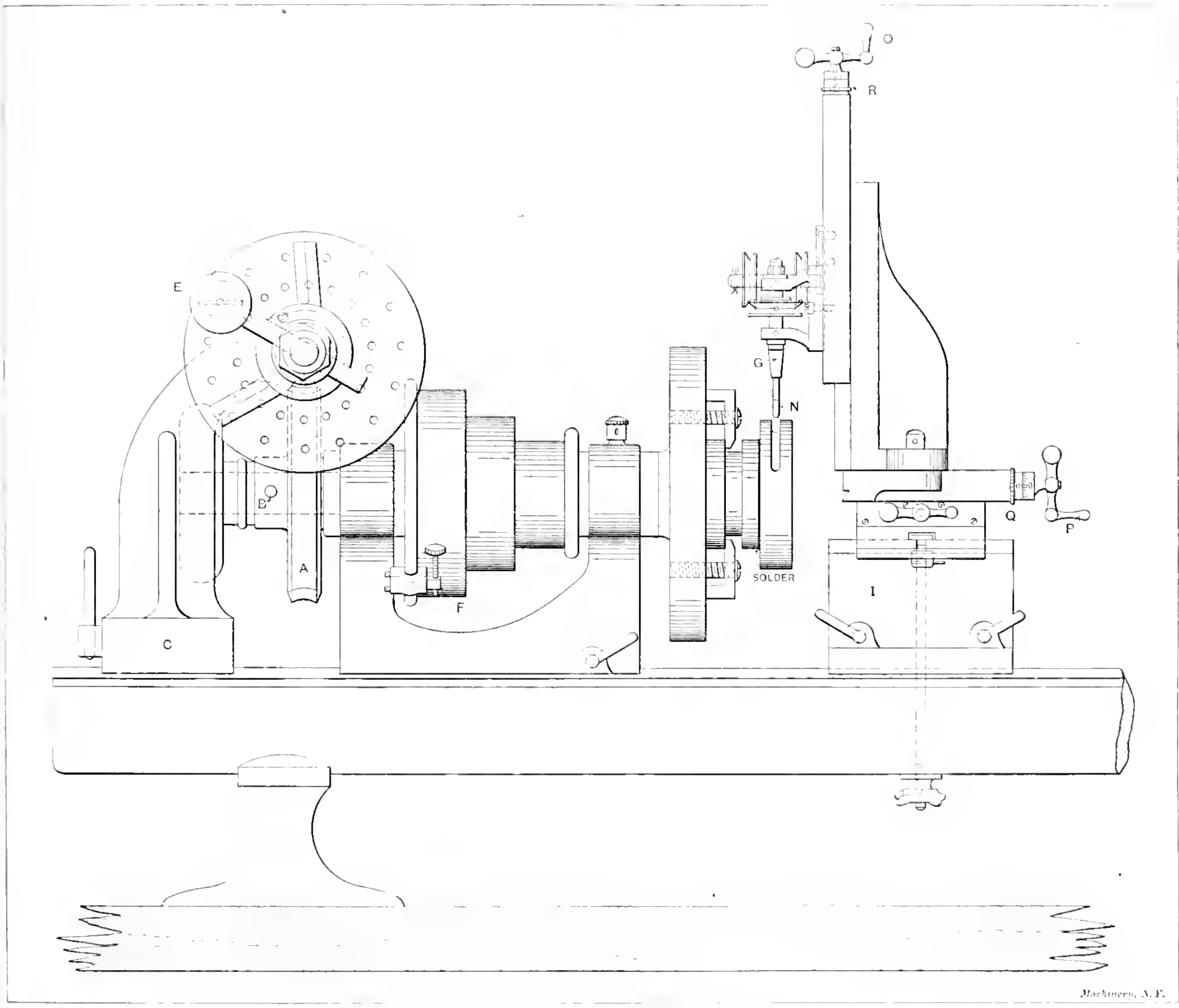

Fig. 3. The Lathe Set Up for a Vertical Milling Operation

in the spindle I of the attachment and moving the indicator across the plugs by lever B. When the indicator shows that each plug is exactly the same height, the screw X of the index-plate C should be tightened. The milling attachment should also be adjusted until the indicator shows that it is parallel with the face of the gage.

The end mill R, 0.150 inch in diameter, is now inserted in the spindle and the movable stops s on each side of a stationary stop on the horizontal slide, are set so that the mill has a horizontal movement, approximately equal to the center-to-center distance between the holes U. The mill is also set central vertically with these holes. The bridge b is then cut away by feeding the mill to and fro with lever B and inward by handle S. When the end of the mill is brought in contact with bridge b, before taking the first cut, the graduated sleeve T should be set to zero so that it may be used to determine the depth of the slot. After the bridge b has been cut

To mill the sides to a taper corresponding with that of the ends, the milling fixture is inclined to an angle of 5 degrees, as shown in Fig. 2. The end mill should then be replaced with an indicator, which is again used to test the parallelism of the face of the gage with the milling attachment. The sides of the slots can now be milled tapering in precisely the same manner as described for the end milling operation; that is, by milling one side, then indexing the work 180 degrees, and finally finishing the two remaining sides with the mill on the opposite side of the center. Very light cuts must be taken during this operation, and care should be exercised to leave a sharp corner on the side of each slot.

To Mill the Circular Groove

Before milling the circular groove in the periphery of the gage, a dividing head should be attached to the lathe as shown in Fig. 3. The index plate C, Fig. 2, is replaced with

a worm-wheel *A*. The worm meshing with this wheel should be set central by adjusting the bracket *C* along the lathe bed. An extension block *I* is also inserted beneath the milling attachment to raise it to the required height. The milling fixture is now used as a vertical miller by changing the position of the spindle as shown. An indicator is next placed in the spindle *G*, and with indexing handle *E* in the zero hole of the index-plate, the two slots which were previously milled in the face of the gage, are set parallel with the movement of the cross-slide by turning the lathe spindle; the screw *B* in the worm-wheel is then tightened. A male circular end mill 0.1164 inch in diameter is next inserted in the spindle. This mill must be set central with the sides and periphery of the gage. This can be done in the following manner: First lower the mill, which should be revolving; then turn handle *P* until a "listener" indicates that the cutter is barely in contact with the side of the work. Graduated sleeve *Q* should then be set to zero, after which the mill is raised and moved inward a distance equal to one-half the width of the gage plus one-half the diameter of the end mill. The latter is now central with the sides of the gage. By the same method, it may also be set central with the periphery. The work is now indexed 30 degrees, which will require with this particular dividing head, 15 turns of the indexing crank. A stop *F*, one of which is attached to the flange of the cone pulley on each side of the headstock, is then set against its striking point on the headstock. The work is then indexed 60 degrees or 30 turns in the opposite direction, after which the stop *F* on the opposite side is adjusted as before. These stops, in each case, should be so set that the indexing pin will just enter the zero hole of the dividing plate. Everything is now ready for milling the circular groove which, as shown in Fig. 1, has a length of 60 degrees. Prior to the milling operation, however, a hole 0.335 inch deep as indicated by the sleeve graduations, should be drilled at each end of the slot with a No. 35 drill. These holes will provide a clearance space for the end mill. A square end mill of 0.110 inch in diameter is then used to rough out the groove to a depth of about 0.295 inch. The male circular end mill is then employed for finishing the groove to the required depth. The work is fed by turning the indexing crank, and the stops *F* act as a positive gage, thus insuring that the slot will be the required length. The milling operation is now completed. After the attachments have been removed and the lathe arranged for turning, the gage should be removed from the master-plate by cutting away the solder with a side tool. One gage is now complete and ready for hardening. By the use of this same master-plate, obviously, the other two gages may be made precisely in the same manner as described in the foregoing.

Hardening the Gages

To avoid cracking or distorting the gages during the hardening operation, they are pack-hardened with ground charcoal in separate iron boxes. Each gage is laid in a basket made of 1/16-inch soft wire and wired together with a loop on one end, which is to serve as a grip for the tongs. The cover of the box is luted with fire clay to exclude the air while taking the heat. A hole should be drilled in one side of the cover for a 3/16-inch soft rod. This rod, which is to be used for gaging the heat, should extend to the opposite side of the iron box. After the latter has been exposed to a slow and comparatively low heat for about three hours, the rod is removed and if it shows that the gage has been heated sufficiently, the latter is removed and plunged into a sperm oil bath until it is perfectly cold. It is then heated a little to relieve any external strains which may have been set up, after which it should be laid on a piece of wood and allowed to cool slowly. It should not be left on a cold iron surface as the rapid change of temperature will cause excessive strains which will either crack the gage or warp it out of shape. After the gage is cooled sufficiently to permit handling, it should be polished so that the temper can be drawn. This may be done by the use of a Bunsen burner. To prevent the gage from coming into direct contact with the flame, it should be placed on a 5/16-inch steel plate and heated by contact with the plate. When drawing the temper, the gage should be turned over frequently so that it may be drawn evenly all over to a light straw color. It should then be allowed to cool naturally, wrapped in a piece of waste.

Grinding the Gages

The grinding operations are performed in practically the same way as the milling or turning, the only difference being that a wheel is used instead of a tool or cutter. The gage is, of course, mounted on the master-plate as before. Great care must be exercised before soldering the gage to the plate, that it be located in the proper position relative to the holes in the master-plate. This may be done as follows: First clamp the master-plate and gage together, with two C-clamps, then place a close-fitting plug in each of the two extreme holes in the master-plate. These plugs, which should extend about one inch beyond the surface of the plate, are next placed on the top surface of a parallel block which should be high enough to clear the diameter of the gage. This block should be mounted on an accurate surface plate so that a test indicator may be used to set both grooves in the face of the gage parallel with the plugs in the master-plate. After the grooves have been tested on one side, the master-plate should be turned over, so that the opposite sides of the plugs rest on the parallel block. If the indicator then shows the same reading as before, the gage may be soldered to the plate. The latter is then mounted on the faceplate of the lathe with the plug *M* (Fig. 1) in the central hole, and the gage is indicated on its face and periphery. If it runs out more than 0.004 inch it should be reset. If, however, the error is small enough to permit truing, rough grind the face and periphery leaving about 0.001 or 0.002 inch for finishing after the grooves are ground. This precaution must be taken to insure accuracy as hardened steel changes during a grinding operation after the outer scale is removed. In grinding the ends of the grooves, a diamond lap 0.075 inch in diameter is used. The end of this lap is charged as well as the body. When the ends are being ground, the slide-rest is set to an angle of 5 degrees and the procedure is practically the same as when the ends of the slots were bored; 0.0002 inch should be left for hand lapping. The diamond lap should run at the fastest speed obtainable and the work should revolve at the slowest. To grind the sides of the grooves, the same diamond lap is used and the machine is set up as shown in Fig. 2. A circular end diamond lap 0.115 inch in diameter is used for grinding the circular groove, and the machine is equipped with the same attachments as are illustrated in Fig. 3.

After the periphery and one side of the gage have been finished, the side next to the master-plate still remains to be ground. A step chuck and closer *W* (Fig. 1) is placed in the headstock spindle and three small pieces of sheet steel of the same thickness as the slots in the chuck are placed in each slot. The chuck is then tightened by means of the handle *K*, after which a recess about 0.050 inch deep and large enough in diameter to be a snug fit for the gage, is bored. The chuck is then loosened and the sheet steel pieces removed. The ground face of the work is next inserted in this recess, which should be very carefully cleaned, and the chuck is tightened. Care should also be taken to have the inner face of the gage against the chuck. If the work when tested on the periphery runs true, it may then be finished, first by using a coarse carborundum wheel and afterwards a No. 120 emery wheel; 0.0002 inch should again be allowed for lapping.

When the three gages have been ground as described in the foregoing, the faces should be lapped by rubbing them on an accurate surface plate, using a very little fine emery with plenty of benzine. A smooth and bright finish may be obtained by using a dry and clean plate. In this way, each gage is brought to the exact measurements required. The grooves are draw-lapped with a flat copper stick, powdered emery and sperm oil being used. For a final finish on very accurate work, the copper lap should be followed by one made of boxwood, the abrasive being white powdered oilstone.

* * *

A German company has been formed for making Wright aeroplanes. The capital is 500,000 marks ($119,000). The principal stockholders in the company are leading German firms, including the Krupp Co., the Borsig Locomotive Works, Ludwig Loewe & Co., and the General Electric Co. of Germany.

MAKING THE DeVILBISS PLIERS—1

By ETHAN VIALL*

A shop making one or more small specialties in quantities is always interesting because of the individual problems in tools and jig work that must of necessity be worked out if the output is to be produced at a profit. The cost of the tools and jigs increases, of course, with the complexity of the article or articles and consequent increased number of parts. Many comparatively simple looking manufactured articles are, in reality, very difficult to produce and a small fortune has been spent on them before a single one was put on the market. The cost of tools and the time taken to develop and make them, has proved the downfall of many manufacturers of really first-class articles that were ready sellers. A bunch of orders on hand with no means of filling, is worse than no orders, and if they are filled with articles made in any old way, it is still worse, if that be possible.

If the manager of a firm is wise, and has a fair amount of money back of him and confidence in the factory product, he will look to his tool and jig equipment and see that it is well along, before he begins to do any amount of advertising, so that he will be in a position to handle large orders with promptness before he really begins to push the selling end in earnest. However, the ideal conditions are not always obtainable and a manager often has to make the best of the conditions binding him. Few indeed are so fortunate as the general manager of the DeVilbiss Plier Co., Dundee, Mich., who has in the company with him, men of wide business and mechanical experience who thoroughly understand the principles of business success; these men know a good thing when they see it and have the money to back their opinions. It is, therefore, with unusual gratification that we are enabled through the courtesy of the manager, Allen DeVilbiss, Jr., and factory manager, W. F. Gradolph, to give in detail, each step in the manufacture of their pressed steel, cam-motion, parallel-jaw pliers, and to show every tool and jig used.


Fig. 1. Plant of the DeVilbiss Plier Co

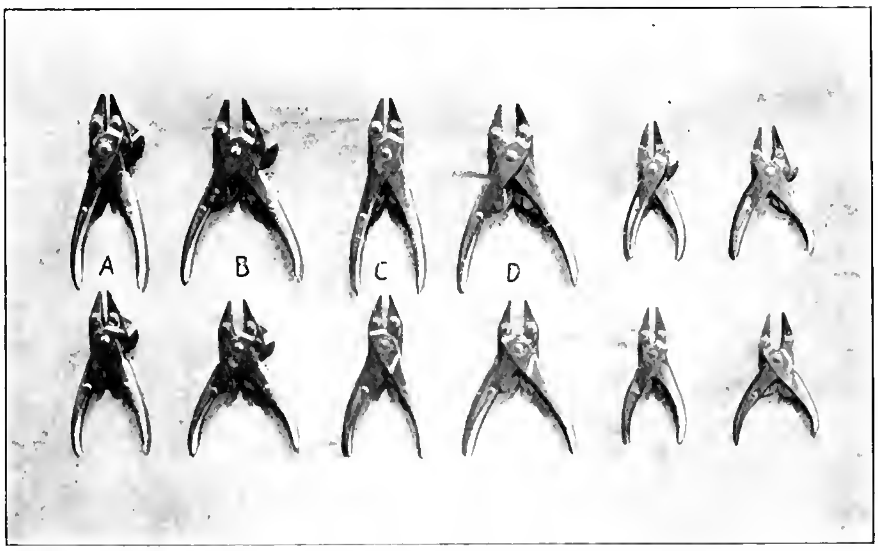

Fig. 2. Product of the DeVilbiss Plier Co

The factory building, Fig. 1, is two stories high, light and roomy and of concrete construction, having a main floor of heavy concrete, which makes an ideal floor for punch press work. This is the largest factory devoted exclusively to the making of pressed steel pliers in the country. The toolroom, Fig. 3, while not imposing, is unusually well equipped and amply large for the work required. All special tools, jigs, punches and dies, are kept in a big concrete vault, although the building itself is practically fire proof.

In order to give the reader a clear idea, from the beginning, of the kind of pliers manufactured, a number of sizes and styles are shown in Fig. 2. *A* is a parallel jaw, cam motion cutting plier; *B* is the same but with a spring inserted to keep the jaws open; *C* is another parallel-jaw, cam motion plier; *D* is the same with a self-opening spring, while the others are simply different sizes of similar types.

Taking up now the various parts that are used in these pliers, a list of which follows, we will give the order in which the various operations are performed on each one and then show the tools and jigs used in rotation.

Parts of DeVilbiss Plier

1. Handles, drawing steel. 2. Jaws (cutting), drawing steel. 3. Jaws (plain), drawing steel. 4. Cams, cold rolled steel. 5. Cutter blades (moving), tool steel. 6. Cutter blades (fixed jaw), tool steel. 7. Links, cold rolled steel. 8. Screws, rivets and springs.

In the above list, handles are divided into outside, inside and spring handles, the last named having a tongue in them for the end of a coiled spring.

Operations on the Handles

The order of the shop operations through which the handles go, is as follows:

1. Blanking. 2. Serrating. 3. Bending and stamping name. 4. Rough shaping. 5. Straightening or finish shaping. 6. Drilling. 7. Hand reaming on three-spindle drill. 8. Burring inside on 1/8-inch emery wheel. 9. Countersinking to remove burrs. 10. Tumbling. 11. Reaming on three-spindle drill. 12. Assembling.

Both the inside and outside handles pass through the same operations, except that the latter are offset between the third and fourth operations. Fig. 4 will make plain the first six operations on the inside handles, and the first seven operations on the outside handles. *A* is the blank; *B* is the serrated blank; at *C* the blank has been bent and the name stamped on it; at *D* it has been rough shaped; at *E* it has been straightened, and at *F* it has been drilled. Going back now to *C*, we follow it down to step *G*, which shows a blank with an outside offset; *H*, the outside rough shaped; *I* the outside straightened; and *J* the outside drilled. *K* shows an outside handle tongued at *T* for a spring, which is done simultaneously with the straightening operation on those intended for spring pliers.

A, Fig. 5, shows the blanking punch used, and *B* the die and stripper plate, which are of the usual form. *C* is a

* Associate Editor of MACHINERY.

blank like *A* in Fig. 4. After blanking, the handles are placed in the sub-press base *D*, and serrated with the punch *E*, producing the result shown at *F*. The top and bottom of this serrating sub-press are made of steel, for as the work is done in a board drop-hammer, cast iron would not stand the jar and strain. The hammer used has been changed so that nearly double the blow for which it was intended can be delivered, as a very powerful blow must be struck to make satisfactory serrations in this way.

The serrated blanks are next bent and the name stamped on them in the formers *A* and *B*, Fig. 6, the name of the firm being stamped on both forks of the blank by plug stencils *C*, inserted in the die. These stencils may be easily removed when damaged or worn, and replaced by new ones. The object of the bending is, of course, to give the blank the proper curve for the subsequent shaping. *E* and *F* are the punch and die used to offset the outside handle, as at *G*. The rough shaping is done with the forming punch and die *A* and *B*, Fig. 7, both inside and outside handles being shaped in the same die, though in shaping the inside handles the blocks *C* are set in. The straightening dies, *D* and *E*, are made on the ordinary "squeeze die" principle and in this case all the squeezing is done just back of the fork of the handle by the sliding blocks *F*, which are shoved in by the bevels *G* on part *E*. The punch *H* presses the handle down onto the form, coming into contact with the handle where the fork begins, just as the sliding blocks press in the sides.

Drilling the holes in the handles is done in the jig Fig. 8, which has a removable center block, the handle being locked in by an eccentric. These holes are next hand reamed in a three-spindle drill press, as shown in Fig. 9, each spindle holding a reamer for its respective hole. The burrs are now ground off on the inside with a 1/8-inch emery wheel, which will not be illustrated as practically the same operation will be shown on the jaws later. The outside burrs are removed by countersinking as in Fig. 10, after which the parts are tumbled for an hour in a mixture of sawdust, sal soda and water; then, merely as a precautionary measure, they are again hand reamed exactly as previously shown in Fig. 9, when they are stored ready for assembling.

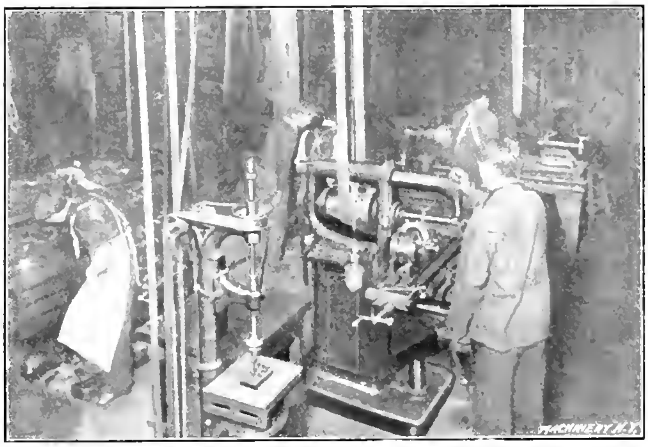

Fig. 3 General View of the Toolroom

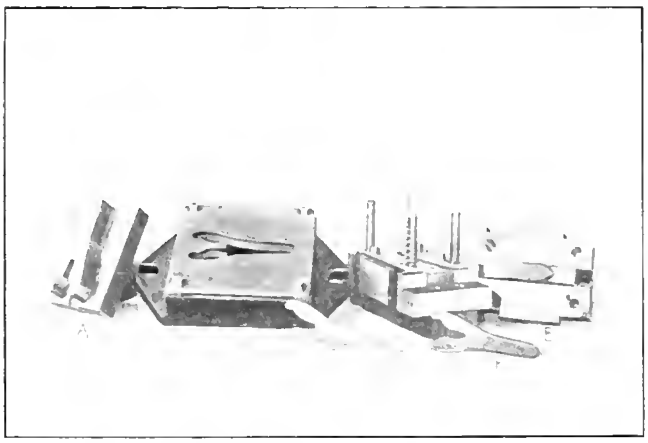

Fig. 5 Handle Blanking and Serrating Punch and Die

Jaw Operations

The shop operations on both the cutting and plain jaws are similar, but for convenience in describing the tools, the list will be arranged as follows:

Cutting Jaws	Plain Jaws
1. Blanking.	1. Blanking.
2. Slotting.	2. Slotting and piercing.
3. Forming.	3. Forming.
4. Annealing.	4. Annealing.
5. Flattening and serrating.	5. Flattening and serrating.
6. Removing burrs and squaring sides.	6. Removing burrs and squaring sides.
7. Drilling.	7. Drilling.
8. Removing outside burr on disk grinder.	8. Removing outside burr on disk grinder.
9. Countersinking cam holes.	9. Countersinking cam holes.
10. Cutting off ends in milling machine.	10. Cutting off ends in milling machine.
11. Reaming in three-spindle drill press.	11. Milling wire slot.
12. Carbonizing.	12. Reaming.
13. Removing inside burr on 1/8-inch emery wheel.	13. Carbonizing.
14. Rough polishing.	14. Removing inside burr on 1/8-inch emery wheel.
15. Drawing to a blue color.	15. Rough polishing.
16. Finish polishing.	16. Nicking outside of jaw fork for a stop.
17. Assembling.	17. Drawing to a blue color.
	18. Finish polishing.
	19. Assembling.

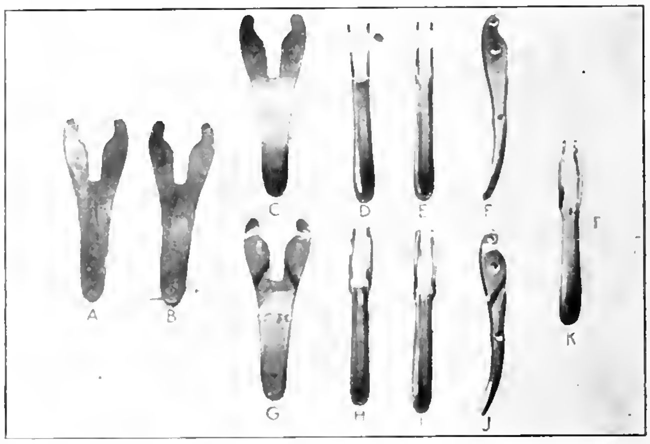

Fig. 4 Steps in the Evolution of both Inside and Outside Plier Handles

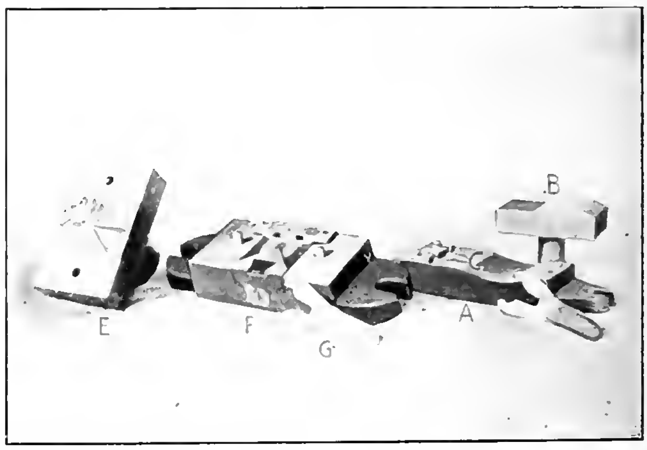

Fig. 6 Punch and Die for Bending, Name Stamping and Offsetting Handles

Most of the operations are graphically represented in Fig. 11, the upper row showing the steps in the evolution of the cutting jaws and the lower row those of the plain jaws; *A* is the blank, which at *B*, upper row, is slotted—lower row, slotted and pierced; at *C*, formed; at *D*, annealed; at *E*, flattened and serrated; at *F*, sides ground; at *G*, drilled; and at *H*, carbonized. While a few of the steps have been omitted in this illustration, they will be shown in detail when describing the tools and jigs for them.

A, Fig. 12, shows the blanking punch; *B*, the die; *C*, the slotting die, and *D*, the slotting punch used for cutting the jaws, while the same letters in Fig. 13 represent corresponding tools for the plain jaws.

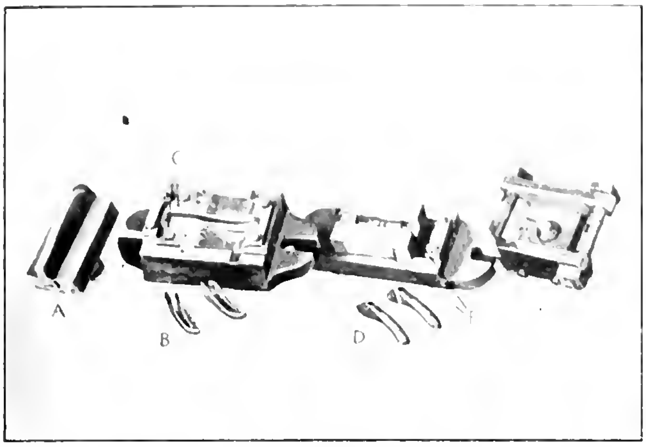

Fig 7 Handle Shaping and Straightening Punches and Dies

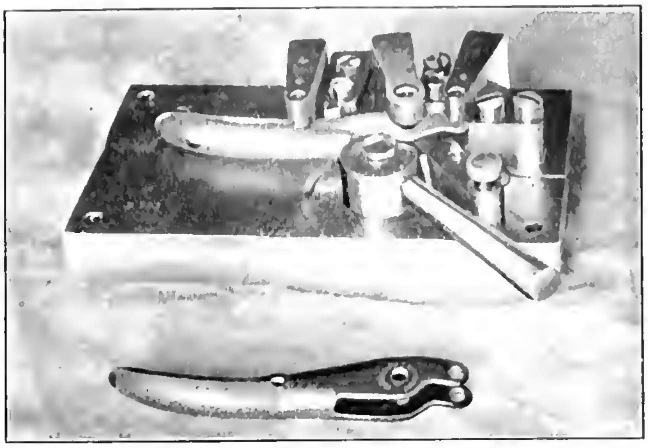
Fig 8 Jig for Drilling the Handles

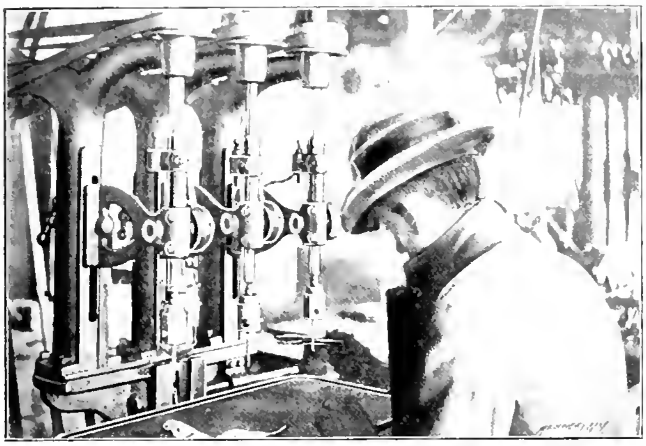
Fig 9. Hand Reaming the Handles in a Three-spindle Drill Press

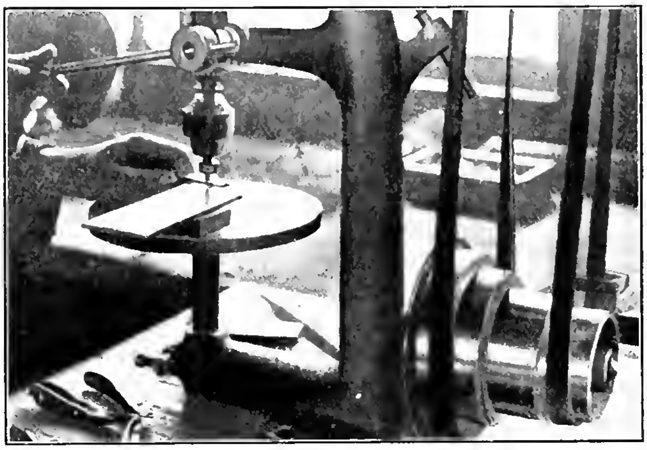
Fig. 10 Removing Outside Burrs with a Countersink

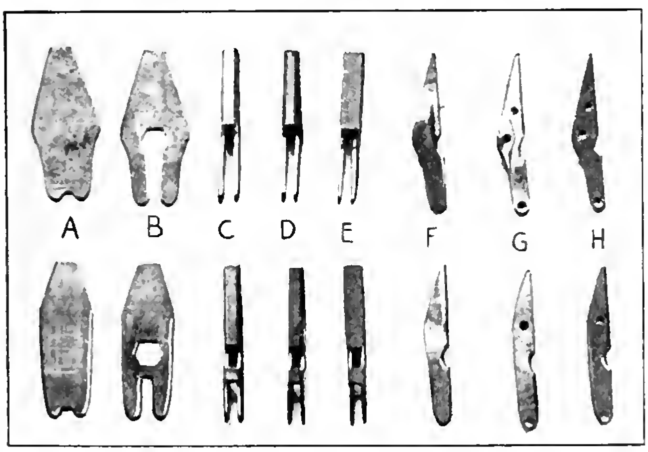

Fig 11 Steps in the Evolution of the Cutting and Plain Jaws

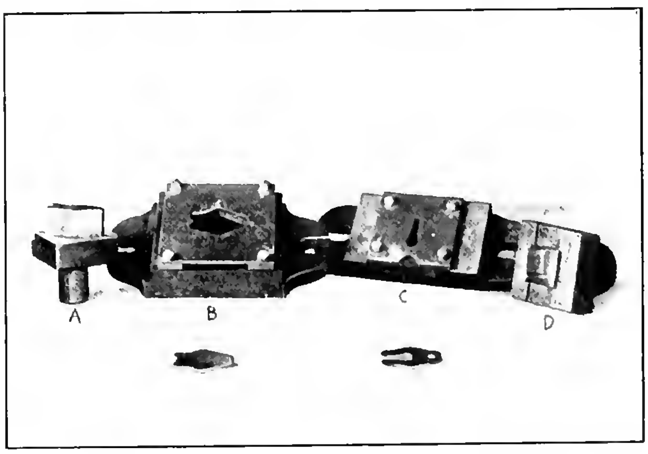

Fig 12 Blanking and Slotting Punches and Dies for the Cutting Jaws

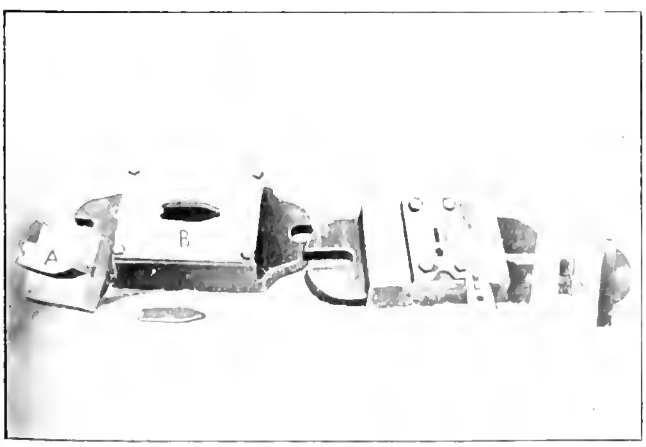

Fig 13 Blanking, Slotting and Piercing Punches and Dies for the Plain Jaws

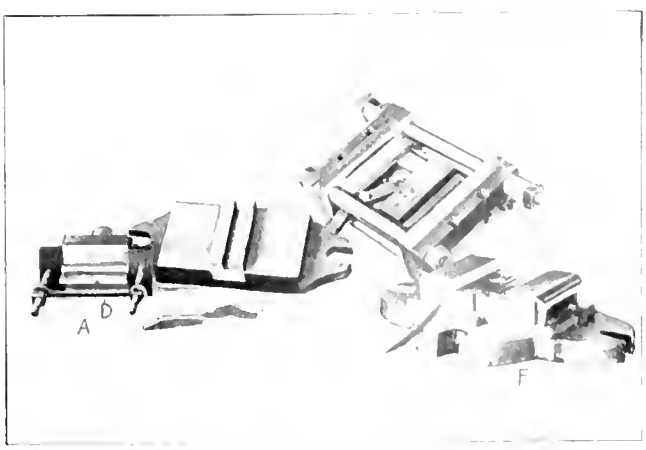

Fig 14 Jaw Forming Punch and Die and Serrating Tools

The forming is done with the punch and die, *A* and *B*, Fig. 14, both styles of jaws being formed in the same die, as the locating blocks are so made as to only come in contact with parts of the jaws that are alike in both cases. The action of the "knockout" bar *D*, is interesting, as many an elaborate stripping scheme is less efficient. When the forming punch is set, this bar is at rest in the die slot slightly below the surface of the die, which allows the flat jaw blank to be located properly. As the punch descends, the bar strikes the bottom of the die slot and since it fits loosely on the punch studs, the punch can descend the full stroke without damage or making it necessary to have a very deep slot in the die. As the punch rises, the studs slip through the holes in the bar until the nuts are reached, when the bar rises, carrying the formed jaw with it. At *E* and *F* are shown the serrating tools, but as this is one of the most interesting and important operations, the tools are shown on a larger scale in Fig. 15. Between the forming and serrating operations, the jaws are annealed by heating to a dull red and allowing them to cool slowly, as indicated in the table of operations.

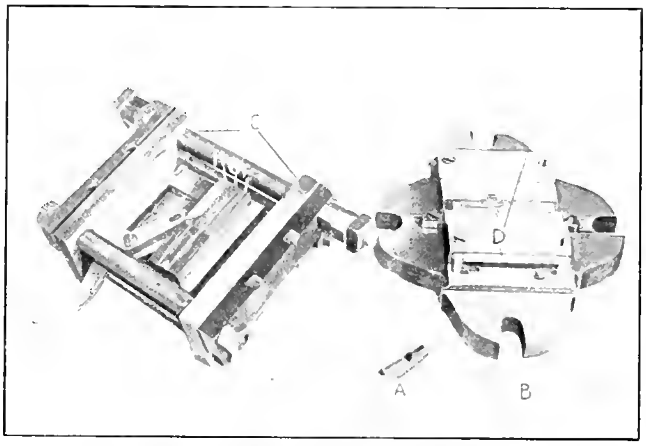

Fig. 15. Combination Punch and Die for Flattening and Serrating the Plier Jaws

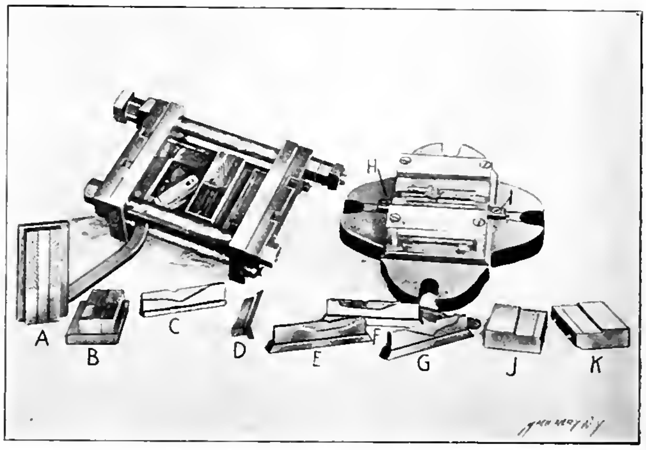

Fig. 16. Another View of Serrating Punch and Die with Attachments

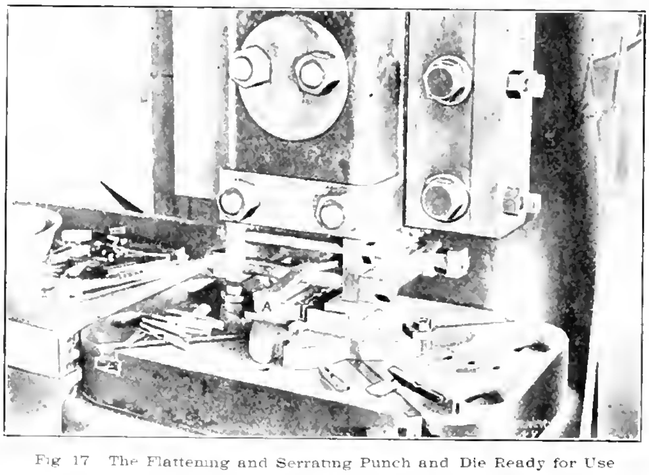

Fig. 17 The Flattening and Serrating Punch and Die Ready for Use

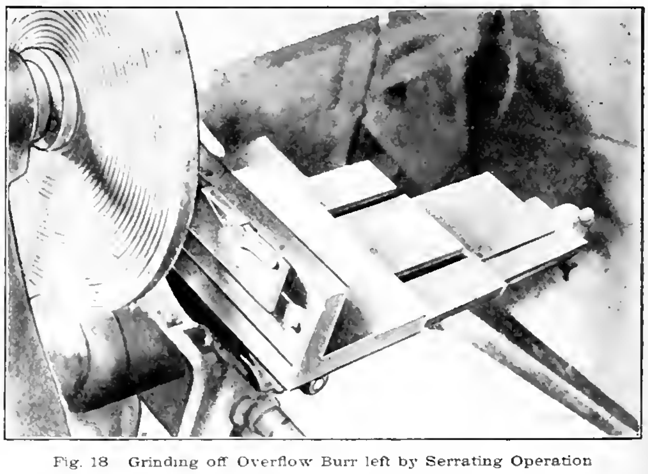
Fig. 18 Grinding off Overflow Burr left by Serrating Operation

Serrating the Jaws

The flattening and serrating of the jaw face, is done at one setting but with three strokes of the press, a formed jaw blank like *A* being held in the "squeeze" or clamping die *B*, the clamping slides of which are operated by the beveled parts *C* of the punch coming in contact with the rollers *D* which, in turn, press against the slides. In using this serrating punch, the face of the jaw is first flattened by the blank punch *E*; the lever *F* is then shifted over and the blank creased one way with the punch *G*; the lever is then pushed over as far as it will go, which on the stroke of the press, creases the jaw in the opposite direction, finishing the serrations.

The punch just referred to is the first one of this type made. It has the flattening punch at one side, but in the later ones the blank is put in between the serrating punches as at *A* and *B*, Fig. 16, which makes the handling of the shift lever much simpler, as the first stroke can be taken with the lever in a central position and then for the other two strokes it is shifted alternately to the left and right as far as the stop will let it go. At *C*, *D*, *E*, *F*, and *G* are shown forms for locating the different sizes of jaws in the die, which are made to fit a slot in the bed-plate and are held in by the two clamps, *H* and *I*. A pair of the sliding clamp blocks is shown at *J* and *K*, the releasing springs being shown projecting from the inner edges.

Fig. 17 shows the serrating punch and die set up in a punch press ready for use. Like the punch and die used in the drop hammer, this tool is made entirely of steel for the reason that cast iron is too weak. The credit for developing this tool is due to Mr. W. F. Gradolph, and the design is fully protected, but it thoroughly solves a problem that is far more difficult than it looks at first.

Finishing the Jaws on a Disk Grinder

The serrating operation just described, naturally leaves an overhanging burr on the sides of the jaw which is removed by grinding on a Besly disk grinder fitted as shown in Fig. 18. As there is considerable burr to be removed in order to properly square the sides of the jaw, a coarse grade of emery must be used on the disk to get quick results, but though coarse emery cuts fast it has a tendency to "shell off" in a case of this kind which, if not remedied in some way, necessitates frequent changes of the disk facing which is costly both in time and money; so in order to remove the burr quickly and at the same time avoid the shelling effect, a disk of number 16 emery is taken, coated with glue and number 40 emery put on which fills in and supports the coarser grains, at the same time allowing them to cut with practically the same freedom as at first.

Originally the jaws were so held in the die as to prevent the "overflow" but it was soon found that when flattened and serrated in that way they had a tendency to develop cracks along the edges which are entirely avoided by the present method.

Drilling, Milling and Reaming the Jaws

The drilling of both types of jaws for any one size is done in the same jig, two holes being drilled in the plain and three

in the cutting jaw. The style of drilling jig used for this work is shown in Fig. 19, and it will be noted that the locating of the jaw is done from the serrated face and the rounded ends, the movable or clamping slide coming in contact with the untrimmed end. After drilling, the burr left on the outside of the jaw around the holes is removed by holding it for an

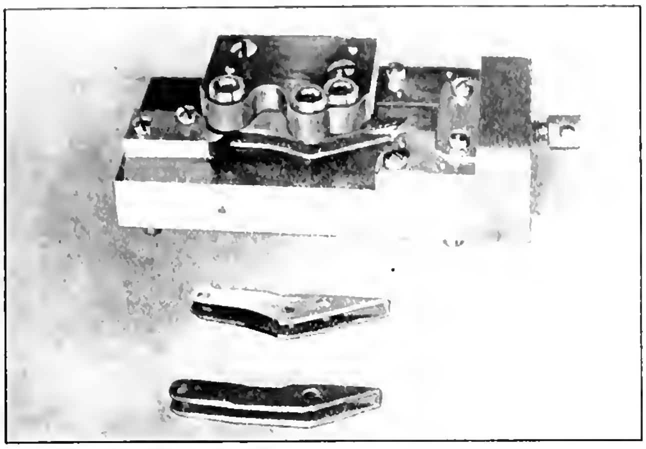

Fig. 19. Drilling Jig for the Jaws

instant against a disk grinder. Next the cam rivet holes are countersunk in a drill press, with a drill and the block *A*, Fig. 20. The outer ends of the jaws are now trimmed to exact length with a small side mill *B*, while they are held in the jig blocks *C* and *D* which are held in the milling machine

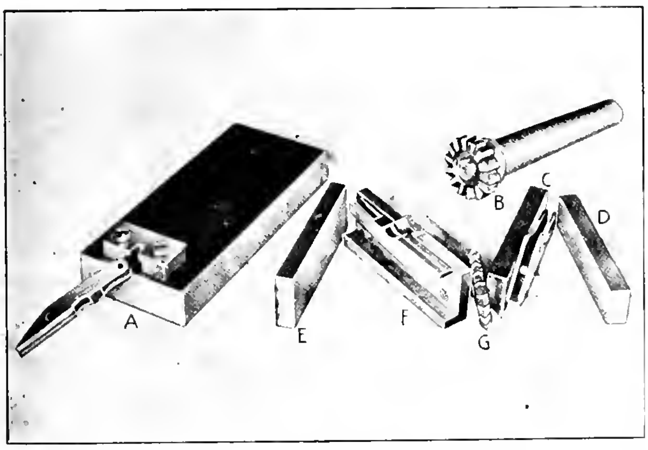

Fig. 20. Countersinking and Milling Jig and Tools

vise. The jaws are located in the block by two pins, one of which goes through the forward hole, the other supporting the cam end of the jaw. As in most of the other jigs, both styles of jaws are machined in the same jig.

Wire slots are milled only in the plain jaws, using the jig

Fig. 21. View showing Method of Bunching Jaws for Carbonizing

blocks *E* and *F* in the vise, and the cutter *G*. The idea of milling a wire slot in only one jaw is that the serrations on the jaw opposite the slot will hold the wire better than two V-slots.

The holes in the jaws are reamed out on a three-spindle drill press, in the same way as were the handles; the jaws are then strung on two stiff wires as at *A*, Fig. 21, packed with bone in boxes like *B*, placed in the furnace shown and carbonized. After being heated the proper length of time, the boxes are drawn out one at a time, the lid removed and the clusters of jaws lifted out with wire hooks *C* and plunged into water. When dried, the inside burrs are removed with a 1/8-inch emery wheel, as in Fig. 22. The plan of leaving the removal of the inside burrs until after the jaws have been hardened, is a good one, as a wiry edge is not turned into the hole as would be the case if ground when soft.

The plain jaws are then "nicked" to a uniform depth on the back edges as at *A*, Fig. 23, where they come in contact with the handles, to make sure that the jaws will all open the same distance. This is done by setting the jaws on the fixtures and swinging them around the pin *B*, against the emery wheel.

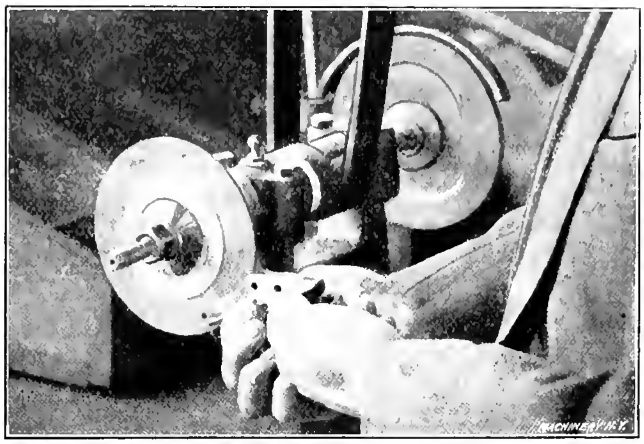

Fig 22. Removing the Inside Burrs from Jaws after they are hardened

All jaws are now rough polished, drawn to a blue color in an oil bath, then finish polished and sent to the assemblers.

* * *

THE VALUE OF BOOK STUDY

An interesting illustration of the value of book study is related by a New Jersey business man who recently advertised

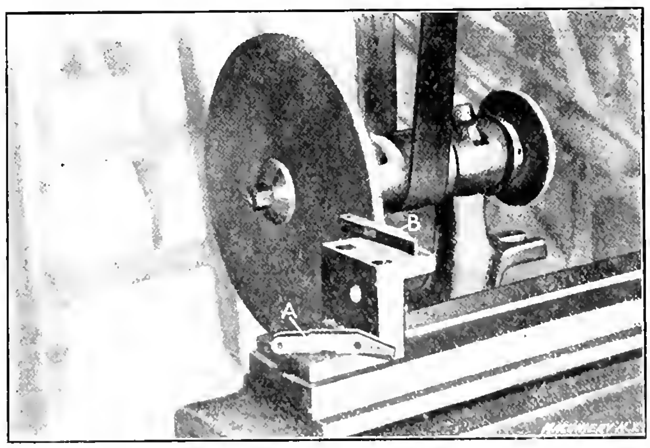

Fig. 23 Grinding a Stop on the Back of a Plain Jaw

for a chauffeur. One of the applicants was a well-educated man who had been conducting a "Queries and Answers" column in a motor journal. He was well-informed on the literature of automobiles, well-versed in thermodynamics, and familiar with the various text-books, trade catalogues, etc. Especially was he thoroughly conversant with all the intricacies and difficulties of the power plant of an automobile. He had, however, never run a machine, and wanted the experience. So he was engaged for a trial on the strength of his general knowledge, and a few days' practice was sufficient to make him a good driver; in fact he was often consulted as an expert in engine troubles. As one of our correspondents says, this goes to confirm the contention that book learning helps a man out, and a correspondence school's course is not entirely useless even in automobiling.

EXAMPLES OF BOX-TOOL DESIGN

By F. P. CROSBY*

A number of box-tools of different designs, with examples of the work for which each is intended, are shown in the accompanying engravings. While these tools are designed for some specific part, they can, of course, with slight modifications be adapted to other work; therefore a study of the different tools illustrated, will doubtless be of suggestive value to those engaged in the construction of box-tools for turret lathes and automatic screw machines. In all of the engravings the reference letters in the assembled and detailed views are the same for the corresponding parts.

A box-tool of the pilot type that is used to finish work after the surplus stock has been removed by roughing tools, is shown in Fig. 1. The work itself is indicated at *A* by the dotted lines, which represent a cone for a ball bearing. The pilot *B* enters the work before either of the cutters begins to operate on its respective surface. This pilot should be tempered and ground true. The inverted cutter *C* which sizes the flange of the cone, is held in position by a clamp *D*, which is forced down by a collar-head screw; and it is further

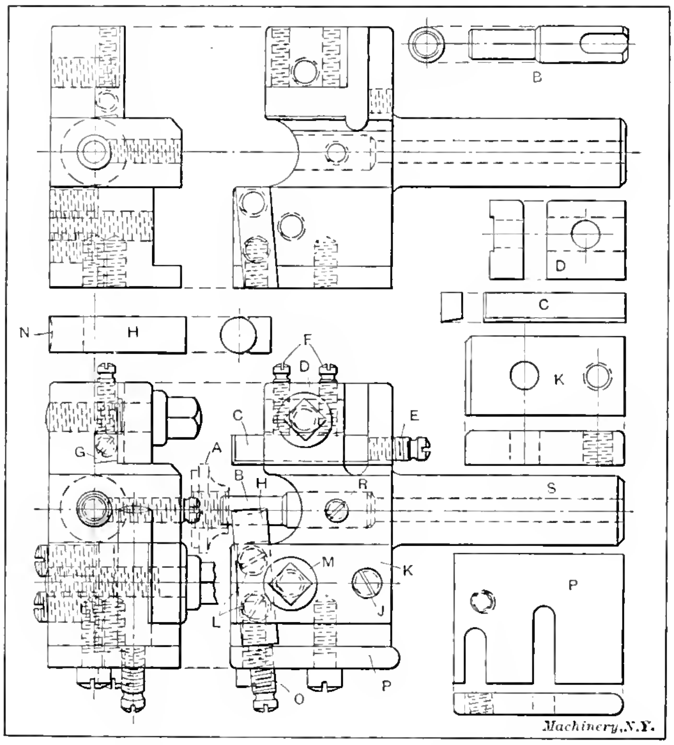

Fig 1. Finishing Box-tool for Ball Bearing Cone

secured against a beveled shoulder at *G* by the set-screws *F*. The cutter is adjusted forward by the screw *E*. By loosening the screws *F* and the collar-head screw, the cutter may be easily removed for sharpening. The cutter *H*, which rests on a bolster as shown in the detailed view, is adjusted to cut to the proper diameter by the screws *L*, after which the clamp *K* is made level by the screw *J*. The collar-screw *M* is then used to secure the tool in place. The cutter is made from drill rod, and it is slightly cupped out on the cutting end as shown at *N*. The adjusting screw *O*, which passes through plate *P*, prevents the cutter from backing away from the work. This adjusting-screw plate has its screw holes slotted as shown in the detailed view, to obviate the necessity of removing the screws when it becomes necessary to sharpen the cutter. Pilot *B* is held firmly to the tool body by set-screw *R*. The hole *S* through the shank makes it easy to remove the pilot in case this is necessary.

A pilot box-tool for finishing another type of ball bearing cone, is shown in Fig. 2. The shape of the work itself is indicated by the dotted lines *A*. This tool is somewhat similar in its construction to the one just described. The cutters *B* and *C* are inverted, and are used to face the flange at *D*, and to turn it to the proper diameter. These cutters are held by the clamp *F* and screws *G*, and are adjusted forward by the screw *H*. The cutter *J*, which operates on the top of the stock, rests on a bolster of the proper angle (see detailed view), and is adjusted up or down by the screws *K*. The clamp *L* which binds against this tool, is beveled at *M* to correspond with the angle of the tool. This clamp is secured

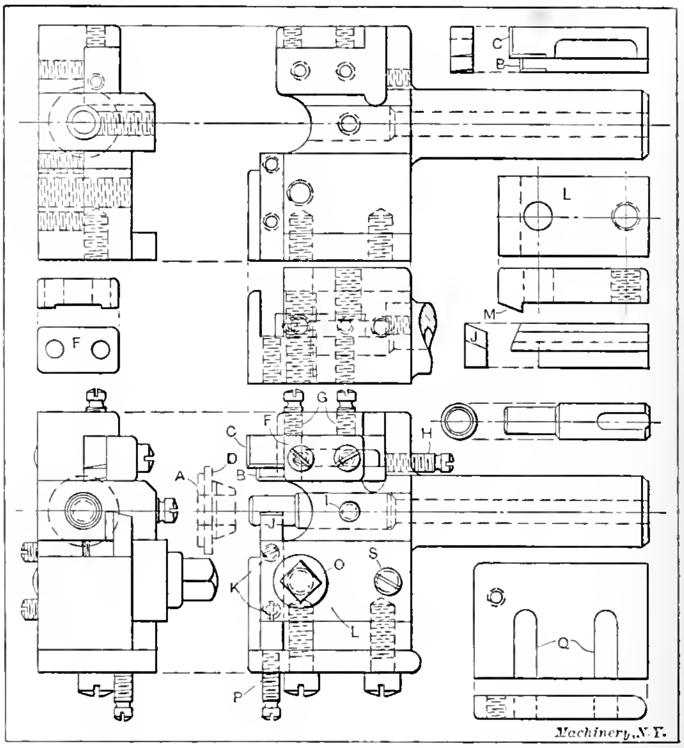

Fig. 2. Box-tool for Finishing Another Type of Ball Bearing Cone

by the collar screw shown, and it is leveled by set-screw *S*. The adjusting screw *P* prevents the cutter from slipping back. The holes *Q* in the adjusting-screw plate should be slotted as shown so that it will not be necessary to remove any screws when the cutter has to be taken out of the holder.

A box-tool for finishing a treadle rod cone for a sewing machine, is shown in Fig. 3. This tool is also of the pilot type. The cutters in it operate on opposite sides of the work which

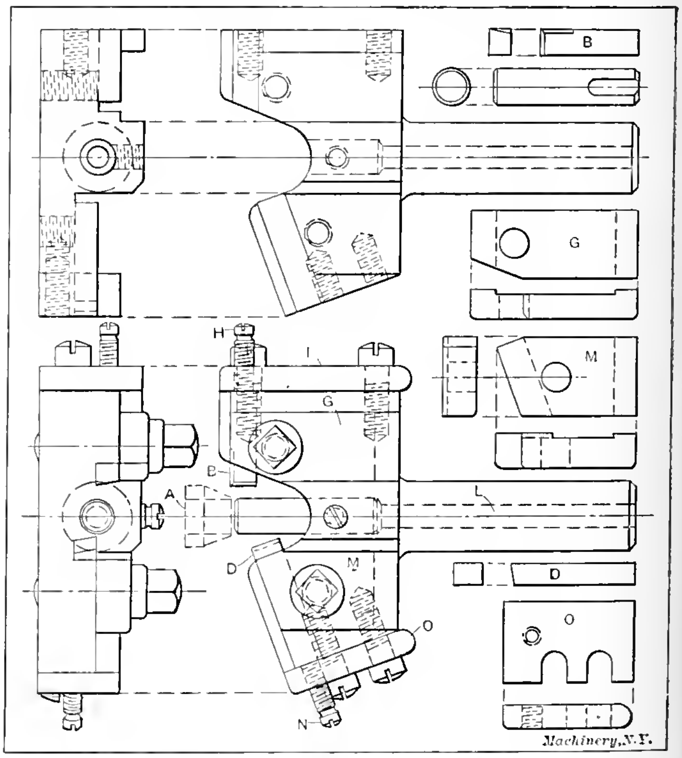

Fig 3. Box-tool for Finishing Treadle-rod Cone

is again illustrated by the dotted lines at *A*. The inverted cutter *B* sizes the cylindrical part of the cone, while the front cutter *D* is set at the proper angle to finish the tapered part. The rear cutter *B* is held in place by the clamp *G* and a collar

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screw. It is adjusted forward by the screw H in the plate I which is held by screws as shown. The pilot is retained by a set-screw, and it is easily removed by inserting a small rod in the hole L which passes through the shank. The cutter D is held by clamp M, and is adjusted by screw N, which passes through a tapped hole in plate O, the plate being held to the body or base by screws. The screw holes in both the adjusting plates I and O are slotted to facilitate their removal. The general construction of the tool will be clearly understood by reference to the detailed views of the various parts.

The design of box-tool illustrated in Fig. 4 is used for finishing the bushing of a double-taper cone bearing, the form

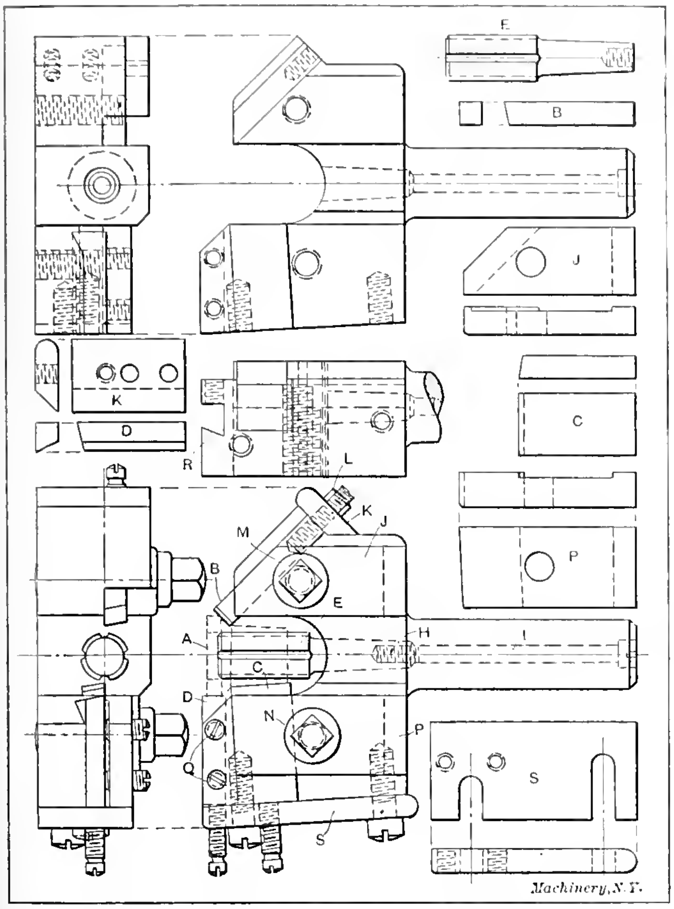


Fig. 4. Tool for Finishing the Bushing of a Double Taper Cone Bearing

of which is shown in dotted lines at A. The cutters are so arranged that they all cut on the center; that is, the cutting edges lie in a horizontal plane. The inverted cutter B, in the back, forms the short angular surface, and the cutter C in front forms the long tapering part of the bearing. The large diameter is turned to size by cutter D. The pilot E has a bearing in the bore nearly equal to the length of the work, and it is provided with oil grooves as shown. The taper shank of this pilot is tapped for the screw I which extends the whole length of the shank; this screw draws the pilot back to its seat. The adjusting-screw plate for cutter B is held in place by two screws. It is not necessary to remove this plate to take out the cutter, as the latter can be drawn out from the front after the collar-screw M is loosened. The cutter C is removed by slipping off the adjusting-screw plate S after loosening the collar-screw N. The cutter D is held in a dove-tailed slot (shown at R in the detailed view of the holder

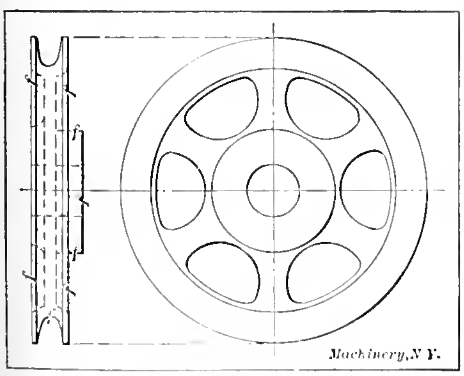


Fig. 5. Pulley that is finished by the Tools shown in Figs. 6 and 7

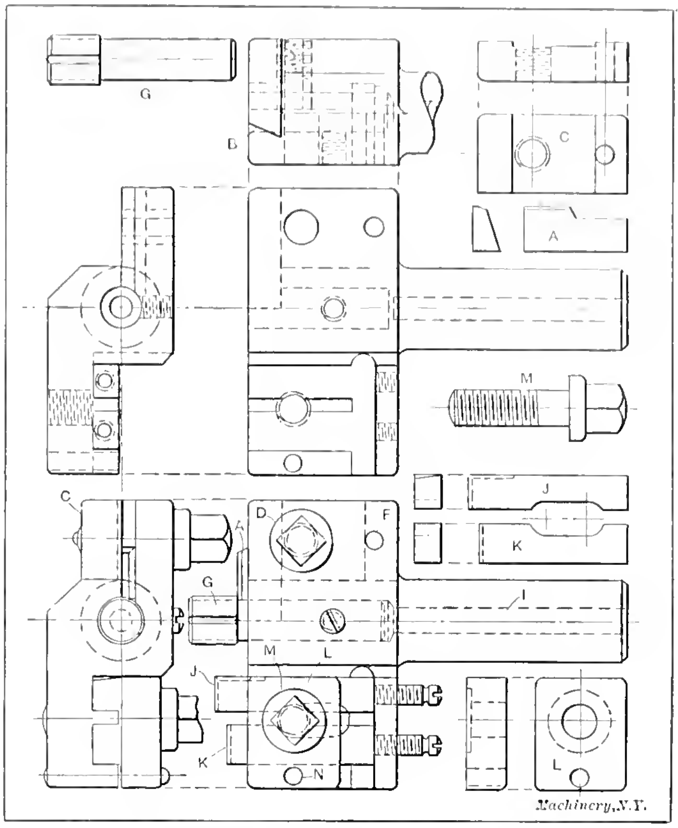


Fig. 6. Tool for Facing the Extension Hub Side of the Pulley

body) by two headless set-screws Q. It is also backed up by an adjusting screw in the plate S. These adjusting screws should all have fine threads, say from 32 to 40 per inch, and be nicely fitted so they will keep their adjustment and not give trouble.

Fig. 5 illustrates a loose pulley for a sewing machine, that is finished as indicated by the marks f. This part is completed in two operations. The box-tool for finishing the side of the pulley on which the hub projects beyond the rim, is shown in Fig. 6. The inverted cutter A which faces the end of the hub, is fitted to a dove-tail B, which is shown in the detail view of the holder body. This cutter is held by a clamp C (clearly shown in the end view) from the under side, and it has no

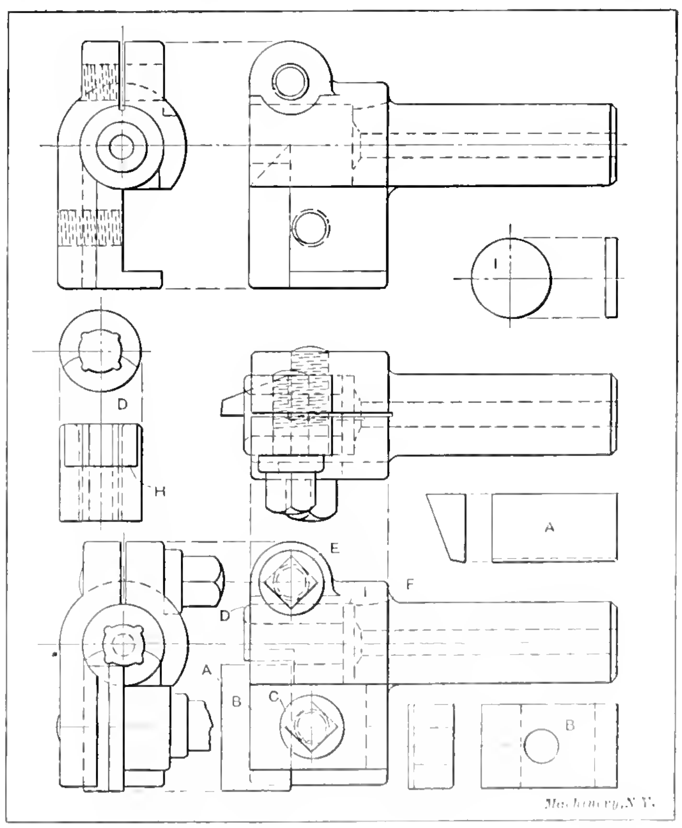


Fig. 7. Tool for Facing the Flush Side of Pulley

adjustment. The collar-screw *D* is tapped into this clamp, which is prevented from getting out of place by the dowel-pin *F*. The pilot *G* is made small in the shank, so that tool *A* may be so placed as to insure the removal of all burrs around the bore of the hub. The pilot is held by a set-screw and it is provided with oil grooves. The cutter *J* sizes the outside of the hub, and the cutter *K* faces the side of the pulley rim. These cutters are both held by the clamp *L* and the collar-screw *M*. The dowel *N* prevents the clamp from turning when the screw is being tightened. No side plates are used on this tool, and the cutters are all easily removed.

Fig. 7 shows the box-tool used for the second operation on the pulley illustrated in Fig. 5. As the hub is flush with the rim on the side for which this tool is intended, it needs only one cutter to face both. This is done by the cutter *A* which

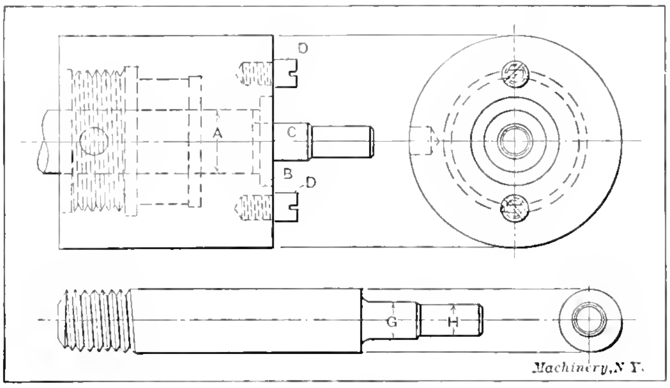


Fig 8. Chuck and Arbor on which the Pulley, Fig 5, is mounted during the Second Operation

is held in a dove-tailed slot in the front of the tool, and is fastened by the clamp *B* and collar-screw *C*. The bushing *D*, in which the end of the work arbor is supported, is held by the collar-screw *E*, and to obtain the necessary compression, the body of the tool is slotted as far back as *F*. This bushing is provided with oil grooves as shown in the detailed view, and one side is cut away as far back as *H* to clear the cutter *A*. The end of the arbor that the work is mounted on, is 1/16 inch smaller than the bore of the pulley, which allows the cutter to be set in far enough to prevent any burr forming at the edge of the bore. A disk *I* is inserted back of the bushing *D* so that the latter may be easily removed by passing a rod through the hollow shank.

Fig. 8 illustrates the arbor and chuck used for the second operation on the loose pulley, the box-tool for which has just been described. This chuck is fitted to the nose of the spindle, and the work is mounted on the projecting arbor and driven by the pins *D*. The bore *A* through which the work arbor passes, as well as the face *C*, should be ground after hardening, to insure accuracy. The arbor itself, which is shown in detail, should also be ground after hardening. The thread on the end of this arbor should be of a coarse pitch, enabling the arbor to be removed quickly from the draw-spindle, as it has to be removed for every piece operated on. The diameter *G* is made a driving fit for the work, and the end *H* is a running fit in the bushing of the box-tool. The counterbore at *B* is to provide clearance for the hub of the pulley which projects beyond the rim on one side.

* * *

The total tonnage of vessels launched during 1909 in all the countries of the world amounted to 2,006,500 tons. Of this tonnage, more than one-half, or 1,017,000 tons, was built in the United Kingdom and 258,000 tons in the United States. The total tonnage for the whole world shows a decrease of 40 per cent from that of 1906. Of sea-going merchant steamers of over 3,000 tons, about 75 per cent were built in the United Kingdom.

ECONOMY IN GRINDING*

By JOHN J. THACHER†

It is very often the case that a grinding machine falls short of its highest possible output by reason of the inattention of the operator to some of the short cuts and time-saving methods that have been highly developed in the use of other machine tools. It is the case with grinding machines as with other machine tools, that the development of short cuts and kinks of various sorts, greatly increases the aggregate output of the machines. The lack of such time-saving methods is the reason for the unfavorable attitude of some firms to the grinding process. It is almost always the experience of a demonstrator sent out by the manufacturer of grinding machines, that his results are not maintained by the operator. First one little kink is lost sight of, then another, and the time increases very slightly on each individual piece ground, but the aggregate of the day's output is soon considerably below what it should be.

A grinding machine will size work to a commercial degree of accuracy with remarkably little attention on the part of the operator, but the quantity output of a machine is very largely dependent on the ability and willingness of the operator to hustle; hence the reason for the almost universal prevalence of the "piece system" in the grinding department.

Several little kinks that I have observed at the works of the Brown & Sharpe Mfg. Co. may be of interest to those who would increase the output of their grinding machines.

Spotting Work for the Back-rests

Spotting work for the back-rests is a great help to the operator in several ways. When a piece of work is placed in the machine, assuming that the automatic cross-feed stop shield shown at *A*, Fig. 1, has been adjusted from a previous piece ground, the grinding wheel should be run back from the work about 1/32 of an inch. This is accomplished by turning the cross-feed handwheel *B* about one revolution in the opposite direction to that in which it is automatically revolved. The table carrying the work can now be moved by the handwheel marked *C*, provided for the purpose, bringing the various back-rests successively in front of the grinding wheel, as shown in Fig. 2. The wheel is then fed into the work by hand without reciprocating the table; it should be fed into the work until the diameter where the shoes of the steady rests bear is within one-thousandth inch of the

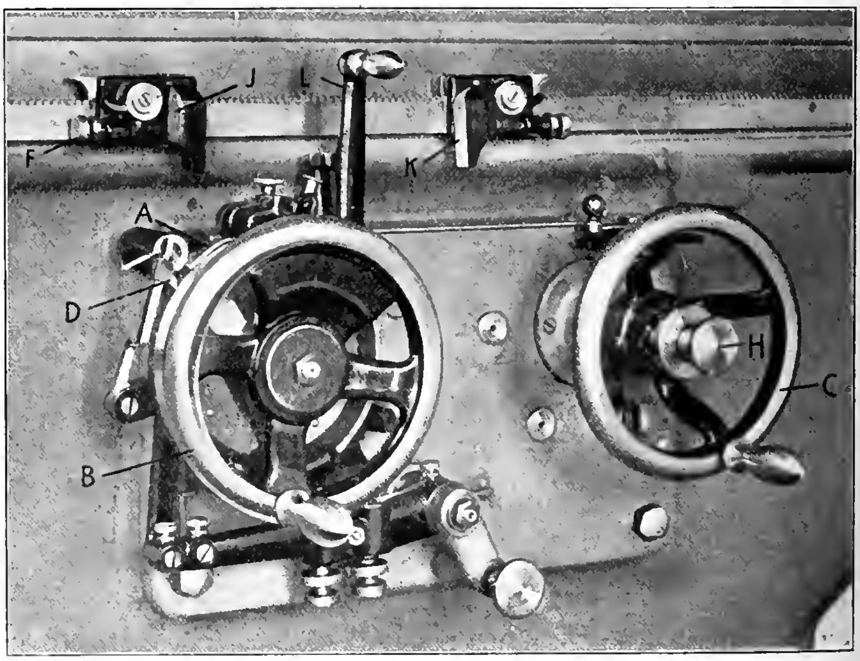


Fig 1. Controlling Mechanism of the Brown & Sharpe Grinder

* For additional information on this subject, see the following articles previously published in MACHINERY: A Factor in Grinding, June, 1909; Cylindrical Grinding, May, 1909; Form Grinding Operations in the Shops of the Landis Tool Co., August, 1909; Grinding and Grinding Machines, April, 1908; Helps and Don'ts for Grinding, August, 1908; Precision Griuding, September, 1907; The Cost of Grinding, October, 1906.

† Address: Care of Brown & Sharpe Mfg. Co., Providence, R. I.

finished size. The guard A, Fig. 1, as it approaches the pawl D, serves as a gage to determine the extent to feed the wheel in. This operation takes a very short time and provides a smooth surface for the bronze shoes. This surface is so near the finished diameter that the shoes are not worn large before the work is reduced to the finished size, therefore the work is accurately and steadily supported during the finishing cuts. This is found particularly advantageous on hardened work where a large amount of stock is left for finishing and where chatter marks are more apparent if the supporting shoes of the back-rest do not fit the work very closely. It is also found to be a great saving on the wear of the shoes themselves.

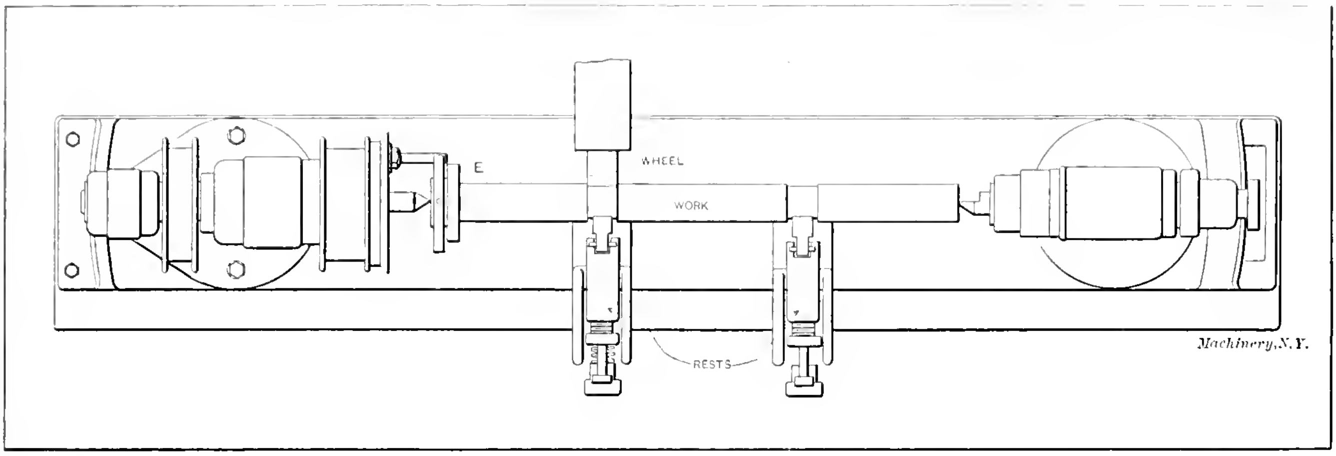


Fig. 2. Plan showing Method of Spotting Work for Back-rests

Grinding to a Shoulder

A time-consuming error among grinder operators is made on account of the prevalence of the idea that the reversing dogs on a grinding machine should be set to reverse the table traverse when the grinding wheel is within a very few thousandths of an inch of a shoulder on the work as at E, Fig. 2. It is a fact that most grinding machines will reverse within one or two thousandths of the same place each time, provided the rate of table travel is not changed. The variation in the depth of center holes in the work makes it necessary for the operator to try the reversing of the machine by hand after placing each piece in position to make sure that the wheel will not gouge the shoulder as it would surely do if the center holes were a little smaller than in the piece previously ground and a close limit for reversing were used. There are two ways to prevent the wheel gouging the shoulder on the work; one is the adjusting of the reversing dog by the screw F, Fig. 1, for each piece ground, which is a time-consuming operation; the other and better method is to bring the shoulder on the work up to the wheel by hand (using handwheel C after spotting for the back-rests as described), then feed the wheel straight into the work, reducing the diameter next to the shoulder for a distance equal, of course, to the width of the wheel, to the finished size. This is quickly and easily done by using the knock-off shield A against the pawl D for a gage as described. The table may then reverse for the subsequent complete grinding of the piece when the wheel has advanced not closer than 1/8 inch or more from the shoulder, and the edge of the wheel next to the shoulder does not become worn away or rounded because it runs off the work, or nearly off, at each end of the piece. A wasteful truing off of the wheel is thus easily avoided.

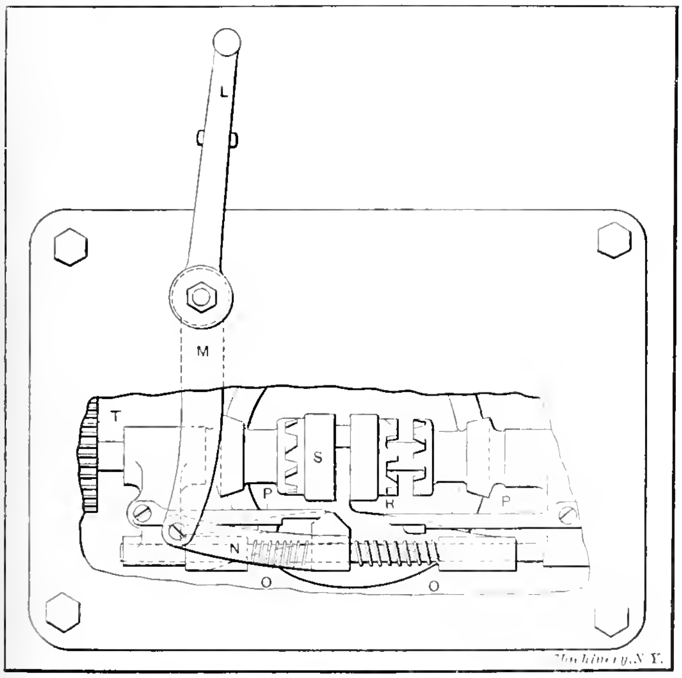


Fig. 3. Reversing Mechanism of the Brown & Sharpe Grinder

This operation of necking the work at a shoulder with the full width of the wheel, obviates the necessity of a dwell of the table at that reversing point. If a machine dwells when reversing at the shoulder end of the traverse, it must of necessity dwell at the other end where the wheel usually runs nearly off the work; here the dwell is not only of no value but it is very likely to cause the wheel to grind the end of the work undersize. While this dwell is only momentary, it is quite a factor in a day's output that can be readily eliminated.

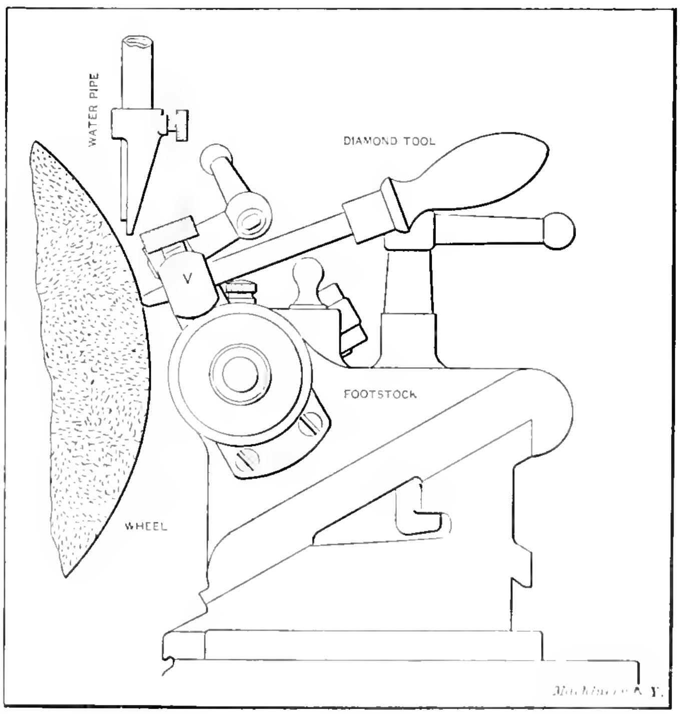


Fig. 4 The Way the Diamond Tool should be mounted for Truing the Wheel

If for any reason the necking of the work with the wheel is not deemed expedient and a dwell is required, this dwell is needful only once or twice during the grinding of a given piece and can be produced at will by the operator pressing the knob H, Fig. 1. Pressing this knob stops the power traverse

of the table, which may then be fed over by hand, using handwheel C, to face up the shoulder, and the dwell may be prolonged to allow one or more revolutions of the work as the particular quality of work and wheel may require, instead of the length of dwell being dependent entirely on the speed of the reciprocating table, as is the case when the dwell is automatically supplied by the gearing of the table. The table traverse is started after the dwell by pulling the knob H to the position shown in Fig. 1. A dwell so produced is not duplicated at the other end of the work except at the will of the operator.

It should be clearly understood that a grinding machine can be reversed with the shoulder on a piece of work 1/8 inch or more from a grinding wheel, then stopped at the reversing point and "forced over" this 1/8 inch or more beyond the normal reversing point without disturbing the reversing dogs and without subjecting the reversing mechanism to any strain.

In Fig. 3 are shown the elements of the reversing mechanism of the Brown & Sharpe plain grinders, which shows quite clearly how this traverse beyond the reversing point is accomplished. When the reversing dog J or K, Fig. 1, strikes and reciprocates the reversing lever L, the motion is transferred by its fulcrum stud and lever M to the arm N which compresses the reversing spring O. When this arm, which compresses the spring, has moved far enough to give considerable tension to the spring, the taper lug on the arm N raises the latch P thus releasing the yoke R which is connected to the reversing clutch S, this deriving its power from gear T. The spring, which is under compression, throws the reversing clutch as soon as the latch releases the yoke R. This movement of the yoke is sufficient to relieve the compressed reversing spring so that the reversing lever can traverse farther than the position where reversing takes place without unduly compressing the reversing springs. Thus the facing up of a shoulder on the work slightly beyond the reversing point without disturbing the reversing dogs on the sliding table can be readily accomplished without undue strain on any part of the reversing mechanism.

Truing the Wheel

When truing the periphery of a grinding wheel for all regular cylindrical work, a bort diamond, mounted in a suitable holder, is used, as shown in Fig. 4. This holder should be so mounted in its support that the distance from the diamond to the support V is as short as possible, thus avoiding spring or vibration in the holder which produces an irregular surface on the grinding wheel, appearing on the work in the form of a mottled effect or chatter. When work of large diameter is being ground, the wheel should be brought forward to the position shown in Fig. 4 when truing it off. The time consumed in moving the wheel forward with the cross-feed handwheel, is more than offset by the more rapid cutting of the wheel by the diamond, and, furthermore, the surface of the wheel is in better shape as stated.

For internal grinding, it has been proved economical by practice to true off the grinding wheel with a piece of a large wheel that has been worn down to such a small diameter as to render it useless for grinding; this piece of wheel must be harder than the wheel being trued off. This is a much quicker process than using a diamond, as the piece can be held in the hand and pressed to the grinding wheel as often as occasion requires. For this same purpose, bricks of various abrasive materials have been made and are generally used when pieces of a worn-out wheel are not available.

Design of the Footstock

The footstock of the grinding machine is of enough importance to warrant more attention than is generally allotted to it. The design that is in common use among grinding machine manufacturers, includes among other elements what might be called a spring-actuated spindle. The spring, which forces the center against the work, is primarily for the purpose of allowing the work to expand from the effect of the heat developed in grinding. As heat is very largely dissipated by the use of water, the more practical value of the spring-actuated footstock is to apply a firm pressure of the center against the work without force sufficient to distort it. This is very difficult to do with a screw and handwheel and is accomplished on a lathe by setting the center solid against the work, and withdrawing it until the work can be easily turned by hand. This represents a looseness between centers intolerable on a grinder and also causes a great waste of time. When grinding heavy work, there are two reasons why it is often necessary to clamp the footstock spindle solid after inserting the work in the machine. The weight of the piece of work tends to crowd the footstock center back on account of the angle of the center; also the momentum of the piece when the table reverses at the footstock end of its traverse tends to pound the center away and any looseness thus developed will render futile any attempt to produce round work.

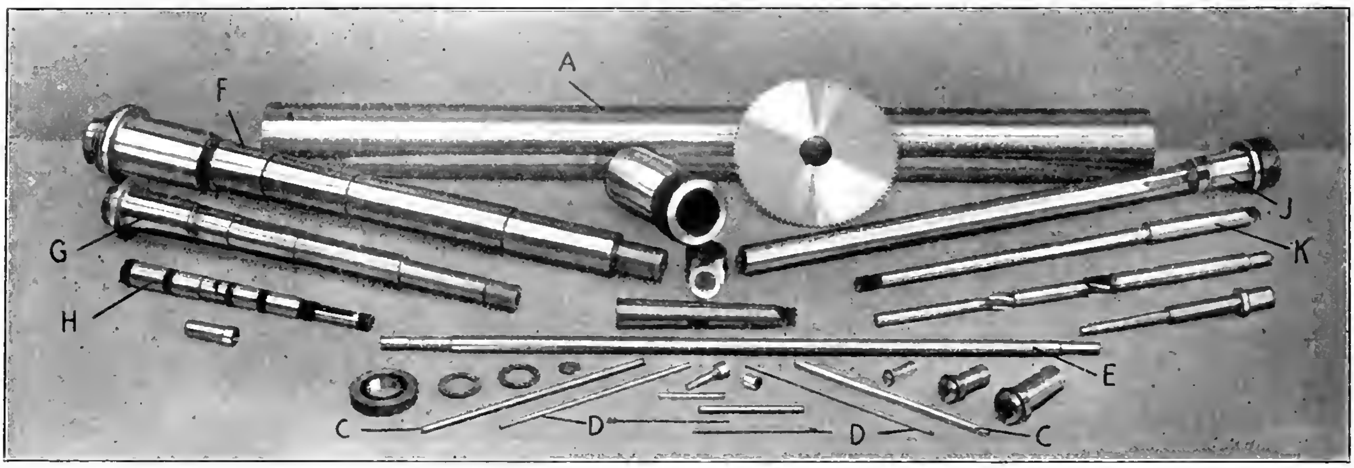


Fig. 5. Examples of Ground Work

Time Required for Grinding

In Fig. 5 there are shown several samples of work that has been finished on the grinding machine. Without exception every piece has been machined complete before it is sent to the grinding department; all threads have been cut, keyways and slots milled, holes drilled, etc., therefore all external and internal strains have been equalized in the pieces before they are ground. The grinding process is the most free-cutting process known to metal workers and should be the last cutting process as it distorts the work the least. The piece marked A is an overhanging arm for the milling machine, made of machinery steel 4½ inches diameter and 69 inches long. These pieces require an exceptionally good finish and are ground complete in thirty minutes for each arm. They are revolved in the grinding machine by a pin temporarily driven into one end near the periphery, this pin engaging the driving arm on the headstock pulley; with this arrangement pieces of sufficient size can be ground from one end to the other complete, while such small pieces as those marked C and D must be turned end for end to complete the grinding. These last pieces are about ½ and ¼ inch diameter, respectively, and 10 inches long. They are ground at the rate of fifteen

per hour and have a limit of 0.00025 inch either side of the dimension given. The shaft marked E is about 40 inches long and 1 inch in diameter where it is ground; this piece can be readily dogged at one end. These are ground at the rate of twenty minutes each with a tolerable variation of 0.00025 inch larger or smaller. The tapered collet shown in the center of the engraving is ground in four minutes. The milling machine spindle marked F is ground complete in one hour. The limits are very close, *viz.*, 0.00025 inch total variation, and the taper behind the collar is ground to a gage. The smaller spindle marked G has the same close limits as the larger one, and is ground complete at the rate of seventy in sixty-four hours. The spindle marked J, which is 34 inches long, has a threaded guard over the end and on this guard the dog is clamped. Thirty-nine of these spindles are ground complete in thirty hours. The screw machine spindle marked H, is a very difficult piece to finish owing to the fact that it is bored out its entire length so that it is practically a hardened steel shell which is cut away at the smaller end. When grinding these spindles in large lots, they are roughed out all over in large quantities then finish-ground later. It requires thirty minutes to completely grind one spindle.

This last example illustrates very clearly how difficult it is to estimate the time required for grinding a piece of work, as every feature of the piece enters into the problem and if it were not for the two slots which so cut away and weaken the small end that the grinding wheel cannot be forced into the work, these spindles could be ground in about ten minutes less time for each one. Placing the work on an arbor for grinding, very seldom increases the total length of time to grind when there are several duplicate pieces in a lot, as two arbors may be employed and the operator can insert one arbor in the work while the machine is grinding the work mounted on the other arbor.

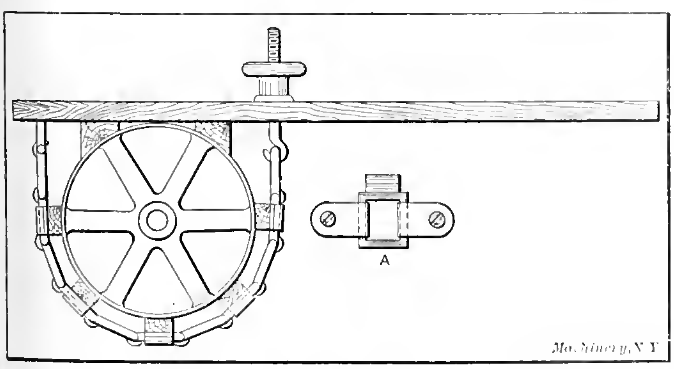
Number of Operators

The economical operation of a grinding machine presents very varied problems. It is sometimes an advantage for one man to run two machines; this is generally on long pieces where the time of actual grinding far exceeds the time of placing the work in the machines. There are, however, some jobs where two men can work very successfully on one machine. This is the case with short, large bushings that are driven on an arbor, in which case the time of changing the arbor from a finished piece to an unground piece equals or exceeds the actual time of grinding. When these conditions exist, the operator and the machine are non-productive at least half of the time, and this non-productive period can be reduced to a minimum by a helper to assist the operator.

* * *

AN EASILY MADE PRONY BRAKE

The accompanying sketch shows an easily made and cheap prony brake, suitable for testing gas engines, etc. The drawing requires but little explanation. The band is made of common malleable sprocket chain links of the ordinary de-



Simple Prony Brake made of Malleable Sprocket Chain Links and Wooden Blocks

tachable variety. One of the links to which the wooden blocks are fastened by means of sheet-iron clips and wood screws is shown at A. This form of link can be bought for a few cents. It is evident that such a brake band can be cheaply made and easily adjusted to any size pulley or flywheel by taking out or putting in links as required. G. C.

THE DETAIL ENGINEER

By GEORGE P. PEARCE*

The Novelty Works had the opportunity to supply some small finished pieces at a certain contract price. The price was low and the profit on each piece would be small, but as there would be thousands of pieces ordered and the deliveries would not be rushed as long as shipments were made in reasonable time, the shop could work on the order to "fill in," and this alone was an inducement. The owner and superintendent carefully looked over the sample piece and concluded that it could be made for the price, with enough profit to make it worth while. To be more sure they called in Bill, the machinist who should do most of the work, and he looked over the piece and thought that in hundred lots the time would average one hour each. This seemed reasonable, and without the slightest misgivings the contract was closed.

On the first hundred castings the time records showed two and a half hours each. The boss sent in a "hurry-up" call for the superintendent and asked "how about it?" The superintendent explained that it seemed as if that particular lot was "hoodooed," for although everyone worked like "blazes," progress was slow; however, this was the first lot, and, of course, it took time to watch and figure out the quickest methods; the next hundred certainly would show considerable improvement.

The second hundred were made in exactly two hours and eleven minutes each. The boss told the superintendent that something had to be done, for at this rate he would lose thousands of dollars. The superintendent tried other men and rigged up jigs and fixtures of all kinds, but could not get the time lower than two hours and five minutes. The boss then "personally" saw one hundred through, and stirred up so much excitement and hustle that the time ran up to two hours and fifteen minutes each. By now it was settled in the mind of the boss that he was "caught for fair," and he wondered how much he could break the contract for, as it evidently was impossible to keep on in this way. He thought of sending for Mr. Wm. Steelworth, the detail engineer, to see what he could do, but then surely it would not be possible to cut the time on the work any lower, for had he not made every man work so hard on one lot that they could scarcely walk home, and he did not believe any man could drive them harder. The superintendent was of the same opinion, but he had heard such good opinions about this man that he suggested giving him a trial.

When Mr. Steelworth arrived, the boss took him in his private office, told the whole story, and expected that Mr. Steelworth would offer his suggestions and remedies there and then; but no such thing happened. He simply said that from what he had been told it seemed quite a proposition, but he wished to go right into the shop where he could observe all conditions and study out his own solution. This was unexpected, as the boss had supposed he would outline his plan of campaign and submit it for approval, and, if satisfactory, he would then be allowed to adopt it and possibly "see it through." The boss never allowed anyone to try anything new in the shop without his approval; however, he decided for once to break this rule, and Mr. Steelworth went into the shop.

The first move was a trip to the pile of castings, and the superintendent smiled at the length of time it took to look over the castings; nor could he see the need of examining so many, for three or four should tell the story of how they were "running." After this came a more leisurely examination of the different jigs and fixtures. There was one thing that rather rattled the superintendent. After he had minutely described every operation, how the castings were chucked and the different tools used until the finished pieces were passed to the inspection and shipping department, Mr. Steelworth persisted in following a set of castings through the shop, "counting every time a man breathed," as Bill had said. This made the men ill tempered, and they were telling one another what a "man driver" he was going to be.

The next day Mr. Steelworth asked the superintendent that aluminum patterns be made to replace the wooden ones. Both

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the boss and the superintendent explained that this was quite unnecessary, the wooden patterns were accurate and good enough, and lighter than anything else; and, anyhow, on these small pieces, weight did not count. But Mr. Steelworth said it had to be aluminum patterns or he would go no further; besides this, he wanted that central cored hole done away with, and a solid casting made instead. This meant the addition of three-eighths pound of metal and looked as if instead of reducing he was planning to increase costs.

The aluminum pattern castings were made, however, and were cleaned up, ready to send to the foundry, but Mr. Steelworth wanted the patterns machined all over and the machine marks buffed out. The superintendent thought this was going too far, and sarcastically remarked that they did not get castings with buffed surfaces and that a reasonably smooth pattern would draw well and be "good enough." Mr. Steelworth observed that he wanted these this way. After several trials, the men got the patterns smooth and accurate enough, and they were passed on to the foundry. Mr. Steelworth saw the foundry foreman, with the result that the next batch of castings was to be well pickled.

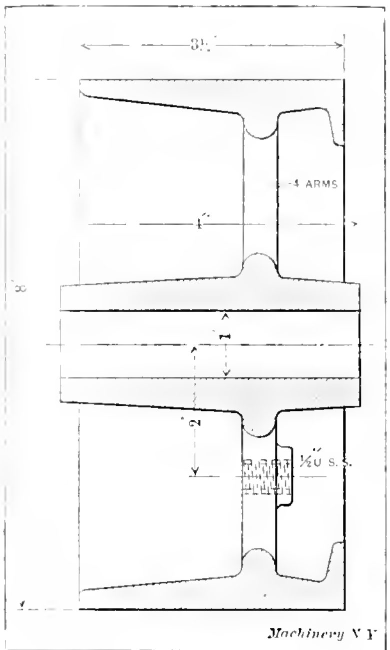


Fig. 1. Drawing of the Piece to be made

While waiting for the castings Mr. Steelworth picked up a big chunk of cast iron and had Bill fit it on the lathe nose; the front end was faced and holes were drilled and tapped so the casting could be quickly clamped to the face; the chunk of iron was also rough turned true. Soon the castings came in and a rusty looking lot they were in comparison to the nice "faced" ones that had previously been used. Bill was to machine them, and he quickly spotted that the central hole was not cored, at which he "cussed," for it meant a drilling job before he could bore them. He also had a few words to say about making the ungainly chuck, when he could catch them in the four jaw chuck and hold them just as well, besides having a better chance to true them up. His soliloquy was cut short by the arrival of Mr. Steelworth who said they would start in on the castings. "*They*," Bill muttered. "Is it going to take two men to do the job now? 'Cut time' indeed." The first thing Bill was told to do was to put the "chunky-chuck," as he called it, on the lathe nose, and then step the end of it down so as to be an easy fit in the large recess at the back of the casting. This he did and the casting slipped easily into place. Bill started for his monkey-wrench to tighten the cap screws which clamped the casting, but Mr. Steelworth stopped him and handed him a handy little ratchet wrench.

"*We'll* have to drill a hole through it before I can bore it," remarked Bill.

"*We* won't bore it at all, but will drill it small and ream it," remarked Mr. Steelworth. Get a twist drill, 1/64 inch small, and a dog." Just as Bill came back with these things, the whistle blew, and further work was postponed until after dinner.

Bill was back early and went to the superintendent as soon as that worthy appeared.

"Say! I don't want to interfere with any of your plans, but I'll be darned if I want to ape the green hand to instructions received from Mr. 'Great Ideas.'"

"What in the world has happened now?"

"Well! I don't mind clamping those castings to a piece of junk instead of the proper chuck, but when it comes to expecting castings to slip over shoulders, as if two castings ever came to within a strong sixty-fourth, and then having to drill the hole with a twist drill and ream it, as if a hole could be drilled central with a twist drill scotched by a dog, and there is no need for a reamed hole anyway. Besides this, goodness knows how much more time-wasting foolishness is coming, and it certainly is not going to be Bill who will deliberately waste castings and time to the tune of a "know nothing."

"Well, Bill, I have been noticing things myself and have talked it over with the 'old man,' and we decided to let it run this afternoon and let Mr. Steelworth trip himself on the time limit."

With a grunt Bill went and got a hammer and "round nose" to chip the start for the drill, but Mr. Steelworth arrived before he got started and told him to leave the hammer and chisel alone, and taking a tool holder, he ground the tool a kind of a cross between a facing and hogging tool which enabled him to take a quick facing cut right across the boss and then turn a countersink almost as large as the drill; he next put the drill against the tailstock center with the dog resting on the tool-post block and the heel of the tool touching the drill close to the cutting end, so that it could not run out. The lathe was speeded up way beyond what Bill generally ran it for similar work, and the drill fed in with a good heavy cut which was kept up right through. As the drill changed its "growl" when the point went through, Mr. Steelworth brought the flat part of the tool-holder against the dog and forestalled the drill's "hogging through" and twisting everything out of shape by snatching off the tail-center. Bill felt a little disappointed, as he had anticipated a broken drill, but still he smiled, for had not Mr. Steelworth ground the drill by hand in a few seconds and only sighted it up, and everyone knew it was quite a job to grind a drill so it would drill its own size and no larger. Besides he knew the drill was "loose" by the easy way it came out. He was disappointed again, for although the drill was not drilling to size, the hole was not quite a sixty-fourth out and this oversize really helped, for it only took a few seconds to put the reamer through. The drilling and reaming time was five minutes.

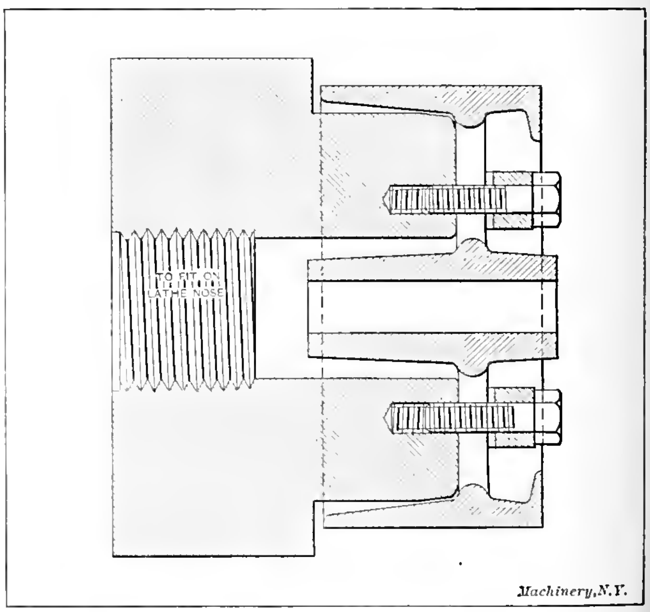


Fig. 2. Method of Chucking

Next Mr. Steelworth told Bill to take the casting out and put it on the tray at his right hand, then twist round and pick another from the tray on his left and put it on the chuck without moving his feet. Bill had some personal thoughts about such detailed instructions instead of saying "change castings"; and whoever heard of taking an unfinished casting out after once it was chucked; however he did according to schedule, and was surprised to find that the next casting went on all right; it was not often that two castings came so near. The facing, countersinking, drilling and reaming were quickly done, and ten were done in fifty minutes with only one casting refusing to go on the chuck, the only trouble being a little

snag which was quickly knocked off with the butt end of a lathe tool. Mr. Steelworth asked Bill if he thought he would have any trouble in keeping up a twelve per hour rate and Bill thought it would be easy for he had not hustled any above keeping right at it.

The next thing was facing the two sides as far as they reached down. Mr. Steelworth brought an old sleeve coupling up to the lathe and put it on a block so the top of the coupling was about 30 inches from the floor. Then he took a short mandrel he had picked out of the "pile" and drove it lightly in the casting; next he took a heavy dog about three sizes too big for the mandrel and to Bill's amazement clamped it on the driving plate, which he had put on the lathe, with its tail sticking outward. He put the mandrel on the centers, and then the convenience of the arrangement became apparent for the tail of the dog reached into the casting plenty far enough to catch the arm in the casting. Bill inwardly chuckled, for he knew that some of the castings would go further on the mandrel before they became tight, and then where would the dog drive be? Next Bill was told to get another tool-post, tool-holder and two tools which were fastened in the tool-block, one tool having been ground right hand and the other left. They were spaced the required distance, and were quickly fed across the side in one cut, thus facing both sides at once. It was but a moment's work to take the job out of the centers and put it on the sleeve; one quick blow with a soft hammer drove out the mandrel. As a block of wood had been placed in the sleeve, the mandrel just fell far enough to be loose in the casting, and was easily picked up with the left hand while another casting was picked up with the right and placed on the sleeve, the mandrel being placed in position while the free right hand was picking up the hammer. The mandrel was driven in by two light blows, and the job put in the lathe, when to Bill's surprise the dog tail just reached in to about the same distance. While he was facing the two sides Mr. Steelworth explained that as all the castings had reamed holes, they come tight enough in almost the same place on the mandrel if driven with about the same force; if Bill had any doubts as to being able to hit every time the same, he could easily mark the mandrel and drive as far as the mark—there was no need for the job to be very

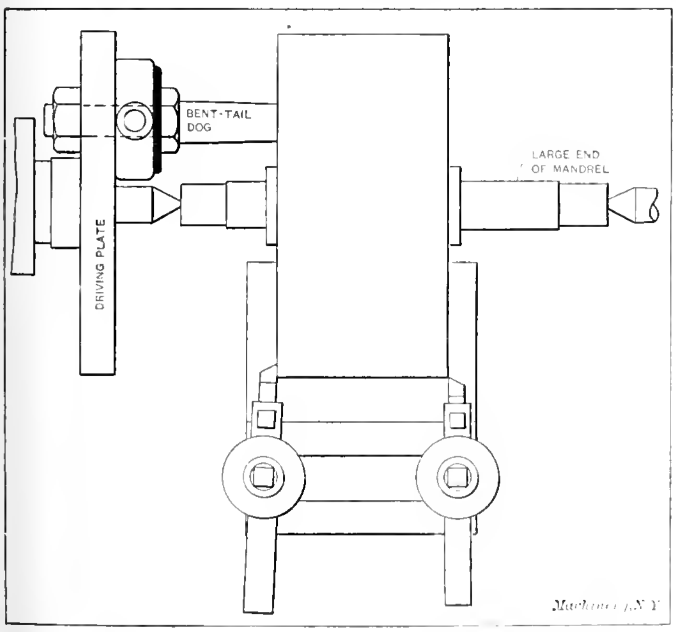


Fig. 3 Method of Driving the Work when Facing the Sides

tight, as it was not driven by the mandrel. The time for this operation was four minutes.

The next thing was turning the outside diameter and for this the two tools were again used, one set nearly to the required diameter and the other to take a light finishing and sizing cut. They were placed a little further apart than the width of the job so that both would not be cutting at the same time. The work was driven in the same manner as when facing. This operation Bill told the boys he knew how to go one better, and cut the time almost in two by placing the two tools close together so that it would only be necessary to wait the length of time for a little over one cut, instead of over two cuts. The first time he had a chance he tried it. The fellows thought Mr. Steelworth must have been slow, until the moment the roughing tool got across and the finishing tool immediately changed its cut enough to prove that the roughing tool had been springing the work, and, of course, the finishing tool had no chance to even up this inaccuracy. Thus the "improvement" fell through and Bill was glad to find that

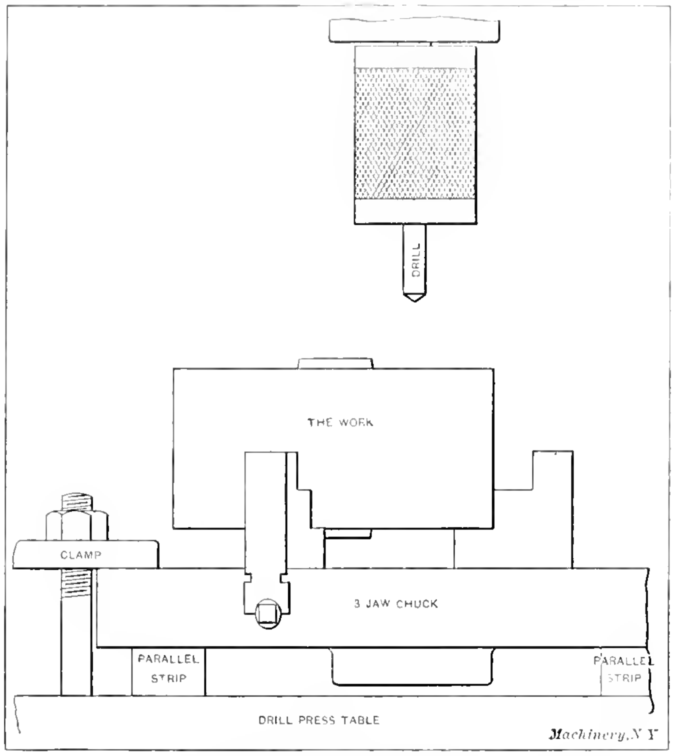


Fig. 4 Method of Holding the Work for Drilling and Tapping

another cut across saved the casting. In the future, Bill was always very careful to try things before he chased around saying what he was "going to do." The roughing and finishing cuts and changing took eleven minutes.

Next, there were the bosses to be faced to the right thickness in relation to the sides. This time the work was driven tightly on the mandrel and the two tool-holders provided with tools ground what Bill termed "right- and left-hand parting," which came as near as anyone could suggest; these were set oversize for roughing, and one of the tool-holders so twisted that when the body of the tool nearly touched the finished side of the job it would leave nearly one thirty-second of stock to be removed in finishing; of course both tools were set to reach the mandrel simultaneously. When once set up, it proved a very quick method, as four minutes each, including changing, was the average time. Bill supposed that the bosses would have the finishing cut taken in the same way, but Mr. Steelworth said that for this job it would be better to finish them on the drill press. Here the table was nicely cleaned and two parallels clamped on it so the work could lie on its finished sides and be clear of the table. A counterbore was put in the chuck and the stop collar set so as to face the boss to the exact height. Bill was instructed to let the counterbore make two or three revolutions after the collar reached the stop so as to put a nice bright finish on the boss, but not to leave it running longer than that, as it would tend to dull the cutting edges. By having the box of unfinished pieces on the left and moving from left to right, Bill was able to change and face at the rate of one per minute, or two minutes for the two bosses.

Next there was a hole to drill and tap. For this Mr. Steelworth picked up a three-jaw lathe chuck which he placed on the drill press table. In this he clamped the casting so that the hole to be tapped would come about central with the hole through the chuck body, which was carefully located under the center of the drill chuck and clamped there. Then he took an old broken drill stub which he carefully ground and also thinned the point, there being enough twist left to get

the chips out before the drill went through. This was placed in the drill chuck, and the drill press head moved down until the drill could only be lifted high enough to clear the work when it was changed. While this was being done, Mr. Steelworth had set Jimmie at work to roughly grind the castings where the drill would enter, as the place could be easily reached by the emery wheel. Mr. Steelworth said it was better to grind off the scale in this case than to have to grind the drill too frequently; besides it would allow the drilling to be done at a much higher speed than if it had to drill through the scale first, and it would not pay to keep changing the speed on this short hole. Jimmie ground four per minute and Bill drilled them at one per minute, using the power feed which Mr. Steelworth insisted upon, not because it was quicker, but because it was sure to keep the drill under a good cut all the time, and not let it scrape round without cutting and grind off the edge.

The superintendent came along at this time and nearly had a fit when he saw the drilling layout; he politely asked Mr. Steelworth what was the matter with the drilling jig he had had specially made for this operation and which cost over $50.00. Mr. Steelworth said that there were three things about it that made it an unprofitable tool; first, the hinged cover was tightened by two swing bolts with wing nuts which meant six actions in changing pieces, and the drill had to be raised nearly a foot more than necessary to let the lid open up or else the jig had to be pulled to one side and then located again; second, the casting was located on the bottom of the jig, and while there was a fairly large opening in the base it was not large enough for all the chips, and they would get onto the locating surface when the job was changed; thus the man would have to be constantly cleaning the jig which would use up quite a little time; and third, the jig was absolutely unnecessary, anyhow, as the three-jaw lathe chuck located and held this particular piece better than any jig, and it was only necessary to swing the wrench handle one-third turn to open the jaws enough to release the job, which meant only two short actions to change jobs. The very construction of the three-jaw chuck meant freedom from chips and chip troubles; the drill did not need to be raised much over an inch to change jobs; and the stub drill and close drill head meant that the hole would be drilled well within the requirements of the work. The superintendent passed along and thought that perhaps after all the jig and fixture craze is in many instances overdone.

Bill told Mr. Steelworth that they had always tapped the hole by hand, as it did not take long to catch the piece in the vise and run the tap through, and it saved the time for clamping in the jig, the broken taps, and backing the tap out. He also wished to point out that the wrong size drill had been used for the hole; why, it was almost a thirty-second larger than the size called for in the table, and he pointed out the "diameter at root of thread" in his pocket-book. This seemed to squelch Mr. Steelworth, for he meekly asked for the tap and a socket wrench to loosely fit it. Bill knew he meant "tap wrench," but he brought a "socket" and grinned as he waited around. Mr. Steelworth certainly was completely tangled up by now, for instead of putting the work in the vise he put the socket wrench there, and then, apparently not knowing what to do, he picked up a hack-saw and deliberately sawed the "socket" off. He then put this in the drill chuck, and, slowing the drill press down, he put the tap in the square hole and held it there while he brought the drill head down and followed the tap right through the casting that had been left in the lathe chuck. Just before it dropped through the hole, he placed his hand under the table and caught it. One minute each was ample time for tapping, and Bill never mentioned hand tapping again. The pieces were now finished, the actual working time on each being twenty-eight and a quarter minutes. Mr. Steelworth asked Bill if he could keep on making them at this rate, and Bill said if things went along as smooth as they had that afternoon he was sure he could, but he never knew a set of castings to be cast so near, machine so easy, and work along with so little trouble as this lot. Mr Steelworth said he did not think there would be any more trouble with hard or sandy castings; however, he made the time rate thirty-five minutes each, which enabled Bill to earn more money in the next eighteen months than he ever had before.

The boss and the superintendent were both in the private office waiting, for it was now nearly an hour after quitting time. The superintendent had told the boss the surprising news that ten castings had been put through that afternoon, and how he had secretly taken one and carefully measured it up and found it extremely accurate and nicely finished. When Mr. Steelworth came in, he was received with a smile. The boss spoke first:

"How long do you find it will take to machine those castings?"

"Your man Bill will gladly take them on piecework at thirty-five minutes each."

"I am real glad to hear that, as it will change thousands of dollars loss into thousands of dollars profit. But Bill must have had a great change of ideas this afternoon, for this morning he said no man could make them under two hours each."

"Well I should say Bill was right when working under the handicap that he has been."

"Mr. Steelworth, you would do myself and my superintendent a great favor if you will explain what you found wrong with our method of getting those castings machined, for it seemed to us to be the only right way, and surely our method of finishing each is standard practice."

"I know nothing about 'standard practice.' The failure with your method was that not enough attention had been given to details—the little things. The castings were made from wooden patterns with loose bosses, the patterns had warped, loosened up a little at the joints, and the loose bosses kept getting sand under them with the result that the castings were crooked and had tilted bosses. The chuck jaws would always pull the boss straight and throw the edge of the casting out, so the man had to put wedge pieces under half the bosses to make the casting run nearly true. Then the molds were faced, and while the castings were good looking, they had a chilled scale that took the edge off the tool in one cut, even running at the lowest speed. Then the man had to carefully caliper to get the sizes; all this measurement had to be repeated for each piece, as he changed tools every time. Besides this, he fetched the castings from the 'pile' four or five at a time, which meant many trips; he kept them on the floor near the lathe and had to stoop to pick up each one; every one as it was finished on the lathe was carried over to the drill press and placed on the floor near it. The lathe tools were placed on the lathe tool stand and mixed with the others, thus taking a little extra time to pick them out again, the drilling was done onto the hard scale, the drill was too small for tapping in cast iron, and the tapping was done by hand, it being necessary to change the taps in tapping on account of the small hole; in fact it was a minute here, a few seconds there, and a continual waste of time throughout the whole operation. This combined with the attempt to apply turret lathe methods to a common engine lathe on a job that was not suitable, all helped to consume over two hours on a half-hour job. All I have done has been to attend to the little details that often seem to be too small to be worth paying any attention to."

Both the boss and the superintendent said it was absurdly simple, but it had never been so thoroughly brought home to them before that the minute here, the second there, the short trips across the shop for wrenches and the "hunting" for tools made all the difference between success and failure. They were extremely grateful to Mr. Steelworth and the boss never asked him how much his services were but passed him a check that was over twice the amount he intended to ask.

* * *

The progress of aeronautics is indicated by the fact that the aviation department of the Motor Supply Co., Ltd., of London, England, has published a catalogue of aeroplanes containing full description and prices. The Bleriot monoplane can be had for about $2,500, and a Farman biplane for from $4,200 to $5,500, the price varying considerably according to the engines provided. The Santos-Dumont monoplane may be bought for a mere $1,500, while the Wright machine commands a price of from $5,500 to $6,000.

A FORMED TOOL POST AND A RECESSING TOOL FOR SCREW MACHINE WORK

In Figs. 1 and 2 are shown a couple of screw machine tools which have been found to be very convenient in screw machine work by the Colburn Machine Tool Co., of Franklin, Pa.

The first of these is a recessing tool of simple but rigid construction. The body of the tool comprises a shank, fitting the hole in the turret, and a head having a T-slot milled through it, to form ways for the slide carrying the boring tool which is to do the recessing. This slide is operated through a small movement by means of the handle shown. The handle is screwed into a plunger fitting a hole in the shank, and having an eccentric diameter at its outer end fitting a cross-slot in the tool-slide. By this means the rocking of the handle gives the

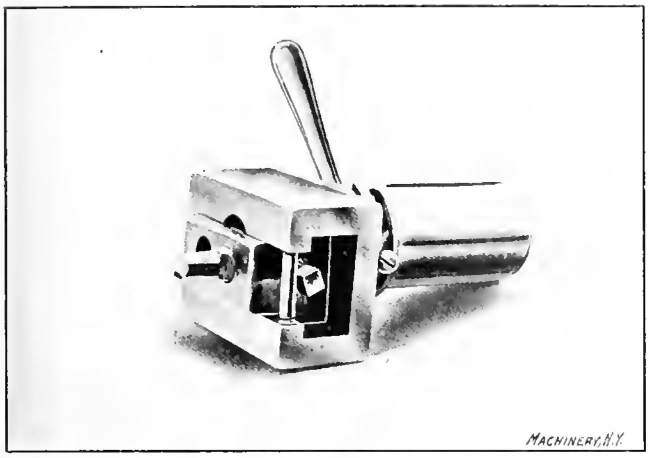


Fig. 1. A Convenient Recessing Tool for Screw Machine Work

desired movement to the tool. To limit this movement in the outward direction, to give a desired depth of recess, a slotted circular stop is provided, adjustably clamped to the side of the shank, as shown, for the handle to strike against. By adjusting this up or down, the depth of recess is changed to suit.

The T-slot in the head for the tool-block is strengthened by screws passing through from one side to the other, one of which can be seen at the front. Two holes are provided for the boring tool with which the recessing is done, thus increasing the diameter range of the device; this range is for diameters from 0 to 2½ inches. The tool is held in place in the

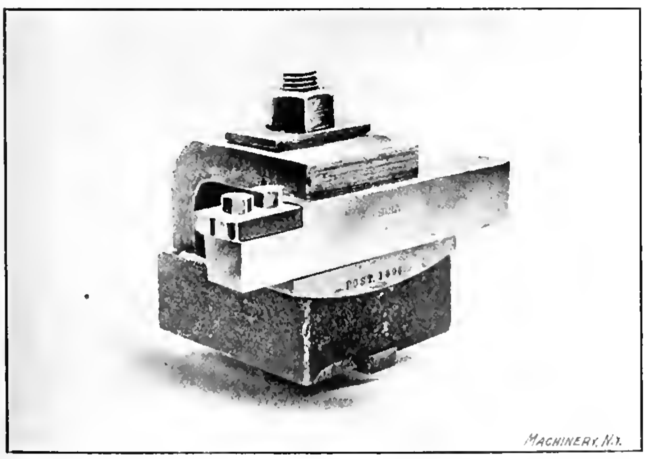


Fig. 2. Separate Blade Formed Tool, with Open Faced, Rocking Holder

socket by the set-screw shown, which is screwed into the other end of the tool-block when the other hole is used.

In Fig. 2 is shown a formed tool and holder of considerable interest. This firm follows the practice, on ordinary work, of making formed tools for use in the screw machine out of comparatively thin plates of tool steel, screwed onto a soft steel holder or shank. This method greatly reduces the amount of costly tool steel used. It is also quicker and easier to produce the desired outline on a thin blade, than it is on the end of a large tool-block of solid stock.

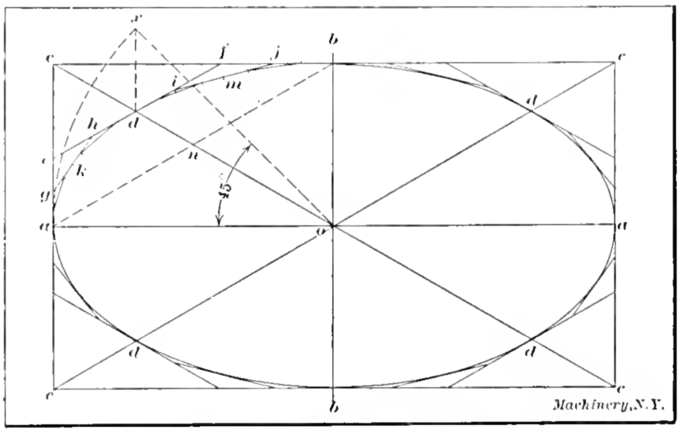
The formed tool-holder permits rocking the tool-blade up or down to get the proper center distance, and in addition has the advantage of holding it in such a way that it may be operated close up to the face of the chuck, as it is of the open-faced type.

The shank of the formed tool is set on a circular rocker, as shown, of a type similar to that used for the ordinary tool-post. The strap by which it is clamped is bent down at the rear end to rest on the bottom of the tool-block. The bearing at this point is also circular, on a radius struck from the same center line as that of the rocker under the tool. Furthermore, the rectangular washer used under the nut on the clamping bolt, for drawing down the strap against the tool, is seated in a similar cylindrical surface in the top of the strap, turned out to a radius from the same center line. It will thus be seen that, by loosening the clamping nut slightly, the tool rocker and strap may all be swung one way or the other, to raise or lower the point of the tool, without disturbing their bearings on the tool-block, or the bearing of the washer on the top of the strap.

* * *

SIMPLE METHOD OF DRAWING AN ELLIPSE

In the February 24 issue of the *Engineering News*, Mr. G. W. Colles gives a method for drawing ellipses which is very simple and convenient, and which, therefore, will undoubtedly be of interest to draftsmen and designers in general. Most methods only give points upon the curve, ignoring the fact that the *direction* of the curve at the point is fully as important as the point itself. The present method is based on the fact that every ellipse may be considered a strained circle, that is, one which is distorted in one or two directions proportionately at all points. The accompanying illustration



A Simple and Convenient Method of Drawing an Ellipse

shows the method applied. Lines *aoa* and *bob* are the axes, intersecting at *o*. Upon these construct the rectangle *cccc* within which the ellipse is to be inscribed. Draw the diagonals *cc*. Draw *ox* at 45 degrees to axis *aa*, making it equal to *ao*, and drop a line *xd* perpendicular to the axis *aoa*, intersecting *oc* at *d*, which is a point upon the ellipse, and the tangent *edf* is drawn parallel to *coc*. In small ellipses, the three points and tangent on each quadrant will be sufficient to enable the ellipse to be constructed satisfactorily, but for greater exactness bisect *ae* and *ed* at *g* and *h*, and *df* and *fb* at *i* and *j*; then the lines *gh* and *ij* will be tangent to the ellipse, and will practically draw the curve, but if this is still insufficient we may bisect *gh* at *k* and *ij* at *m* and again bisect *ag*, *gk*, *kh*, *hd*, *di*, *im*, *mj* and *jb*, joining the points of bisection to give further tangents to the curve.

* * *

According to a report from Consul Albert Halstead of Birmingham, a patent for improvements in typewriting machines owned by the Yost Writing Machine Co., of New York, has been revoked under the new British patents law. Not only was the patent revoked, but the company was ordered to pay the cost of the British applicant for the revocation, this cost amounting to more than $150. Under these conditions it is advisable for inventors and firms contemplating to secure patents in Great Britain when they do not intend to manufacture in that country, either to refrain from obtaining patents, or to be sure to confer the rights of manufacture upon some firm which will manufacture the articles in the United Kingdom.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

MAY, 1910

PAID CIRCULATION FOR APRIL, 1910, 26,453 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages a year of additional matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MONTHLIES

More than seventy-five per cent of the readers in the machinery industry in this country are readers of monthlies. The published figures of the two leading journals in that industry show their aggregate domestic circulation to be about 56,000, of which some 43,000 is monthly; and these figures do not take into account the circulation of the other monthlies.

There must be a reason for this preponderance in favor of the monthly, and the reason is that the great majority of mechanical readers obtain all the current information they have time to digest, in a monthly at the minimum cost and in the most convenient form.

These figures are not used to boost MACHINERY any more than the four other monthlies; nor to disparage the weeklies. Both are valuable, both are needed; the weekly for the commercial end of the business where the news and markets are required, the monthly for the mechanical end where practical information is essential—and everyone knows that such matter does not lose value by being published monthly.

* * *

FURNISH PLENTY OF CLAMPING DEVICES

Too much time is lost in the average machine shop "hunting" for suitable clamps, straps and screw-jacks, for fastening work to the faceplate of a lathe or the table of a planer or shaper. Unfortunately many superintendents have not yet realized the necessity for providing an adequate supply of these devices, which, though simple, are of the highest importance in turning out first-class work. In the interest of economy every shop should be equipped with a complete collection of such devices; a convenient central place should be provided for keeping them, and each man should be required to return them to that place after use. On many classes of work more time is lost trying to find suitable tools of this kind than is used in the actual performance of the machine work; and on account of inferior clamping and supporting devices, the work itself is often not as satisfactory when completed as it would have been if proper clamping facilities had been provided.

VARIATION IN GAS ENGINE EFFICIENCY

No doubt the article on the location of the gas engine igniter by Mr. Miller in the April number was read with interest—and some disappointment by those who expected to obtain definite information on this important subject. They learned, however—if not already aware of it—that the location of the igniter depends on a number of variable factors, and under common conditions no definite rule can be laid down for its location which will give the maximum efficiency for a certain type of engine. In fact it appears that the position of the igniter may often be varied in individual engines with resulting increase or decrease of efficiency. It also appears from our correspondence with the author that the horsepower developed by two engines of the same bore and stroke may vary considerably; for example, a nominal twenty-horsepower model developed from 17 to 22 horsepower in individual engines. The reason for this variation, according to a statement received from the author, is the position of the inlet valve, shape of inlet valve, size of cored passage at inlet valve, and particularly the shape of cored passages. All these factors affect the flow of the incoming charge. The author writes:

> We were building gasoline engines in a certain shop, 8 inches cylinder bore, 16 inches stroke. One of these engines under brake test developed nearly 17 horsepower, while another made from the same drawings and patterns, exactly alike in all details, developed nearly 22 horsepower. These engines generally varied from 19 to 21 horsepower. A change in the position of the igniter on one of these engines resulted in its developing 24.4 horsepower. I claim from experience gained in building hundreds of these engines that the variation in horsepower is directly traceable to the cored passages of these engines.

If this experience proves anything, it shows conclusively the need of a reform in certain practices in gas engine construction. It shows the need of standardizing all parts and securing uniformity in sizes of passages. Perhaps this means more machine work and greater cost of construction, but surely such great variations in power and efficiency are not allowable in good practice. No doubt much of the inefficiency of gas engine performance, and resulting dissatisfaction, has been caused by variations in castings that were assembled with no machine work done where it ought to have been done, if the highest efficiency and uniform power rating were to be secured.

* * *

THE USE OF THE SECANT

There are eight regularly named trigonometrical functions, of which four (the sine, cosine, tangent and cotangent), are by far the most extensively used. In this country, however, we make considerable use of another pair of functions, the secant and cosecant. The secant is, of course, the reciprocal of the cosine. Tables for these functions are commonly given and are in everyday use here in America. In Europe the student is taught what they are, but no tables of secants and cosecants are published, and practical use is never made of them.

The reason for the difference in practice is probably a deep-seated one. The secant is useful in that it avoids, in numberless instances, the division of a simple integral number by an unwieldy decimal, permitting, instead, the simpler multiplication of the decimal by an integer. This refers, of course, to the use of natural functions only. With logarithmic functions there is not the same difference in favor of the secant, so the person who uses logarithms has no use for it. There are thousands of common everyday American mechanics using natural functions who have gone no further in their studies. For these thousands, tables of secants have been prepared, and rules and formulas printed which call for the use of these tables.

In European countries, on the other hand, the common everyday workman knows little, and cares less, about trigonometry. It is studied by comparatively few except those in the schools who take courses which include trigonometry, logarithms, and mathematical branches even more advanced. It is, therefore, on the whole a hopeful sign that the secant survives among us, when it has become in Europe of little more use than the vermiform appendix.

THE CANCELLATION OF MACHINE TOOL ORDERS

A subject which vitally concerns every machine tool builder — the cancellation of orders without forfeit — is to be discussed at the coming convention of the National Machine Tool Builders' Association at Rochester, N. Y. The difficulties of discontinuing this practice are obvious, and while it is doubtful if the discussion results in a practicable method of correcting the abuse, it will serve to focus the general attention of manufacturers on a practice which is not tolerated in any other industry, and it may result in some modifications of the present custom which will help the situation. Machine tool builders usually enjoy cordial relations with their customers and most of them will hesitate to adopt rigid conditions of sale that will offend good friends, and which if rigidly adhered to will allow many sales to pass to competitors who are not so scrupulous. But the practice of accepting orders from dealers and users for machines to be delivered several months ahead is often a sort of gamble in which all the risks are assumed by the manufacturer; because if any sudden drop in business takes place the dealers have little hesitation in cancelling the orders and throwing all the loss on the manufacturer; and the buyer is not always to blame, because he often simply accepts the terms urged on him by the salesman.

When orders are placed for machine tools they call for money to be invested in material, sometimes for equipment to be purchased, for the organization to be kept up to a certain strength and for outlay in various directions to make deliveries as promised; and the cancellation of such orders should be penalized in some reasonable proportion to the value of the machines. Machine tool builders who order pig iron for castings must take the iron no matter what changes have taken place in manufacturing conditions or in price in the interval before delivery. No cancellations are permitted; and so far as practicable buyers of machinery should be held to similar terms.

* * *

INDUSTRIAL EDUCATION AND THE SALES DEPARTMENT

Few people in the selling department realize the importance to them of industrial education. It doesn't attract them because it apparently doesn't touch their work; but they forget that mechanical ability in the men who construct the machines is as necessary to their sale as the foundation is to the building in which the selling department has an office. Imagine one selling organization representing a concern whose product is turned out by mechanics of the highest skill; and another representing a plant manned by "floaters" and half-educated machinists, with a superintendent and foreman of the same character.

Which organization would *you* prefer to represent, and why?

Perhaps you, who read this, are one of the big manufacturers who have given time and money to improving conditions which every thinking man sees will determine the future of our machinery industry; perhaps you are in the selling end of the business with only a slight interest in the manufacturing part. We say to you that whether you occupy a leading or a minor position, your future is linked with the prosperity of the machinery industry, and *that* is based on the mechanical ability of the workmen.

The reading of a good mechanical journal is an essential part of a mechanical education; but that isn't enough, and MACHINERY for several years has been building up a system for supplying inexpensive, but practical and authentic, material to mechanics who seek to educate themselves, and as a help to the various agencies which are pushing industrial education. We have at present about $60,000 worth of such material, and during the past year have sent out over 2,000,000 pieces of printed matter of an educational character. There are nearly 500,000 more-or-less skilled men connected with the machinery industry, and it takes a lot of material, systematically distributed, to reach them all, even occasionally. If you are taking no part in the work for industrial education, write us and we will suggest how you can help.

This isn't a money-making proposition.

MACHINING A GRINDER COLUMN AND KNEE

By ETHAN VIALL.*

In the manufacture of a universal grinder, the Thompson Grinder Co., Springfield, Ohio, uses several interesting jigs and fixtures. The center columns, the shape of which is shown in Fig. 1, are first strapped, small end down, to an angle-plate on a boring mill and the large end is counterbored as at *A*; the casting is then reversed and set over a centering base-plug on the boring mill table, and the center hole *B* is bored out. From here the casting goes to a Fosdick radial drill, Fig. 3, where the two large holes in the base, one of which is for the elevating screw, are drilled and reamed. The jig used is shown more plainly in Fig. 4. The casting is centered by the counterbored base which fits over the turned bosses on the jig spider.

The planing fixture used to hold the column while finishing the V's, is as simple, yet as complete and mechanically

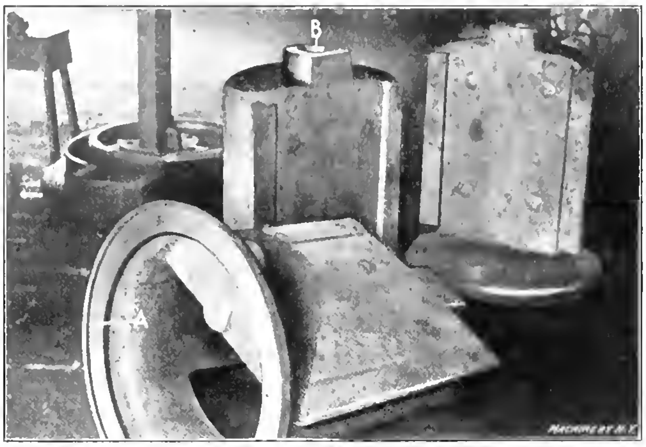

Fig. 1. Partly Machined Grinder Column Castings

correct, as it is possible to make it. The casting itself is placed on what is practically a mandrel, consisting of part *A* (Fig. 2), which passes through the bored center hole of the column, and a flange *B*, turned to fit the counterbore in the base of the column. The whole fixture is mounted on two V's and a base, and is so arranged as to be easily indexed and locked in the desired position. The casting is located on the mandrel in the correct position relative to the index holes in the flange, by means of the plug *D*, which enters the reamed elevating screw hole, previously mentioned. The first posi-

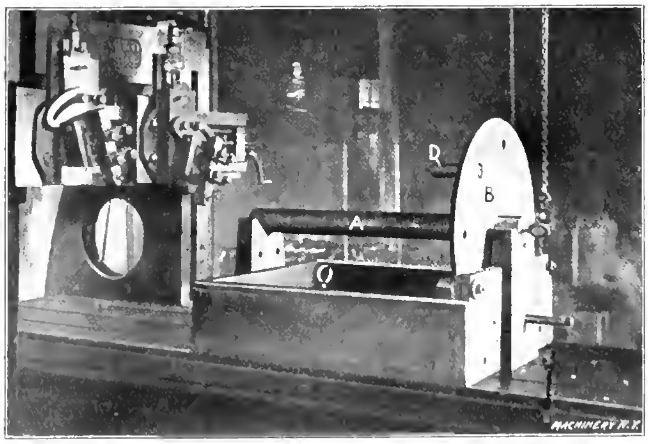

Fig. 2. Fixture used for Planing V's on Column

tion of the casting is shown in Fig. 5, where it is ready to have the flat sides of the V's planed. After this operation the jig is indexed, as in Fig. 6, by using the pin *A*; the other side of one V is then planed, after which the jig is indexed to the opposite position and the other V finished.

There are many advantages in a fixture of this kind, not the least of which is the ease with which the different planing positions are obtained, and the proper relation of the V's to the center of the column.

The knees fitting the columns are planed in gangs, using

* Associate Editor of MACHINERY.

the jack shown at *A*, Fig. 7. The first position of the knee is shown at *B*. After the dovetail ways are finished, they are used to locate the casting on the special angle-plate *A*, Fig. 8, and the pads *B* and *C* are finished.

* * *

OLD TAPER TURNING ATTACHMENT

A. J. Leatherman, 21 College St., Dayton, Ohio, has sent us a clipping from the *Scientific American*, November 29, 1851, illustrating and describing an engine lathe, built by J. D. White, Hartford, Conn., having a taper attachment. A patent was granted to Mr. White for the invention May 21, 1850. The attachment consisted of a guide bar mounted on the lathe bed top in front. This guide bar was adjustable to vary the angle of taper, and had a rack cut on the front surface. Just how it controlled the action of the cross-slide is not clearly shown in the illustration and description, but apparently the cross-slide was shifted with the bar, which, of course, would throw it out of square with the spindle and make it useless for squaring up when the lathe was set for taper turning. It would be interesting to learn if one of these lathes is still in use.

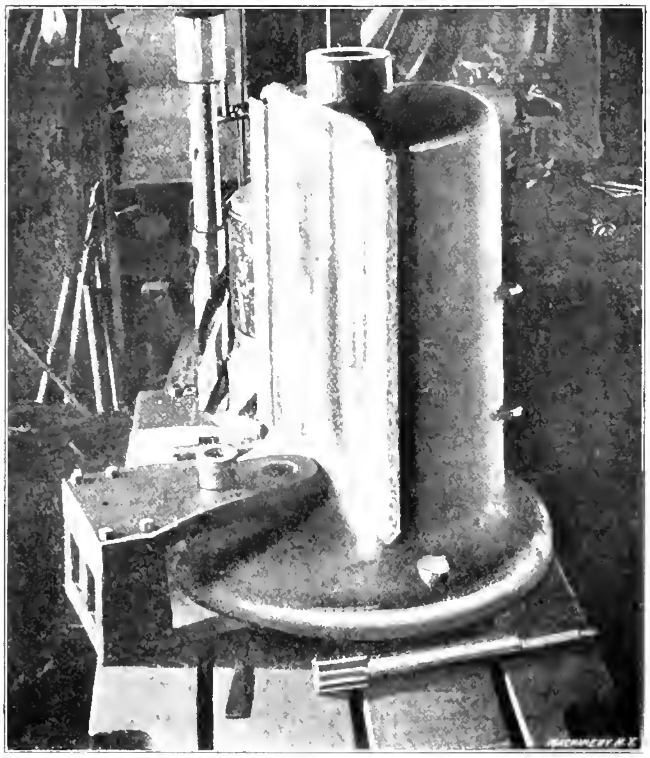

Fig. 3. First Drilling Operation on Column

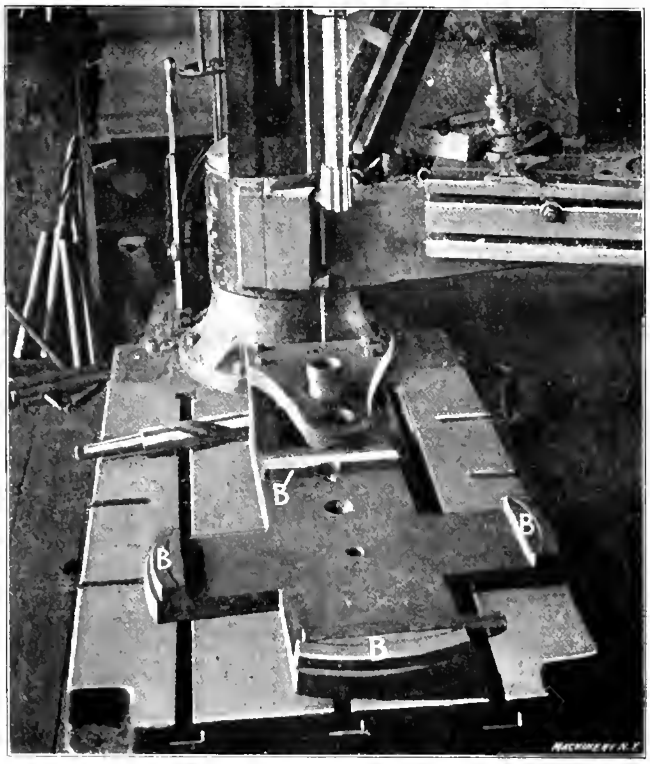

Fig. 4. Jig used for Drilling Column

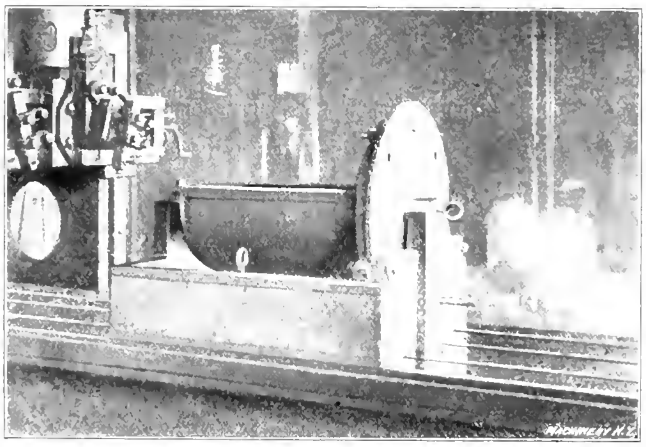

Fig. 5. First Planing Position of Column

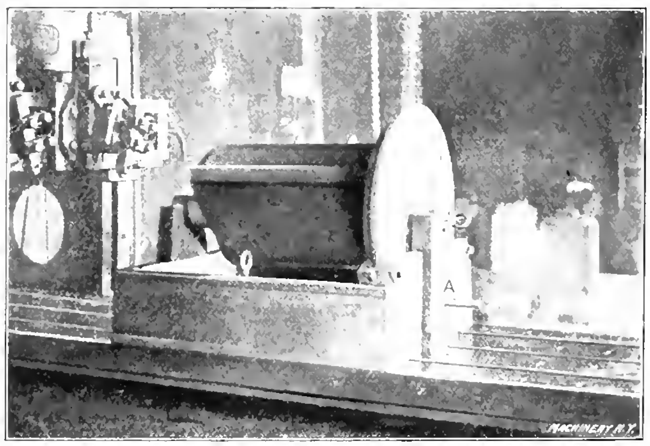

Fig. 6. Second Planing Position

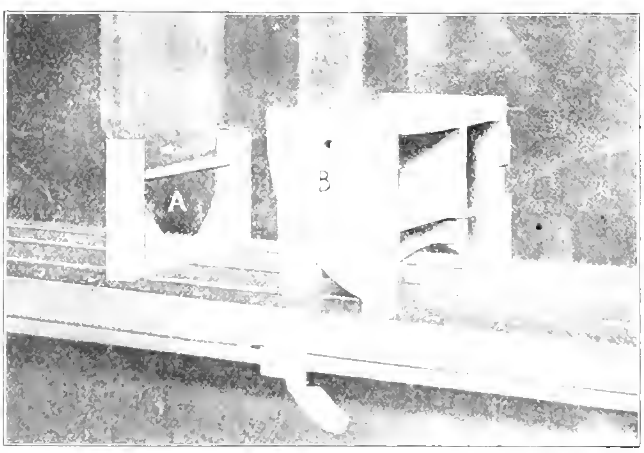

Fig. 7. First Position of Knees on Planer

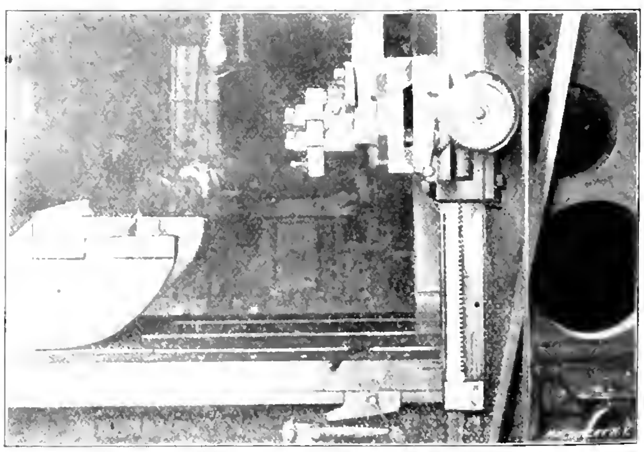
Fig. 8. Second Position of Knees

ESTABLISHING A COMMERCIAL STANDARD FOR PIPE FITTINGS*

By F. W. BARROWS†

There is no doubt that the early attempts to produce salable fittings, confined as they must have been to the filling of orders for a few of the smaller sizes, and to be used for what would now be considered low pressures only, were less hampered by competition, and the manufacturer easily produced goods which not only satisfied the customer, but also yielded a good profit. Prices were higher, and he was not obliged to count expenses so carefully. Later, competition for orders, to be obtained only at lower prices, reduced these profits; and to save himself, the manufacturer must cut down the cost. Because of the small production resulting from reduced sales, the manufacturer did not feel able to invest more capital in improved facilities, thus reducing labor cost, so a quicker and more effective method was readily found in the reduction of weight; thus saving the profit by the saving in raw material.

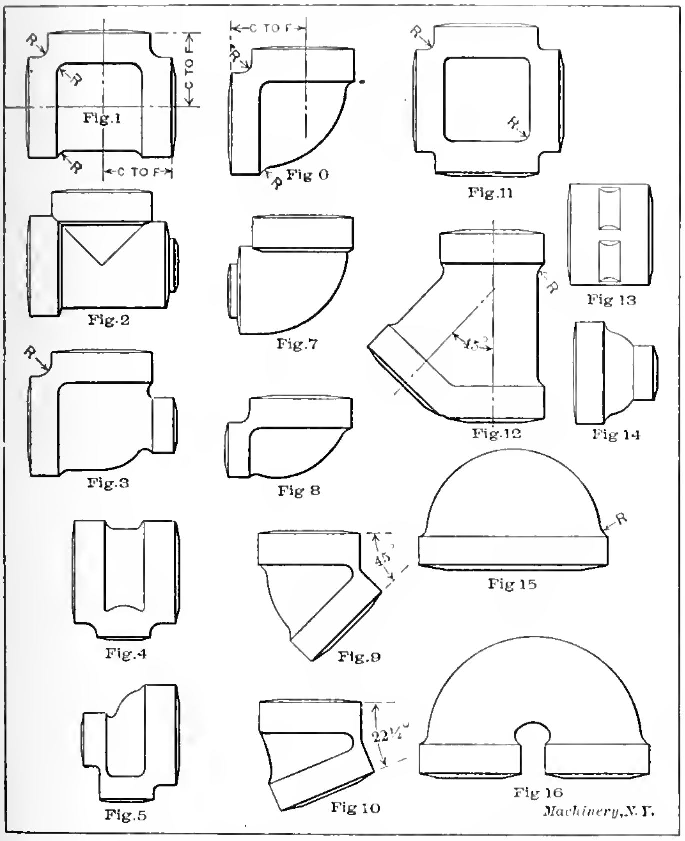

Fig. 1. 1-inch Tee. A Straight Fitting. Fig. 2. 1 x 1 2 x 1-inch Tee. Old Style Reducing Tee, Reducing on Run only. Fig. 3. 1 x 1/2 x 1-inch Tee. New Style Reducing Tee, Reducing on Run only. Fig. 4. 1 x 1 2-inch Tee A Reducing Fitting, Reducing on Branch only. Fig. 5. 1 x 1 2 x 1 2-inch Tee. New Style Reducing Tee, Reducing on both Run and Branch. Fig 6. 1-inch Ell. A Straight Fitting; sometimes called a Quarter-bend. Fig. 7 1 x 1 2-inch Ell. Old Style Reducing Ell. Fig. 8. 1 x 1 2-inch Ell. New Style Reducing Ell. Fig. 9. 1-inch, 45-degree Ell. A Straight Fitting; sometimes called an Eighth-bend. Fig 10. 1-inch, 22 1 2 degree Ell. A Straight Fitting, sometimes called a Sixteenth-bend. Fig. 11. 1-inch Cross. A Straight Fitting. Fig. 12. 1-inch, 45 degree Wye. A Straight Fitting. Fig. 13. 1-inch Coupling. A Straight Fitting. Fig 14. 1 x 1 2-inch Coupling. A Reducing Fitting; commonly called a Reducer. Fig 15. 1-inch Return Bend. A Straight Fitting; called a Close Return Bend Fig 16 1-inch Return Bend. A Straight Fitting; called an Open Return Bend

This change in weight was the more willingly made, because it gave an opportunity to improve the pattern and core-box; heretofore, they had been all that could be desired, but now they were discovered to be entirely inadequate. The old outfit consisted of a single pattern and a half box, and the increasing demand for the goods made more patterns necessary; perhaps enough loose patterns were made to fill the flask, then the loose patterns were gated together and a complete core-box was made; the gated pattern and the solid core marking the first step towards reducing the labor cost.

These gated patterns, if for fittings made up of straight pipes, like tees, Figs. 1 to 5, crosses, Fig. 11, laterals, Fig. 12, or couplings, Figs. 13 and 14, were usually made of wood; if for elbows, Figs. 6 to 10, or return bends, Figs. 15 and 16, they were made of brass. The core-box, first made of wood, was quickly worn out, and was replaced by one of cast iron, cut by the machinist or toolmaker from the solid stock. The metal pattern-maker's work, at this time, was applicable only to soft metals, white metal and then brass. Later on the boxes as well as the patterns were cast from wood patterns, first in brass, when it was found that the brass boxes did not retain their roundness, the ductile metal being quickly hammered out of shape by the core-maker, and then in iron, which was a great improvement; later when the master patterns for these boxes were successfully made of plaster, it was thought no further improvement could be desired. Here the pattern improvements rested for some time and the efforts to reduce cost were concentrated upon perfecting the machines for tapping, and on increasing the output.

Automatic machines had long been used for the tapping, and they were constantly being improved. When a greater output was found necessary, additional machines were made, in which were embodied the changes found desirable. The first machine designed to tap all sizes was necessarily made heavy enough for the biggest fitting, with two or three changes of speed to accommodate the various sizes. This was further complicated by the changes made to suit the different pitches of thread, and when the need of more machines became apparent, one of the first improvements suggested was to increase the output by restricting the machine to fewer sizes, thus making its speed constant. It was still found necessary to provide for change of pitch; first, because of the constantly increasing number of reducing fittings (some idea of the variety of sizes may be had from the statement that at least one firm was prepared to furnish any combination of sizes possible, from four-inch down to quarter-inch, in either tees, crosses or 90-degree elbows) for all of which the new machines must be adapted; and later to suit the different standards, the Briggs, the English, the fine Casing threads used in oil and gas wells, and more rarely, fine threads for brass tubing; some small fittings were even tapped to fit standard bolt threads.

This change of the machine to suit different pitches, was very much simplified by making the lead-screw a continuation of the tapping spindle, and removable. Then when a change was called for, a lead-screw and nut, of the desired pitch, could be substituted for the regular Briggs' standard screw. As the machine reversed itself at a fixed point, no change of speed was necessary to accommodate the change of pitch. The improved machines soon caught up with the foundry. With the old machines, the foundry had easily kept ahead of the tapping-room, and thus escaped all complaints based on delay in getting out orders. Now the tapping-room proceeded to roll up its sleeves and show the foundry how to rush out the goods. To increase the foundry output, further improvements in pattern outfit were then found necessary, and how this was accomplished may be seen in what follows.

A one-inch ell was made from a gate of eight brass patterns (see Fig. 17), the molder putting out from 120 to 130 flasks per day; but even with this production, greater than ever before, the firm was unable to keep up with the orders, and it was suggested that this pattern be put on a "squeezer"; this was the only form of molding machine then in common use, and immediately the question came up as to what should be done about flasks. Let it be explained that the firm used the same kind of machines in the brass foundry, and had many of the patterns—made of brass for brass goods—mounted on stripping plates. The flasks used in the brass foundry were of iron, and were interchangeable as regards dowels; but the brass foundry ran three heats each day and one man or job required not more than twenty flasks.

The firm had already tried, without success, to use snap flasks on these molding machines (the writer does not know why it failed), and it seemed for a time, as though the use of stripping plates in the iron foundry depended on the cost of the flasks. The one-inch ell would require not less than 125 flasks, and we were hopeful of getting 150 molds a day. As the iron foundry took but one heat a day, it would therefore be necessary to provide 150 flasks, if our expectations were to be realized. Again, all the brass foundry patterns were fitted to one of two standard sizes of flasks; as a consequence, the molder could easily be changed from one job

* See MACHINERY, November, 1909: Pipe Fittings, Theory vs. Practice in Their Manufacture.
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to another, without any change of bottom boards or flasks. This arrangement was entirely practicable for the brass foundry, with its comparatively small run of sizes in the work produced, but would not be economical for the iron foundry, with its much greater variety of work and sizes, where the practice had been to furnish many more sizes of (snap) flasks—in fact, almost as many sizes as there were patterns. While the work might be so arranged that the molder could continue to use the same bottom boards—*depth* of flask, or a small variation only, of its size, making this possible—he was almost sure to get a new flask with the new job, and the question of being able to store so many flasks and quickly

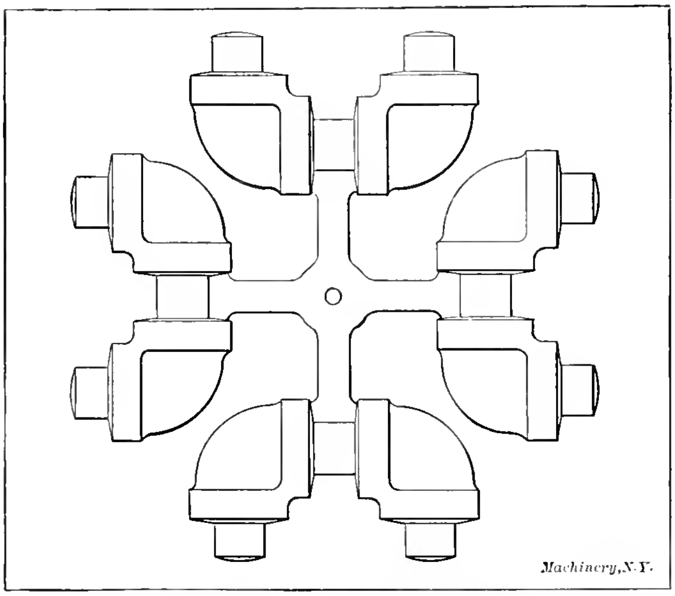


Fig. 17. Method of Gating Eight Brass Patterns

change from one size to another, threatened the success of their use. Neither was the greater cost of so many flasks to be overlooked.

Stripping plates would make cheaper help available, a fact that had already been demonstrated in the brass foundry, and as we fondly hoped, would also increase production. Both of these features would decrease cost, and therefore seemed very attractive to the firm; so it was decided to make the one-inch ell outfit and try it out with a snap flask. Taking into consideration the unskilled help we proposed to utilize, it was thought best to increase the present size of this flask and spread the patterns a little further apart, which would tend to prevent break-downs in the mold, and lessen the liability of wash by their pouring. Then it was suggested that a little more sand around the outside of the mold would make the use of bands or slips unnecessary, and the flask was still further enlarged.

The molder, like most all tradesmen, was quite conservative, and freely predicted the failure of the new pattern; but he proved to be a false prophet, for while the production went down—the result of increasing the flask size—the cost went down so much faster, that the first few days showed a saving of more than thirty per cent in molding cost, with an increasing output that promised to still further increase this saving. But in one way the molder's prophecy was verified; we had failed to increase production; in fact we had decreased it some twenty per cent, and a second set of patterns was ordered at once, as the firm could no longer afford to run the gated pattern, and this reduction of output put it still further behind its order.

The conservative molder, seeking to justify his predictions, criticised the new mold because of its, to him, unnecessary size, pronouncing it a "great big nothing," and called attention to the fact that its large size had not prevented some "run-outs." While these run-outs might well have been due to lack of skill—the new man was a laborer taken from the floor—it was thought best to use bands in the future.

Elated with the continued success of the new pattern, the molder was now in danger of becoming an extreme radical on the subject of stripping plates. He made many suggestions: the flask was too large, it took too much sand to fill it; the core-prints were too long, and the patterns could safely be placed more closely together. So a new layout, Fig. 18, was made, doubling the number of pieces, in a slightly larger flask, and shortening the core-prints. This shortening of the prints resulted finally in a reduction of core cost. Another laborer was taken from the floor gang, and given the first pattern, which had now been running some weeks; the first man who was now quite skillful, was given the new set. His first day's output beat that of the bench molder with the gated pattern, by a quarter, and reduced the cost to about one-half of what the bench molder had received.

The immediate effect of all this was a rush of work in the pattern shop, and complaints from all the rest of the factory. The stripping plates could not be gotten out fast enough; the patterns, at first made all of brass, wore out too fast, and should be made of harder metal. For this excessive wear the roughly-made molding machine was greatly responsible, the guides being very loosely fitted and thus causing rapid wear where the patterns passed through the plate when in use. Soon there was a space all around the patterns, so wide that a fin of sand would be formed on each half mold made; then when the molds were closed, these fins would be crushed together, and as the surplus sand could go nowhere else, it would be forced into the mold itself, making a very rough parting line on the castings; or perhaps the loosened sand would be washed away by the molten iron and lodge in the casting, under the core or in the top of the mold, either of these results being likely to cause its rejection by the inspector, and thus increase the percentage of bad castings far above the limit fixed by the firm. The core-prints of most patterns were too long; many of them did not match the core-box; the flask made for the first one-inch ell was too deep, and could safely be reduced, giving the molder still less sand to shovel. This question of flask size and depth, was, after some time, fixed by first allowing the necessary depth of sand for the nowel side, and then making its size as large

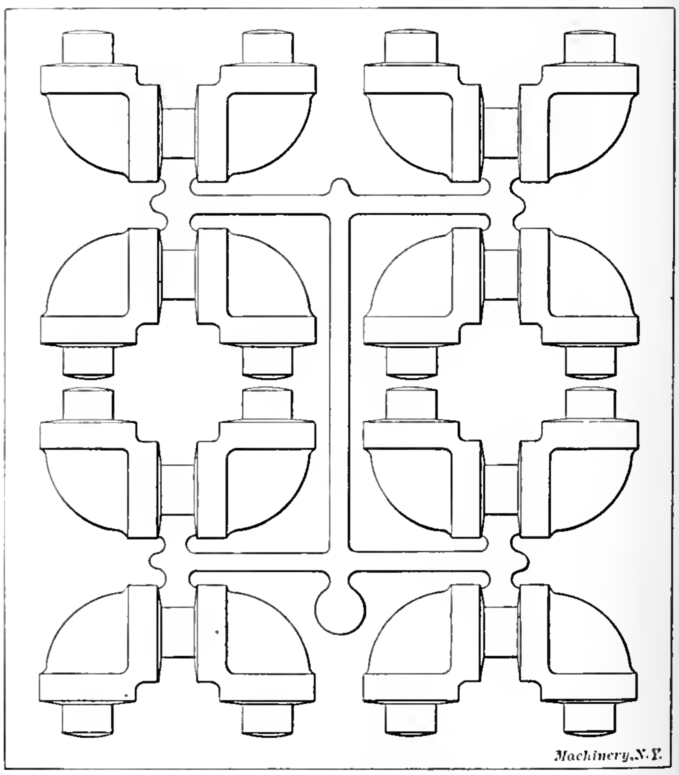


Fig. 18. Method of Gating Sixteen Patterns

as this depth of sand—and the size of the molding machine—would allow, without dropping out.

To these foundry complaints were added those from the tapping-room: such a fitting had too much stock; another wouldn't tap, *i. e.*, the hole was too large; that one was too small to clear the tap and consequently, the tap left a shoulder at the end of its run; this one couldn't be tapped through, *i. e.*, the taps would strike together if the machine allowed them to run through the thread bosses; and still another had too short a threadway.

All of these faults, it was expected, would be corrected in designing and making the new patterns; and as though the foundry complaints, supplemented by those from the tapping room, were not enough, the office added a sort of appendix by announcing that this making over of the patterns would give an excellent opportunity to grade the fittings as to weight and size. What they really had in mind was the price list, and while they did not propose to allow any additions to present weights, they were hopeful of increasing the margin on some fittings by cutting down their weight—grading, they termed it—but sad to say, this grading, like the recent tariff revision, failed to produce any noticeable change in cost.

The first visible effects of these changes were in the design,

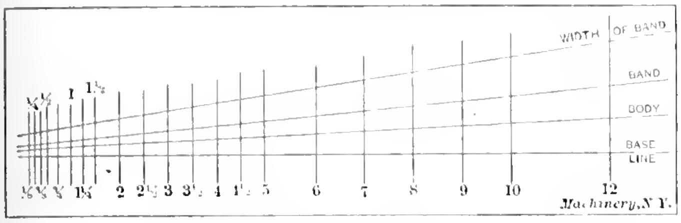


Fig. 19. First Diagram Prepared for the Design of a Graded Set of Pipe Fittings

and were most conspicuous in reducing fittings. In this designing the so-called fitting scale or diagram was used. After many talk-fests and much weighing and comparison of samples from different makers, it was decided that a set of experimental fittings, comprising tees and ells, from half-inch to twelve-inch, inclusive, should be gotten out, tested in all known ways, and criticised by all departments interested in their production. Alterations were to be made if considered advisable, and when everyone—meaning, finally, the manufacturer—was satisfied, the fittings were to be considered as standard in all respects.

To establish a temporary standard for the experimental castings, two sizes of fittings, one-inch and eight-inch, were made up, and having been corrected until their general appearance and weight were pronounced satisfactory, a diagram was drawn as shown in Fig. 19, by laying off on a base line, points through which were drawn perpendiculars marking each size of pipe. These points were spaced to correspond with variations in pipe diameter.

Having fixed, as above, on the one-inch and eight-inch sizes,

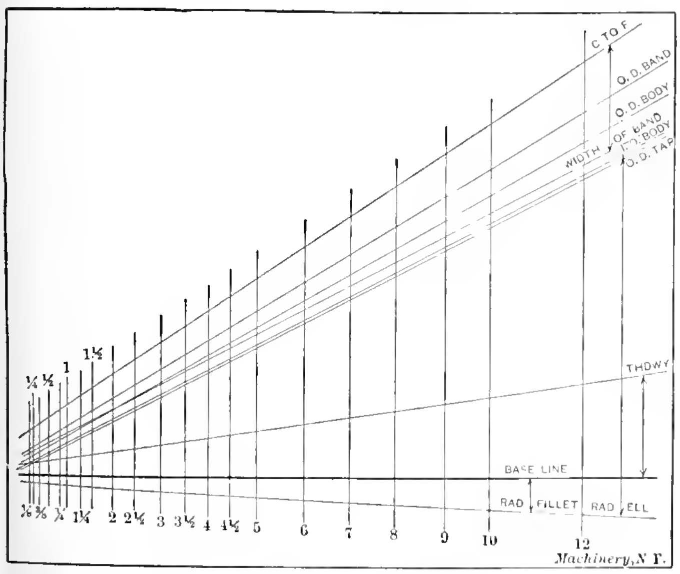


Fig. 20. Second Diagram, used for Pipe Fitting Dimensions

it was proposed to set off from the base line the dimensions of these two sizes, each on its own perpendicular; then lines were to be drawn connecting similar dimensions of the two sizes, and these lines, by crossing all perpendiculars, would fix dimensions for all sizes.

Some preliminary figuring of the thickness necessary for strength, in the different sizes of fittings, was done by using the formula $pd = 2tS$, in which

$$t = \frac{pr}{S - p},$$

p = pressure, 100 pounds per square inch,
r = outside radius of pipe = inside radius of fitting,
t = required thickness,
S = safe tensile strength of material, fixed by applying the formula $S = \frac{p(r+t)}{t}$ to the one-inch size already perfected. This gave $S = 487$, and to make even figures, the value of S was taken as 500. By the formula $t = \frac{pr}{S - p}$, the necessary thickness of the eight-inch size was found to be 0.862 inch, that of the six-inch, 0.662 inch, and of the three-inch size, 0.35 inch.

As these results were very unsatisfactory, all attempts to obtain or fix the thickness by formula were abandoned. But as all formulas for strength of pipes and cylinders fix the thickness by the diameter, other conditions being equal, the perpendiculars marking the different sizes of pipe were spaced by the normal pipe diameter, making the one-inch perpendicular the starting point.

The space between 1 and $1\frac{1}{4}$ inch was made one-quarter inch, as was also that between $1\frac{1}{4}$ and $1\frac{1}{2}$; spaces for sizes from $1\frac{1}{2}$ to 5 inches were made one-half inch; and from 5 inches up, one inch; all laid off in succession towards the right. To the left the smaller sizes were spaced, 1 inch down

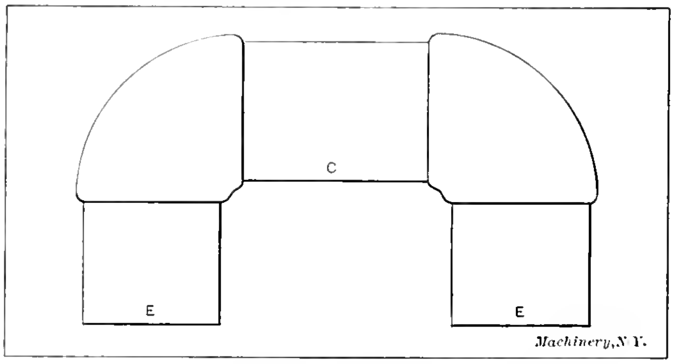


Fig. 21. Core for Ells, causing Difficulties on Account of Settling while "Green"

to $\frac{1}{2}$ inch, one-quarter inch apart, and from $\frac{1}{2}$ to $\frac{1}{8}$ inch, one-eighth inch apart.

This first diagram, Fig. 19, showed thickness at end, or "band"; thickness of body, "body"; and "width of band"; three dimensions only, all to be measured on the perpendicular for desired size of fitting, and from the base line. It was the intention of the designer to establish all other dimensions—not already fixed by usage—by the tap size. The troubles of the designer had just commenced, however, as it was soon found necessary to take into account the actual outside diameter of the pipe, at the end and after it was threaded; and then to allow some regular clearance for the tap, this clearance to increase with the pipe size. The length, which it was intended to fix by adding to the outside diameter of the tap, the regular length of thread plus three threads, to clear the "run" of the machines, was not uniform. Therefore, the first scale was discarded and a second scale, Fig. 20, was made. The base line was drawn and perpendiculars for 1 and 8-inch sizes were erected, seven inches apart, as in the first scale. On these the radius of the outside of the two pipes at the end, after threading, was laid off, and a line "O. D. tap" drawn through these points. Then perpendiculars for all sizes were erected, their positions being fixed by so placing them that the space between the base line and line "O. D. tap" equalled the outside radius of each pipe. These dimensions were Briggs' standard.

From this line, "O. D. tap," a second line, "I. D. body," was established, giving one-sixteenth clearance for radius of an 8-inch tap, and one-thirty-second for a 1-inch size. Then the thickness, fixed by the two corrected fittings, was established for all sizes by the line "O. D. body." Another line, "O. D. band," fixed this dimension, and another, "C to F" graded the length. (See Figs. 1 and 6.) "Rad. fillet" was arbitrarily fixed and applies to all dimensions marked R in the illustration of the fittings. The line marked "Rad. ell"—radius of center line of ell being understood—was drawn through points, dis-

tant from "I. D. body," a distance equal to the "I. D. body" plus the radius of the fillet, and is, therefore, the same line as that marked "Rad fillet." "Width band" explains itself and is fixed by the space between "C to F" and this line; like all other dimensions, this one can thus be taken from the base line. "THDWY," meaning length of thread, was added sometime later. A complete set of tees and ells was designed from this perfected diagram, and made up and sent to the office for inspection, each piece having its weight marked in white lead.

As a set from the old patterns, similarly marked and showing the results of competitive designing, was placed in line with the new fittings, the contrast was quite marked, and the designer of the new fittings was highly complimented upon their appearance. But when the weights were noted—the 6-inch ell, for example, was some five pounds heavier than the old fitting—all further compliments were confined strictly to the general appearance.

It was at first thought that corrections in weight—ordered at once—might be made by cutting out the excess of metal from the inside, in the space between threadways; and this was done successfully in some cases. For the 6-inch ell mentioned, this method would reduce the thickness some forty per cent, which was not to be thought of, and some other way out had to be found. The price, at the time, made it impossible to produce a set of uniformly proportioned fittings which would all sell at a profit, and much time and money was expended in the efforts to produce graded fittings. Patterns have been changed and lists corrected, until much more uniform profits are now realized, but there still remains, with some manufacturers, the tendency to reduce cost—meaning weight—that a better price may be given to secure an otherwise desirable order.

When fittings were made from a single pattern, or even when a gate of patterns was used, such changes involved a comparatively small outlay, which would be increased many fold by any change in the present costly machine patterns, and the multiple core-boxes now in quite common use; so it is quite probable that the order, if it involved a change in the pattern, would now be refused.

Other reasons for continuing the present standard in use might be given; for instance: Many special fittings were made from the regular pattern by the use of a specially constructed core-box, which added nothing to the molding cost; or they were made from a special pattern fitted, when possible, to the regular box, thus saving in cost of cores, and avoiding delay in filling orders. As any change in these special fittings could be made only by the consent of the customer, who might not object to the change in the fitting, but would always object, strenuously, to any increase of cost, it is obvious that any change of the standard fitting was the more to be avoided.

Many lines of piping are in use for high pressure (200 pounds or less) which are made up with standard weight wrought iron pipe. It is practically impossible to increase the length of thread on this pipe and still conform to the standard taper, because of its limited thickness; and the fitting manufacturers take advantage of this in producing so-called heavy fittings, which can be made to fit standard core-boxes, and be tapped with standard taps.

Because of the clearance necessary for "run of machine," in tapping, any additional length of the threadway could only be obtained by adding more length to the pattern, and as core-prints had already been reduced to the shortest possible length, a new box would also be necessary, and fewer patterns, or a larger flask must be used; more time would be taken in tapping, the standard tap—if taper—would not tap through without making the fittings larger than gage, and new taps would have to be made. Other reasons for adhering to the established standard, will suggest themselves to the practical reader, who without doubt, will admit that fittings are *strong* enough, and that changes have to do with their appearance rather than with their strength.

For some time the changes made to correct weights, or as it became the custom to say, "to grade them by the list price," were noted on the diagram; but as there seemed to be no end of such changes, and also, when molding machines came into use, as more draft was found necessary on the ends of all patterns, which made it imperative to change many boxes, because the increased length of thread could not be "tapped through" without making the fittings over-size when gaged, the scale was abandoned in favor of a list for the standard fittings; but the principle was still useful when it was desired to produce fittings adapted to some new need.

The diagram in Fig. 20 was entirely successful in producing a complete set of longturns, or water fittings, as they are sometimes called, no list of prices having been previously established for these goods.

Orders for reducing fittings, Figs. 3, 4, 5, 8, and 14, which sell at better prices, weight for weight, than straight fittings, were eagerly sought after by those makers who were fortunate in possessing machinery adapted to tapping such fittings without making separate runs for each size involved; and because it was impracticable to carry separate patterns and boxes for each of the many combinations, it was the custom to place bushings in the core-boxes, to reduce some more common size to the unusual size ordered. A disposition to accommodate the customer brought more and more orders for these goods, until the bushings used, ever increasing in number, became quite an important item in pattern outfit, and it was deemed advisable to make them interchangeable.

The first move in this direction was, necessarily, to so fix the size of all boxes that while all fittings would tap a full thread and none would have too much stock—all taps for tapping machines are arranged to ream and tap at one operation—each size must be exact, or the bushings wouldn't fit. These sizes were fixed, the smaller ones by reamers, for the iron boxes, and all were made to suit plug gages.

Then, because it had been sometimes found necessary, in making unusually great reductions, to use more than one bushing, placing them one inside of the other, the length of thread, formerly made a fixed number of threads, had to be arranged so that the use of bushings did not produce unsightly shoulders in the casting or form recesses in the core-box which must be filled up before any cores could be made. The new lengths were fixed by laying down the core sizes, in parallel lines, across which other lines were drawn for outside and inside ends of the bushings. An allowance of three degrees was made at the outside end for draft, and a line drawn for the inside end which would give the nearest average of original lengths of thread. As this involved but slight changes in length no new taps were required; and because the lengths now varied with each size of pipe and not by pitch of thread only, the change gave more uniform results when the "C to F" dimensions were to be fixed.

The cost of cores had made it necessary to reduce the length of the prints to a minimum, fixed by actual needs; and they must also be round—the reamers corrected this—to avoid the removal of excessive stock, a cause, in small sizes, of the breaking of many taps; they must also fit the pattern prints; if too large, a "crush" would result, or in extreme cases, the cope would not close down, producing "plated" molds. On the other hand, if they were too small, the core would "float," and the hole in the casting would be out of center, and this would cause "flat" threads; then, because the taps—usually fitted somewhat loosely in tapping machine spindles, to prevent breakage—tried to follow the hole, "crooked" fittings, as those tapped out of line were called, would be produced.

It is impossible to avoid slight variations in size of cores, caused by wear of the box, or by changes in core after making and in process of drying. In such as are made solid, the closing of the box affects the size; and because these solid cores are dried standing on end of prints, the weight, which limits the size that can be successfully made solid, causes the core to settle down, while it is still "green," and enlarges the ends which support it. This weight causes ell cores, Fig. 21, to settle down at the unsupported center, *C*; and while the weight enlarges the ends, *EE*, the sagging of the center spreads the ends apart; this is another cause of "crushing."

Many attempts to so arrange patterns and boxes that these faults might be overcome resulted finally in the production of a second set of gages, to be used in sizing prints, and made with a gradually increasing difference, as the sizes grew larger, between diameter of core-box gage and that of the print gage.

In some cases an allowance was made, in ell cores, for the spreading, by making the distance between the centers of the pattern prints slightly larger than that between the centers of the core prints, or rather, of the core-box.

In the tapping-room many castings were cracked in tapping, a fault not always discovered by the inspector, and therefore the cause of many complaints from customers. It is very easy to crack a pipe fitting on its parting line, as in nearly all fittings the partings of core-box and pattern are both in the same plane, making lines more or less pronounced the whole length of the casting. These lines weaken the casting just the same as scoring or nicking with a file would weaken it; therefore the dowels of both box and flask should be nicely fitted, and kept so. Some patterns were strengthened at the points marked *R* to prevent this cracking, and care was taken in fitting all false jaws in which the castings were held by the chuck while being tapped.

Twenty-five years ago seventy pounds steam pressure was considered high enough for all ordinary purposes and fittings carrying steam at one hundred pounds were few; now one hundred is about the minimum, and even this is endured, in many cases, only because the boiler inspector could not be persuaded to further raise the limit; and the manufacturer, needing more power and too poor to install an entirely new power plant, was obliged to help out this pressure by increasing the speed of the old engine, designed for seventy pounds and seventy revolutions, up to one hundred revolutions. This was all that could be coaxed from the old Corliss gear, and even at this high speed and increased pressure, steam often followed the whole length of stroke, repairs became more frequently necessary and weak spots developed in all steam lines. This brings us back to the necessity for *better* fittings, not heavier, perhaps, for a great deal *can* be done in the matter of threading; both pipe and fittings could be much improved in this respect.

The die for threading is quite commonly made too thin to cut the Briggs' standard length of thread on the pipe, and in the effort to keep the end of the pipe *small* enough, is so made that it leaves an abrupt shoulder at the end of the thread. It should be thicker, that both the taper and length of thread may conform to the standard. If the fitting is tapped slightly over-size, this shoulder comes up against the fitting before the tapered end fills the hole. If the thread holds, this shoulder may be forced hard against the end of the fitting; hard enough to make a tight joint at seventy pounds, but which *might* leak after the pressure had been raised to one hundred.

Small fittings, sizes up to ¾ and 1 inch, and in some shops, to 1¼ incn, are tapped straight, manufacturers claiming that they will make up just as tight as though tapped taper. The real reason for tapping them straight is found in the cost of taps.

Large taps are made by inserting cutters—parallel bars of steel with one side threaded—in grooves milled parallel with the surface of the tapered tap body. These cutters are held in place by a threaded ring which engages the thread on the cutters and also a thread cut upon the rear end of the tap body, enlarged for this purpose to match the cutters. The cutters may therefore be advanced to compensate for the length lost in the grinding, by unscrewing this ring, sliding them along their grooves and then replacing the ring.

As the cutters are made very cheaply, this construction saves much expense; but it is obviously impracticable to make the smaller sizes in this way, and they have to be made solid. If then they were tapered, grinding the end which has to ream out the rough hole in casting and therefore requires frequent sharpening—would soon spoil the size,' and they are consequently made straight, another effect of which the price-list is the cause.

Enough has been said to convince the practical reader that the market-price is the principal thing to be considered in designing standard fittings; and also that this designing will be confined to changes in their appearance rather than in their weight, unless the manufacturer "sits in the game."

* * *

An industrial or trade education is an education in the art of making things. A technical or engineering education is an education in the art of getting things made.

DESIGNING ECCENTRICALLY LOADED BOLT AND RIVET GROUPS*

By HARRY GWINNER†

When a beam or bracket is eccentrically loaded as shown in Fig. 1, tangential shearing stresses are often produced in the rivets or bolts, which are far in excess of the direct shearing stresses due to the vertical load. The direct shearing stress on each rivet is equal to the given load divided by the number of bolts or rivets. In addition to this there is a tangential shearing stress due to the eccentricity of the loading. The resultant of these two shearing stresses must not exceed the shearing or bearing value of the bolts or rivets. A practical example will best illustrate this matter.

Example:- A cantilever or bracket supports a load of 5,000 pounds 18 inches from the center line of the support *H*, as

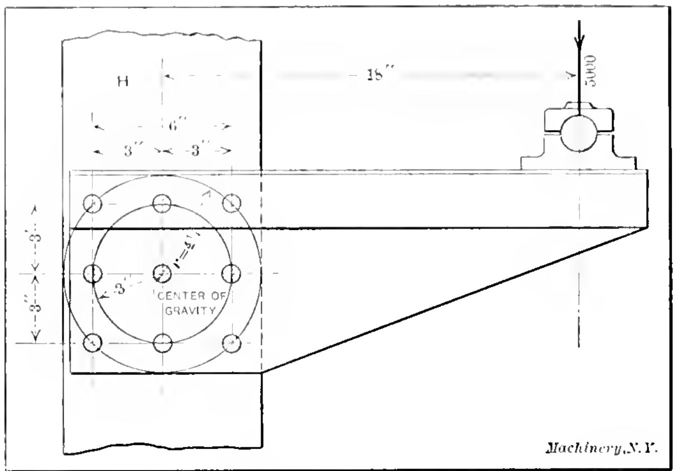


Fig 1 Eccentrically Loaded Rivet Group

shown in Fig. 1. It is required that a suitable group of rivets, giving ample safety, be designed.

In the accompanying Data Sheet Supplement will be found four tables which will greatly facilitate the solution of problems of this kind. These tables are for rivets ¾ inch in diameter, stressed at 10,000 pounds per square inch, giving a safe stress for the rivet area of 4,400 pounds. The first step in designing the rivet group is to assume a certain arrangement for the rivets. In the present case, assume that we decide upon three vertical lines of rivets three inches apart, as shown in Fig. 1. This will make the extreme distance between the outside rivets six inches. The vertical spacing of the rivets should be three inches, the tables in the accompanying Data Sheet Supplement being calculated for this spacing.

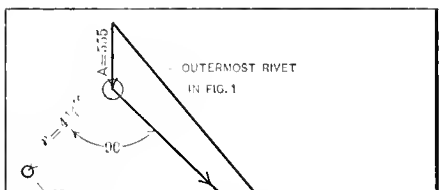


Fig 2. Finding the Total Resultant Shearing Stress on the Rivets

In Sheet III of the accompanying Supplement, a table is given for finding the number of rivets required when arranged in three lines. We locate in this table first the main section headed "18 inches" which is the lever arm of the load. In this section we follow the column under 6 inches, which is the distance between the outside rivet holes, until we come to the figure 5.6, which gives the load in thousands of pounds, or, in this case, represents a load of 5,600 pounds. This is the nearest figure in the table to the given load. Now we follow the horizontal line from 5.6 to the extreme left, and find the number of rivets required for carrying the load, which in this case equals 9.

* With Data Sheet Supplement.
† Dean of Mechanical Engineering, Maryland Agricultural College, College Park, Md.

As a check, on this work, we may carry out the following calculations:

$$\text{Direct shear} = A = \frac{5{,}000}{9} = 555 \text{ pounds.}$$

$$\text{Tangential shear} = B = \frac{W\,L}{P} = \frac{90{,}000}{25} = 3{,}600 \text{ pounds.*}$$

In the formulas above

A = vertical component of the total shearing stress on the rivet,

B = component of shearing stress caused by the eccentric loading,

W = total load in pounds,

L = distance from the center of rivet group to load,

P = polar section modulus.

The polar section modulus P is found from the accompanying table in the section headed "Three Rows of Rivets," opposite the number of rivets which, in this case, is 9, and in the column headed "6," which is the distance between the centers of the extreme rivets in a horizontal direction. This gives us 25 for the polar section modulus in this case.

The resultant of A and B is found graphically as shown in Fig. 2, and is about 4,000 pounds. This is well within the limits of the safe shearing stress of the rivet and the arrangement is, hence, a safe one. In testing the arrangement for strength, attention should also be given to the bearing value of the rivet or bolt on the connecting plates. If the resultant S should exceed the bearing value, the grouping should be re-arranged so as to make the joint safe both for shearing and bearing. The approximate formula

$$N = \frac{\dfrac{W\,L}{a} + W}{V}$$

gives results practically correct for a wide range of cases. In this formula

N = total number of rivets,

V = safe stress in one rivet,

a = average distance from center of gravity to rivets, and

W and L denote the same quantities as in the formulas previously given.

It may be of interest to some to know how the polar section modulus or the values of P given in the table above were calculated. Considering the group just designed we will find its section modulus.

$$\text{Polar section modulus} = \frac{\text{polar moment of inertia}}{r},$$ r being the distance from the center of gravity of the group to the center of the most remote rivet. The polar moment of inertia, designated I_p, is equal to the sum of the products of the area of each rivet multiplied by the square of the distance of each rivet from the center of gravity. In Fig. 1,

$$r \doteq \sqrt{3^2 + 3^2} = 4.25, \text{ approx.}$$

Each rivet is assumed to be of unit* area. In the group under consideration we have four areas at the distance of 4¼ inches from the center of gravity, four at a distance of 3 inches, and one at 0 inch. We then have

$$\begin{aligned} 4 \times 1 \times 4.25^2 &= 72 \\ 4 \times 1 \times 3^2 &= 36 \\ 1 \times 1 \times 0 &= 0 \\ \hline I_p &= 108 \end{aligned}$$

Hence, the polar section of modulus equals

$$\frac{I_p}{r} = \frac{108}{4.25} = 25,$$

which is approximately the same as the value already found from the table.

* * *

The industrial growth and development of Sweden during the last twenty years is indicated by some figures recently published by the Swedish government. The development has, in fact, been so remarkable that it reminds one rather of the boom of a new territory rather than the normal development of an old country. The value of the products of Swedish manufacturing industries in 1887 was only Kr. 191,000,000 ($51,000,000), while in 1907 this value had risen to Kr. 1,496,000,000 ($405,000,000), or an eight-fold increase in twenty years. This great development in the industries has, of course, brought with it a development in other lines as well. The assessed valuation of properties in towns and cities has increased from Kr. 1,040,000,000 ($280,000,000) to Kr. 2,800,000,000 ($775,000,000), and in the country districts the assessment of property other than agricultural has increased from Kr. 272,000,000 ($73,000,000) to Kr. 1,050,000,000 ($283,000,000). This development in the manufacturing industries is largely due to the fact that with the exception of the southern portion of the country, Sweden is not as well suited for agricultural pursuits as some other countries, while it is exceptionally well fitted for a large industrial development owing to the fact that water power is cheap and abundant and that the people in general are mechanically inclined.

* * *

In the January, 1907, issue of MACHINERY the Plauen bridge in Germany was referred to as having the longest masonry bridge span in the world. The span of this bridge is 295.2 feet long. It is now surpassed by the Grafton bridge near Auckland, New Zealand, which is 910 feet in total length and 40 feet wide, and which has a middle arch of 320 feet span, the roadway of this span being 147 feet above the valley.

VALUES OF POLAR SECTION MODULUS FOR UNIT AREA OF RIVETS AND FOR ONE, TWO, THREE AND FOUR VERTICAL ROWS OF RIVETS

One Row of Rivets		Two Rows of Rivets						Three Rows of Rivets					Four Rows of Rivets				
No. of Rivets	Value of Pol. Sec. Mod.	No. of Rivets	Horizontal Distance between Rivets					No. of Rivets	Horizontal Distance between Outside Rivet Rows				No. of Rivets	Horizontal Distance between Outside Rivet Rows			
			3	6	9	12	15		6	8	10	12		9	12	15	18
1	0	2	3	6	9	12	15	3	6	8	10	12	4	10	13	16	20
2	3	4	8	13	19	24	30	6	14	18	21	25	8	22	28	35	41
3	6	6	14	21	29	37	46	9	25	30	35	40	12	38	46	55	64
4	10	8	22	30	39	50	61	12	38	43	49	56	16	56	66	77	89
5	15	10	32	40	50	64	77	15	53	59	66	74	20	77	89	102	116
6	21	12	44	52	63	77	93	18	72	77	86	94	24	102	116	130	146
7	28	14	58	66	77	93	110	21	93	99	107	116	28	131	145	160	178
8	36	16	75	82	94	110	128	24	117	123	131	141	32	163	178	194	213
9	45	18	93	100	113	129	148	27	144	150	159	168	36	199	215	232	252
10	55	20	113	120	132	149	170	30	174	180	189	199	40	240	256	273	294
11	66	22	135	142	154	172	192	33	207	214	222	233	44	284	300	318	339
12	78	24	159	166	178	196	216	36	243	250	258	268	48	332	348	365	390

* Note that the stress thus found is the stress in each ¾-inch rivet and not the stress per square inch. While the formula used is that commonly employed for finding the stress per square inch, the result in this case is due to the fact that the polar section modulus P is not the section modulus for a group of rivets of ¾-inch diameter, but for a group where each rivet is of unit area. The method of obtaining the polar section is explained later in this article.—EDITOR.

* When this is done the stress B as previously found, becomes the stress per each rivet and not the stress per square inch. See previous note.—EDITOR.

DERIHON "FRICTION MILL" FOR TESTING THE DURABILITY OF METALS

In the April number of MACHINERY (page 647, engineering edition) was described a portable apparatus for measuring the hardness of metals, designed by the firm of Usines G. Derihon at Loncin-lez-Liége, Belgium. This was used particularly for testing the hardness of metals used in automobile construction, the makers being engaged in the business of furnishing drop forgings for this work. The apparatus herewith illustrated and described was devised by the same firm for testing

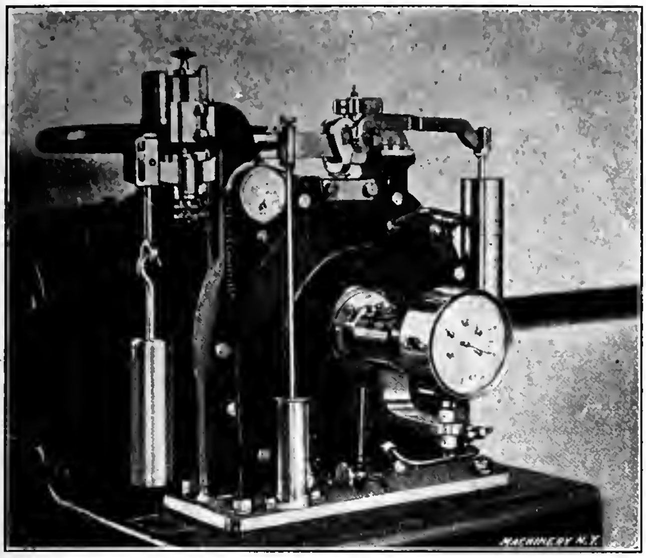
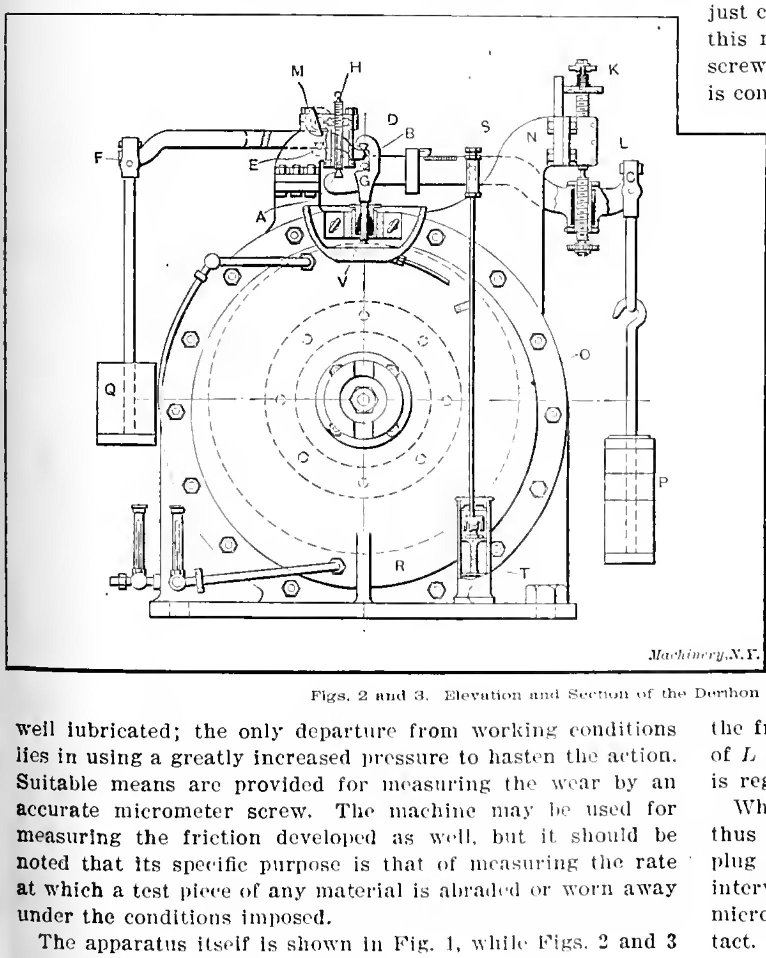
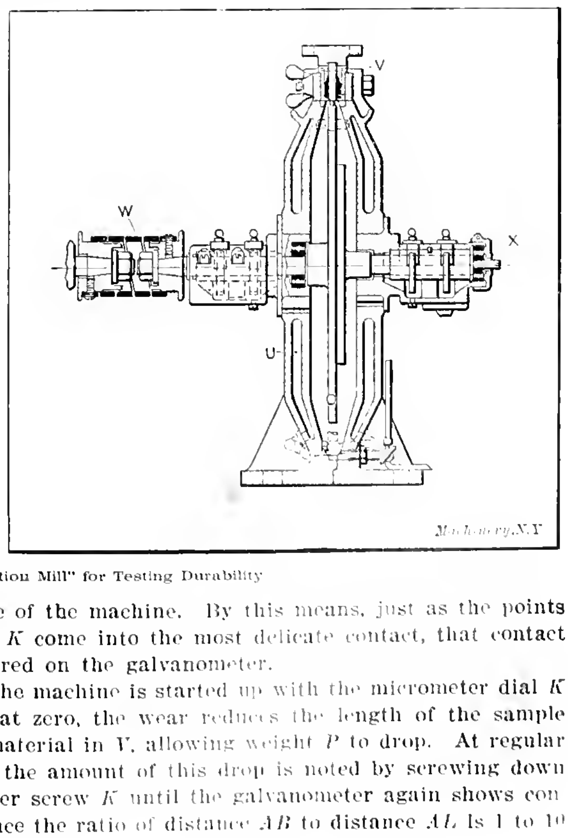


Fig. 1. An Apparatus for Measuring the Susceptibility of Metals to Wear

the durability of metals subject to wear. This has also found its greatest use in the hands of the makers in investigating the suitability of various materials for use in automobile construction, for such applications as gears, bearing metals, etc., where durability is a prime requirement.

With this apparatus the metal to be tested is subjected directly to wear under working conditions—that is to say, the wearing is effected by contact with a moving metal surface





Figs. 2 and 3. Elevation and Section of the Derihon "Friction Mill" for Testing Durability

well lubricated; the only departure from working conditions lies in using a greatly increased pressure to hasten the action. Suitable means are provided for measuring the wear by an accurate micrometer screw. The machine may be used for measuring the friction developed as well, but it should be noted that its specific purpose is that of measuring the rate at which a test piece of any material is abraded or worn away under the conditions imposed.

The apparatus itself is shown in Fig. 1, while Figs. 2 and 3 show the construction. It comprises a casing R, in which is mounted a disk O of extra hard steel rotated from a motor or other prime mover at a constant rate of speed. A holder V, containing the sample to be tested, is pressed down on the periphery of the revolving disk by an accurate and adjustable set of weights, P and Q. The amount that has been worn off from the sample by the revolving disk is tested from time to time by micrometer screw K.

Casing R is filled about one-third full of oil to give the condition of lubrication desired. This casing is water-jacketed, space for this being provided at U as shown. By regulating the water supply, the temperature of the casing is kept constant so that the factor of temperature does not have to be considered in comparing various tests. Disk O is one meter in circumference, and may be revolved at from 500 to 3200 revolutions per minute, giving a surface speed varying from about 27 to 175 feet per second.

The test piece is in the form of a small cylindrical plug, set into the square shank V of stirrup G. This square shank is carefully adjusted and fitted in the stuffing box guide shown, to avoid vibration and oil leakage. Care in the latter particular has to be exercised owing to the high centrifugal force with which the oil is thrown from the revolving disk.

The pressure is applied to the sample by means of weights P, hung on the outer end of the lever whose knife edges are shown at A, B and C. The fulcrum is at A. This bears on an abutment having a screw adjustment by means of screw H and worm M; by using this, lever A, B, C may be brought to the horizontal position at the beginning of the test. The upper end of stirrup G carries a knife edge D, which receives the upward pressure of a lever pivoted at E and carrying weight Q at its outer end. The purpose of this lever and weight is simply to balance the system before weights P are put in place. A sliding scale on the weighing lever provides the fine adjustment necessary for effecting this equilibrium. Weight Q, by furnishing another point of contact for stirrup G at D, serves also to hold the latter firmly in position.

With the test piece in place in V, and the levers set to the horizontal position by adjustment M, as described, the first thing to do is to set the micrometer screw to read from zero. Disk K being set at zero, screw L is turned until the points just come into contact. No dependence is placed on feeling in this matter, as that would not be delicate enough. Instead, screw L is insulated from the lever in which it is seated, and is connected by wire with a battery and galvanometer through the frame of the machine. By this means, just as the points of L and K come into the most delicate contact, that contact is registered on the galvanometer.

When the machine is started up with the micrometer dial K thus set at zero, the wear reduces the length of the sample plug of material in V, allowing weight P to drop. At regular intervals the amount of this drop is noted by screwing down micrometer screw K until the galvanometer again shows contact. Since the ratio of distance AB to distance AL is 1 to 10

and the graduations on dial K read to 0.01 millimeter, actual changes in the length of the test specimen as fine as 0.001 millimeter are read directly, and with accuracy. A dashpot T is supplied, as shown, connected with lever A, B, C, by spring connection S. This steadies the action of the lever, tempering the vibrations and making fine measurements possible. The ratio of distance AB to AC is 1 to 12, so that the pressure applied is easily found.

The apparatus is shown ready for work in Fig. 1. It is provided as shown with revolution counters, galvanometer and thermometers for indicating the temperatures of the jacket water. A motor is shown direct connected to the apparatus. This may be provided with volt and ampere meters if it is desired to make records of the power absorbed in friction. Since, however, this frictional loss is largely due to the friction between the plate and the oil bath, rather than that between the plate and the test piece, such use is not recommended.

In using this apparatus in testing the durability of metals, some investigations were made to see if there is any relation between hardness as measured by the Brinell apparatus, and durability as measured by this machine. No direct relation between the two characteristics was discovered. The accompanying table gives particulars of a series of experiments along this line. In these experiments the test piece was subjected to a pressure of 48 kilogrammes per square centimeter (682 pounds per square inch), with the friction disk turning at 3200 revolutions per minute or 175 feet per second, for a period of ten million revolutions.

An examination of the table proves that the presence of carbon has an unexpectedly small effect on the resistance to wear as compared with manganese and silicon. This is in accordance with the experience in railroad work, in which rails high in manganese and silicon have been found to wear less rapidly than when these elements are lacking. It would seem that the carbon has practically no effect at all, since half hard steel having a high percentage of manganese and silicon wears much less than hard steel having a small percentage of these two elements. Compare, for instance, samples 1 and 2 in the table, the latter of which was worn out nearly twice as rapidly as the former. Not until this second sample had been hardened, as shown in test No. 7, could it be compared with respect to the wearing of sample No. 1.

It is evident and, in fact, proved by experience as well as by these experiments, that heat treatment has an effect on the resistance to wear. Mild steel which in the natural state wears 0.325 would only wear 0.025 if casehardened and tempered. Similar improvement occurs in nickel chromium steel.

Similar tests have been made on bronze and other bearing metals. Bronzes containing lead and antimony are of the kind which resist wear best, in spite of their weak cohesion. One of the test bars was so soft that an 8 millimeter ball under a weight of 12 kilogrammes made an impression on the metal. This same test bar, however, gave the smallest coefficient of wear. Hard bronze, on the other hand, such as phosphor-bronze, wears more rapidly. Hard bronzes have broken down and abraded as soon as the pressure reaches one kilogramme per square millimeter (1422 pounds per square inch) in the machine. On the contrary, soft and anti-friction bronzes have never acted in this way, whatever the pressure used.

The designers of this apparatus are now studying the effects of elements other than lead and antimony for bearing metal purposes, and expect to be able to publish valuable results in the near future. The information here given was sent us by the American representative of Usines G. Derihon, Mr. H. A. Elliott, 7502 Carnegie Ave., Cleveland, Ohio.

COMPARISONS OF VARIOUS STEELS FOR DURABILITY AND HARDNESS

No. of Sample	Analysis							Breaking Strength	Elastic Limit	Elongation per 100 m m.	Contraction per cent	Hardness Number (Brinell)	Rate of Wear (Derihon)
	Carbon	Manganese	Silicon	Sulphur	Phosphorus	Chromium	Nickel						
1	0.20	1.30	0.50	0.02	0.05	......	......	92,500	54,100	32	64	156	85
2	0.43	0.80	0.30	0.02	0.06	......	......	116,600	71,200	18	50	255	151
3	0.06	0.50	0.02	0.03	0.01	......	......	56,900	55,600	40	70	99	325
4	0.36	1.70	0.16	......	......	......	......	109,500	79,700	20	......	187	57
5	0.38	1.35	0.08	......	......	......	......	126,600	101,000	14	......	187	80
6	0.34	1.20	0.06	......	......	......	......	130,800	105,300	13	......	196	200
7 (No. 2, tempered)	0.43	0.80	0.30	0.02	0.06	......	......	185,000	175,000	......	20	340	89
8 (No. 3, casehardened and tempered)	0.06	0.50	0.02	0.03	0.01	......	......	......	......	......	......	228	25
9 (casehardened and tempered)	0.08	0.33	0.16	0.01	0.01	1.20	4.76	......	......	......	......	444	20
10 (air tempered)	0.28	0.48	0.22	0.01	0.02	1.43	4.55	242,000	227,000	10	30	387	28

* * *

RUSTPROOF FINISH ON IRON

The so-called "Coslettizing" process for producing a rust-proof finish on iron is referred to in a recent issue of the *Brass World*. This process consists in boiling the iron or steel article to be treated in a solution of one gallon of water, four ounces of phosphoric acid and one ounce of iron filings. By this means a black coating is produced on the iron or steel which protects it from atmospheric and other corrosive influences. This formula gives good results when care is used, but when carelessly handled a certain amount of undissolved iron filings may be left on the surface of the article being treated. As far as the protection of the coating against corrosion is concerned, it is stated that a piece of steel treated by the process and immersed in salt water for nearly a year has resisted its attacks so that it is practically free from corrosion, while a similar piece untreated has become badly rusted.

* * *

The rifle barrel rollers in the Springfield Armory, Springfield, Mass., evidently are not superstitious; at least they seem to have no fear of the hoodoo "13." The billets from which the barrels are rolled are passed between a pair of rolls having eleven grooves, the grooves being shaped so as to roll the barrels large at the breech and small at the muzzle. A barrel is passed once through each groove, except the finishing groove, through which it is passed three times, thus making thirteen passes in all.

IRREGULAR SPACING OF THE CUTTING EDGES OF REAMERS*

By "A"

The question of the proper manner in which to "break up" the flutes of reamers (spacing the cutting edges irregularly), is one which has puzzled mechanics considerably. Some claim that if the flutes of half of the reamer are broken up exactly alike with the other half of the reamer, opposite cutting edges hence being exactly diametrically opposite, the object sought, i. e., the elimination of chatter and the possibility of reaming a round hole, would be obtained. Others maintain that the cutting edges around the whole reamer should be irregularly spaced so that no two cutting edges are diametrically opposite.

The advantages obtained by having the two halves of the reamer identical are that the reamer can be exactly measured, and that an equal width of the land of all the cutting edges can be more easily obtained if desired, as the milling machine table on which the reamer is mounted while fluting would have to be raised or lowered only half the number of times for obtaining this result than would be the case if every tooth were irregularly spaced. The writer, however, does not believe that these advantages in any way outweigh

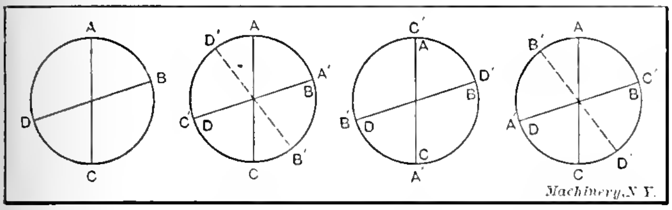


Fig 1 Fig 2 Fig 3 Fig. 4
Four-fluted Reamer, with Cutting Edges Diametrically Opposite. Note Coincidence of Cutting Edges at Various Times during the Revolution

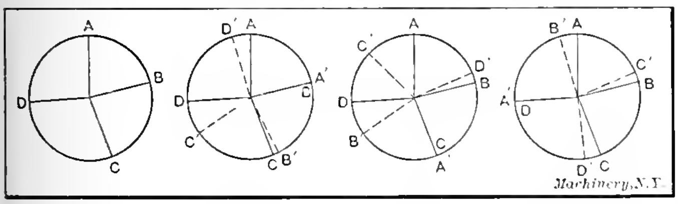


Fig. 5 Fig 6 Fig. 7 Fig 8
Four-fluted Reamer, All Cutting Edges Irregularly Spaced Note that there is no Coincidence of the Cutting Edges during the Whole Revolution

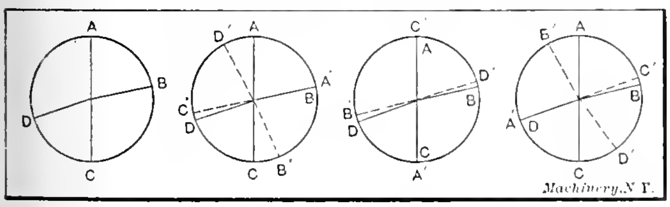


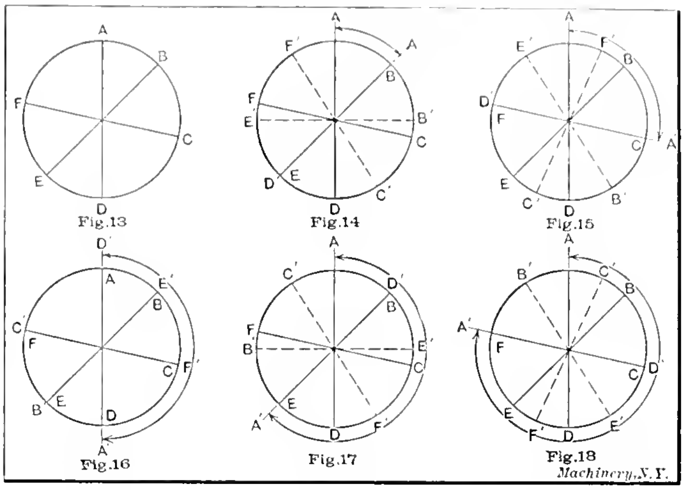
Fig. 9 Fig. 10 Fig. 11 Fig. 12
Four-fluted Reamer, with only Two of the Cutting Edges Diametrically Opposite. This gives Practically as Good Results as shown in Figs. 5 to 8

the disadvantages resulting from this method. When the flutes are not irregularly spaced all around the whole reamer, the tool is liable to chatter, and if it once starts to cut a "cornered" hole, it will continue to do so.

The accompanying illustrations will show why this happens. First, take as an example the case of a four-fluted reamer. Assume that the cutting edges are irregularly spaced as shown in an exaggerated manner in Fig. 1. When this reamer is revolved the cutting edges *A* and *C* will simultaneously occupy the positions originally occupied by *B* and *D*, as shown in Fig. 2. When it is revolved further, *B* and *D* will simultaneously occupy the positions originally occupied by *A* and *C*, and when it has been revolved half a revolution, as shown in Fig. 3, all four cutting edges will occupy the same relative positions as in Fig. 1. In Fig. 4, again, cutting edges *A* and *C* occupy the original positions of cutting edges *D* and *B*. This action is conducive to the production of a four-cornered hole.

* The following articles dealing with the construction and making of reamers have previously been published in MACHINERY: "Hand Reamers," January, 1906; "Reamers," August, September, October, November, and December, 1907.

In Figs. 5 to 8, again, are shown the relative positions occupied by the cutting edges of a reamer having four flutes irregularly spaced all around the whole circumference. It will be seen that here no two cutting edges at any one time will occupy the same position as has been occupied previously by any other two cutting edges, letting alone the fact that the positions of all four cutting edges never coincide except at the end of a full revolution. In Figs. 9 to 12 is shown a method of spacing the cutting edges where two

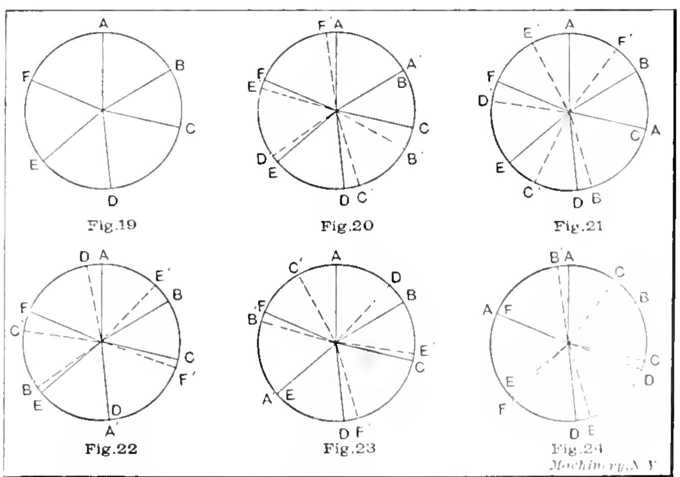


Figs. 13 to 18. Reamer with Six Flutes. Cutting Edges Diametrically Opposite

of the edges *A* and *C* are diametrically opposite, while *B* and *D* are not. This method of spacing the flutes is practically as effective as that shown in Figs. 5 to 8, and when the reamer revolves, the positions of the four cutting edges will never coincide, except when the reamer has been turned around a full revolution. If the reamer starts wrong or commences to chatter, a reamer of the type shown in Fig. 1 has no possibility of correcting itself, whereas reamers broken up in the manner shown in Figs. 5 and 9 will do so.

The illustrations, Figs. 13 to 18 and 19 to 24, show reamers with six flutes. In the first case all the cutting edges are diametrically opposite each other and in the second case all of them are irregularly spaced so that no two are diametrically opposite. The illustrations shown in connection with these, indicate how in the first case, the positions of two and two cutting edges coincide constantly, and how after half a revolution all the cutting edges coincide, whereas, in the second case, there is no coincidence of position of any two cutting edges until the reamer has been turned around a complete revolution.

The error in measuring a reamer when all the cutting



Figs 19 to 24 Reamer with Six Flutes. Cutting Edges Irregularly Spaced

edges are irregularly spaced, and when no two are diametrically opposite, is very slight. The irregular spacing should be so small that the error in measuring should not exceed 0.0003 inch. It has been the experience of a toolmaker of both mechanical and commercial experience that this is rather an advantage, as the reamer, when new, will be a small

amount oversize, providing a slight allowance for wear which is not too great even for a hand reamer. In general, there is no need of a greater irregularity in the spacing of the flutes than that the error may be limited to 0.00025 inch.

As far as concerns the difference in the width of the land of the reamer edges, which is the inevitable result of breaking up the flutes if the table or the cutter is not raised or lowered between consecutive cuts so as to make up for the difference in spacing, the writer does not consider this matter of enough importance to warrant any deviation from the best practice of spacing the cutting edges. The only reason for lands of even width would be for the sake of appearance, as the unequal width of the lands in no way interferes with the efficiency of the reamer. The commercial difficulties in making the lands of equal width, however, are rather too great to warrant unnecessary expense on account of a matter which has no mechanical importance.

* * *

MACHINE SHOP PRACTICE*

TOOL GRINDING—2

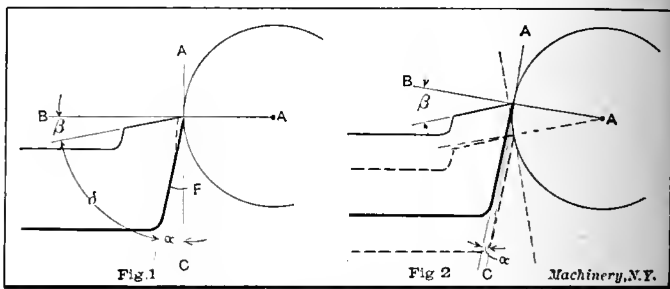
In the preceding installment of this article which appeared in the March number, the shape which should be given the cutting edge of a tool was considered in a general way and it was also explained that the slope for tools which require slope, should be back from the *working part* of the cutting edge, as this is necessary in order to give keenness to that part of the edge which does the work.

Now, in order that the cutting edge may work without interference, it must have clearance; that is, the flank *F* (Fig. 1) must be ground to a certain angle a so that it will not rub against the work and make the cutting edge ineffective. This clearance should be just enough to permit the tool to cut freely. A clearance angle of eight or ten degrees is about right for lathe turning tools, while three or five degrees is sufficient for planer tools.

As was explained in the Shop Operation Sheet accompanying the March number, the back slope of a tool is measured from a line *A-B* (Fig. 1) which is parallel to the shank, and the clearance angle, from a line *A-C* at right angles to line *A-B*. These lines do not, however, always occupy this position with relation to the tool shank when the tool is in use. As shown in Fig. 2, the base line *A-B* for a turning tool in use, intersects with the point of the tool and center of the work, while the line *A-C* remains at right angles to the first. It will be seen then, that by raising the tool, the effective clearance angle a will be diminished, whereas lowering it, as shown by the dotted lines, will have the opposite effect. The effective angles of slope and clearance of a planer tool will also change when its position with relation to the work is varied; thus, in Fig. 3 a tool is shown in a normal position; if this tool were inclined as in Fig. 4, evidently the effective clearance would be greatly increased while the slope angle would be zero, with the result that the tool instead of cutting or shearing the metal, would work with a scraping action. A planer tool is, however, always clamped in a fixed position with the shank at right angles to the table as shown in Fig. 3, whereas a lathe tool, the height of which may be varied, is not always clamped in the same position. This is one reason why a turning tool is given more clearance than one used for planing. The turning tool also requires more clearance because it has a continuous feed and cuts along a spiral path instead of along a straight path, as in the case of a planer tool which is fed at the end of the stroke.

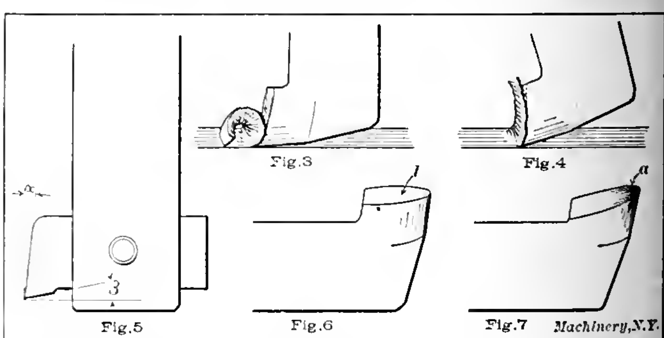
A turning tool for brass or other soft metal, particularly where considerable hand manipulation is required, could advantageously have a clearance of twelve or fourteen degrees, as it would then be easier to feed the tool into the metal; but, generally speaking, the clearance for turning or planing tools should be just enough to permit them to cut freely. Excessive clearance means that the cutting edge will be weakened by a lack of support which may result in its crumbling under the pressure of the cut.

The lip angle or the angle of keenness δ (Fig. 1) is another important consideration in connection with tool grinding, for it is upon this angle that the efficiency of the tool largely depends. By referring to the illustration it will be seen that this angle is governed by the clearance and the slope β, and as the clearance remains practically the same, it is the slope which is varied to meet different conditions. Now, the amount of slope a tool should have depends on the work for which it is intended. If, for example, a turning tool is to be used for roughing medium or soft steel, it should have a back slope of eight degrees and a side slope ranging from fourteen to twenty degrees, while a tool for cutting very hard steel should have a back slope of five degrees and a side slope of nine degrees. The reason for decreasing the slope and thus increasing the lip angle for harder metals is to give the necessary increased strength to the cutting edge to prevent it from crumbling under the pressure of the cut. The tool illustrated in Fig. 6 is much stronger than it would be if ground as shown in Fig. 7, as the former is more blunt. If a tool ground as in Fig. 6,



Figs. 1 and 2 Illustrations showing how Effective Angles of Slope and Clearance change as Tool is raised or lowered

however, were used for cutting very soft steel, there would be a greater chip pressure on the lip surface *l*, and consequent greater resistance to cutting, than if a keener tool had been employed; furthermore the cutting speed would have to be lower, which is of even greater importance than the chip pressure; therefore, the lip angle, as a general rule, should be as small as possible without weakening the tool so that it cannot do the required work. Experiments conducted by Mr. F. W. Taylor to determine the most efficient form for lathe roughing tools, the results of which were previously published in MACHINERY (January to August, 1907, engineering edition) showed that the nearer the lip angle approached sixty-one degrees, the higher the cutting speed. This, however, does not apply to tools for turning cast iron as the latter will work more efficiently with a lip angle of about sixty-eight degrees. This is because the chip pressure when turning cast iron comes closer to the cutting edge which should, therefore, be more blunt to withstand the abrasive action and heat. Of course, the foregoing remarks concerning lip angles apply more particularly to the tools used for roughing cuts.



Figs. 3 and 4. Effect of Change of Position on Action of Planer Tool. Fig. 5. Slotter Tool. Figs 6 and 7. Lathe Roughing Tools Ground for Turning Hard and Soft Steel

In order to secure a strong and well-supported cutting edge, tools used for turning very hard metal, such as chilled rolls, etc., are ground with practically no slope and with very little clearance. Brass tools, while given considerable clearance, as previously stated, are also ground flat on top or without slope; this is not done, however, to give strength to the cutting edge, but rather to prevent the tool from gouging into the work, which it is likely to do if the part being turned is at all flexible and the tool has been given slope.

Slotter tools for general work, such as the one illustrated in Fig. 5, are ground in practically the same way as a planer tool.

* With Shop Operation Sheet Supplement.

If we consider a slotter tool, which is, of course, a vertical planing tool, under working conditions, we shall see that the angle *a* represents the clearance and β the slope, which is given, as with lathe and planer tools, to that surface against which the chip bears while it is being severed.

Often a tool which has been ground properly in the first place, is greatly misshapen after it has been sharpened a few times. This is usually the result of attempts on the part of the workman to re-sharpen it hurriedly; for example, it is easier to secure a sharp edge on the turning tool shown in Fig. 1 by grinding the flank as indicated by the dotted line, than by grinding the entire flank. The clearance is, however, reduced and the lip angle changed.

There is great danger when grinding a tool of burning it or drawing the temper from the fine cutting edge, and, aside from the actual shape of the cutting end, this is the most important point in connection with tool grinding. If a tool is pressed hard against an emery or other abrasive wheel, even though the latter has a copious supply of water, the temper will sometimes be drawn, which will be indicated by a dark blue color at the point, as at *a* in Fig. 7. Burnt tools are, however, sometimes discolored so slightly that the discoloration is scarcely discernible, for naturally it is the fine cutting edge from which the temper is first drawn, and it is also this fine edge which does the work.

When grinding a flat surface, to avoid burning, the tool should be frequently withdrawn from the stone so that the cooling water (a copious supply of which should be provided) can have access to the surface being ground. For the same reason a curved surface should be constantly rolled about on the face of the wheel. A moderate pressure should also be applied, as it is far better to spend an extra minute or two in grinding, than to ruin the tool by burning it in an attempt to sharpen it quickly. Of course, what has been said about burning, applies more particularly to carbon steel, but even self-hardening steels are not improved by being overheated at the stone.

As to the kind of abrasive, the writer believes that there is nothing superior to a free-cutting grindstone for tool grinding. A little more time may be required when a grindstone is used, but the fineness and quality of the edge obtained which results in increased tool efficiency, is by far the more important consideration.

* * *

THE GROWTH OF CAST IRON

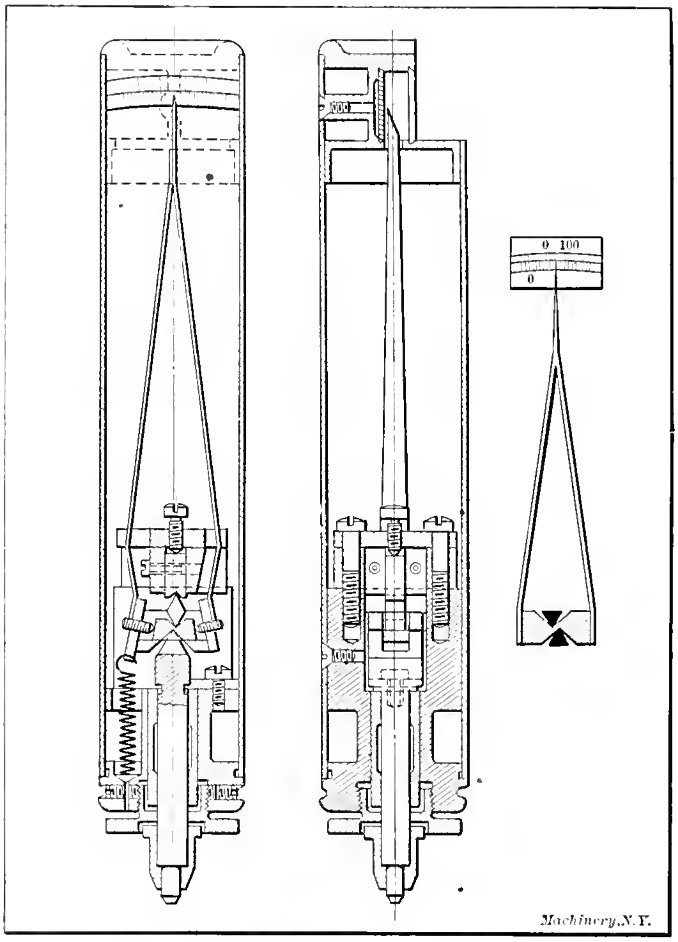
In an article entitled "The Growth of Cast Iron" in the March, 1910, issue of MACHINERY, a comparison was made of the results obtained in the experiments made by Prof. H. F. Rugan and Prof. H. C. H. Carpenter with those obtained by Mr. A. E. Outerbridge, Jr. It was stated that Mr. Outerbridge's experiments did not show an increase in weight of a sample which had increased in volume after repeated heatings, while the other experimenters' samples showed an increase in weight as well as in size. As an explanation of this condition it was stated that Mr. Outerbridge had his samples enclosed in an iron pipe sealed at the ends with clay. Our attention has been called to the fact that the other experimenters heated their samples in the same manner, using an iron muffle furnace sealed with fire clay, so that in this respect there was no material difference in the manner of heating the samples. While the specimens were thus completely protected from the direct action of the flame, the results of the experiments indicate that the gases entered the muffle. Iron heated to the temperature used, about 1470 degrees, becomes permeable to gases. Hence the manner of heating does not account for the difference of the results obtained by the different investigators.

* * *

From the preliminary reports of an industrial census recently taken in Great Britain, it appears that the value of the machine tools built in that country in 1907 was $13,575,000. Of other classes of machinery, locomotives were built valued at $22,100,000, this, however, not including the locomotives constructed by the railway companies themselves. The total value of all classes of machinery built in Great Britain was $450,000,000 in the year mentioned.

THE HIRTH MINIMETER FOR ACCURATE MEASUREMENTS

The accompanying illustrations show a measuring apparatus devised by Mr. Albert Hirth of the Fortuna Works, Cannstatt-Stuttgart, Germany, intended for a comparator to indicate differences of fractions of millimeters existing between the piece measured and a standard gage block, or between the piece measured and a sample piece of arbitrary dimensions. The general construction of the minimeter is shown in Figs. 1 and 2, and the principle of its action in Fig. 3, this principle being the introduction of a long lever arm which at the same time serves as an indicating needle, and a short arm the length of which is determined by the distance between two knife edges. The bearing points of these two knife edges may be varied in order to provide adjustment for the apparatus. One of the advantages of the device is that it eliminates the necessity for lubrication and overcomes the disadvantages of play on dead centers. As indicated in Fig. 1, a spring holds the lever against the knife edges and returns it to its normal position after measuring. The whole mechanism is



Figs. 1 to 3. Construction and Principle of Action of the Hirth Minimeter

enclosed in a tube, the upper part of which is provided with an opening which permits a graduated scale to be seen and the indications of the pointer to be read off. The scale is provided with graduations corresponding to hundredths of a millimeter (about 0.0004 inch). The measuring instrument proper can be mounted in different holders so that it can be used with equal facility for measuring flat and round pieces as well as inside diameters of holes.

In Fig. 4 the minimeter is shown arranged for measuring, or rather comparing, dimensions of flat pieces. In this case the instrument proper is mounted on a standard or upright, carrying at its upper end a clamp for holding the minimeter and at its lower end a small circular table placed on a bracket adjustable for height. When cylindrical pieces are to be compared, the instrument is mounted as shown in Fig. 5. In this case the location of the measuring instrument proper is adjusted by means of the adjusting mechanism shown on the side of the holder, so that the indicator points to zero when the sample or standard gage is placed in the holder. Then

the differences in dimensions of the various pieces are noted by inserting them in the instrument in place of the sample or gage. For measuring inside diameters the instrument is mounted as shown in Fig. 6. In this case the minimeter is held in a bracket having a two-point support provided with means for adjustment so that it can be easily applied to the required diameter.

It is evident from this brief description that the apparatus is a very convenient one for machine shop use. It permits of a comparison of different measuring instruments and gages at given intervals, without the employment of relatively costly standard measuring machines. When standard gages are at hand it indicates exactly the size that the piece of work must have in order to obtain the desired degree of accuracy. It is so simple in its application that it may be employed by the ordinary mechanic as easily as any of the ordinary measuring instruments with which he is familiar. It is evident that this instrument can be applied to many special uses not directly referred to in this description.

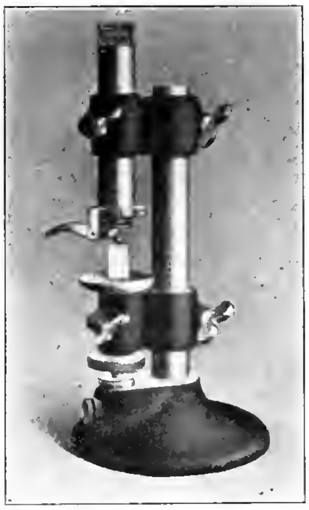


Fig. 4. The Minimeter mounted for Measuring on Flat Surfaces

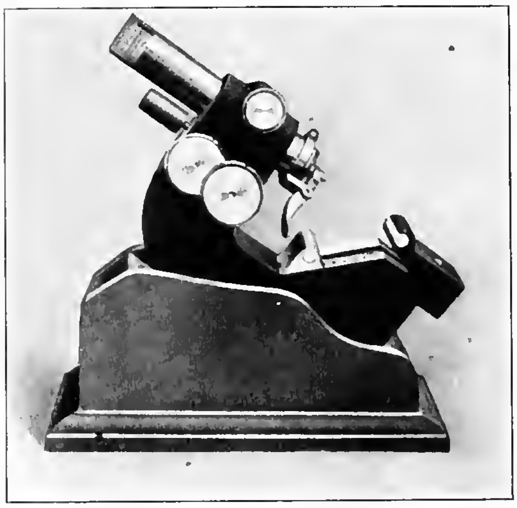


Fig. 5. Minimeter mounted for Use on Cylindrical Surfaces

Fig. 6. The Minimeter used for Internal Measurements

* * *

MAKING FILMS IN A VACUUM

A new method of producing thin metallic films by volatilization in a vacuum was described at a recent meeting at the Academy of Science by Prof. L. Houllevigne, which may have an important commercial influence on the production of gold leaf. The metal to be deposited is first deposited on platinum wire which is then heated in a high vacuum. The film forms on a glass cylinder which is kept in constant rotation near the heated wire. In this manner thin films have been produced of gold, silver, platinum, copper, zinc, tin and cadmium.

* * *

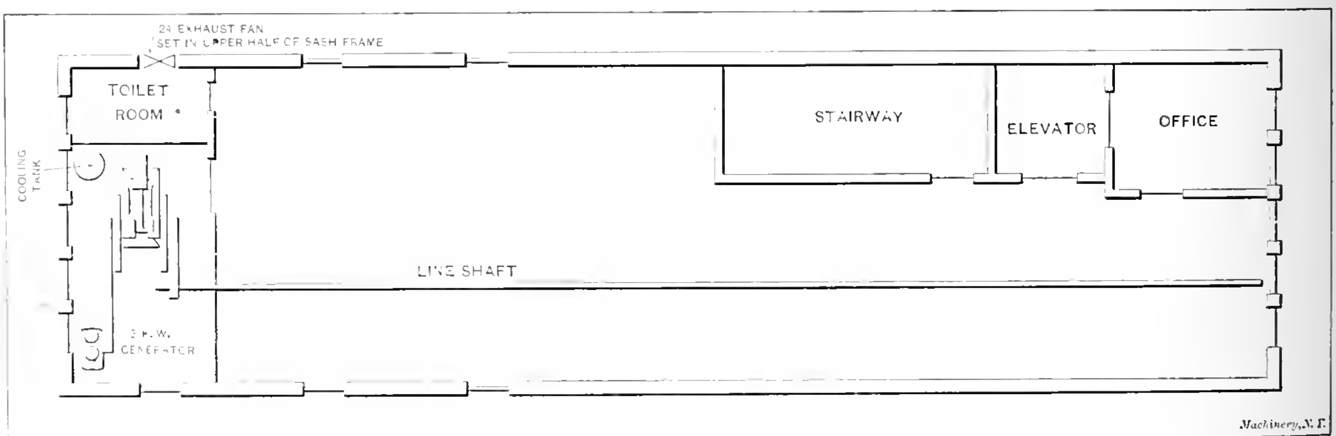
Barney Oldfield drove a 210-horsepower Benz racer one mile in 27.33 seconds at Daytona Beach, Fla., March 16. He broke the former world's mile record of 28.23 seconds made by Fred Marriot with a Stanley steam car in January, 1906, on the same course. The speed attained by Oldfield averaged 131.72 miles per hour.

INSTALLATION OF STATIONARY GAS ENGINES FOR FACTORY USE

By H. J. BACHMANN*

The use of stationary gas engines for industrial purposes in New York state, has been made difficult where the provisions of the factory law are not complied with. It is a well-known fact that the burnt gases which escape from any explosion engine will soon contaminate the air to such an extent as to render it unfit for breathing purposes. The law requires that al work-rooms be provided with sufficient means of ventilation, and it is therefore necessary to make provision for exhausting the foul gases and admitting a constant supply of fresh air.

In the accompanying engraving a typical floor plan of a small loft building such as is used for a large variety of manufacturing purposes, is shown. It is a mistake to place a motor, especially a gas engine, in an out-of-the-way dark corner of a room and expect satisfactory results. In such a location, the motor is neglected, often becomes over-heated, and repairs are made with difficulty. When the engine is located as shown, it takes up a large amount of otherwise available floor space and light, but the benefits derived from such a location more than compensate for the additional expense involved. In the first place, the power plant is in a large, light room, entirely separate from the manufactory, so that it is easy to keep it clean and well ventilated. There is also room for a small generator, which will furnish current for electric light and such small portable electric tools as are used in the shop. This will also do away with another source of vitiated air; namely, the burning of gas jets at each machine, to say nothing of the additional safety and comfort to the operator. If it is desired, this current may also be used for ignition purposes in place of batteries or hot tubes.



Plan of Small Factory driven by Gas Engine, showing Ideal Arrangement

The opposite side of the engine is belted direct to the lineshaft, as shown, from which a drive is taken for the 24-inch

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exhaust fan which is set in the upper part of the sash frame in the toilet. All the partitions shown, run up to the ceiling except the one between the engine room and toilet. With this arrangement the fan will keep the air of both these rooms in as good condition as outdoors without perceptible draft.

If a forced circulation of air is also desired in the factory, a register may be placed near the ceiling in the partition between the engine and work-room, which may be opened or closed to secure the desired result. Furthermore, provision may be made for the supply of fresh air through the windows by opening each sash slightly at the top and bottom. To prevent a draft from this source, the windows may be fitted with any good make of window ventilator.

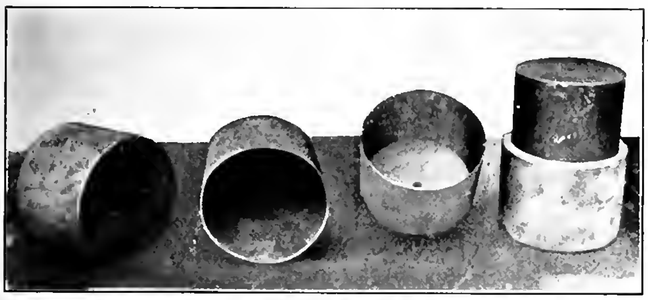
A manufacturing plant arranged as outlined will come up to the strictest requirements of the health and factory laws and may be run in the most economical manner as regards expense for power consumption. Incidentally, the working conditions will be favorable toward securing the steady services of high-grade, intelligent workmen.

* * *

THIN CASTINGS

By WILLIAM PAINTER*

The gray iron castings which are shown in the accompanying illustration do not exceed 1/16 inch in thickness at any point, and they are made commercially in quantities to take the place of sheet metal cups. These castings have practically no draft and they must be without blow holes as they are required to be water-tight. They are made in five different sizes, but only two sizes are shown in the illustration. The four larger ones of those illustrated are 8 inches in diameter



Cup-shaped Castings which do not exceed 1/16-inch in Thickness

and 6 inches deep, and the smaller one is 7 inches in diameter and 5 inches deep. The weight of the larger size is 3 pounds 4 ounces, while that of the smaller one is 2 pounds 8 ounces. The smallest size which is cast is even less than 1/16 inch in thickness and its weight is only 1 pound 4 ounces. This smallest cup has a diameter of only 6 inches and a depth of 4 inches, while the two larger sizes have a diameter of 9 and 12 inches and a depth of 9 and 10 inches, respectively. The weight of these castings must not vary more than 4 ounces.

The work is done under the direction of our foreman iron molder, Mr. Fred Hockenberry, and the process is as follows: First, the pattern which is of metal, is turned to the weight required, the patternmaker allowing from 2 to 8 ounces over the weight of the casting for which the pattern is intended. They are made perfectly straight on the outside, with 1/32-inch draft inside, so a molder will see at once the necessity of rapping the pattern when removing it from the sand.

There are three ways of molding these floats. A two-part flask cut in the middle and having a cope and drag may be used, or a three-part flask having a cope, cheek, and drag, or a two-part snap flask, where flask is removed, and a slip or outside box is forced over the mold; this latter method is not safe, as in forcing the box over the mold, a crush is likely to follow.

The sand used for this job was one-half No. 0 Albany and one-half No. 0 Dresden thoroughly tempered. The greatest care must be taken in wetting and thoroughly mixing the sand, so there will not be any wet or dry parts to come in contact with the pattern, as they will cause blowing or scabbing of the casting.

When molding a float in a two-part flask the molder places the pattern on a plain board; the drag half of the flask, which should be 2 inches deeper than the pattern, is then placed over the latter, and filled about half full of sand sifted from a No. 6 riddle. The sand is then peened around the pattern evenly, care being taken not to leave hard and soft spots that might cause a blow or swell in the casting. After the molder has the first course of sand peened evenly, he makes the second riddling. Care should be taken to see that the pattern is covered, and that there are no soft spots between the two riddlings. The flask is then filled with sand, and rammed properly, and the loose sand is struck off on the bottom board. This board must be set level on the sand edges of the flask. The board is next removed and the sand is vented inside and out of the pattern, so that all gases such as steam and air may escape, as in castings as thin as these any gas that cannot escape will cause a hole in the side wall of the casting. After the venting is done, the board is placed on the flask which is then rolled over. We now have the pattern in the drag half of the flask. The parting is made, care being taken that the sand be firm around the top of the pattern; parting sand is put on the mold, and the cope half of the flask is placed on. The ears should be tight on the pins so that the cope cannot shift. Sprues are placed in opposite corners for pouring, and also in the remaining corners for risers. Enough sand is then riddled to cover the top of the pattern, the sprues are thoroughly tucked around, and the cope is then filled with sand and well peened to get the sand firmly back of the sprues so as to prevent a "run out." The sand should not be rammed too hard over the top of the pattern, as it will cause blow holes and cold shots. The sand is next vented, care being taken not to strike the pattern; the pattern is then rapped through the cope. It should not be rapped much, however, as there is only an allowance of 4 ounces to go on.

After the sprue-pins are removed, the cope is lifted. The gates can best be cut before the pattern is drawn, as then there is no danger of loose sand dropping down the side wall. The gating is one of the important points in casting these floats. A runner should be cut to the right and left of the sprues about 1 inch wide and ½ inch deep.

Leaders to the casting 1½ inch wide and 1/16 inch thick at the point of entering the mold, tapering back to a size of ¾ inch wide by ¼ inch deep where they join the runners, will allow the iron to flow into the mold easily, saving the cutting of the green sand core. The gate should be well thumbed down, so that no loose sand can wash into the mold, as a small particle of sand flowing with the iron and dropping down the side, will leave a hole in the casting. A straight gate is cut into the riser to relieve the strain as the mold has to be forced very hard.

The pattern is drawn with two screws, and great care has to be taken not to break the sand, so as to allow any loose particles to fall in, as it is impossible to remove them. After the pattern is removed, the cope is closed onto the drag, the mold is placed on the floor, and enough weights are placed on the flask to insure the cope not rising when the iron is poured.

The best hot iron is used, and the mold is poured two up; after pouring, the mold is allowed to stand until it is thoroughly cold. As the castings are very thin they should not be exposed to the air while hot, as they are likely to crack by cooling too quickly.

The iron which is used is high in silicon and low in sulphur. Some manganese is added for strength and phosphorus for fluidity. An analysis of the iron used is as follows: Silicon, 2.75; sulphur, 0.005; manganese, 0.20; phosphorus, 0.60; coke, 0.60 to 0.75 in sulphur.

* * *

The dangers of atmospheric electricity in aerial navigation are attracting considerable attention. While an ordinary balloon without metal parts is not exposed to any danger as long as it floats in the air, the modern dirigibles are provided with much framework made of conducting metals. Even a balloon, however, may be charged with electricity and a spark produced when contact with the ground is made, thus setting fire to the gas.

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LETTERS ON PRACTICAL SUBJECTS

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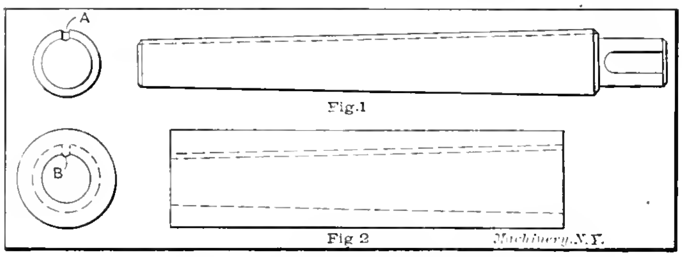
LAPS AND THEIR USE

I have read carefully the interesting article on "Laps and Points on Lapping" by Mr. F. P. Crosby in the February number, and no doubt he has successfully used the method described. However, my experience has been that copper is not a metal to be quickly and accurately worked, and I am sure that Mr. Crosby's method would not be practical in a shop where nearly every hole is finished by lapping—by all classes of workmen. I should be afraid that the split lap, as shown in Fig. 3 of the article referred to, would expand and revolve on the arbor, possibly causing particles of emery to become loose and lodge in the work, especially if it were of brass or aluminum. This style of lap and method of holding might be suitable for very small tool work, but even then it would be expensive.

In consideration of the above article, and in view of the fact that accurate lapping is a very difficult operation for many machinists, it would seem fitting at this time to again consider it in a light possibly new to some. Lapping is not, however, as difficult as it would seem, providing the proper methods and tools are used in the process.

I consider the material used for holding the abrasive one of the most important factors when the work is soft; and it is very important that this material should be softer than the work, which would make it easier to charge. In shops where nearly every hole is finished by lapping, lead has been adopted as the best known metal to use. It is inexpensive and can be remolded by apprentices; besides it charges very quickly, which is a much desired and important feature.



Figs. 1 and 2. Lap Arbor and Lead Lap with Driving Key

The lap arbor illustrated in Fig. 1 is used for holding the lead laps, which may be molded in as many sizes as desired. The molding arbor should be an exact duplicate of the working arbor. A small groove *A* is milled the entire length of the molding arbor, producing a driving key *B*, Fig. 2, which fits the working arbor. This driving key is very necessary, as it is almost impossible to prevent considerable lap friction between the work and the lap. Without the driving key, the lap would surely revolve on the arbor and become tight in the work.

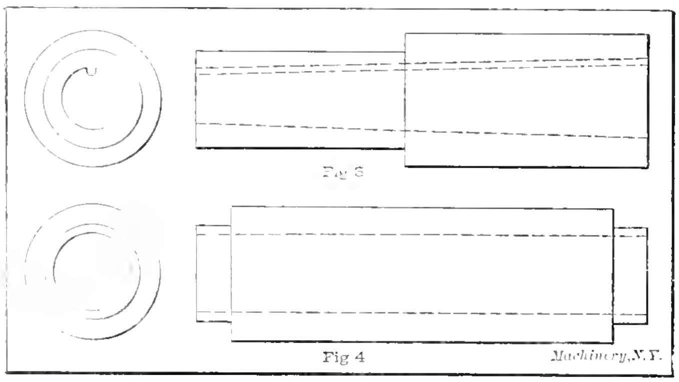


Fig 3 Lead Lap with Two Diameters Fig 4 Method of Preventing Bell-mouthed Holes

It is very convenient to have laps with two or more diameters, as shown in Fig. 3, which enables the operator to readily find a size without a waste of metal for each job. It may be necessary, of course, to slightly reduce one of the diameters to obtain the desired size. The usual custom is, when a lap is a little too small, to flatten it between two parallel plates in an arbor press, which forces the metal outward on the open sides.

For outside lapping or "ringing" a cast-iron adjustable lap is used, similar to the one shown in Fig. 5. Any piece of cast iron will do, but it is much better to have special castings of several sizes for this purpose, with holes in each end as shown. The slots and holes serve to hold the loose particles of the abrasive.

Fig. 4 shows a method of preventing a "bell-mouthed" hole (large at the ends). A shell about 3/16 inch long is left on each end of the work, which is cut or ground off after the lapping is finished. This will remove the bell-mouthed part, which is otherwise practically unavoidable. The causes of a bell-mouthed hole are as follows:

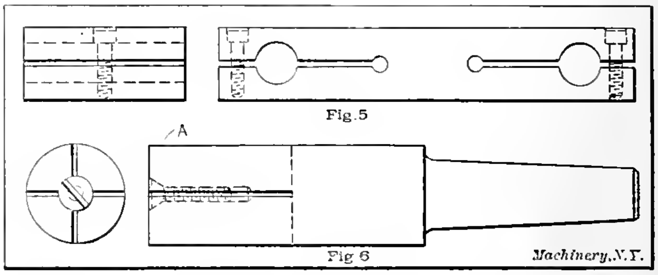


Fig. 5. Adjustable Cast-iron Lap. Fig. 6. Form of Lap for Blind Holes

1. Too much loose emery and oil at the mouth of the hole, which assists in cutting faster.

2. Lapping too long in one position, causing the cutting medium inside the hole to become dull, so that the abrasive which is outside, being sharp, cuts faster.

3. Lap arbor under-size, not straight, and too long. When possible, the contact portion of a lap should be shorter than the work, which will greatly assist in preventing a taper hole.

Fig. 6 shows the style of lap to use in a hole which bottoms, or does not extend through the piece to be lapped. It is slotted and tapped for an expansion screw, which makes adjustment very easy. The slots hold the loose particles of abrasive. This style of lap is usually made of cast iron, and has a taper shank which is fitted to the drill press or lathe spindle. With it a hole which bottoms can be lapped straight, as the point of contact on the lap extends back from the end about 1/4 inch to a point *A*; beyond this point it is slightly tapering.

If the methods given in the foregoing are not in accordance with the best practice, I shall be very glad to read in the columns of MACHINERY of any which have been actually and successfully used in high-class and very accurate machine and tool construction, where quality and quantity have been the guiding powers.

S. C. S.

PLAINER LETTERS AND FIGURES IN DRAFTING-ROOM AND SHOP

Everybody will agree that letters and figures too plain and distinct would be difficult to obtain. Many will also agree that certain small details properly attended to would contribute much to a quicker and clearer understanding of written characters of all kinds. Is it not a curious truth that characters representing sounds—letters—are in the case of the twenty-six used in our language, so diverse in form that each may easily be distinguished from any and all the others —though few mistakes would occur if this were slightly otherwise—while in the case of the nine digits where one character gives absolutely no clew to the identity of any other when used in groups, and where the identity of each character is of relatively great importance, we use forms that not only may be but often are mistaken one for the other?

Even on the printed page, that in all cases is viewed from the bottom only, the use of sixes and nines which are the same inverted, is to be condemned; and in shop drawings and tool marking it is utterly indefensible. The forms of numerals used by most persons in writing are far superior to those

in use by most draftsmen on their drawings or by the designers of typewriter type, or the designers of stamps in general. Not only should the nine be different in *form* from the six and all other figures, but eights, threes and fives should each be so distinct in form from all the others that a slight failure to print clearly or a slight wearing or dirtying of a print, or carbon copy, would not lead to error or that annoying uncertainty so often met with in the shop.

It is needless to say that no radical change can be undertaken. An attempt on the part of the writer to distinguish the figure seven by the use of a short horizontal line across the center of its stem soon led to its abandonment because sevens so treated were persistently read F.

A brief review of the nine digits as used by draftsmen,

Fig. 1. Suggested Changes in the Form of Figures

diesinkers, type designers and some others, leads to the following suggestions: Avoid the use of the "Roman"; it has perverted so upright a character as the figure one and made it look like other things. Two has suffered also.

The figure three is good with flat or a curved top, with a wide open low-hanging lower lip or a return curve making the lower opening more like a slightly enlarged upper opening of a curved top three, but care should be used that the fives and eights used therewith are so different as to make confusion of the characters difficult. A good combination would seem to be a flat top three—no Roman on the left end of the flat—and an open lower part (see specimen A, Fig. 1). The five to be used with this three should be fairly well

862	551	556	561	566	571	576	581	586	591	596
863	601	606	611	616	621	626	631	636	641	646
864	651	656	661	666	671	676	682	687	692	697
865	702	707	712	717	722	727	732	737	742	747
866	752	757	762	767	772	777	782	787	792	797
867	802	807	812	817	822	827	832	837	842	847
868	852	857	862	867	872	877	882	887	892	897
869	902	907	912	917	922	927	932	937	942	947
870	952	957	962	967	972	977	982	987	992	997
871	94 002	007	012	017	022	027	032	037	042	047
872	052	057	062	067	072	077	082	086	091	096
873	101	106	111	116	121	126	131	136	141	146
874	151	156	161	166	171	176	181	186	191	196

Fig. 2. The Clear, Open Style of Figures commonly used in Mathematical Tables

closed (see specimen B). Then the eight of the usual form would not be mistaken for either three or five.

Six as usually made is not open enough. Many steel stamps of medium and small size have the figure six of such a closed form as to make reading uncertain even where there is no question of confusion with nine. An open figure six (specimen C) is certainly much clearer and less liable to misreading than one of those would-be artistic affairs (specimen D).

The figure seven has suffered slightly at the hands of the vertical writer who sometimes forgets to be even vertical, and makes his stem take on a reverse angle (specimen E) when he should make this member an exception (see specimen F). The distinctive mark at the left end of the horizontal member should be retained (as shown) as it prevents mistaking seven for one when it stands too close to the right of a five.

Eight would certainly be more distinctive and less likely to be taken for something else if it retained the stem used in script. Even when threes and fives are made as suggested, the beautifully rounded and symmetrical outlines of eight, as usually made, are not sufficiently characteristic for the purpose.

As made, the nine is perhaps the worst offender of all. Not only must it be helped out with prick-punch marks, dots and bars, but it is often so closed as to resemble its neighbor, the characterless character, eight. A straight stem nine has everything to recommend it from the shop man's viewpoint.

The writer hopes the foregoing may lead to a discussion of the subject. Its importance is not likely to be overestimated.

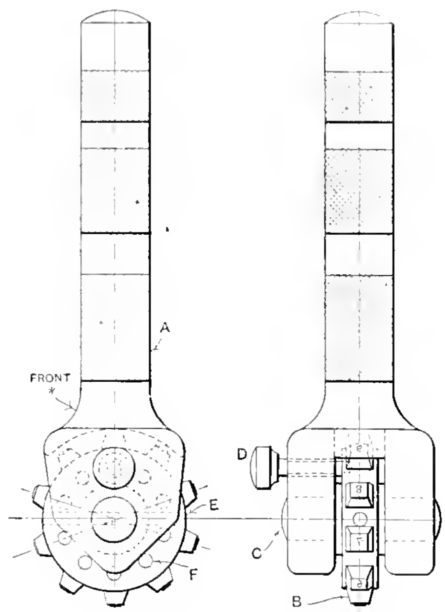
Wm. S. Rowell

Morton Park, Ill.

[The different styles of figures shown in Fig. 2, which is reproduced directly from a page of Gauss' logarithm tables, are commendable because of their clearness and dissimilarity, which tend to lessen mistakes. Figures of this kind are generally used in mathematical tables. It will be noted that there is a decided difference between all the figures, which are not only of a very open style, but, in some instances, of different heights as well.—Editor.]

NUMBERING TOOL

The numbering tool shown in the accompanying engraving is made to be used as if it were a single die. This tool will be found very convenient in the machine shop for numbering machine parts. The handle *A* is turned from tool steel and is hardened on the upper end. The hardened wheel *B* contains around its periphery the numbers from one to nine and a cipher. This wheel is fastened to shaft *C* by a pin *E*, which is driven through both parts. A screw *D* with a conical point fits in the holes *F* in the side of the stamp wheel, thus holding the latter in position when the tool is in use.



Numbering Tool with Rotary Stamp Wheel

This screw is hardened and knurled. Shaft *C* is casehardened and it should be well fitted to its bearings. Crossed lines or a star indicates the front of the tool so that the figures may be held right side up without any trouble. By combining the usual ten dies upon one wheel in this manner, a lot of useless handling is done away with and the work of numbering parts is greatly facilitated.

L. H. Georger

Buffalo, N. Y.

LAPPING OF SMALL HOLES

Mr. Crosby's article on lapping in the February number of Machinery reminded me of a personal experience in that line about three years ago. I was then a college student and spending my vacation in a small shop manufacturing a special kind of sewing machine. The shop was not equipped as well as it might have been, and as a result the only manner of finishing the holes in the positive-motion cam-rollers *A*, Fig. 1, was by lapping. Hundreds of small shops all over the country finish work in this way.

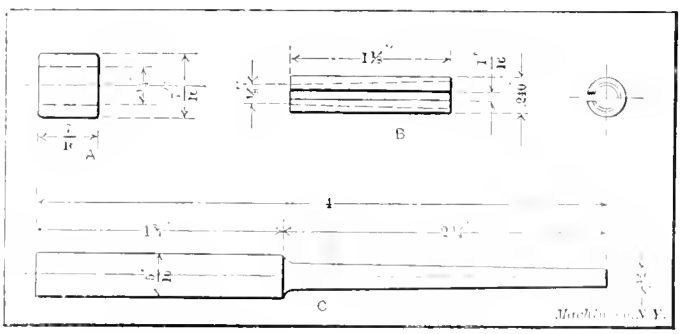


Fig. 1. Lap and Lap-arbor for Lapping Cam-roller shown at A

The rollers were made in a screw machine and casehardened. An exact size for the lapped holes was not necessary;

what was wanted was a straight hole, entirely free from "bell-mouths." The amount of metal to be abraded in this manner was rather abnormal, ranging anywhere from 0.005 to 0.010 inch.

The lapping was done in an ordinary speed lathe, and the rollers were held by the three most useful fingers of the right hand. This latter circumstance, although inconvenient, was the only practical method that gave very satisfactory results.

A taper arbor *C* was chucked true in the lathe and was not removed while the lathe was being used for lapping. This arbor had a taper of ¼ inch per foot, the same as a standard taper pin. The laps, one of which is shown at *B*, were made out of solid brass rod. The arbor holes were drilled and reamed with an ordinary taper pin-reamer. The

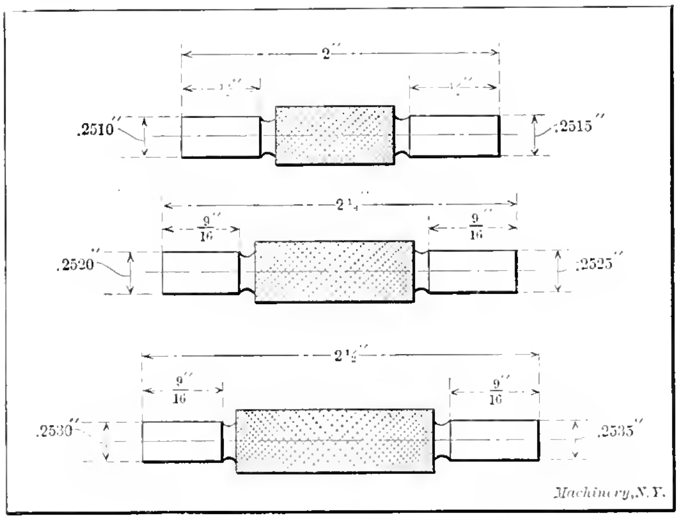


Fig. 2. Gages for Testing Lapped Holes

laps were then split while on the taper arbor, by means of a small square-nosed tool fixed in the tool-post and fed by hand, with the lathe spindle locked in place.

Three hardened and ground limit gages (Fig. 2) each end of which varied by 0.0005 inch, were constantly used during the process of lapping. Fine emery and oil served as an abrasive.

From time to time the laps had to be dressed with a file and tested with a pair of micrometers, as everything else being equal, "bell-mouths" were invariably the result of unevenly-worn laps.

The gages shown were made by the author from broken taps and milling cutter shanks, and they were machined and ground to size on a bench lathe. Not being very elaborate, they were made of varying lengths to prevent confusion.

Flint, Mich. M. Terry

CLEARANCE FOR BROACHES

There is one point in the article published in the January number of Machinery, engineering edition, on "Cutting Square Holes on a Keyseating Machine," upon which I cannot agree with the writer, *viz.*, giving no outside clearance to the teeth of a broach. The advantage gained by the support obtained with no clearance would be counteracted by the scoring of the work which would be caused by this type of broach, for immediately back of the cutting edge on each tooth, while cutting, the surface of the work is perfectly dry, and owing to this kind of broach never cutting to its full size the first time through the work, the friction caused by the hole being smaller than the back of each successive tooth and the dry surface of the work, prevents a good finish from being obtained.

Under the most favorable conditions, lubricating the cutting edges of these broaches is difficult, as each tooth of the broach is lubricated by the amount of lubricant carried in the flute cut to form the tooth; therefore the longer the hole to be broached of a given size, the less satisfactory the result will be, as the lubricant is used up before reaching the bottom of the hole, and if the tooth space is not of sufficient area to hold the chips accumulated, there is a tendency for the broach to seize.

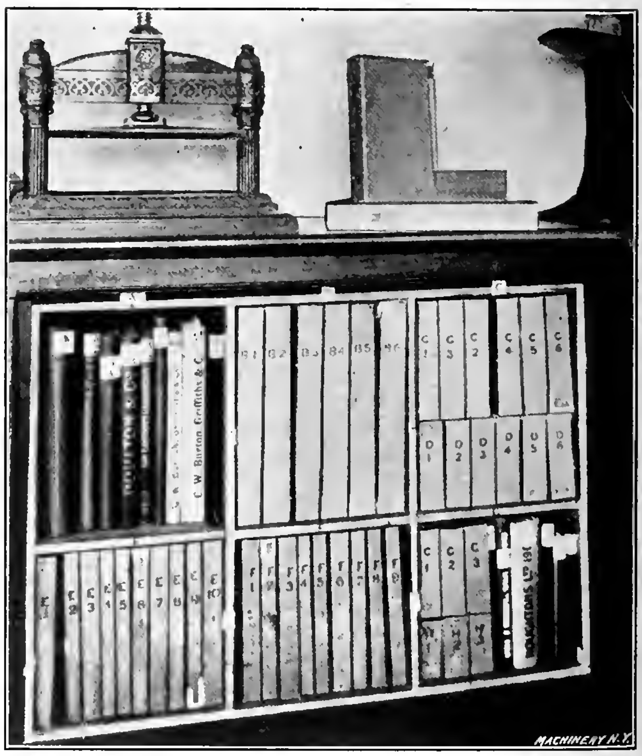
The style of broach that I have found most satisfactory in actual practice is made with a pilot 2 inches long, the diameter of which should be equal to the largest size of cutting edge on the broach. Each tooth should be relieved on the outside and undercut to form front rake; each tooth should increase in size 0.002 inch, except the last three teeth, which should be parallel and equal to the finished size of the hole. The area of each flute for each tooth should be as large as possible without making the tooth too weak to stand the strain of cutting. The diameter of the shank should be equal to the width across the bottom of the flute, of the largest tooth, and the length equal to the length of the hole in the work plus the depth of the guide hole in the ram of the broaching machine. W. C.

CATALOGUE FILING SYSTEM

I was greatly interested in the editorial in the November number of Machinery, describing a system of filing catalogues. At our works, for many years no attempt was made at systematic filing, and when a particular catalogue was called for, it was rarely forthcoming until a long search had been made for it. At last it became absolutely essential that some system of filing should be adopted.

First all dead and duplicate matter was removed, thus considerably reducing the number of catalogues to be handled. A number of cardboard boxes were then made, each measuring about 12 by 9 inches, with a width of 1 inch. The boxes were numbered and lettered at the back, and then placed in suitable pigeon-holes in a vertical position, as shown in the accompanying engraving. The letters corresponded with the pigeon-hole letters, and the numbers were run consecutively under each letter. Each box was then filled with as many books or leaflets as it would conveniently hold, each book being numbered and lettered the same as the box, in which it was placed. Large books were not put into the boxes, but simply placed on the shelves, library fashion, as shown.

As the boxes of the size given were found to be too deep



Cabinet in which Catalogues are filed

for small books, we had some made L-shaped. This allows easy extraction of the books, and at the same time keeps the backs of the boxes in line, thus preserving the neatness of the arrangement.

The catalogues were indexed in a card index under the firm names, and another index of subjects is being arranged as required. This latter index should be very valuable when more fully developed. The system is really very simple, costs little to install, and can be gradually introduced. The file is neat in appearance, and we have found it to answer its requirements admirably. C. J. Robertson

West Bromwich, England.

DANGEROUS OXY-ACETYLENE APPARATUS

Believing that you are desirous of informing your readers correctly, concerning the bad practices which are resulting disastrously to the oxy-acetylene industry, you are requested to publish the following communication. Realizing that some of your readers may possibly consider that the statements were inspired by a selfish interest, we invite a most searching investigation as to their correctness:

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen, produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dangerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself, can not be ignited without a mixture of air, or oxygen, unless it is compressed to more than thirty pounds pressure.

Chemically, oxygen is made from chlorate of potash, and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene, nor the chemicals, are at all dangerous if they are properly handled; improperly treated, they can be made exceedingly dangerous, just as can ordinary coal, or water gas, or any of the hydro-carbons, such as gasoline, or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry, that they are the subject of yearly inspection by a body of engineers, in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character. Generators built in accordance with these rules, can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond question, that what is known as the carbide-to-water types, are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat", which is similar to the heat of lime, when slaking, only the heat is much greater. One pound of carbide will boil six pounds of water; consequently the engineers for the insurance underwriters have a rule, requiring one gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water came into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with rapid generation, there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators, in the earlier part of of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding, than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers, they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene, that when it is compressed to from 30 to 45 pounds, or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art, some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience, there are persons who are manufacturing acetylene by compressing it direct from carbide, without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting, and passed resolutions condemning this process, which is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck, and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over, it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire, and an explosion follow. Obvious as is this danger, there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly, no intelligent insurance representative would approve of such apparatus.

So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen, are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash, and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly, and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use. It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts, under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer, and the most expensive part of the plant, the compressor; such a plant could be built at small cost, and at considerable profit. That this is

being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals, have the compressors built with two stages of compression, with an intercooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas, there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen, must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites, can be, and are sold, for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results and tend to discredit the process. Such apparatus has injured the art not only in this country, but in Europe as well. Solicitations have been received by the company which the writer represents, to sell its apparatus in Austria, by a very prominent firm, whose letter states that that country has numerous cheap and ineffective plants, which have brought the process into disrepute.

AUGUSTINE DAVIS,
New York. President Davis-Bournonville Co.

THE DIFFERENTIAL SCREW FALLACY

I notice an article in your April number (page 647, engineering edition) on the Derihon testing machine, and without criticising the principle upon which it is based as giving more or less reliable indications of hardness, I am very much surprised to see, in this age of enlightened mechanics, the old-fashioned device of a differential screw adopted as a means for increasing power. The earlier text-books on mechanics estimated the force exerted by a screw from a comparison of the distance traversed by the hand lever and the corresponding advance in the screw, and, by the same method, the differential screw was shown to have wonderful possibilities. But no allowance was then made for friction, which has since been shown to eat up about 90 per cent of the power applied to standard bolts and nuts, and, as a matter of fact, it has been demonstrated practically as well as theoretically that the pitch of a screw has very little effect upon the pressure exerted by a given force at a given distance from its axis.

It is high time, therefore, for the differential screw fallacy to be exploded, and without knowing the exact details of construction, I feel very safe in asserting that the pressure exerted by the differential screw in this case is no greater than the pressure that could be exerted by the screw *C* alone if attached directly to the handle bar *M*.

I came to the conclusion about thirty years ago that differential screws never accomplished any useful purpose, and established this fact by experiments as well as by analysis. Later in 1891, "Some Experiments with a Screw Bolt" was reported to the American Society of Mechanical Engineers, which confirmed my own experience, and in discussing this paper, I gave a general analysis of the power of screws as affected by friction.

Experiments on the friction of screws were again reported to the same society in 1895, and it should be more generally understood how little the pitch of a screw really has to do with its power. This really depends more upon the relation between the diameter of the screw and the length of the lever arm to which it is attached than it does upon the pitch of the screw, and it makes little difference whether the advance of the screw comes from a single thread or from the difference in the pitches of two threads combined.

There may be instances in which differential screws can be used to advantage for the purpose of reducing velocity ratios, but when used for the purpose of increasing power they are, and always have been, a mechanical absurdity.

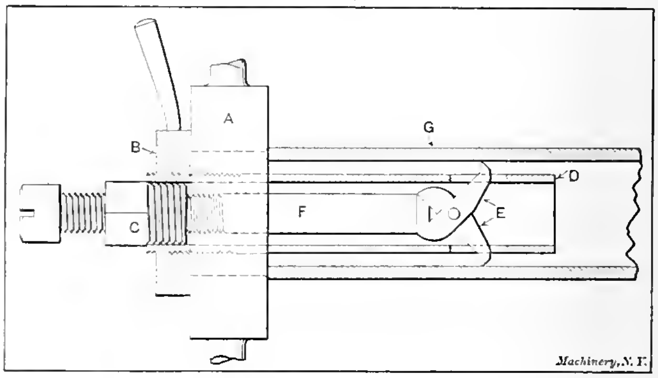
WILFRED LEWIS,
Philadelphia, Pa. President Tabor Mfg. Co.

[The use of the differential screw principle in the Derihon apparatus enabled the designer to provide a thrust bearing of comparatively large area and small pitch diameter. A swivel and suitable thrust bearing would have been necessary if *M* were mounted on *C*, in order that the steel ball *B* may not rotate when in contact with the piece being tested. The efficiency of a screw thrust bearing designed like this in the Derihon apparatus is undoubtedly much higher than that of a plain thrust bearing of equal diameter. We agree with Mr. Lewis that the efficiency of differential screws in general, is very low.—EDITOR.]

PIPE FITTER'S KINK FOR STARTING DIES

While in a pipe fitter's shop recently, the subject of threading pipe came up, and the man of the shop showed me the device shown in the sketch which he said had helped him in threading pipe that was hard to start the thread on.

In this case the part *D* is a piece of ½-inch pipe about six inches long with a thread cut on the outer end about two or three inches; *C* is an ordinary plug with a hole through the center, through which a 5/16-inch rod is screwed, the plug



Device for Starting Dies on Pipe

being screwed in the end of the ½-inch pipe; *E* are steel jaws pivoted, as shown, and forced outward through holes cut in the sides of the ½-inch pipe; *B* is a plate with a handle, which is screwed on the outer end of the ½-inch pipe, and *A* represents the die used in threading the pipe *G*. By screwing the rod *F* either with a wrench or screw-driver, the jaws are forced outward against the inside of *G*; then by screwing the die and the plate *B* at same time, the die will start the thread in a very satisfactory manner. The device is easily removed by unscrewing the rod *F*.

X. Y. Z.

LOOSE CORRESPONDENCE METHODS

Americans would sell more machinery abroad if they were less "slap-dash." I write, say, to the Robinson Lathe Co. asking who is its German representative; in the meantime the company changes to the United States Machinery & Mfg. Co., or some such name, and answers under that head simply: "Our German agents are Blank & Bros." I have no letter copy with the U. S. M. & M. Co. so their statement does not interest me a little bit. Later I write a second letter to the R. L. Co. and get a second reply from the U. S. M. & M. Co. again without any reference to the R. L. Co. This is a common experience. Also, young firms with high-sounding names advertise or their products are described, without any street address; and inquiries come back stamped "Unknown." The Niles-Bement-Pond Co. needs no street address; but the Universal Machine Tool Co. and the General Mfg. Co. do.

ROBERT GRIMSHAW
Dresden, Germany.

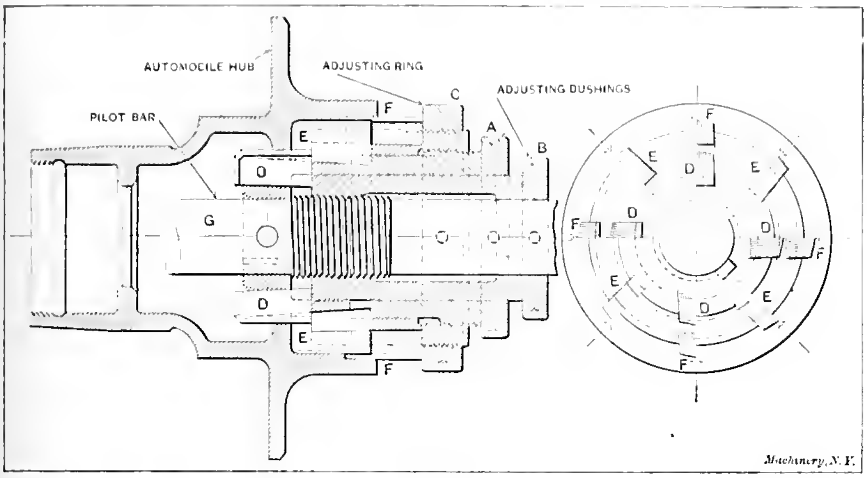
POINT IN GAS ENGINE PISTON MANUFACTURE

The article in the April number of MACHINERY about machining gas engine pistons, does not bear out my experience in such matters. In my experience the boss cast on the closed end of the piston to hold it by when turning, would have a mushy center where cut off. This would be the worst possible thing to have on a gas-engine piston, making a weak end, and giving a ragged surface, causing premature ignition. There would also be a chance of loss in work and material, as cutting off this boss is the last of a series of operations. Our company does not permit a piston to pass, having a rough or porous end; we also chill all pistons over the ring grooves.

Oil City, Pa. JOHN REID

AN ADJUSTABLE BORING-HEAD

A design of adjustable boring-head which can be used for boring three different sizes at once is shown in the engraving. The particular tool illustrated is intended for boring out the axle hubs of automobiles. The body of the boring-head is of cast iron, and it contains, as shown more plainly in the end view, three different sets of blades for reaming a corresponding number of diameters in the hub. The blades fit into slots which should be dove-tailed to an angle of from 3 to 5 degrees to prevent the blades from lifting out of the head. The bottoms of these slots are also tapered, as



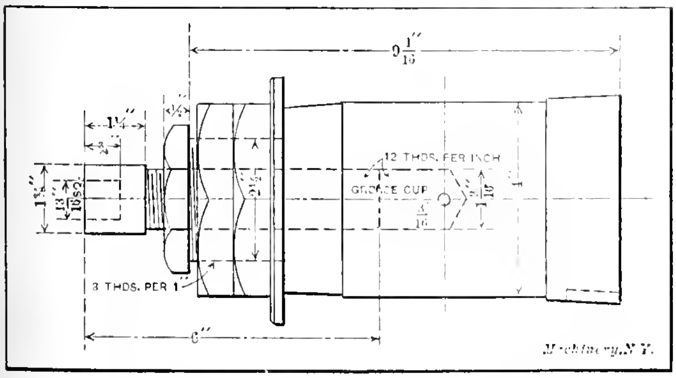
Adjustable Boring-head for Machining Three Different Diameters Simultaneously

shown in the sectional view. The blades, of course, have a corresponding taper so that by changing their longitudinal position they may be set to different diameters. The body of the reamer is attached to a pilot bar *G* by a taper pin or key. This bar is threaded (16 threads per inch), as shown. Adjusting bushing *B* is an accurate fit over the bar on one end, and is threaded to it on the other. The recess which is cut into this bushing is to do away with the long bearing and to lessen the length of the threaded part. A second adjusting bushing *A* is accurately fitted over *B*. The outside of this second bushing is threaded into the reamer body, and it is also a close running fit on the end. The last adjusting bushing is threaded to the outside of the reamer body. As will be seen, any one of the three sets of blades may be adjusted independently. For example, by screwing in bushing *B*, the four blades *D* could be adjusted out to any dimension within the limits of adjustment. Similarly, by turning bushing *A* or *C*, the blades *E* or *F* may be adjusted, respectively. These blades are made of the best tool steel and they should be a snug fit in the head. They can be ground to take an end cut when this is necessary.

Pawtucket, R. I. HAROLD E. MURPHEY

GREASE CUP IN THE WRIST-PIN

A grease cup that is made by boring a hole in the center of the wrist-pin and screwing in a plug which has a square recess



Locomotive Wrist-pin with Self-contained Grease Cup

which will take the regular grease cup wrench is shown in the engraving. A lock-nut is provided to prevent the plug from working loose. Regular hard grease is used. Two holes are drilled in the wrist-pin, one in the front and one in the back, and oil grooves are cut in the connecting-rod brasses. This plug is the design of Mr. Charles Cotter, traveling engineer for the Duluth and Iron Range R. R., and it has been used on the engines of this road for a number of years, giving great satisfaction. AUSTIN G. JOHNSON

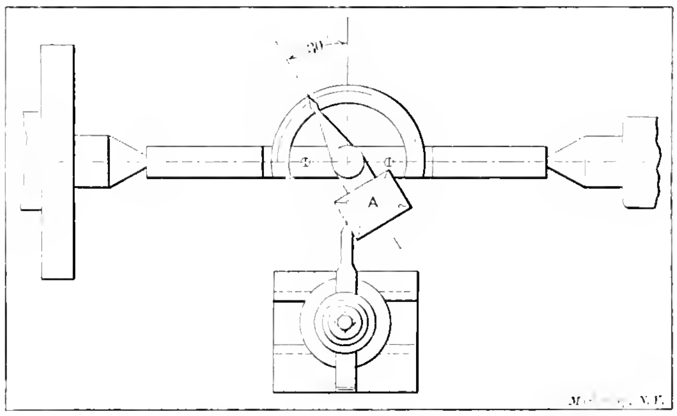
Two Harbors, Minn.

TINNING STEEL PANS

In answer to the question by G. S. on the How and Why page of the February number of MACHINERY relative to the tinning of steel pans, I would suggest the following, which I tried with good results: In tinning sheet metal, if the parts are scaly, they should first be sand-blasted or pickled so that the tin will adhere properly. Before tinning, they should also be put into a muriatic acid bath. The parts are then dipped into melted tin, removed and plunged into oil while still hot (we use melted tallow). They are then re-dipped into the tin; this second dipping gives a thicker and heavier plate. The oil acts as a flux which gives the tin plating a brighter and smoother finish. After the pieces have been dipped a second time, they are put onto racks to drip until cold. The cast-iron pot or vat in which the tin is melted, should be about 12 inches deep and several inches wider and longer than the pans. Wire hooks are used when dipping the parts to be tinned; the pieces should be perfectly dry before they are placed in the molten metal. J. S. S.

COMBINATION TEST BAR AND PROTRACTOR FOR THE LATHE

A combination test bar and protractor intended for use in the lathe is illustrated herewith. It is quite difficult when the cutting edge of a tool is to be set to a certain angle, to



Protractor for Setting Lathe Tools, which is mounted on Hardened and Ground Test Bar

hold an ordinary protractor with one hand, and adjust the tool with the other. With this device the protractor is set to the required angle and then the tool is adjusted to one of the hardened edges on the rectangular piece *A*. The edges of this rectangular piece are ground after the tool is assembled, thus insuring their accuracy. The cylindrical part on which the protractor is mounted is hardened and ground so that it may be used as a test gage. When the protractor is being set, the lathe centers are tightened just enough to hold it in position so that the workman has both hands free for setting the tool. The small slots in the corner of the piece *A* were cut in to prevent it from cracking during the hardening operation.

This protractor may be used to advantage for setting lathe tools when making angular cutters for the milling or screw machine or when making bevel or miter gear blanks, and for setting threading tools for either internal or external threading. E. E. MARTIN

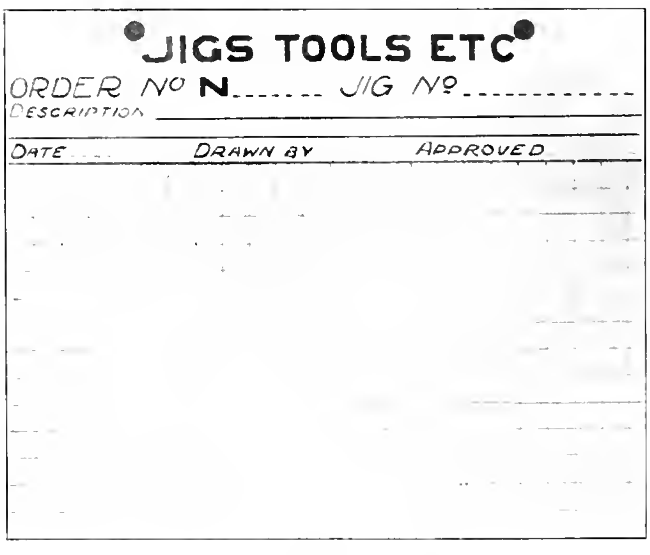
Providence, R. I.

SIMPLE METHOD OF MAKING BLUE-LINE PRINTS

Some time ago the writer found that it would be a great convenience to have a number of forms, but as these were to be used in small quantities it was hardly advisable to have them printed. Blueprints with blue lines upon a white field was just the thing, and a very simple method of making them was found, which will possibly be of interest to other draftsmen.

A negative was prepared as follows: A piece of tracing cloth somewhat larger than the desired size was placed upon a smooth board with the dull side of the cloth exposed, and the edges tacked securely. Two thin coats of black shellac varnish, such as is commonly used by pattern-makers, were applied to the cloth, so as to make it perfectly opaque. The shellac was allowed to set for about an hour, so that it was thoroughly dry, but not long enough to become brittle, and then the tracing cloth was removed and placed upon the drawing board with the varnished side up. The desired lines were then laid out upon the tracing cloth by rubbing it thoroughly with soft white chalk, and then drawing the lines upon it with a lead pencil, the pencil point leaving a black line where it removed the chalk from the black surface. The letters and figures desired were laid out in the same way. The ends of a piece of wire about six inches long were then ground down to a sharp point, one end being flatted slightly on an oilstone. The lines in the chalk were then traced over with the sharp point of this wire so as to scratch them evenly through the shellac. The letters were also outlined with the sharp point of the wire, and then the shellac inside these outlines was scraped off with the flat end of the wire. The shellac was found to come loose very readily, so that with a few minutes' practice letters could be formed that looked fairly presentable, almost if not quite as easily as they could be made with an ordinary pen upon tracing cloth. The chalk was then removed, and after trimming, the negative was ready to make blueprints from.

The accompanying illustration shows a blueprint that was



Print with Blue Lines on a White Sheet

made from a negative which was the writer's first attempt along this line. This negative has been in use for quite a long time, possibly two hundred prints having been made from it, and it shows no signs of wear. By referring to the engraving it will be noticed that the cross lines in the body of the print are lighter in color than the heading, so as not to obscure the writing and sketches made upon it. This was accomplished by placing a piece of thin bond paper in front of the negative when printing.

This method has been used by the writer in preparing forms for monthly labor records, monthly reports, shop sketches, etc. Of course it is hardly applicable to the preparation of complicated drawings, and possibly could not be recommended for forms having a great deal of small lettering or figuring upon them, but for plain ruled forms with fair-sized letters, it does very well.

It was mentioned previously that the shellac should not be allowed to set long enough to become brittle before finishing. The reason for this is that when the shellac becomes brittle it will chip away when scratched, making it impossible to get satisfactory results. BRUCE C. MCALPINE

Jackson, Mich.

DIVIDING A CIRCLE INTO EQUAL PARTS

A simple method of dividing a circle into any number of equal parts is shown in the accompanying illustration. To divide any circle, draw a line *A-B* from *S* at any convenient angle with *L-S*; then divide *A-B* into the number of parts that the circle is to be divided into. Draw from the last point *G* a line *D-C* through *L*. Count down two divisions from *G* on *A-B* to *E*, and draw *E-F* parallel to *C-D*. Strike two arcs at *H* from points *L* and *S* and with *L-S* as a radius. Then draw the line *N-K* through point *P;* the point of intersection *M* will then be the first point on the circle; in other words, arc

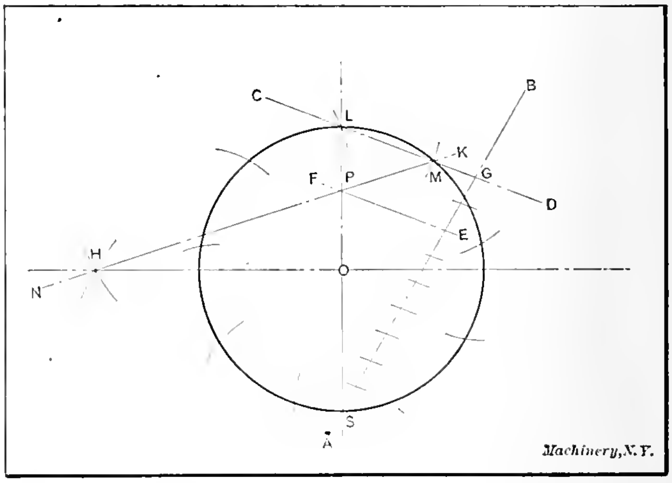


Diagram for Dividing a Circle into Equal Parts

L-M is one division of the circle. Of coure I do not claim to be the originator of this method of dividing a circle; it is, however, so simple that it will doubtless be appreciated by those who have not been familiar with it. ROBERT WILKINSON

Buffalo, N. Y.

[We will be glad to receive from any of our readers the geometric proof of this method of dividing a circle, which will doubtless be of general interest.—EDITOR.]

FINISH ON IRON CASTINGS

In the February number, E. S. S. asks through the How and Why page for a good method of securing a glossy enameled finish on iron castings. Two methods are given in the following, which I have used with good results, after a long search for suitable preparations:

For a fine, rich, black gloss, I use Minett's air-drying black varnish, which can be obtained from almost any wholesale paint and oil store. Two or three coats of this varnish should be applied; it dries quickly and when dry becomes hard. It will weather longer than any preparation that I know of, and it also fills the pores and will not break out in streaks. This varnish is cheap, and it gives a rich, bright gloss to the work.

When castings are very porons, the following preparation may be used as a filler to obtain a smooth surface: For one quart of this filler mix one-half pound of white lead, one pound of whiting and one gill of varnish, with enough turpentine to properly thin the filler. The white lead is to bind or hold the mixture together, the whiting is for filling the pores, and the varnish is to give a glossy finish. After putting on one coat of the filler, a coat of ivory black should be applied, and then a coat of varnish. This finish is not as cheap as when the black varnish is used, but it is a good one and lasting.

The gray or streaked spots, referred to by E. S. S., which appear on malleable castings are very common, especially after certain metals have been plated. Some experts claim that it is the pickling acid working out of the pores, and I am inclined to believe that this is the trouble. The Platers' Organization of America has, I understand, this same question under dis-

cussion at the present time, but as yet no one has explained how to prevent these streaks from showing. Poor oxidization will also aid in causing the streaks to appear on account of the rough porous surface which contains so many small cavities that secrete the acid. J. S. S.

IRREGULAR SPACING FOR REAMERS

The accompanying table will be found useful in fluting reamers with irregularly spaced cutting edges. All even numbers of flutes from 4 to 24 are given in the column to the left, and the number of turns of the dividing head crank to be made when indexing for each flute are stated in the body of the table. For four flutes, two sets of figures are given, one when the diameter of the reamer is under two inches, and one when the diameter is over two inches. The table gives the movements for the spacing of half the reamer only; then the same movements are repeated for the other half.

IRREGULAR SPACING FOR REAMERS

Table is for one-half the reamer; repeat the same movements for other half

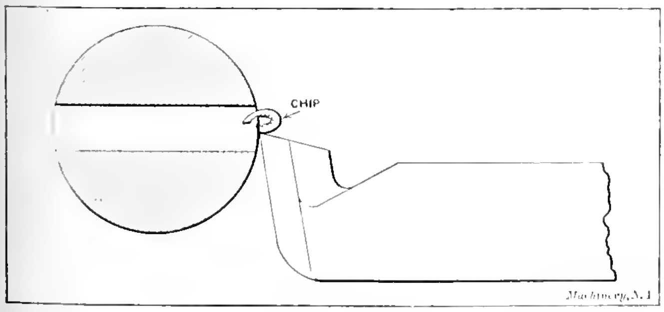
No. of Flutes	Turns for Dividing Head											
4	$9\frac{3}{4}$	$10\frac{1}{4}$	Under 2 inches diameter									
4	$9\frac{1}{2}$	$10\frac{1}{2}$	Over 2 inches diameter									
6	$6\frac{1}{3}$	$6\frac{2}{3}$	7									
8	$4\frac{1}{4}$	$4\frac{3}{4}$	$5\frac{1}{4}$	$5\frac{3}{4}$								
10	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5							
12	$2\frac{4}{5}$	3	$3\frac{1}{5}$	$3\frac{2}{5}$	$3\frac{3}{5}$	5						
14	$2\frac{3}{7}$	$2\frac{4}{7}$	$2\frac{5}{7}$	$2\frac{6}{7}$	3	$3\frac{1}{7}$	$3\frac{2}{7}$					
16	2	$2\frac{1}{7}$	$2\frac{2}{7}$	$2\frac{3}{7}$	$2\frac{4}{7}$	$2\frac{5}{7}$	$2\frac{6}{7}$	3				
18	$1\frac{7}{9}$	$1\frac{8}{9}$	2	$2\frac{1}{9}$	$2\frac{2}{9}$	$2\frac{3}{9}$	$2\frac{4}{9}$	$2\frac{5}{9}$	$2\frac{6}{9}$			
20	$1\frac{11}{20}$	$1\frac{13}{20}$	$1\frac{15}{20}$	$1\frac{17}{20}$	$1\frac{19}{20}$	$2\frac{1}{20}$	$2\frac{3}{20}$	$2\frac{5}{20}$	$2\frac{7}{20}$	$2\frac{9}{20}$		
22	$1\frac{4}{11}$	$1\frac{5}{11}$	$1\frac{6}{11}$	$1\frac{7}{11}$	$1\frac{8}{11}$	$1\frac{9}{11}$	$1\frac{10}{11}$	2	$2\frac{1}{11}$	$2\frac{2}{11}$	$2\frac{3}{11}$	
24	$1\frac{5}{24}$	$1\frac{7}{24}$	$1\frac{9}{24}$	$1\frac{11}{24}$	$1\frac{13}{24}$	$1\frac{15}{24}$	$1\frac{17}{24}$	$1\frac{19}{24}$	$1\frac{21}{24}$	$1\frac{23}{24}$	$2\frac{1}{24}$	$2\frac{3}{24}$

Freeport, Ill. D. O. BARRETT

[This method of indexing, it will be noted, makes the two halves of the reamer exactly alike, and opposite cutting edges are exactly in line, that is, they are not off-set or "broken up." An article is published in another part of the paper regarding the practice of irregular spacing for reamers, where the subject of "breaking up the flutes" is more thoroughly treated. —EDITOR.]

FINISHING SLOTTED COLLETS IN THE LATHE

A small shop received an order for a number of Brown & Sharpe collets (No. 7 inside taper and No. 9 outside taper). There being no grinder to finish the outside diameter, it meant that the collets must be rough- and finish-turned in the lathe. As the work had to be accurately done, it occurred to me that if the collets were finished and polished before the drift slot was cut, they would be bruised while this was being done, which would make it necessary to go over them again; therefore, I concluded when turning them to allow 1/32 inch above the largest size for finishing after the slots were cut, and to make them straight. When turning these collets after the drift slots had been finished, I noticed that when my turning tool reached the slot, a deep groove was left on one side of it, but when the tool had passed the slot, it cut smoothly. The cause of this trouble was as follows: When the tool reached the drift slot, and as the point left it on one side, a chip was balancing itself on the point so that when the opposite side of the slot reached the tool the chip was between the tool and collet which caused the groove. The relation between the chip, the tool, and the work will be understood by referring to the illustration. Invariably on each succeeding turn of the collet this groove was formed on one side. By driving a piece of hardwood in the slot the trouble was overcome. The wood should not be driven in too tightly, as it may spread the metal on either side of the slot. This wood was also an advantage in filing, as the file did not leave a flat on either side of the slot, as is usually the case.

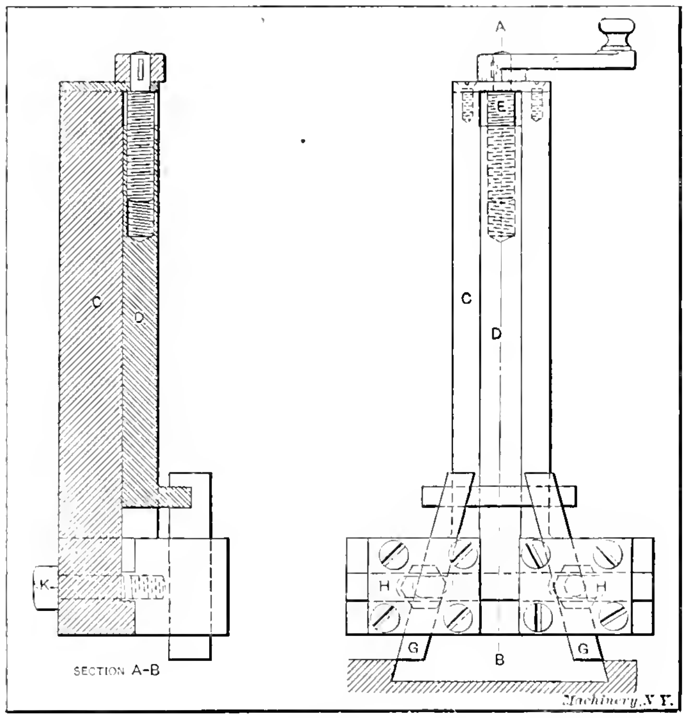


Sectional View of Slotted Work showing Chip Interference when Tool is crossing Slot

Covington, Ky. ROBERT LANG

TOOL FOR PLANING DOVETAILS

A tool for planing dovetails is illustrated herewith. This tool was designed by Mr. C. H. Marsh, foreman of the planing department in the works of Fay & Scott, Dexter, Me. It is used principally to plane the dovetail ways in lathe aprons, in which the lead-screw nut slides. When the tool is in use, the shank *C* is held in the clapper-box of the planer. When the cutters are to be set for planing a dovetail of a given size, the lever *F* is turned, thus moving slide *D*, which, in turn, moves the cutters *G* up or down until they are set to the required width at the top of the dovetail. The head is then raised or lowered until the tools just brush the work; they are then fed into the dovetail by turning lever *F*, the movement of each tool being, of course, on an angle corresponding to its angular position in the blocks *H*. Perhaps a better adjustment of the cutters is secured by loosening bolts *K* and moving the blocks *H* in or out, thus keeping the cutters closer to the tool body. J. GRAY CARD



Tool for Planing Dovetails

Dexter, Me.

* * *

CORRECTION

An error occurred in the wiring diagram No. 7 for shunt reversing motors, MACHINERY'S data sheet for March. The connections for the fields are tapped in on the same side of the line, so of course, there could be no field. One connection for the field should be shown transposed to the opposite side of the line.

HOW AND WHY

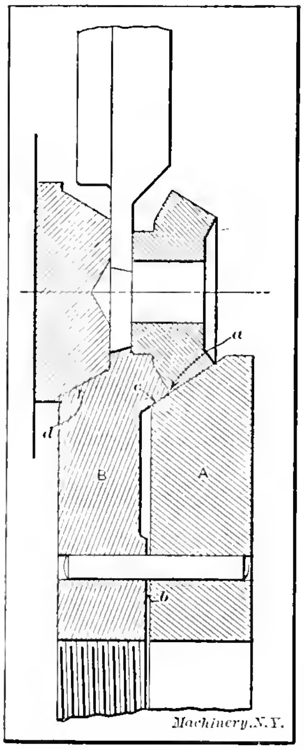
A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

FORMING TOOL FOR BEVEL GEAR BLANKS

H. M.—Kindly give me through the columns of MACHINERY some information relating to the designing of a tool for forming the outside angular surfaces of small bevel gears on automatic screw machines.

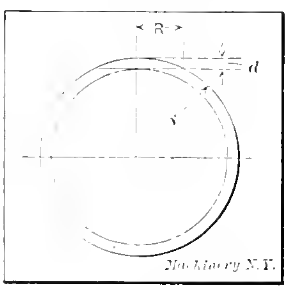
A.—The forming tool for forming the outside angular surfaces of a bevel gear can best be made as shown by the accompanying illustration. The forming tool consists of two sections A and B, doweled together. Two fillister head screws, not shown in the illustration, are also used for clamping the sections together. When grinding the two sections, allowance should be made so that a slight clearance of about 0.002 inch is allowed between the parallel faces at b; then, when the tool is fastened in the tool-holder, the clamping screw will entirely close any space at point a. When grinding the inside face c of section B, the angle should be somewhat less than the corresponding angle on the part A, so that the sections will fit very tightly at a. The angular surface at d takes a roughing cut on the next piece. The calculations necessary for forming tools of this class were quite fully treated in an article on circular form and cut-off tools in the April issue of MACHINERY, so that it will not be necessary to deal with this question here. It may be mentioned, however, that the face of the section A when cut down below the center, would theoretically be slightly concave, but the amount would be so slight that it would be imperceptible, and of no account in practice. When an absolutely true taper is required, a circular forming tool cut down below the center should not be used, but instead a taper turning box tool or a taper turning attachment, operated from the cross-slide. A so-called dove-tail forming tool is also sometimes found convenient. All of these methods have been used to good advantage.



THREAD ROLLING IN AUTOMATIC SCREW MACHINES

J. G. S.—I would like some information relating to thread rolling on automatic screw machines; in particular, I would like to know about methods used for making the rolls for thread rolling on this class of machines.

A.—The Brown & Sharpe Mfg. Co., Providence, R. I., states regarding the method of determining the pitch diameter for rolls for thread rolling in the automatic screw machine, that it is the practice of this company to first determine the pitch diameter of the piece to be rolled and then to deduct from it 1/6 of the double depth of the thread, and to use the constant thus obtained as a multiple for determining the pitch diameter of the thread roll. In general, a thread roll is made of a diameter about three or four times the diameter of the piece to be rolled. In such cases it is, of course, necessary to provide the roll with a triple or quadruple thread, as the case may be, in order that the angle of the thread on the roll shall be the same as the angle of the thread on the piece to be rolled.



The hand of the thread on the roll must be opposite to that of the thread to be rolled. A little consideration will easily make this clear. The calculation of the diameter of the roll should be based upon the pitch diameter of the thread to be rolled, and not upon the root diameter as has sometimes been done and which gives unsatisfactory results. The angle of the thread of the roll must equal the angle on the piece to be threaded, and when the diameter of the roll is a certain multiple of the diameter of the piece being threaded the roll must be provided with a multiple thread corresponding to the rate of increase. The diameter of the thread roll is found from the formula:

$$d = N\left(D - \frac{C}{6}\right)$$

in which d = pitch diameter of thread roll,

N = approximate ratio between pitch diameter of roll and pitch diameter of piece to be threaded,

D = pitch diameter of piece to be threaded,

C = double depth of thread.

As an example, assume that we wish to roll a piece 0.372 inch in diameter with 16 threads per inch, this being a No. 24 A. S. M. E. standard screw. The pitch diameter of this screw is 0.3314, and the double depth of thread equals the outside diameter minus the root diameter, or $0.372 - 0.2908 = 0.0812$ inch. Assume that the diameter of the roll will be made approximately twice the diameter of the screw. Then:

$$d = 2\left(0.3314 - \frac{0.0812}{6}\right) = 0.6357 \text{ inch.}$$

The roll will also have a double thread of 1/8 inch lead, and the outside diameter will equal:

$$0.6357 + \frac{0.0812}{2} = 0.6763$$

and the root diameter:

$$0.6357 - \frac{0.0812}{2} = 0.5951$$

Rolls made according to this formula have given good satisfaction. When rolling a thread on the Brown & Sharpe automatic screw machines, the following points should be taken into consideration: 1. The thread rolling tool-holder should be fastened to the cross-slide which carries the cut-off tool so that the piece will be severed from the bar before the roll returns. 2. The roll should be fed to the work in the same manner as a knurl. 3. The roll should be brought to within 0.010 inch from the piece on the quick rise of the cam, then fed the distance R in the accompanying engraving at a certain number of thousandths inch per revolution, and then released from the work by a quick rise of the cam, at the same time bringing the cut-off tool in position. 4. The feed per revolution for thread rolling is practically the same as for knurling, a table for which was given in MACHINERY, July, 1909, engineering edition. The formula for calculating the rise on the cam for thread rolling is given below; in the accompanying engraving, let

r = radius of piece to be threaded,

d = depth of thread,

R = rise on cam.

Then

$$R = \sqrt{r^2 - (r - d)^2} + 0.010.$$

* * *

In a paper by Mr. W. L. R. Emmett on the application of electricity to the propulsion of naval vessels, read before the American Association of Naval Architects and Marine Engineers, the author states that the efficiency of a turbo-electric installation on board ship can be brought up to 92 per cent, and he also expressed his opinion that no other form of speed-reducing gear between the turbine and propeller could be made to show as high an efficiency. Recent tests, however, on the Mellville-MacAlpine turbine reducing gear, illustrated in the February issue of MACHINERY, engineering edition, shows an efficiency of 98½ per cent.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the current month.

LANDIS HEAVY-DUTY PLAIN GRINDING MACHINE

The accompanying illustrations show a new self-contained **plain** grinding machine of large capacity (16 inches by 72 **inches)** built by the Landis Tool Co., of Waynesboro, Pa. As will be explained later, it is designed to be fitted with special appliances for chilled roll grinding; it will also be furnished with provisions for taking work such as pistons or rods, and similar parts met with in railroad shops. It is essentially,

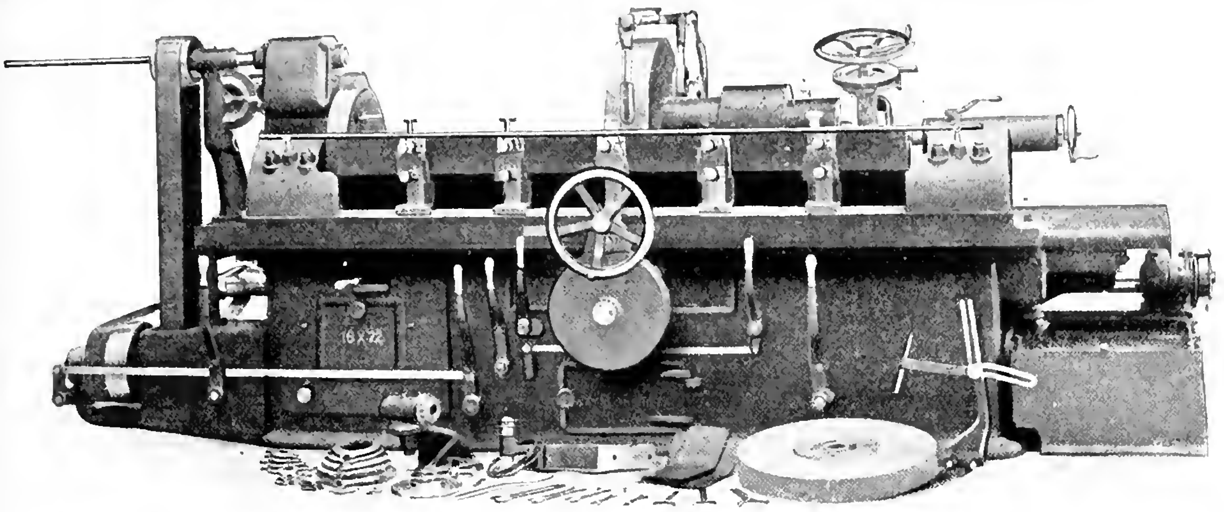


Fig. 1. Landis 16- x 72-inch Plain Grinding Machine for Heavy Duty

however, a plain grinding machine, of high power for heavy-duty operation, fitted for hard service in manufacturing work.

All the conveniences of the older design have been retained. The machine is of the traveling wheel type, with headstock and footstock mounted solidly on the stationary base of the machine. Quick-change, geared speeds for the work, and

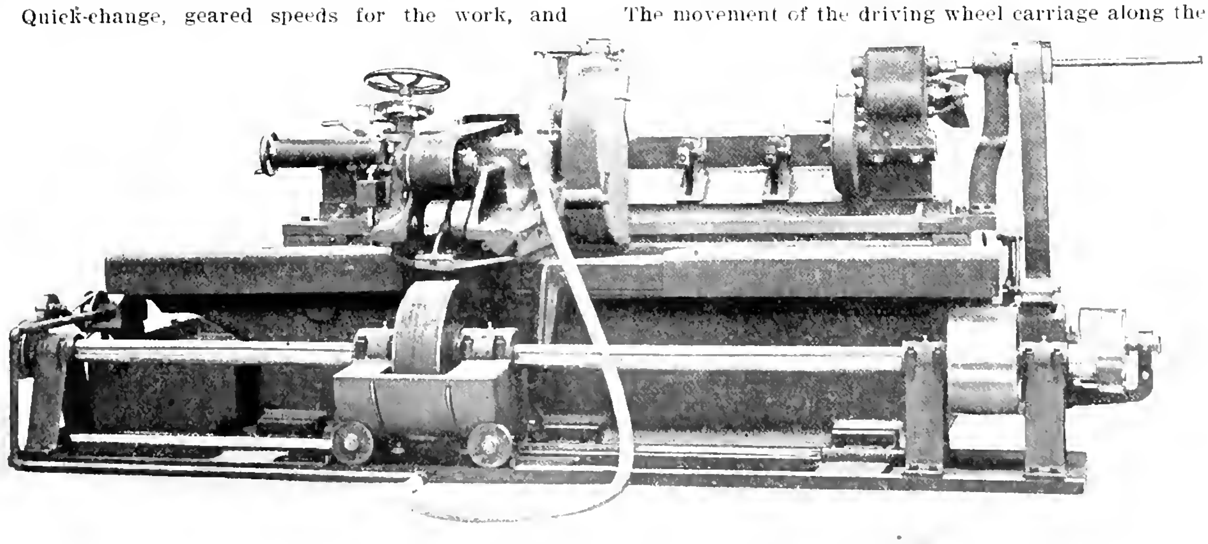


Fig. 2. Rear View of Landis Grinding Machine, showing Self-contained Drive

feeds for the wheel traverse, are provided. The geared feed can be operated automatically, and is provided with an automatic stop. The controlling handles are all reached from the front of the machine. The work speed and wheel feed are started and stopped together by a clutch in the pulley at the end of the feed box at the left of Fig. 1. These drives can also be operated separately, and their speeds are varied entirely independently of each other.

A new and interesting feature of the design is the drive for the wheel spindle. This is best seen in the rear view of the machine in Fig. 2. The power is applied to the large driving pulley at the right, mounted on the heavy main driving shaft, running the length of the machine. This shaft has keyed to it a pulley, mounted in a carriage on rollers as shown, which is connected with the driving wheel slide by an arm so as to always keep in alignment with it. A belt runs from this pulley over a series of idlers and over the pulley on the grinding wheel spindle. These intermediate pulleys are so arranged as to automatically take up any change in the belt length, and at the same time keep it under uniform tension. Almost two hundred degrees of contact are provided on both the driving and driven pulleys. The six-inch belt can stretch about eight inches in length before it is necessary to remove a section to shorten it.

The movement of the driving wheel carriage along the main shaft in unison with the wheel slide is made easier by the method of keying the driving pulley to the shaft. This "key" is in the form of rollers in the hub of the pulley, engaging stepped grooves on the driving shaft as seen in Fig. 4. This does away with the heavy frictional resistance to sliding motion which would be felt if the pulley were keyed to the shaft as usual, especially when driving under a heavy strain. The mounting of the pulley carriage on rollers, in addition to this, gives perfect freedom of movement.

Great care has been taken to give the grinding wheel head the massiveness and rigidity required for the rapid production of accurate work. The spindle is of very large diameter, and is made of hardened steel. The bearings are phosphor-bronze; they are self-aligning and are adjusted in taper bearings to take up the wear. Self-oiling boxes are furnished. The very important feature of protecting these bearings from grit and emery has been attended to, positive dirt-

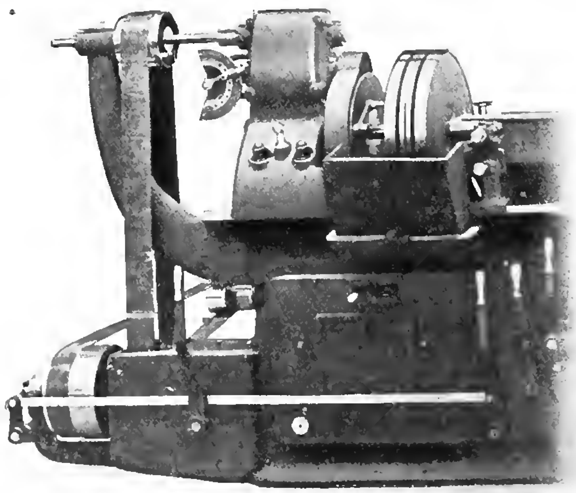


Fig. 3 Heavy-duty Grinder with Gap in Bed, for Railroad Work, etc.

proof covers being used for the purpose. The wheel collar is provided with an angular groove on its face, in which two weights are adjustably mounted. By this means the grinding wheel may be balanced so as to run quietly at the highest speeds. This also is an important feature in the production of good work. Wheels up to 24 inches diameter and 4 inches face can be used on work up to the full capacity of the machine.

Besides driving the wheel spindle, the main driving shaft has also connections with the pump and with the feed and work spindle mechanism. The feed and speed connections are taken off from the pulley at the extreme right in Fig. 2, and at the left in Fig. 1, being belted to a gear box at the end of the machine in front. From this gear box a belt connection with the headstock, which is strongly geared, giving ample power for the largest piece of work that can be placed in the machine, is provided. It gives five rates of speed for each of the two positions of the back gear in the driving box, or ten rates of speed in all, indicated plainly on a dial. All the clutch mechanisms are of hardened tool steel, and all the gears have planed teeth.

For roll grinding, the machine is fitted with special supports for the necks or journals of the work. Previous to the operation of finishing the body of the roll, these journals or necks are themselves ground, with the roll carried on centers the same way as for regular plain grinding, but in grinding the roll face, the work is supported by its own bearings. The importance of having the roll face true and concentric with the journals is, of course, vital. This method of supporting the roll while finishing it has been found the only practical and reliable one for general use.

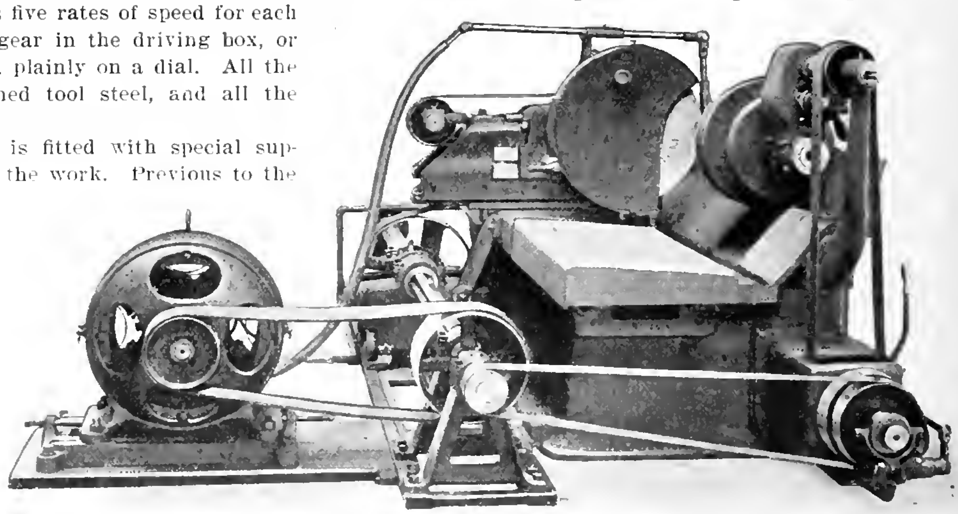


Fig. 4. End View of Gap Grinder, showing also Details of Self-contained Electric Drive

To compensate for any slight error in the alignment of the headstock and center line of the rolls, and to avoid any tendency of the drive to shift the roll from its true position parallel with the bearings, an equalizing fixture is adjusted to the face of the headstock. This drives the roll with equal force from opposite points. Neither the neck bearings nor the equalizing fixture are here shown.

As explained, this machine is also made in a form which is adapted more particularly for railroad work. For this work a gap in the bed is provided, as shown in Figs. 3 and 4. When the gap is provided, the grinder is adapted to handle locomotive pistons, piston valves, valve stems, cranks, links and knuckles, pins, axles, etc., it being possible to grind piston rods with the pistons in place and to swing valve yokes when grinding the stem. The gap can be located at the time the machine is being built in any desired position to suit special work.

STURTEVANT ELECTRIC FORGE BLOWER

The accompanying illustration shows a motor-driven forge blower made by the B. F. Sturtevant Co., Hyde Park, Mass., applied to a pair of Sturtevant forges. The blower is composed of a pressure fan of the multi-vane type, enclosed in a pressed steel plate casing, driven by a direct-connected electric motor, operating from the electric lighting circuit if necessary. The multi-vane type of fan wheel is highly efficient and gives a greater pressure and volume of air than can be obtained from fans of the ordinary type.

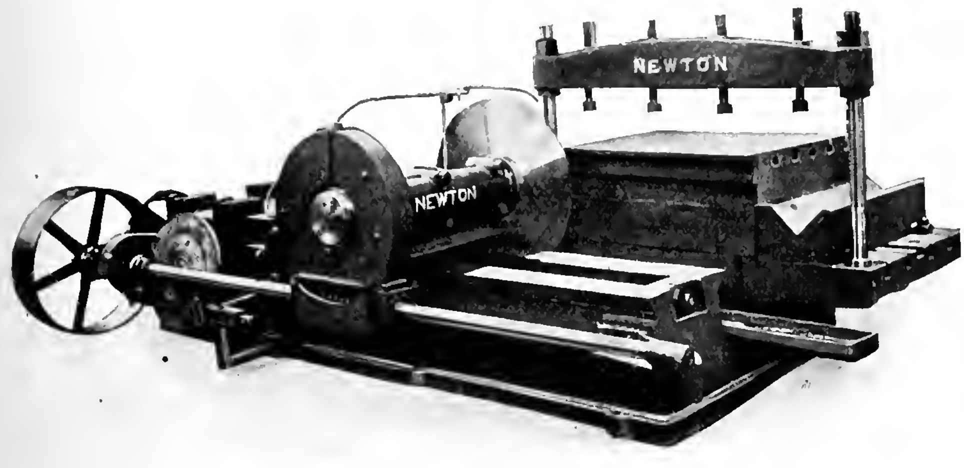
It may be of interest to mention that with this blower con-

Motor-driven Forge Fan made by the B. F. Sturtevant Co., Hyde Park, Mass., applied to a Double Forge

nected to a forge with a tuyere area of 1.5 square inch, two-inch round soft steel stock may be heated to a welding heat in four minutes, and one-inch round soft steel stock in $2\frac{1}{2}$ minutes. The blower can be set on a bench, shelf or box, or on the floor near the forge. The casing is arranged so that it can easily be revolved to discharge in any desired direction. The weight of the complete outfit is 35 pounds; the total height is $14\frac{1}{2}$ inches, and the width from the inlet of the fan to the outside end of the motor-shaft 10 inches. The base is provided with four holes for screwing the blower to the floor or shelf. In addition to its use as a forge blower it will be found convenient for blow pipes, soldering tubes, etc.

NEWTON COLD SAW CUTTING-OFF MACHINE

A modification of the combination type of cold saw cutting-off machine manufactured by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., is illustrated herewith. This machine is designed to give a maximum output on work comparatively short in length and of large diameter. The drive for the spindle is direct through a triple-threaded steel worm which is fitted with roller thrust bearings and a large wormwheel having a bronze ring. By having a wheel of large diameter, the length of the stock that can be cut is limited, but the life of the gearing is prolonged and chatter at the saw reduced to a minimum. In this connection it might be mentioned that on all types of machines, the saddle feed screw has a bearing at each end permitting of its being always maintained in tension for the purpose of eliminating chatter.



Newton Cutting-off Machine with Powerful Direct Worm Drive

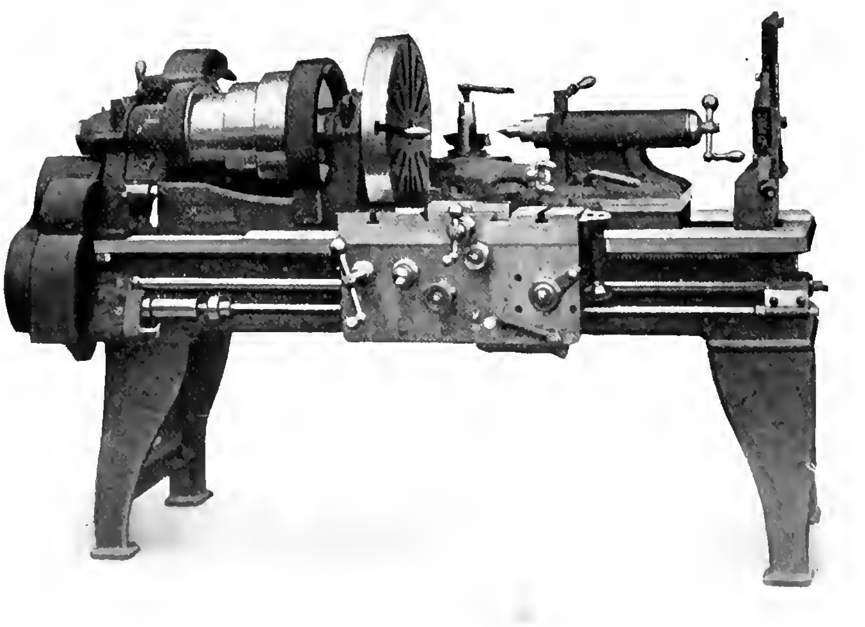
Both worm and wheel are encased, as shown, for continued lubrication. On this particular machine the spindle has a continuous capped bearing which is equal in length to the over-all diameter of the saw blade. The spindle saddle has a square locked gibbed bearing cast solid with the taper shoes to compensate for wear. The feed of the saddle is continuous and has a variation ranging from ¼ to 1½ inch per minute. An adjustable, automatic and positive safety release is provided and also a power quick return. As the motor is fitted with a double throw switch, the quick return is, of course, available in both directions.

This machine is furnished with a bottom table having an in-and-out adjustment for setting work to the required position for obtaining the desired length. In addition, there is furnished an auxiliary top table for handling flats or multiple pieces, and a V-block for holding angles or round stock. The clamping yoke just above the table is rigidly supported by two vertical screws to which are fitted nuts for obtaining the necessary vertical adjustment. Ordinarily, for clamping work it is desirable to operate the independent hand jacks. All the operating levers of this machine are located within convenient reach of the operator, and it is furnished with a pump, piping and attachments for cutter lubrication. All parts are of the very best material and all the high speed shaft bearings are bushed. The gears, where necessary, are made of steel, and the machine is rigidly designed throughout.

BRADFORD HEAVY PATTERN LATHES

A new design of heavy pattern engine lathes has recently been brought out by the Bradford Machine Tool Co., Cincinnati, Ohio. These machines are built in 18- and 22-inch sizes, the accompanying illustration showing what is known as the 18-inch heavy pattern Bradford standard lathe. In the design of these machines special efforts have been made to correctly distribute the metal in order to provide sufficient strength for the most severe duty. The machines are double back-geared, and are provided with a three-step cone pulley for a 3½-inch belt on the 18-inch size, and for a 4-inch belt on the 22-inch size. The spindles are made of high carbon crucible steel, bored from the solid, ground and mounted in adjustable bronze bearings. The hole through the spindle in the 18-inch size is 1 11/16 inch, and in the 22-inch size is 2 inches. The spindles extend clear through the head so that draw bars and tubes for draw-in attachments can be conveniently used; the draw-in attachments can be furnished and attached to the lathe at any time.

The carriage has a full bearing on the V's for its entire length, and is gibbed in front and back and designed with an extra amount of metal in the cross bridge. The apron is of the double-plate pattern, with a non-interfering safety device, so that the feed-rod and the lead-screw cannot be engaged simultaneously. The lead-screw is cut from a master screw, and the nut is of the split pattern made of phosphor-bronze. A chasing dial is provided for catching the threads, so that threads can be cut without stopping the lathe or reversing the lead-screw. The range of threads that can be cut on either of the sizes of lathes is from 2 to 40 per inch including 11½ threads. The feeds cover a range of from 8 to 90 per inch for the 18-inch size, and from 5.7 to 64 per inch for the 22-inch size. The feed gear train is at all times independent of the screw cutting train, which provides for a simple and direct drive for each. The idea of using a separate train of gears for feed purposes will appeal to all mechanics as a feature of great merit. The lathe is provided with a friction cross-feed graduated to read in thousandths of an inch, and with a friction traverse feed in the apron, and automatic stop for the carriage.


Eighteen-inch Heavy Pattern Engine Lathe made by the Bradford Machine Tool Co., Cincinnati, Ohio

An improved taper attachment, turning tapers up to 4½ inches per foot, 16 inches in length, and available the full distance between the centers, can be provided. If required, quick-change gear device, coarse screw-cutting mechanism, relieving attachment, draw-in attachment, etc., will be provided.

The general dimensions of the 18-inch size are as follows: Swing over ways 20¼ inches; maximum distance between centers of six-foot lathe, 2 feet 2½ inches; back-gear ratios

10.95 to 1, and 3.31 to 1; spindle speed range, 12 to 349 revolutions per minute; weight of lathe with six-foot bed, 2950 pounds; and weight of bed per additional foot, 140 pounds.

The 22-inch size swings 22½ inches over the ways and takes 3 feet 7½ inches between the centers on an 8-foot bed. The spindle speed range is from 11 to 346 revolutions per minute; the back-gear ratios are 10.04 to 1 and 2.82 to 1. The weight of a lathe with 8-foot bed is 4400 pounds, and the weight of the bed per additional foot, 175 pounds.

A noteworthy feature is the complete manner in which all gearing has been covered. Not only does this provide for added safety in operating the machine, but the gear guards have been designed so that they give to the machine a finished and pleasing appearance, as well.

WOOD TILTED-TURRET SCREW MACHINE

A tilted-turret type of screw machine, with a friction geared head and geared automatic feed for the turret slide, has recently been brought out by the Wood Turret Machine Co., Brazil, Ind. This machine embodies in its design many improvements and new features which adapt it to the rapid and accurate production of duplicate parts.

It will be noted, by referring to the engraving Fig. 1, that the head and lower half of the gear guards are cast integrally, thus assuring great strength and rigidity. In addition to the friction geared head, a three-step cone of large diameter and wide face is provided, giving a powerful drive to the machine. Two spindle speeds for each speed of the cone are obtained by the friction geared head, thus enabling the operator to use two speeds without stopping the machine to throw in the back-gears. By moving the handle shown at the side of the cone to the right or left, the back-gears are thrown in or out while the machine is in motion, thus securing the necessary speeds for changing from boring to tapping, or for turning different diameters on the same piece, without stopping the machine.

The headstock end of the machine with the protective casing removed, is shown in Fig. 2. This view shows clearly the arrangement and construction of the friction geared head, and

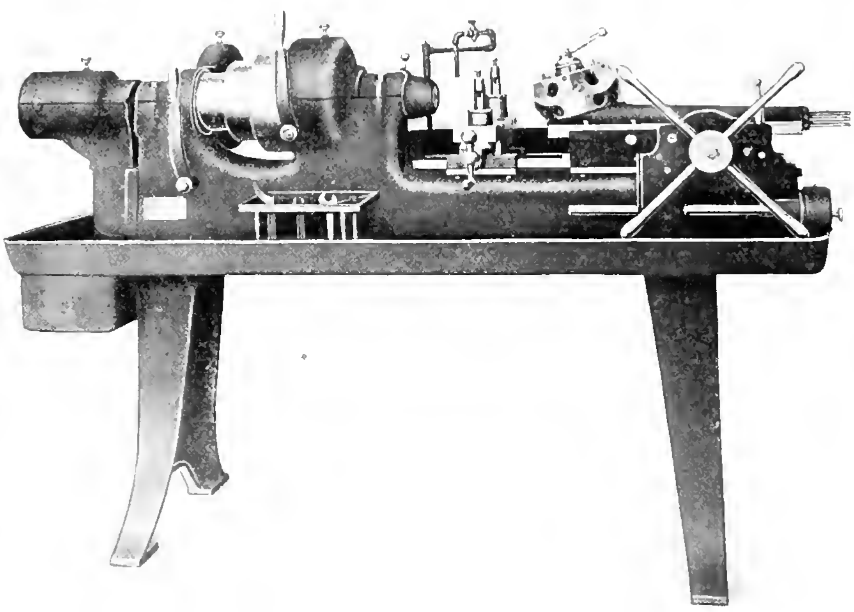


Fig. 1. Wood Tilted-turret Screw Machine with Friction Geared Head and Geared Automatic Feed to the Turret Slide

also the chain drive for the geared automatic feed to the turret slide. As will be noted, there is a sprocket screwed to the spindle of the machine which transmits the motion through a roller-chain to a shaft located in the bed. This shaft extends to the rear of the bed and transmits the feed motion to the gear-box of the turret slide. The details of the geared automatic feed are shown in Figs. 3 and 4. The necessary reduction in the speed of shaft *A* (which is the one that is connected by chain to the spindle) is obtained by means of four gears *B*, *C*, *D* and *E*. Gear *B* is keyed to shaft *A*, while gear *C* and the three gears adjacent to it, are solid and run free on their shaft. Gears *D* and *E* are also solid and are free to turn on their shaft. The power is therefore transmitted from *B* to *D* and from *E* back to *C*. The pull-pin *F* operates a sliding key which engages any one of the three gears mounted on the shaft with *D* and *E*. As these gears are always in mesh with the three which are adjacent to gear *C*, three different rates of feed may be obtained.

By referring to Fig. 4, the position of the gears which are interchanged to double up the number of feeds, making six in all, may be seen. This view also shows the automatic trip mechanism for disengaging the feed. This trip operates in

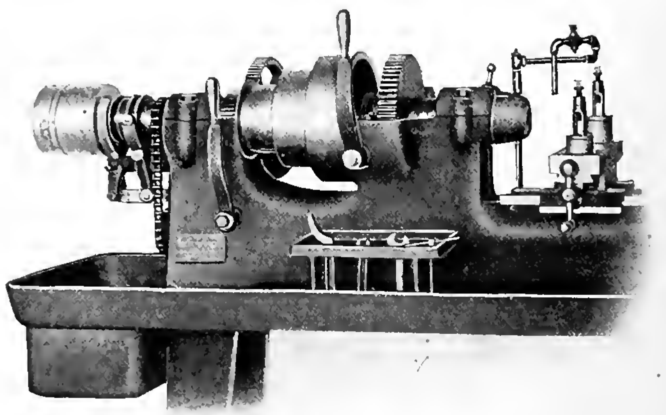


Fig. 2 View of Headstock End showing Construction of Friction Geared Head

conjunction with independent adjustable stops for each hole of the turret. The feed is transmitted from the spur gear on the pull-pin shaft *F* through two gears and the shaft *G* to the gears *H* and *I*. These latter gears are so arranged that they can be instantly interchanged, as stated, thus doubling the number of available feeds. On the same shaft with gear *I*, there is a worm meshing with a worm gear. This worm is held in a rocker arm, which throws it in and out of mesh with the worm gear by the operation of the hand lever. The worm gear is keyed to the same shaft that carries the turnstile. The turnstile shaft has mounted on its other end a spur pinion meshing with a rack secured to the under side of the turret slide, resulting in the automatic movement of the turret slide. The small forked lever *J* passes up through the under side of the turret saddle, and automatically trips out or disengages the feed in connection with the independent adjustable stops for each hole of the turret.

Among the special advantages of this machine might be mentioned the tilting of the turret which makes possible the use of extra large box tools and die-heads on this machine. When the turret is swung around to the rear position, the tools are thrown up at an angle of approximately 30 degrees, entirely clear of the turret slide. The tilt of the turret also minimizes the strain on the center-bolt of the turret head, and applies part of the thrust directly to the inclined surface of the slide. This feature also causes a full bearing on the slide, and eliminates the tipping which is likely to occur with the high turret. Stock may be passed into or directly through the tilted turret, since the center-bolt has a hole directly through it; this feature allows the use of a short, stiff box tool and eliminates the necessity of the box tool rest guide. Thus with this machine it is possible to obtain the benefit of the long effective motion to the slide. The turret also being hexagonal allows the box tool to be bolted to the face, leaving the turret hole open to let the work pass through. Work, when machined, is passed into or directly through the turret, coming out at the rear through one of the auxiliary holes in the lower half of the turret without interfering with a tool in the rear position.

In regard to the general construction it may be mentioned that the machine is equipped with bar feed for automatically

feeding stock through the spindle. There are four gears and a scroll which gives the power to two rollers, while a second scroll is used to fit the adjusting jaws to the stock. Provision is made on the stock adjusting jaws to take round, square, hexagon, or any other shaped stock that one may desire to use. The same lever (located on the left-hand end of the machine) which operates the automatic bar, operates the automatic chuck, opening it before the feed is thrown into action when the lever is thrown to the left, and closing it after stopping when the lever is thrown to the right. Thus one lever controls two operations, and at the same time eliminates

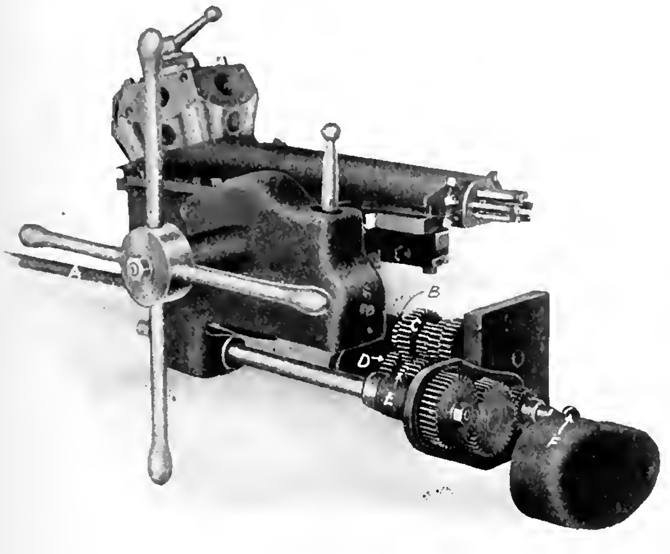


Fig. 3. Detail View of the Geared Automatic Turret Feed

the danger of trying to roll stock into the machine when it is gripped by the collet.

The turret slide, which rests and moves in the saddle, is furnished with a taper gib fitted the whole length of the saddle on either side, providing a means of adjusting the slide sideways. The saddle is gibbed to the outer edges of the bed by flat gibs throughout its entire length. There is a supplementary taper base to the saddle by means of which the turret holes can be adjusted to the exact height of the center of

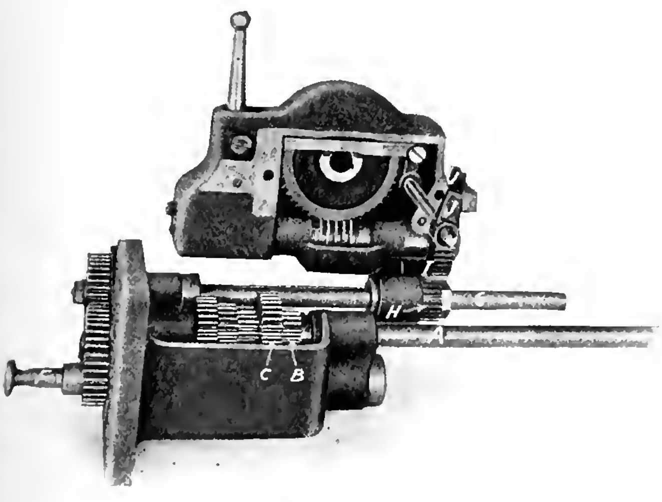


Fig. 4. Another View of Turret Feed Mechanism showing Automatic Trip

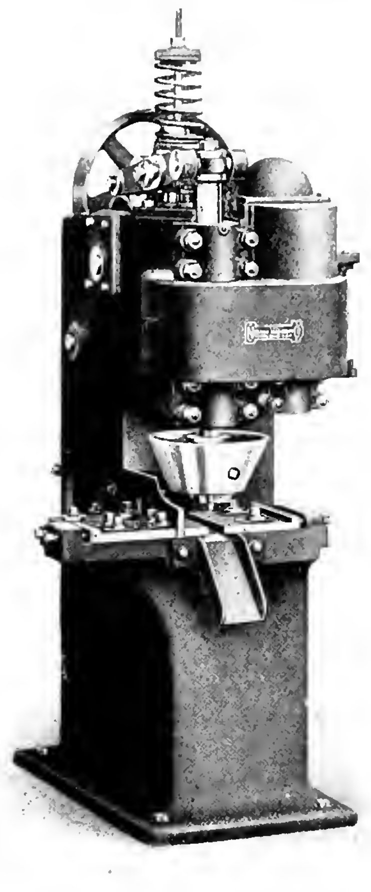
the spindle. This provision makes it unnecessary to rebore the turret holes. Automatic stops for each hole in the turret are furnished with the machine and are instantly adjustable to different lengths.

Hill, Clarke & Co., Inc., of Boston and Chicago, are the sales agents for this machine. This firm also has branch offices at New York, Philadelphia and Cleveland.

NATIONAL NUT BURRING OR SHAVING MACHINE

The accompanying illustration shows a new design of nut burring or shaving machine for hot pressed nuts, recently brought out by the National Machinery Co., Tiffin, Ohio, manufacturer of bolt, nut and rivet machinery. The machine is of the semi-automatic type, of simple design, its specific features being high productive capacity accompanied by perfect safety to the operator.

The machine will easily handle the output of a hot pressed nut machine, and a production of from two to four times that of the ordinary hand-feed burring machine is possible. When in operation, it is only necessary for the operator to place the nuts in a slot at the side of the machine and move them forward. The raising and lowering of the burring spindle, and the feeding of the nuts under the revolving cutter is entirely automatic. This, it will be seen, insures a maximum production, as the machine sets the pace for the operator. At the same time it eliminates all chance of accident to the operator incident to the feeding of the nuts under the rapidly revolving cutter, as this feature is eliminated and taken care of by the automatic feed. The finished nuts are ejected from the machine automatically, passing through a chute shown in the illustration in the front of the machine.



Nut Burring Machine, made by the National Machinery Co., Tiffin, Ohio

The finish on the nuts is uniform. All burr is effectually removed, and as the cutters are lowered gradually by a cam movement, there is no tendency of the burr to turn over the edge instead of being cut off. A compensating spring is provided which takes care of variations in nut thicknesses, and safety arrangements are provided both on the burring spindle and feed mechanism to prevent breakage. Changes for various sized nuts can quickly be made. The machine is built in two sizes, the capacities being 1¼ and 2 inches, respectively.

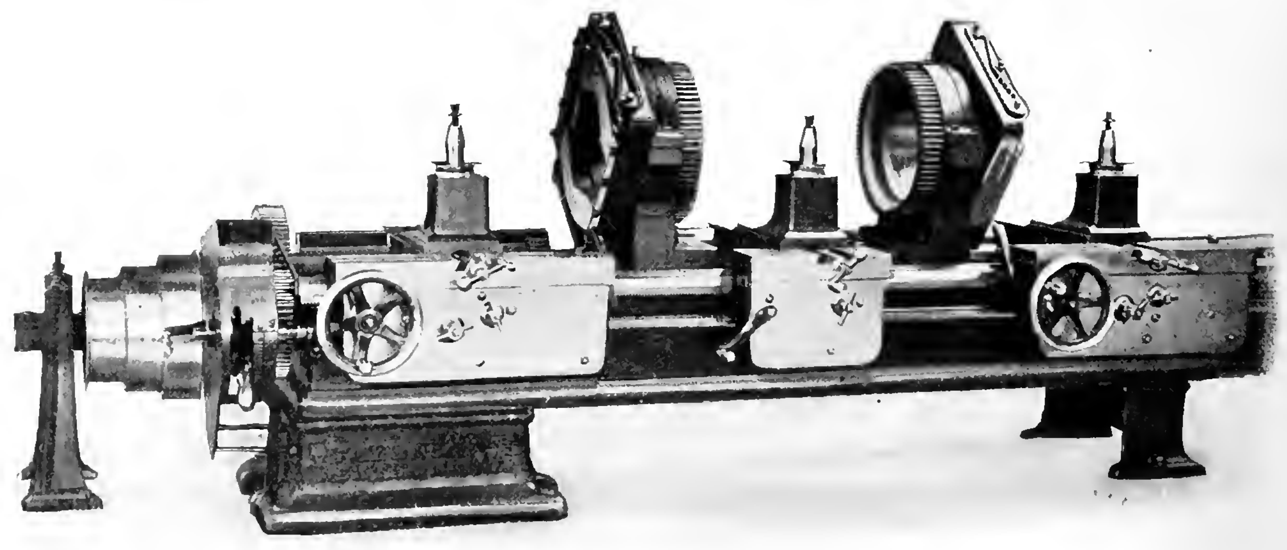
FAY & SCOTT DOUBLE-END TURNING AND FACING LATHE

A double-end turning and facing lathe, which was designed and built by Fay & Scott, Dexter, Me., for the Merrimac Iron Foundry Co., of Lawrence, Mass., is illustrated herewith. This lathe is specially built for facing the ends and turning the flanges of heavy cast iron columns. The work is gripped on the outside by two large hollow chucks, which are mounted in massive bearings or brackets. These brackets may, of course, be adjusted along the bed to accommodate columns of different lengths. The machine will handle a maximum length of 22½ feet, while the chucks will take a maximum diameter of 13 inches. Flanges as large as 32 inches in diameter will swing over the lathe carriages.

As the engraving shows, this machine is equipped with three carriages. Those at the ends make it possible to perform the turning and facing operations on the flanges of columns simultaneously, thus greatly facilitating work of this kind. The carriage in the center may also be used when necessary on special work thus making the tool more universal. The two

end carriages both have power, longitudinal and cross feeds, while the middle carriage has a power cross feed only.

The drive is by belt onto a four-step cone pulley, which is supported by an outboard bearing as shown. The power is transmitted from this pulley through gears to a splined shaft which runs through the center of the bed. This shaft, in turn, is connected to the chucks or work holders through gearing, the arrangement of which is as follows: On the splined shaft and just beneath each chuck is mounted a sliding pinion



Double-end Turning and Facing Lathe built by Fay & Scott

which drives through an intermediate gear to the hollow gear which forms a part of the chuck. One of these intermediate gears is shown in the engraving in mesh with the right-hand chuck gear. These chucks are equipped with hardened cast steel, V-shaped jaws, which are operated by two right- and left-hand threaded screws. These screws, by means of a connecting chain, are turned simultaneously. The chains, as well as the sprockets on which they run, are plainly shown in the engraving. This arrangement makes it possible to obtain a powerful grip on the work, which will withstand the heaviest cutting strains.

The changes of carriage feed are obtained by means of a quick-change sliding tumbler gear at the head end of the lathe. As the engraving shows, the bed of the machine is deep in section, and all parts are heavily built to withstand the strains incident to the class of work which the lathe is designed to handle. The weight of this machine, with a 26-foot bed, is 12,000 pounds.

ROCKFORD SENSITIVE BENCH DRILLS

The sensitive bench drills illustrated in Figs. 1 and 2, are the product of the Rockford Lathe & Drill Co., Rockford, Ill. These machines, while designed along the same lines as the Rockford tools previously illustrated and described, contain one or two important changes in their construction. The machine shown in Fig. 1 is of the 10-inch size and is electrically driven. The motor and speed controller are mounted on an extension cast to the base. The motor can be furnished with either direct or alternating current, and by means of the controller a wide range in speed can be obtained. The driving belt passes from the pulley on the armature shaft over two idlers at the rear which are mounted on an adjustable bracket actuated by the rack and pinion movement shown at the top of the column. This arrangement provides a very quick means of giving the belt the necessary tension. The spindle is counterbalanced by means of a taper plunger that fits in the spline of the quill. The necessary thrust on the spindle is obtained by an adjusting screw which acts on a spring back of the plunger. A stop collar is placed on the outside of the quill above its bearing, as shown, which gives a positive stop and makes it possible to drill different holes to the same depth with accuracy. The machine is equipped with a tilting table which adapts it to drilling holes at an angle and for other irregular work. The size of the table is 8 by 8 inches and its vertical adjustment, 9 inches. The maximum distance from the spindle to the table is 12 inches, and the spindle has a lever feed or 3 inches.

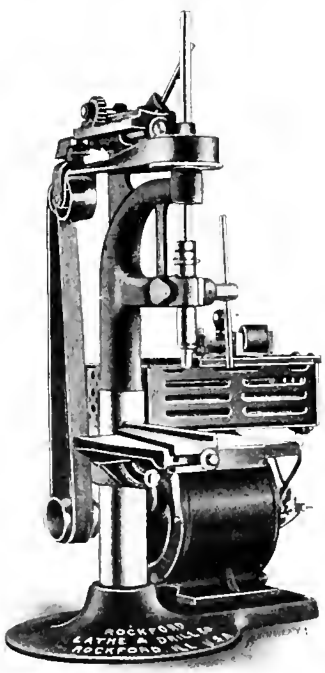


Fig. 1. Electrically-driven Sensitive Bench Drill

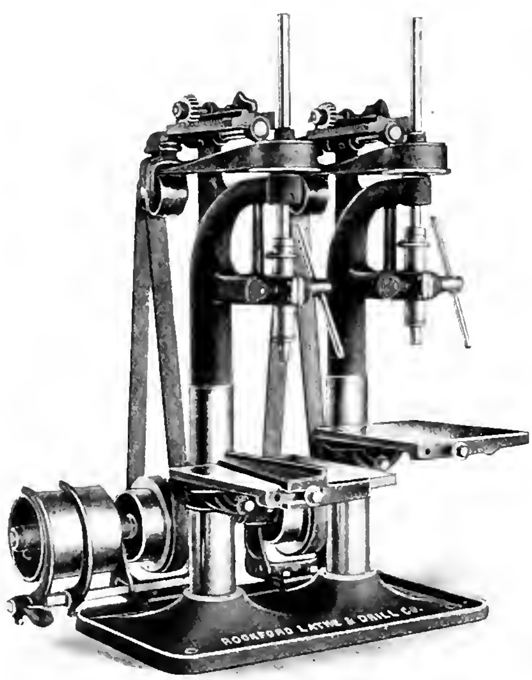


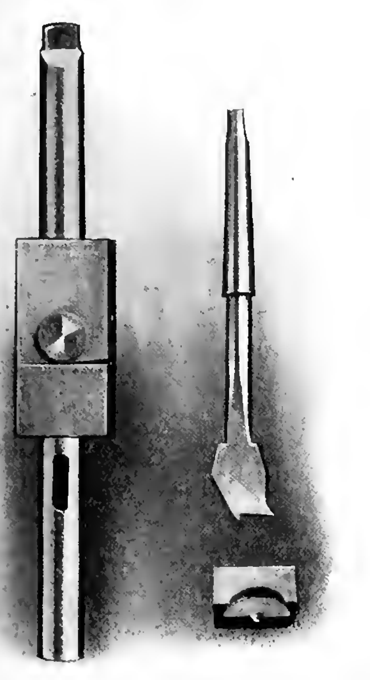
Fig. 2. Two-spindle Bench Drill with Self-contained Countershaft

The machine illustrated in Fig. 2 is of the same size as the one just described, but of the two-spindle type. As the illustration shows, this drill is arranged with a self-contained countershaft which is mounted on brackets attached to the base. It will also be noted that two-step cones are mounted on this countershaft to give the necessary speed variations.

When the belt is to be shifted from one step to the other, the cone is moved over to a stop where a ball plunger engages a hole in the shaft. The belt-tightening arrangement is the same as the one previously referred to, and is especially useful on this particular tool for quickly taking up the slack in the belt when the latter has been adjusted to the smallest cone step. The spindles are also equipped with a spring-actuated counterbalancing device and the tables are of the tilting type. The size of these tables, their vertical adjustment and the maximum distance to the spindle is the same as given for the single-spindle machine.

THE PHILLIPS BABBITT METAL LOCK DRILL

The accompanying illustration shows an interesting tool used for boring undercut holes in bearing boxes, or other surfaces to be lined with babbitt metal, for locking the metal securely and permanently in place. The tool is the invention of Mr. C. H. Phillips, 689 Massachusetts Ave., Cambridge, Mass. Before this drill is used, the hole is first started by using a twist drill ground to an angle of 72 degrees, and a hole is drilled to a depth of 3-16 inch. After that the drill shown to the right in the illustration is used, it being held in the special jointed socket shown to the left. This socket permits the drill to wabble so as to cut or bore a hole having a dovetail section as shown in the view at the bottom of the drill, the point of the drill being guided by the hole already drilled as mentioned. These drills cannot be used in an ordinary drill chuck. They are made in ½, ⅝ and ¾-inch standard sizes, and special sizes can be made if required. High-speed steel drills of this type will bore a hole in a fraction of a minute. Among other uses, it may be mentioned that the tool is very convenient for providing locking means for the babbitt on the shoes on cross-heads of stationary and marine engines, and for thrust bearings on marine engines, as well as for securing the babbitt in locomotive bearings.



The Phillips Babbitt Metal Lock Drill, with Special Socket and Section of Hole Bored

BAIRD LARGE OBLIQUE TILTING TUMBLER

The accompanying illustration shows a large size oblique tilting tumbler brought out by the Baird Machine Co., Oakville, Conn. This tumbler is larger than those previously brought out by the same company, and is known as the No. 3 size. It is especially intended to meet the demand for a machine to tumble castings of medium size and weight, such as valves, stove trimmings, the larger sizes of chain, etc. The capacity of the tumbling barrel is about four bushels or 700 pounds of work. Tumbling barrels of from 28 to 48 inches diameter at the base can be mounted interchangeably in the machine, the barrels being made either of wood, cast iron, sheet steel or brass.

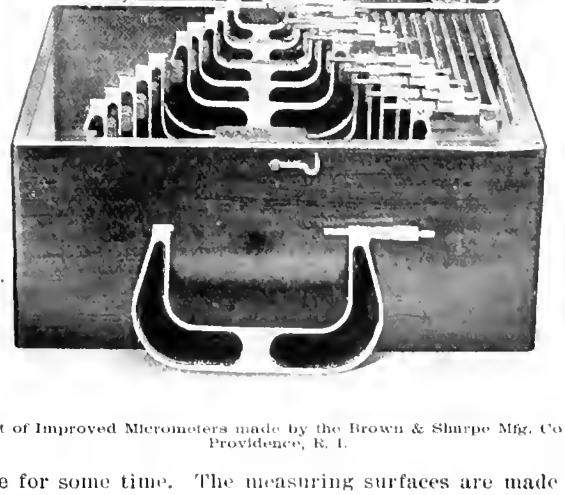
The No. 3 Baird tumbler has all the advantages of the regular line of oblique tilting tumblers built by this company, including convenient means for putting in the work, inspecting articles during the progress of operation, tilting, elevating or dumping the contents, which all can be accomplished without stopping the machine. In addition to the mechanism required for these operations, the No. 3 tumbler is fitted with a clutch pulley controlled by a lever placed conveniently for the operator, near the tilting crank. The tilting mechanism is well back-geared, and makes the operation of the barrel comparatively easy. The weight of the machine without barrel is 2000 pounds.

Large Size Tumbler made by the Baird Machine Co., Oakville, Conn.

NEW LINE OF BROWN & SHARPE MICROMETER CALIPERS

The accompanying illustration shows a complete set of a new line of micrometer calipers recently brought out by the Brown & Sharpe Mfg. Co. of Providence, R. I. The complete set comprises eleven micrometers ranging from 1 inch to 12 inches, and from 25 to 300 millimeters. These micrometers are intended for shops where accurate measurements must be taken on large work, and are made heavier than those of earlier designs. The frame of the micrometer is made of I-section, which provides great strength and rigidity, while at the same time the weight of the instrument is reduced to a minimum so as to make it convenient to handle.

Care is exercised in making to have the micrometers very accurate when they leave the makers, and every precaution is taken to have them retain their accuracy after they have been in use for some time. The measuring surfaces are made perfectly square, so that small projections on a plane surface for example, may be measured with accuracy. A standard gage is furnished with each micrometer for testing purposes



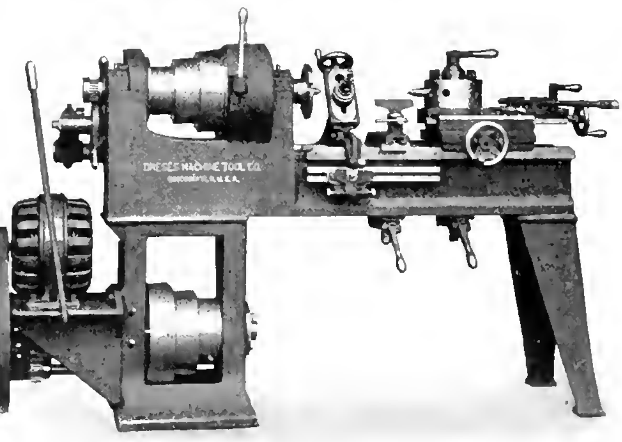
Set of Improved Micrometers made by the Brown & Sharpe Mfg. Co., Providence, R. I.

and means for adjustment to compensate for wear are provided. All points that are exposed to wear are hardened. These micrometers are furnished either singly or in sets of six or eleven, the set of six comprising the six largest sizes, with an inclusive capacity of from 6 to 12 inches.

DRESES ELECTRICALLY-DRIVEN 16-INCH UNIVERSAL MONITOR LATHE

Because of the high speed at which a brass lathe must run, it has been found impracticable to have a geared connection between the motor and spindle. It is also undesirable to mount the motor on top of the headstock as disturbing vibrations are likely to result. To overcome these objectionable features, the Dreses Machine Tool Co., of Cincinnati, Ohio, has equipped its brass lathes with a special form of motor drive. This drive, as applied to a 16-inch universal monitor lathe, is shown in the accompanying illustration. The motor-driven turret lathe described in the March, 1909, number was also equipped with this form of drive.

As the illustration shows, the countershaft with its cone is placed in the cabinet support under the head. The motor, which is mounted on a bracket, has a rawhide pinion on its



Dreses 16-inch Universal Monitor Lathe with Special Motor Drive

armature shaft, which meshes with a large gear on the lower cone shaft. As an electrically controlled device would be somewhat slow for brass and similar work, a frictional mechanical connection between the motor and countershaft is used. The long vertical lever shown operates this device and starts, stops or reverses the countershaft instantly without stopping the motor. It will be noticed that the cone pulley is placed as low as possible to obtain the maximum length of belt and to avoid vibration. The motor used is of the constant-speed, polyphase type and develops, in this particular installation, 2½ horsepower. When a variable speed motor is to be used, single pulleys are substituted for the cone pulleys. This drive arrangement is used on all the screw machines, turret and brass lathes manufactured by this company.

BROWN & SHARPE NEW TYPE FACE MILLING CUTTER

A new type of inserted tooth face milling cutter has recently been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. This cutter, as illustrated in the accompanying halftone and line engraving, Figs. 1 and 2, embodies some important changes from the ordinary type of inserted blade milling cutters, and presents a radical departure from the usual construction. The two main features of the cutter are the means provided for using the same cutter on different size spindles on different machines, this being accomplished by the employment of special sleeves, and the provision for a quick release from the nose of the spindle when the work is finished and the cutter is to be removed.

The cutter consists of four parts, as shown in Fig. 1: the cutter proper, the split sleeve shown to the left, the clamping plate shown to the right, and the drawing-in bolt. As shown in Fig. 2, the sleeve is screwed onto the spindle nose and the outside of the sleeve is provided with a taper fitting the hole of the cutter body. This taper is sufficient to cause the latter to release readily from the sleeve when not forced inward by the clamping plate. When in use, however, the cutter body is drawn onto the sleeve by the clamping plate by means of the drawing-in bolt as shown, and is keyed to the sleeve as indicated, as an extra precaution against turning or slipping. When the drawing-in bolt is tightened, the sleeve is contracted

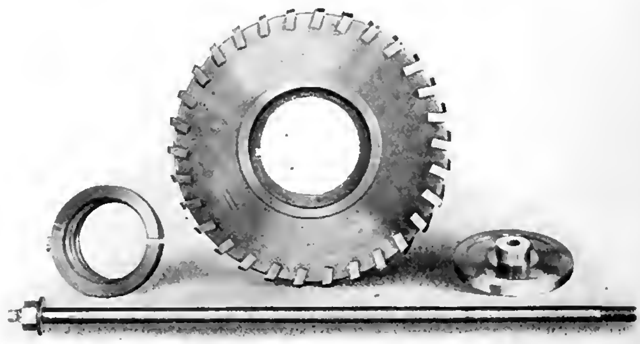


Fig. 1. New Type Brown & Sharpe Inserted Blade Milling Cutter, with Sleeve, Clamping Plate and Drawing-in Bolt

and closely grips the spindle, thus furnishing the full efficiency of the drive to the cutter at all times. The cutter can be quickly and easily removed simply by loosening the drawing-in bolt. As the cutter is made without a hub, it is held close to the spindle end and thus provides for the maximum of working space.

When it is desired to use the same cutter on several machines having different sizes of spindles, all that is necessary is to provide a sleeve for each size of spindle. The outside of these sleeves all fit the hole in the cutter body, while the holes in the sleeves, of course, are made to fit the spindles of the various machines.

The features of the new tool will be readily appreciated both by machine shop owners and machine operators. To the former the possibility of avoiding keeping a large number of cutters on hand, differing only as to the size of hole to fit different spindle noses, will appeal; to the latter the avoidance

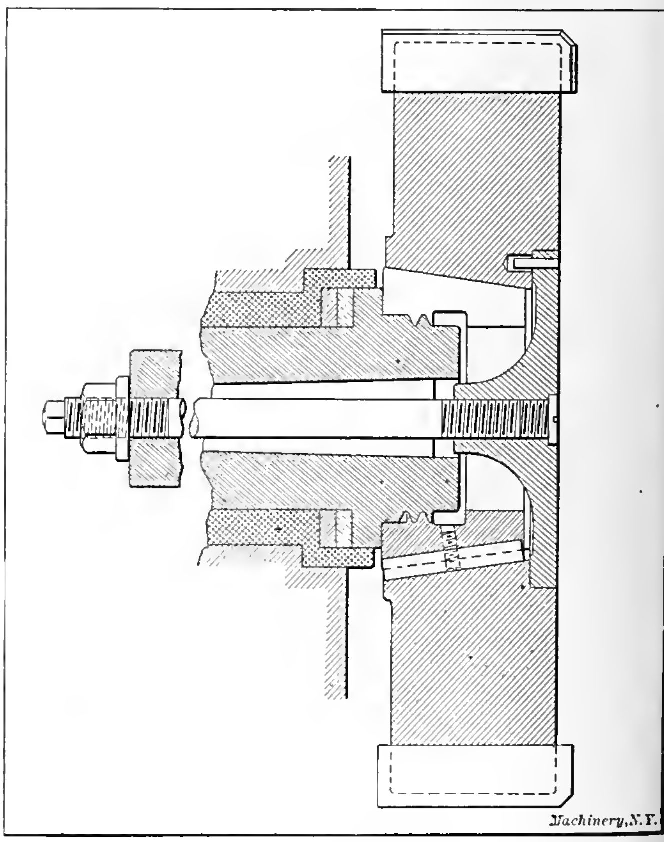


Fig. 2. Section through Milling Cutter Mounted in Place on Spindle Nose

of trouble oftentimes experienced in removing large cutters from the spindle nose after having taken heavy cuts will be of especial interest.

DAVENPORT CLOCK AND WATCH PINION MACHINERY

In Fig. 2 is shown a pinion and staff of the kind ordinarily used in clocks of various sizes and designs. It consists, as may be seen, of a shaft or "staff" on which are pressed three brass disks or "collets." In the two at the right are inserted wires or "needles" as they are called, forming a "lantern" pinion. The disk at the left is turned and shouldered to form a seat for the brass gear wheel, which is afterward pressed on it and staked in place.

Until very recently the thousands of these pinion shafts made every day, had been made in accordance with practices which were fifty years old or more. The first operation consisted in cutting the wire for the staff in lengths a little longer than the finished staff, pointing one end at the same time. This was done in an automatic straightening, cutting-off and pointing machine, and was the only automatic work in the making of the pinion. The brass disks or collets were then driven on in a sort of small arbor press, in which the wires were placed by one boy and the disks by another, and the wire driven through them.

The turning was done by a man in what was called a "clock lathe." This consisted practically of a speed lathe having a live spindle with a draw-in chuck, operated by the knee of the workman. The footstock was of the common type, and the turning was done by tools held in a long bar sliding in adjustable V-blocks on the head- or foot-stock. There were usually four tools in this bar, one on each of the four sides, for turning the different parts of the pinion. Each tool was set out to turn the desired diameter, and stops were provided for each tool, thus duplicating the lengths of the cuts. The pivots were finished by a highly polished steel burnisher, dipped in a soap solution, which was dexterously applied while the pivots were revolving at a high speed. An expert turner could finish from 700 to 1000 pinions in a day of ten hours.

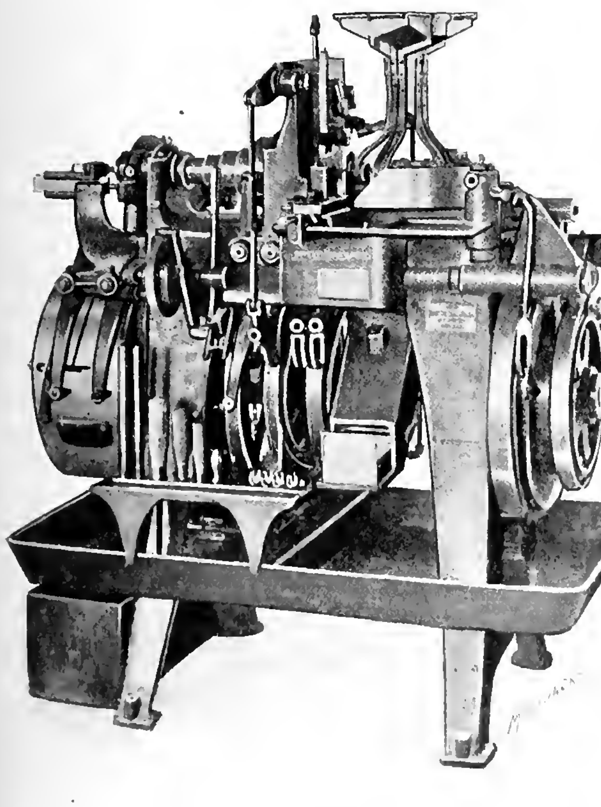


Fig. 1. Davenport Automatic Machine for Assembling and Turning "Lantern" Pinions

The holes in the collets for the needles of the lantern pinions were drilled by girls in a special jig of simple construction. These girls became very expert, pulling the lever which fed the drill with one hand, and indexing the head which held the pinion with the other. Afterward the needles were inserted and the holes staked over to keep the needles in place.

This method of making lantern pinions had been in vogue for so long that it was thought impracticable to perform the operations automatically. That this was not impossible, however, is shown by the line of machines which we herewith illustrate and describe. These consist of a staff turning machine for finishing the staff and pressing on the brass collets, and a lantern pinion drilling machine for automatically in-

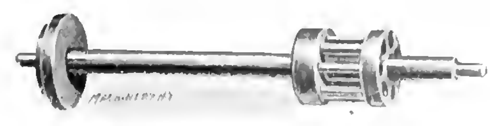


Fig. 2 A Completed Lantern Pinion as used in Clock Work

dexing the pinions and drilling the holes through the needles. These machines are the design of Mr. W. S. Davenport, and are built by the Davenport Machine Tool Co., New Bedford,

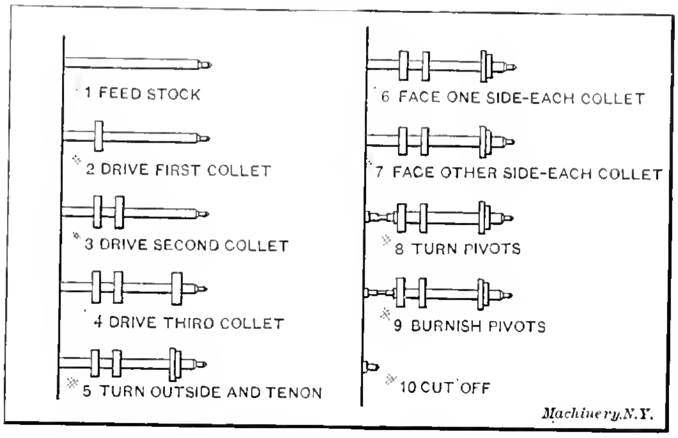


Fig. 3. Order of Operations followed in Machine shown in Fig. 1

Mass. In addition to these we show a universal automatic staff lathe for small clock pinions, which will be described later.

Lantern Pinion Turning Machine

The first machine, shown in Fig. 1, is the automatic turning machine. This performs the operations of finishing the staff over all, pressing on the collets, turning, facing and shouldering them, and delivering the whole completely assembled ready for drilling the needle holes. The machine is similar in many ways to the automatic screw machine of the "Hartford" type, but, in addition to the regular turret, it has another with its axis parallel with the spindle and sliding vertically above it. This turret carries five tools, making seven cross-slide tools available, as is required for finishing the pinions.

The first operation is feeding the stock out to a stop. The pivot on the front end of this stock has already been formed and burnished, as shown in Fig. 3. In the second, third and fourth operations, the collets are driven. These collets are placed loosely in the aluminum hoppers seen above the regular turret in Fig. 1, and by the motion of this turret they are shaken so as to come down an incline, and then to slide down the vertical chute into line with the spindle. Here they are in position to be driven on the wire held in the spindle, which is to form the shaft of the pinion, the spindle being stopped at the time. When two collets are of the same size, as is the case with the first two driven on in Fig. 3, they are both driven from the same magazine, the second magazine driving the third collet.

For the sixth operation the spindle is started and a swinging box-tool held in the regular turret turns off the outside diameters of the collets, and also turns the tenon of the larger collet where it is driven on. The tool-holder with three facing tools then comes down in the vertical turret, and faces one side of each of the three collets for the seventh operation. This vertical turret is again revolved and another holder comes down, facing the other sides of the same collets.

The pivots are now formed (eighth operation) by the regular cross-slide tools, one roughing and beveling the shoulder and the other finishing to size. The pivots are then burnished and polished by a pair of rollers in the vertical turret, in the

ninth operation. These rollers are hardened and highly polished, producing the same kind of a surface on the pivots themselves; they are rigidly held the right distance apart to burnish to the correct size for the pinion being made. Another tool in the vertical turret then necks both, and the last tool cuts off the pinion, for the tenth operation.

The machine will make from 1000 to 1800 complete pinions in a day of ten hours, depending on the size, number of collets, etc. One operator usually runs four machines, making the cost of the pinions so much less than by the old methods described, that the machine commonly pays for itself in about a year's use. The work is more accurate than by the old method, the pivots being finished to within 0.0005 inch above or below the standard size, with the length of the pinion correct to within about 0.002 inch limit above or below.

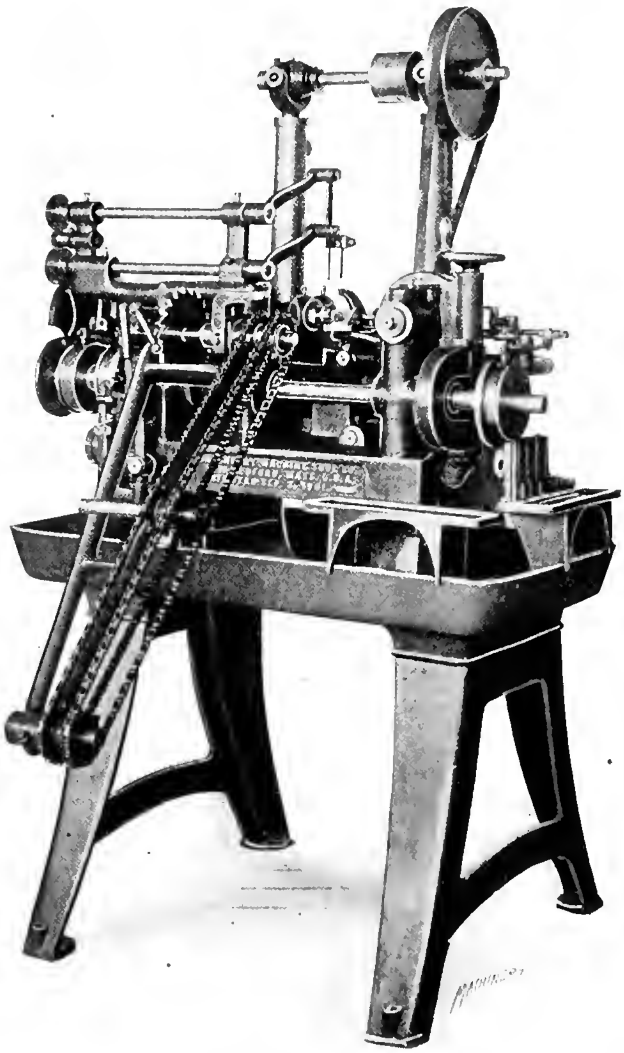


Fig. 4. Automatic Machine for Drilling Needle Holes for Lantern Pinions

In this machine the spindle speeds vary from 3600 to 1200 revolutions per minute, being suitable for wire from 0.075 inch diameter, used for alarm clocks, to 1/4 inch or greater diameter, used in ratchets, etc. Drilling attachments are sometimes placed in the cross-slide and are used for drilling holes through the shafts of ratchets for attaching springs and other parts. The hole through the spindle is 13/32 inch and the largest chuck used is for 3/8 inch stock. It feeds stock four inches long, and turns to two inches length. By making certain changes in the construction, however, it can be made to take cuts three inches long.

Many other kinds of work can be made in this machine besides clock pinions. Among these may be included the center pinions of steam and other pressure gages, pinions for mechanical toys, or other work requiring an unusual number of forming tools or requiring to be burnished. This operation of burnishing makes the best finish known for a staff bearing, being far superior to grinding or any other process.

It may be interesting to state that from the time the first lines were put on paper for this machine until the machine was turning out satisfactory work, was only about five months, which is an unusually good record in automatic machinery building.

Lantern Pinion Drilling Machine

The companion machine which performs the operation of drilling the small holes in the double collets for inserting the needles, is shown in Fig. 4. This has a magazine in the shape of a chain, with side plates having notches in which the pivots of the pinions are placed. The magazine shown holds about 50 pinions; they are taken from the chain by a pair of fingers mounted on the double arms seen about the spindle in the illustration. These place the pinion in line with the work-holding spindle, which then grasps it, the foot center coming up at the same time and holding and centering the outer end.

The spindle is now brought up and, under the action of suitable cams, the drill is fed slowly through the first collet, quickly through the space between the two, and again slowly nearly through the second one. It is then quickly withdrawn, the spindle holding the pinion is quickly indexed, and the drilling is repeated. The machine drills a hole in a second in both disks, or 60 holes a minute, besides feeding the pinions into the spindle, ejecting them, etc. The drill is often as small as 1/32 inch in diameter, and as the hole in each disk is about 1/16 inch long, it will be seen that the drill feeds through about 7½ inches per minute, making allowances for various stoppages during a day of ten hours. This amounts to about 300 feet, which is certainly a long hole for a 1/32-inch drill to make in a day. As one operator can feed four or five machines, the operation is performed at a very low cost. The drills are held in regular watchmakers' chucks, and run about 20,000 turns a minute. Both spindles are hardened, and a high grade of workmanship is supplied throughout the machine. Change gears and index mechanism are provided for drilling from six to twelve holes. The needles are inserted and staked in place by methods commonly employed on such work.

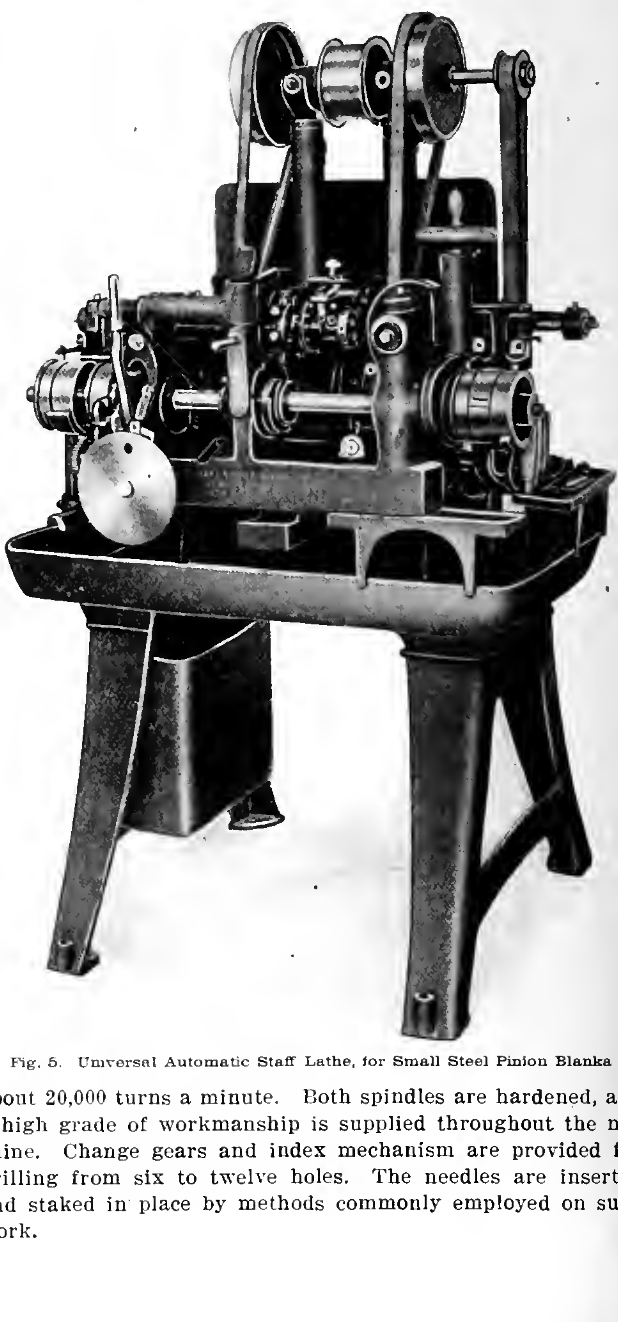


Fig. 5. Universal Automatic Staff Lathe, for Small Steel Pinion Blanks

Universal Automatic Staff Lathe

Another machine in this line is shown in Fig. 5. This is an automatic staff lathe, particularly adapted for turning the staffs with solid pinions, met with in small clocks and clock watches. The main features of this machine are the provision of two spindles in line with each other, and the special form of turret used.

One of the spindles, as in the regular automatic screw machine, is provided with automatic stock feed and collet mechanism. The second one, in line with it, has a similar collet or chuck mechanism, but is not provided with a stock feed. Its purpose is that of grasping the outer end of the work, so that the delicate staffs or pinion blanks are driven from both ends. This is essential on work of this character. Each spindle is separately driven from the self-contained countershaft of the machine; but in addition, there is a shaft back of

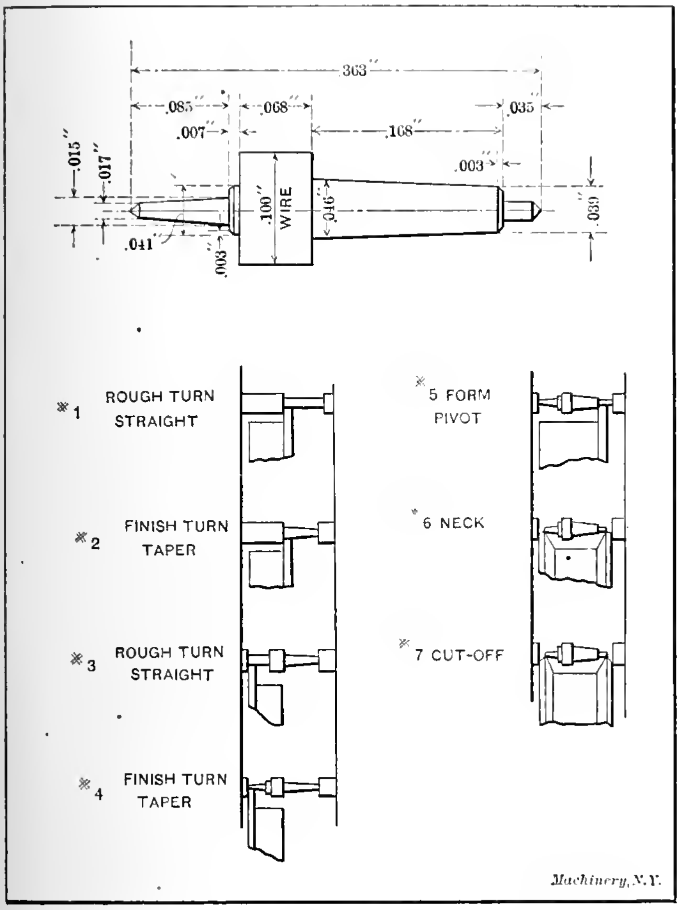


Fig. 6. Typical Order of Operations for Machine shown in Fig. 5.

the two spindles, connected with them by helical tooth spur gearing, which ensures their turning at exactly the same speed. This is essential to prevent small work from being twisted off. When the stock is fed it enters into the chuck of the second or supporting spindle, about 1/8 inch. After the pinion blank is completed and cut off, this piece is ejected before the next feeding of the stock.

The novelty of the turret lies in the fact that it has its axis parallel with the spindles, and has cam movements in line with the spindles for turning, and perpendicular to them for cutting-off, forming, etc.; and, furthermore, in the fact that circular forming tools similar to those ordinarily used for cross-slide work are employed. This construction makes it possible to use the same tool for forming and turning. After the tool is formed down to the desired diameter, it can turn lengthwise the same size; or it can turn taper, if desired, and as determined by the shape of the cams. This turret is really the old-fashioned clock lathe, described in connection with the lantern pinion turning machine, but made automatic, the tools being fed in the same way that the slide bar tools were fed in that lathe.

The tools used in this machine, as may be inferred from Fig. 6, are of the circular formed tool type. They are 1 5/8 inch diameter, and have 3/8 inch smooth holes, fitting on hardened and accurately ground pins in the turret. They are clamped with two screws each. There is a swing gage which can be brought down into position for setting the tool to the correct height to cut properly. This combination of a small hole in the tool and a gage for setting the height of the cutting edge, makes the setting of the tool after sharpening very rapid and accurate. For turning lengthwise, the periphery of the formed tools is notched in eight places, and side-relief is given them, this being done on the relieving attachment of the Hendey lathe. To ensure accuracy in the product, adjustable stop screws are provided for the diameters formed by each of the seven tools, while other screws are furnished for the lengthwise adjustment of each tool. Sizes and lengths are thus easily controlled. The work is usually kept within 0.00025 inch limit. Pivots as small as 0.015 inch for watches are easily made on this machine.

The operating cam shaft revolves slowly during the turning, through change gears; and quickly, and at constant speed, during the feeding of the stock. The handwheel for manually operating the feed is in a peculiar location, being mounted on a vertical shaft as shown. This has proved to be very convenient. The capacity of the machine is for stock up to 3/16 inch diameter. It feeds 1½ inch long and turns one inch long. The workmanship and materials used throughout are of the high character required for machines of this class. The ratchet disk shown at the front of the machine is arranged as a counter for setting the machine automatically when the number of pieces contained in a bar of stock of given length has been made.

Fig. 6 shows on an enlarged scale a sample of the kind of work produced on this machine, and the order of operations followed. The first operation is that of straight rough turning, the tool being fed in and then longitudinally to the required dimensions. In the second operation a similar tool is fed in, and then longitudinally, but it is slowly withdrawn during this longitudinal movement to form a taper as shown. The third and fourth operations of straight and taper turning are similar to the first and second, except that the tool in this case has a shoulder formed on it, which finishes the shoulder next to the body of the chuck. In the fifth operation the pivot at the right-hand end is formed. In the sixth operation a double form tool necks both pivots; and then, in the seventh and last operation, a similar tool cuts the pieces off.

GENERAL ELECTRIC IMPROVED SPEED CONTROLLER

The accompanying illustrations, Figs. 1 and 2, show different sizes of an improved type of speed controller, recently brought out by the General Electric Co., Schenectady, N. Y., and known as CR 162 speed controller. In this device the rheostats often used for the control of shunt-wound direct-current motors (one for starting the motor and the other for varying the motor field current for speed control) are combined in one box and operated by the movements of one rheostat arm.

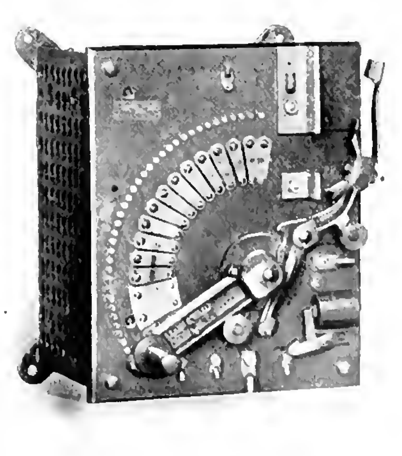


Fig. 1. Speed Controller, Type CR 162, made by the General Electric Company, Schenectady, N. Y.

The device consists of a starting rheostat, the arm of which is provided with a projection carrying a sliding contact which moves over the contact buttons connected to the field resistance. An auxiliary arm on the right hand side maintains a short circuit on the field resistance when starting the motor, and on the starting resistance when the arm is turned back for varying the running speed by regulating the field current.

When starting the motor, the starting arm, due to the action of a spring, cannot be left in position on any of the contact buttons, but must be turned to the right until it engages

the auxiliary arm and forces the latter to be retained by the no-voltage release coil. The auxiliary arm then withholds the spring actuating the starting arm and makes it possible to leave the arm in any position on the field contacts which will give the desired speed control of the motor. If the operator releases the arm at any position while it is being moved to the right during the starting period, it will immediately return to the "off" position. In case of voltage failure, the retaining coil is demagnetized and releases the auxiliary arm which, in turn, releases the spring which carries the starting arm to the "off" position, thus opening the motor circuit.

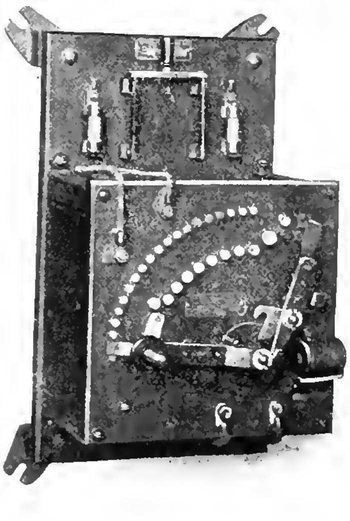


Fig. 2. A Controller of the same Type as shown in Fig 1, Mounted on a Slate Base

The design of the rheostat makes it necessary to apply a little extra pressure to move the arm beyond the maximum speed point, thus calling the operator's attention to the maximum speed position. When it is desired to stop the motor, the switch arm is thrown to the "off" position, de-energizing the retaining magnet and releasing the auxiliary arm which then opens the motor circuit.

The maximum obtainable speed variation is 3 to 1. The controller shown in Fig. 1 is for a 35 H. P. motor, 115 volts current. In Fig. 2 another controller of the same type is shown mounted on a slate base together with a double pole switch and fuses. The controller described is also made with an overload release coil, and is then known as type CR 163.

MILLING ATTACHMENT FOR THE ACME MULTIPLE SPINDLE SCREW MACHINE

A time-saving attachment for finishing parts requiring to be milled, on the screw machine, made by the National-Acme Mfg. Co., Cleveland, Ohio, was illustrated in the July, 1909, issue of MACHINERY. Another milling attachment for use on the Acme multiple spindle automatic screw machine, shown

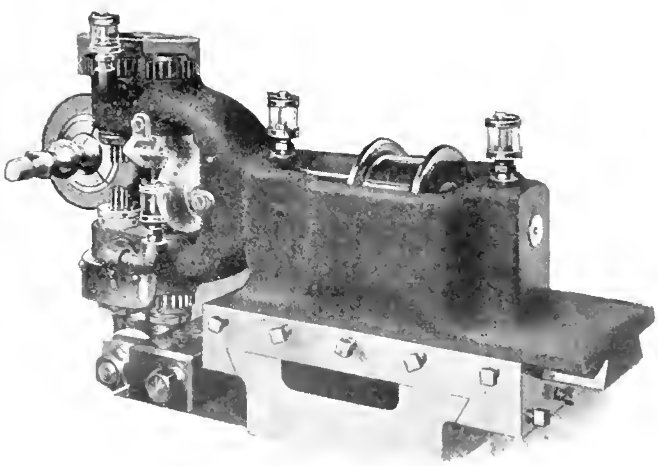


Fig 1. Milling Attachment for the Acme Multiple Spindle Automatic Screw Machine, showing Work Formed, Threaded and Milled in the Machine

in the accompanying engravings, Figs. 1 and 2, has recently been brought out by the same company. This attachment is especially intended for eliminating the handling in the milling machine of work of the character shown in the half-tone Fig. 3, this work consisting of a formed piece threaded on one end as shown, and having two flats milled as indicated. The making of this particular piece has always required two operations, one in the screw machine and one on the milling machine, the latter requiring the constant attention of an operator. The re-handling of pieces of that character is eliminated by the use of the attachment, which is fastened to the top of the slide carrying the cutting-off tool. The end mills shown are fed across the work by the cam movement which operates the cutting-off tool, and the increased movement necessary is obtained by the auxiliary lever shown in Fig. 2. The milling operation takes place at the same chucking as the forming and threading operations, and it will, therefore, be seen that the milling operation does not add to the time required for making the piece. The labor cost is

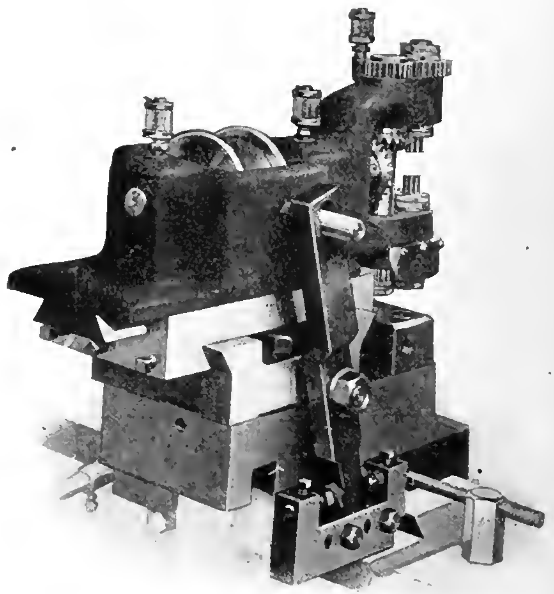


Fig. 2. Rear View of Milling Attachment, showing Feed Arrangement

very small, as the machine is taken care of by the regular operator with very little more attention than without the attachment. The mechanism of the device is simple and easily adjusted, and the attachment can be removed and put in place

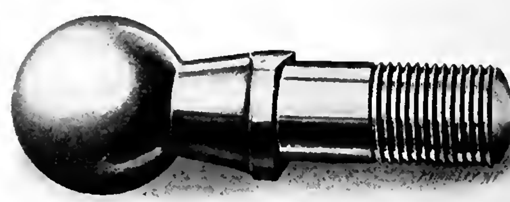


Fig. 3. Piece Milled on the Multiple Spindle Screw Machine

quickly. The cutters are driven from a pulley through bevel and spur gearing, as clearly indicated in Figs. 1 and 2.

SMITH & MILLS CO.'S GEAR-DRIVEN SHAPER

The Smith & Mills Co., of Cincinnati, Ohio, has recently brought out an improved design of back-geared crank shaper, which is illustrated in Fig. 1. As the engraving shows, the cone pulley has been dispensed with and an all-geared drive substituted. This new form of drive provides a simple and effective means for changing the speed of the shaper by the manipulation of one or two levers which are convenient to the operator; the danger incident to the shifting of a belt is also eliminated.

There are eight speed changes in all, four being obtained through the speed change gears and a like number through the back-gears. The speed change gears are divided into two sets of four each, which are contained in separate casings mounted on each side of the column at the rear. The arrangement of these gears and the way in which the various changes are obtained is clearly illustrated in Fig. 2, where the gear boxes are shown in section. As will be seen, the main driving shaft, which passes through the column, has mounted on it on each side a set of two gears which are free to slide longitudinally. Corresponding mating gears are also mounted on a secondary shaft above the main shaft, by which motion

is transmitted through the interior mechanism to the ram. By means of the lever *C* and a suitable connecting-rod, the different combinations of gears may be brought into mesh. Two changes of speed may be obtained by manipulating lever *C* when the small lever *E* at the back of the column, is in position *A*; by moving lever *E* to position *B*, two more changes are obtained, making four, and this number, as before stated, is doubled by the back-gears which are thrown in or out by lever *D*. As the engraving indicates, the shifting lever *C* is provided with a latch and quadrant which makes it possible to firmly lock it and the gears in position.

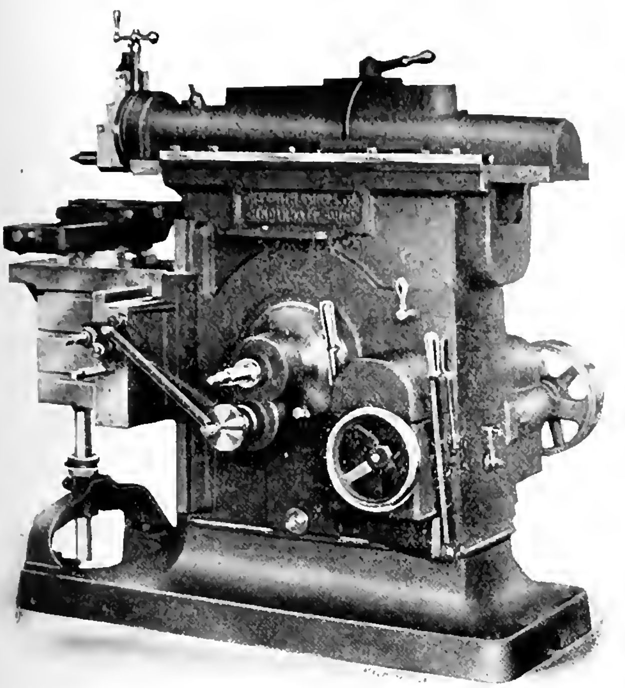


Fig. 1. Smith and Mills Variable All-geared Drive Back-geared Crank Shaper

It will be noted that tight and loose pulleys are shown in place on the main shaft in Fig. 2, whereas a single friction driving pulley is shown in Fig. 1. The former arrangement is fitted to standard designs, but the makers are prepared to furnish the friction driving pulley if this is desired. The company is also prepared to equip the machine with a complete self-oiling outfit, including a pump that will keep all gears of the drive, as well as those in the column, constantly lubricated.

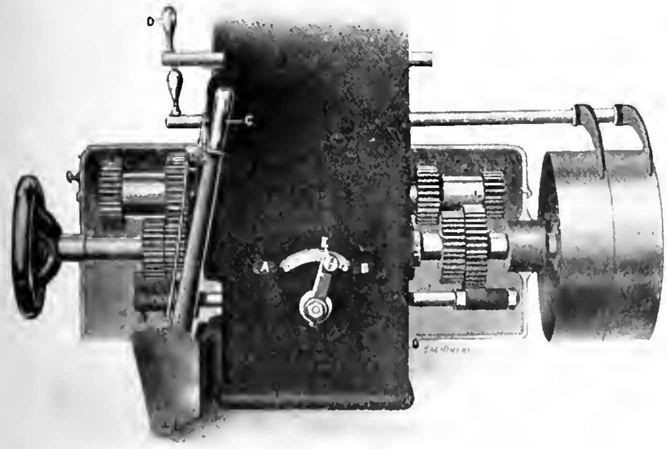


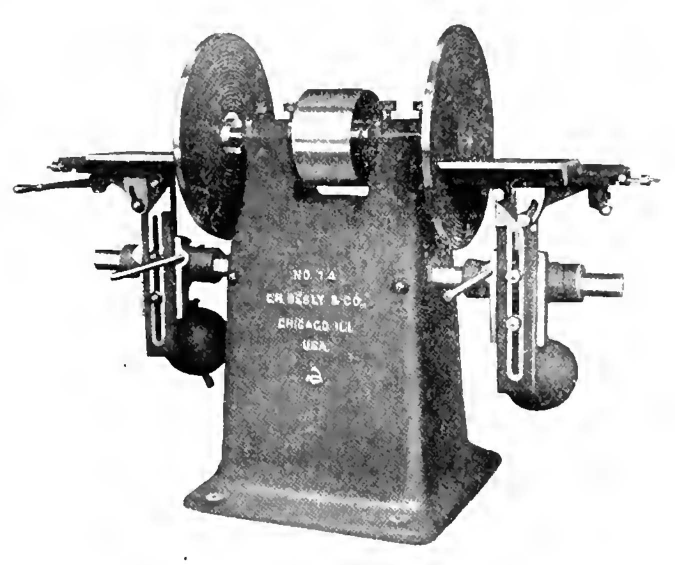
Fig 2. View showing the Arrangement of the Speed Change Gears

In addition to the improvements mentioned, this machine contains a numbers of others which are usually found on modern shapers. Among these may be mentioned the adjustable table support which not only gives rigidity to the table, but makes it possible to do more accurate work. If it is desired to have the machine electrically driven, the company recommends a No. 10 motor drive which consists of a projection or pad attached to the base for supporting the motor. Connection is made between the machine and the motor through a cast-iron gear and pinion on the main and armature shafts, respectively, which are connected by an intermediate rawhide pinion. These three gears are protected by a suitable guard. If a cheaper construction is desired, it may be had by placing the motor on the floor and connecting it with the machine by chain and sprockets.

These shapers are built in 16-, 20-, and 25-inch sizes. The weights of these three sizes for domestic shipment are approximately 2500, 3150 and 3950 pounds, respectively.

BESLY MANUFACTURING DISK GRINDER

The latest addition to the line of disk grinders manufactured by Charles H. Besly & Co., Chicago, Ill., is illustrated herewith. The principal distinguishing feature of this new grinder is its unusual size and capacity. The weight of the grinder complete is about 4000 pounds. The disk wheels, which are driven by a 7-inch belt, are 26 inches in diameter by 13/16 inch thick and weigh about 125 pounds each. Some idea of the machine's possibilities in the matter of output can be obtained from the fact that approximately 30 horsepower is required for driving, when it is being worked at its maximum capacity. In one instance, cited by the manufacturer, the tool, while being used for facing the bottoms of electric sad or flat irons had an output of 300 surfaces per hour and displaced ten milling machines which were specially designed for this work.



Besly Disk Grinder of Unusual Proportions

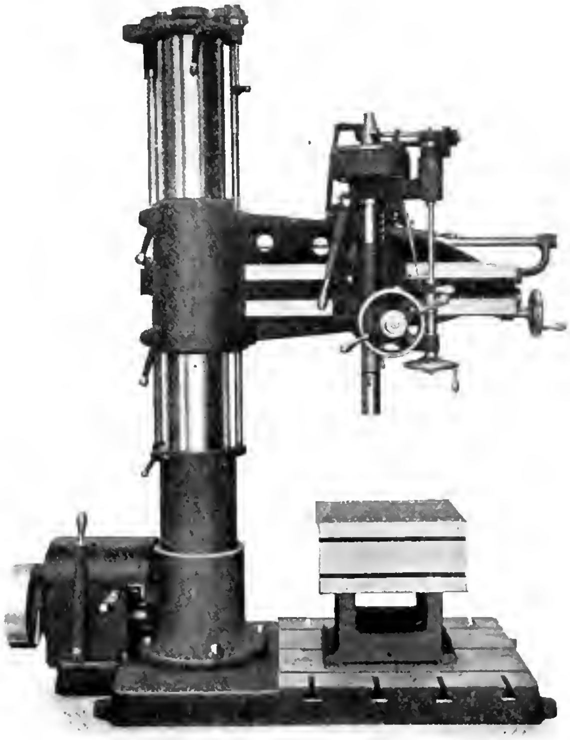
The tables, which have a working surface of 10 by 13 inches, are equipped with a geared lever feed. They are mounted on gibbed dovetailed slides and have a movement to and from the disk wheels of about 2 inches. This movement may be limited by an adjustable micrometer stop screw which is graduated to read to 0.001 inch, so that work may be ground accurately to size and duplicated. The makers state that these grinders are producing, commercially, cast iron printers' blocks to a given size within a limit of 0.0005 inch. Each table bed has two T-slots and a keyway for attaching angle-plates, magnetic chucks, or other forms of work holders in any desired position. The lever for feeding the table is comparatively short, but by the geared motion, a leverage of 14 to 1 is obtained, which makes it possible to force the work against the abrading disk with sufficient pressure to obtain efficient results without undue exertion on the part of the workman. The tables oscillate about a rockshaft and are adjustable in all directions; the weight of each is about 300 pounds. The end-thrust of the spindle is taken in either direction on a single bearing bushing by hardened and ground steel thrust collars. With this construction, the natural warming of the bearing, when running, does not tend to cause the thrust bearing to stick, owing to the fact that the expansion of the crucible steel spindle is greater than the cast-iron bearing bushing.

This grinder is designated as the No. 14-26-L. The design and construction throughout appears to be fully up to the standard of the best modern machine tools.

MUELLER RADIAL DRILL

The latest addition to the line of radial drills manufactured by the Mueller Machine Tool Co., Cincinnati, Ohio, is shown in the accompanying halftone. This tool, while not radically different from previous designs, has been simplified and is rigidly constructed throughout to adapt it to modern shop conditions.

In accordance with the usual practice of this company, the column is stationary, being firmly bolted to the base. It is



Mueller Radial Drill with Geared Speed-box and either Positive or Friction Feed

cast in one piece and has four internal webs, extending its entire length which add to its stiffness. To reduce the springing of the arm to a minimum, all columns are ground to size. The arm itself can be swung completely around the column and be instantly locked by a handle conveniently located. A graduated ring on the column enables the operator to set the arm to a definite position as often as desired. The arm can be lowered at twice the elevating speed, and its vertical movement is controlled by a lever located on the column cap. The head is traversed by means of a double-threaded screw, and it can be instantly locked to the arm by a small handle. A graduated dial connected with the traverse screw, enables the operator to adjust the head to within 0.001 of an inch. The back-gears, which are located on the head, can be engaged or disengaged without shock while the machine is in motion, by a lever that is located directly in front of the operator.

The feed mechanism gives eight changes in geometrical progression for each spindle speed, and is so arranged that either a positive or friction feed may be obtained. The construction and operation of this feed mechanism was fully described and illustrated in the department of New Machinery and Tools, January, 1906. Six variations in spindle speed are obtained through a geared friction type of speed box, which number may be doubled by the back-gears. The construction of this speed box is very simple and the different speeds may be engaged instantly and without shock. A handle for starting, stopping and reversing the spindle is conveniently located on the head. There is also a tapping mechanism on the head which is so arranged that very heavy tapping operations are possible. The tap may be backed out at an accelerated speed, and the spindle is caused to slip when the tap reaches the bottom of the hole.

The plain box table shown in the illustration is furnished with all machines. A universal table, plain swinging table, worm swiveling table or round table, can be had at an extra cost. These machines will be equipped, if desired, for any type of motor drive.

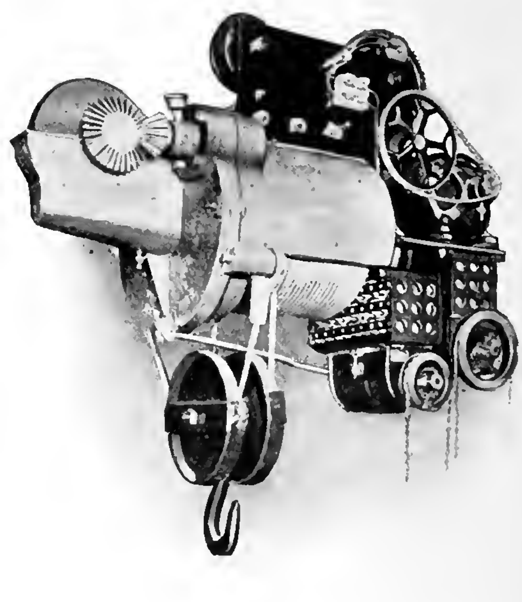
RASMUS FIVE-TON ELECTRIC HOIST

In the November, 1909, number of MACHINERY, we published a note describing a new form of electric hoist built by Gustav Rasmus, 514-16 West 57th St., New York City. This hoist was unusual in that the cable drum itself formed the field of the motor giving certain advantages which we will enumerate later. A new design of this hoist is herewith illustrated and described, which incorporates, among other improvements, an additional motor and mechanism for traversing the trolley on the I-beam.

In building this hoist the poles of a standard motor are removed from the field frame, and mounted on the interior of a cable drum of suitable diameter. The heads at each end of this drum are of special construction, to furnish bearings for the armature shaft which is placed within. These heads also are furnished with extension journals on which they and the drum itself are supported and rotated. The extension of the armature shaft carries a worm meshing with a wormwheel, which is, in turn, connected by bevel gears and spur pinions with the large gear on the cable drum. This, briefly, is the mechanical construction of the apparatus.

Besides the motor inside the drum, a second smaller motor is provided for traversing. This is mounted on a bracket to the right, as shown, and is connected by chain and sprocket, and spur gearing with one of the trolley wheels. Suitable controllers are mounted under the traversing motor bracket, provided with sprockets and operated by hand-chains from the floor.

The construction described has numerous advantages which are at once apparent from an inspection of the hoist, together with others which do not appear on the surface, but which do



An Unusual Design of Hoist, in which the Drum forms the Field Frame for the Motor

appear in the use of the device. Most important of all, the size, weight, number of pieces, over-all height and cost of the apparatus are greatly reduced over other designs. The mounting of the motor inside the drum does away with a great amount of bracing, supporting, etc., which would otherwise be required, and reduces the mechanism and framework to the simplest possible form. The over-all height of the apparatus is unusually small, being only 35 inches for a five-ton machine. This has been effected, as may be seen, without resorting to the expedient of reducing the diameter of the sheaves. In fact, these are larger than on other hoists of the same size, greatly adding to the length of life of the steel cable used. An automatic stop to prevent over-running is provided as shown, which acts directly on the controller through a mechanical connection.

One of the incidental advantages of the construction lies in the fact that the constant coiling and uncoiling of the cable on the drum serves to keep the latter (which, of course, is part of the magnet circuit of the field) constantly cool, even during rapid, heavy and continuous service. A drum section strong enough to carry the load is, by necessity, large enough for the magnet circuit. The area furnished by the cable as it is wound onto the drum, while not great, has the advantage of increasing the section as the speed of the hoist increases, and furnishes cool material at the same time. In lowering again, the extra section is unwound from the drum to cool in the air.

The worm drive employed has definite advantages of its own. The angle of thread is just within the angle of repose. On this account no brakes are required. This obviates the sudden straining of cables which results from the automatic setting of the brakes when the current is interrupted. The apparatus is thereby made very much safer in every way. The compactness and simplicity of the mechanism and the support given to all its parts reduces cramping and friction of every kind to the last degree. The maker is prepared to compare the efficiency of his hoist with that of any other on the market.

The hoist weighs complete as shown but 1000 pounds. The head room required with the hook raised is but 35 inches, and the price is materially less than that of any other hoist of similar capacity on the market. The gearing shown exposed in the engraving is provided with guards, which are here removed simply to show the construction.

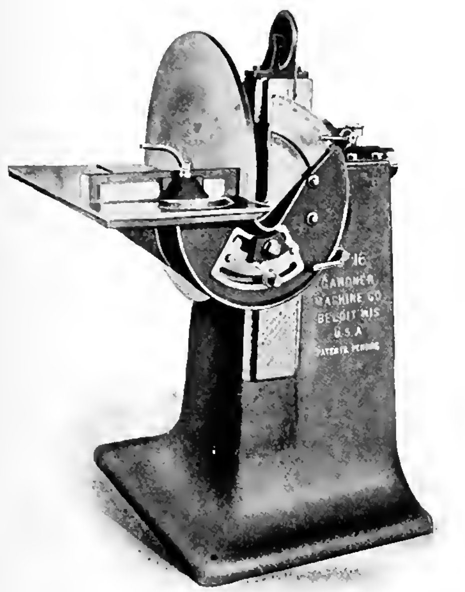


Fig. 1. Gardner No. 16 Patternmaker's Disk Grinder

This hoist can also be furnished simply with the motor, winding drum mechanism and geared connections, for use in direct service in general hoisting.

GARDNER DISK GRINDER FOR THE PATTERN SHOP

The Gardner Machine Co., Beloit, Wis., has just added to its line of disk grinding machinery by putting on the market a patternmakers' disk grinder. This machine is built along the same general lines as a metal-working grinder, the fundamental principle of a revolving wheel faced with flint or garnet paper being adhered to; there are a number of interesting changes, however, which were necessary to adapt the machine to the work of the pattern shop.

A grinder of the single-ended type is shown in Fig. 1. These machines are also made double-ended; that is with disk wheels and work-tables at both ends. The work-table constitutes one of the interesting features of this tool. It is adjustable vertically and it may be locked in any position by means of two quick-acting bolts. The entire weight of the work-table is counterbalanced by a weight within the base of the machine, which is connected by a steel cable passing over a grooved pulley at the top, as shown. This counterbalance, of course, makes it comparatively easy to adjust the table. Provision is also made for tilting the table to any angle with the face of the wheel, and the angle at which it is set, is indicated by graduations on the segment at the end, which also forms the bearing. The inside top corner of the table always remains close to the working face of the wheel regardless of the angular position; the advantage of this arrangement is so obvious that further comment is unnecessary. The original construction of this work-table and its mounting, indicates that it has been carefully designed to insure convenience in handling and also to adapt it for the work of the patternmaker.

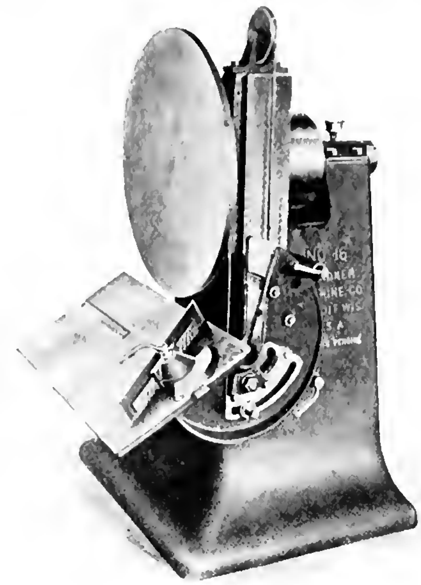


Fig. 2. Grinder with Table Inclined and Lowered

In addition to the angular adjustment, the table is fitted with a special form of protractor or "square gage" as shown in the illustrations. This gage is graduated from zero to 45 degrees in either direction, so that by using these graduations in conjunction with those on the head of the table, any combination of angles may be obtained quickly and accurately. Fig. 3 shows the machine being used to grind a double angle on the end of a pattern part and Fig. 4 shows how a built-up pattern is ground true and given draft at the same time.

Fig. 3. Grinding a Double Angle on the End of a Pattern Part

This protractor is equipped with a gage bar which locates and guides the work at the desired angle. A slight turn of the screw handle shown locks both the protractor and gage bar.

The disk wheels, which may range in size from 24 to 30 inches, are readily refaced without removing them from the spindle, no press being required for the refacing operation. In Fig. 2 the table is shown lowered to give free access for refacing the wheel. These wheels are supported on a 2-inch crucible steel spindle that runs in long babbitted bearings which are reamed and scraped. The end-thrust in both directions is taken at the right-hand box on hardened steel collars 4 inches in diameter which give 9½ square inches of thrust

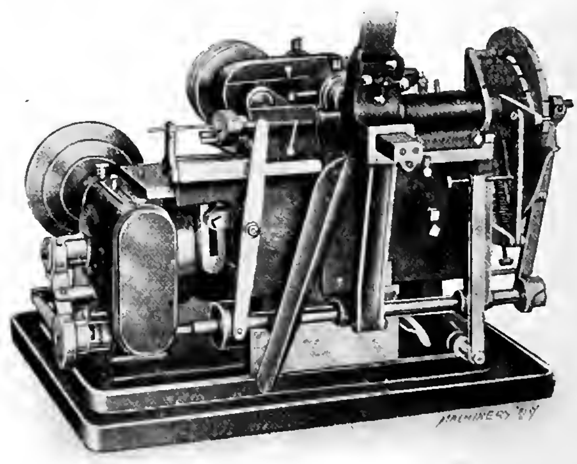
Fig. 4. Truing and giving Draft to a Built-up Pattern

bearing surface. These hardened collars bear against cast iron plugged with babbitt, so that if the spindle heats, the thrust bearing will not stick because of the unequal expansion. The spindle driving pulley is 10 inches in diameter with a 5-inch face, and the speed of the disk wheels is approximately 6000 feet per minute. Five horsepower is sufficient at all times for driving this machine. The weight of a single-ended grinder complete, with countershaft, is 12,000 pounds.

As this machine is equally effective for grinding knots, cross-grains, end-grains, hard or soft woods, and is not even affected by nails or screws, its efficiency as a pattern shop tool is apparent. The makers state that very favorable reports have been received from pattern shops where these grinders have already been installed, calling attention to the general efficiency of the tool and also to the ease with which accurate work may be finished in much less time than is required by the conventional methods.

WALTHAM AUTOMATIC PINION CUTTING MACHINE

In the February, 1908, issue of MACHINERY an automatic precision gear and pinion cutting machine, made by the Waltham Machine Works, Waltham, Mass., was illustrated and described. This machine, it will be remembered, is intended for small gears such as are used in various recording instruments, typewriters, clocks, etc. The magazine feed attachment was mentioned as one of the especially interesting features of the machine. When this magazine attachment is used the machine is entirely automatic in all its movements. An improvement in this magazine feed attachment has recently been made in the machine illustrated in the accompanying engraving, and by means of this improvement the production of the machine is materially increased. The improvement consists in stopping the main cam-shaft while the feeding operations are performed, instead of performing these operations during the time of the return of the slide after the last cut. This makes it possible to use a much quicker return of the work slide than was formerly the case. The feeding attachment automatically ejects the cut pinion and replaces it with a fresh blank, the movements being obtained from one

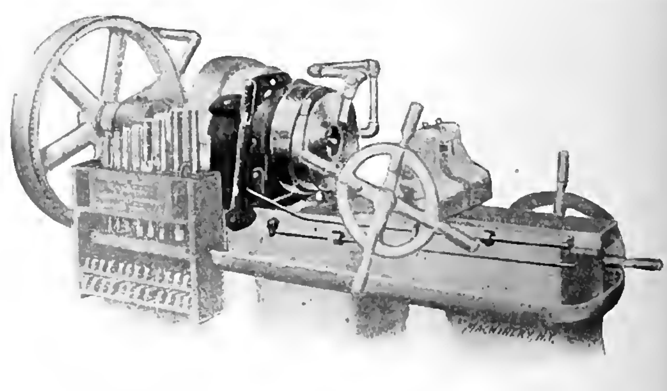


Automatic Pinion Cutting Machine with Improved Magazine Feed Attachment, made by the Waltham Machine Works, Waltham, Mass.

revolution of the cam-shaft attached to the work slide and operative only upon the completion of the last or finish cut. At that time the main cam-snaft stops, as mentioned, and starts again immediately upon the completion of the feeding operation. From 15 to 25 per cent may be added to the production of the machine by the use of this attachment. Its design is such that it is thoroughly reliable and not likely to get out of order.

"LITTLE GIANT" BOLT CUTTING, NUT TAPPING AND PIPE THREADING MACHINE

The accompanying half-tone shows a machine recently brought out by the Wells Bros. Co., of Greenfield, Mass., known as the "Little Giant" bolt cutting, nut tapping and pipe threading machine, the special feature of which is the automatic opening die head, the opening and closing of which is governed by the movement of the vise carriage. The die-opening mechanism consists of a cam ring with knock-out projection on the outside of the head, an upright spring stud



Bolt Cutting and Threading Machine built by the Wells Bros Co., Greenfield, Mass.

in the web under the head, a releasing rod which extends horizontally through the web from the spring stud to the outside of the bed, and two long rods carrying the adjustable stops at the side of the bed.

When the head is closed and the dies are cutting, the upright stud under the head is held within the supporting web so that its head is flush with the top surface of the web. The stud is mounted on a spring and is held down in the web by the releasing rod. When the rod support on the vise carriage strikes the stop shown, a pawl at the end of the rod is thrust

forward. As this pawl is mounted on the end of the releasing rod in the web, the forward movement of the pawl turns the releasing rod, and the upright stud springs up. The stud is so placed that it springs up just in front of the cam ring at its narrowest point, so that one revolution of the head with the edge of the cam ring bearing against the stud forces the head open and brings the knock-out projection around to the stud which is then "knocked-down" into the web and again locked. The rod extending from the hand lever shown to the end of the bed, parallel to the knock-out rod, is also provided with an adjustable stop and serves to close the head automatically when the vise carriage is run back. The heads can also be both opened and closed by hand, as in previous designs, if desired.

As compared with previous designs, the construction of the yoke over the back of the head has been made stronger. The yoke is linked to the yoke support at the top and to two forks on the lever shaft at the bottom, with toggle joints in the middle, one on each side. The yoke carries two segments, one on each side of the head, which fit into the groove in the back of the head. This form of construction gives ample power for instantaneous action.

In the operation of the machine, all that is needed is to put the work into the vise, set the stops, and the machine will do the rest. All holes will be tapped uniformly both as regards diameter and length, and blind holes can be tapped in work held in the vise, without difficulty. The machines equipped with automatic opening die heads are of 1-, 1½- and 2-inch capacity.

TAYLOR-WILSON REAMING MACHINE FOR PIPE COUPLINGS

The Taylor-Wilson Mfg. Co., McKees Rocks, Pa., has recently brought out a pipe-coupling or socket-reaming machine, which is adapted to couplings of a larger size than any machine previously manufactured by this company. The special features of this new tool, which is illustrated in Fig. 1, are its strength, simplicity and capacity for production.

The coupling is held in position while it is being operated on by a chuck composed of one stationary gripper and one

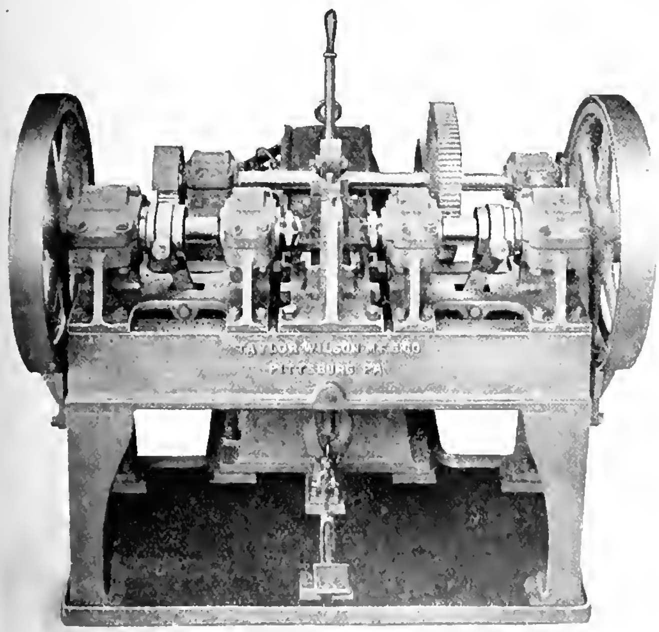


Fig. 1. Taylor-Wilson Pipe Coupling Reaming Machine

movable gripper. The movable gripper is actuated by a toggle joint, one member of which is a U-shaped spring. The purpose of this spring is to compensate for the variation in the diameter of the couplings due to the welding process; consequently when the machine is once set for couplings of any particular size, no further adjustment is necessary until a change of size is required. The toggle is operated by a hand lever, which extends above the center of the machine as shown. The coupling is placed in position to be gripped by the operator and is released by the opening of the chuck; it then drops through a chute which is located under the machine and is delivered into a receptacle provided for the purpose.

In Fig. 2 couplings are shown before and after the reaming operation has been performed. Both ends of the coupling are reamed simultaneously by tools which rotate in opposite directions. These tools are carried in heavy spindles, which rotate in bearings and are driven through cast steel cut gears, preferably by a variable speed motor. This motor, which is located at the rear, as shown, is connected by gearing with an

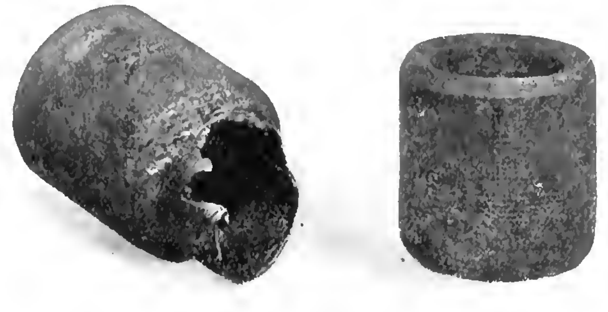


Fig. 2. Pipe Couplings before and after being reamed

intermediate shaft which, through a pinion on the end, drives the large spindle gear to the right, directly. The opposite end of this intermediate shaft drives the left-hand spindle through secondary gearing, which reverses the direction of rotation.

The necessary reciprocating movement is given to the tools and spindles by the foot of the operator through a treadle which is connected to a toggle-joint which in turn connects

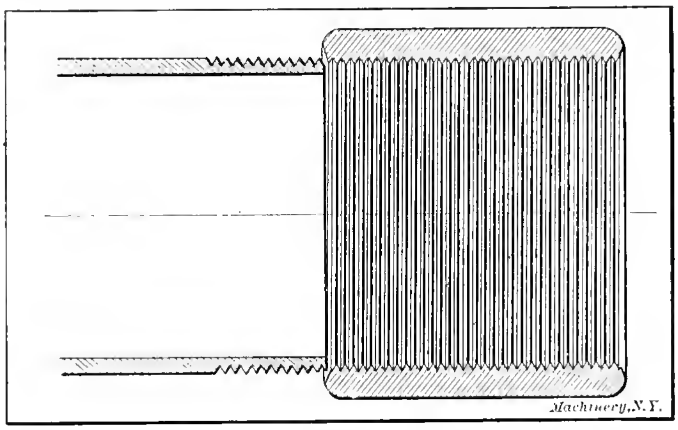


Fig. 3. Sectional View of Reamed Coupling

with the spindles by a pair of trunnions and levers. These levers are connected to the trunnions on the spindles on one end, and the toggle-joint on the other, and work about a pin near the center. The peculiarity of this movement is that when the tools, from a point of rest, are approaching the coupling to be operated on, the movement of the spindles is much greater than the movement of the treadle; but as the tools come near the coupling the condition gradually becomes reversed and the leverage of the treadle on the spindles becomes correspondingly greater.

The reaming of pipe couplings during the past few years has become almost as universal as tapping them, there being, of course, a number of advantages in having the couplings reamed. In the first place, reamed couplings make the process of tapping easier as all the fins which would interfere in starting the tap are removed. This will be understood by referring to Fig. 2. Another advantage in reaming couplings is that the thread is protected from injury in handling, as it starts at a point slightly back from the coupling end as shown in the sectional view Fig. 3. This beveled edge also acts as a guide when starting the coupling on the threaded end of a pipe. This is also made plain in Fig. 3. In addition to the foregoing advantages, a reamed coupling presents a neater appearance than one that has not been finished in this way.

This machine is self-contained and substantially built throughout, and all gears are properly protected by suitable guards. The builders claim that it is capable of very large

production; in fact, they cite one instance where an operator has been able to ream from 5000 to 8000 couplings, ranging in size from 2 inches down, in a day of ten hours.

ADDITIONS TO THE LINE OF FARWELL MOLDING MACHINES

In the accompanying illustrations we show a series of molding machines recently developed and placed on the market by the Adams Co., 623 White St., Dubuque, Ia. Figs. 1 to 6, inclusive, illustrate the construction and operation of a new pneumatic roll-over molding machine. Fig. 7 shows one of a line of new machines of the squeezer type.

Pneumatic Roll-over Molding Machine

The roll-over machine comprises mechanism for jolting the mold, turning it over to an evenly supported foundation, rapping the pattern, drawing it vertically, and then rolling the pattern back again ready for a new flask and a new mold. The machine is portable and of very simple construction. It is easy to operate, as all the heavy work is done by air.

The machine itself is shown in Fig. 1. The angle-plate frame M supports the flask. It is pivoted at one end to air cylinder E, and is supported at the other on heavy steel blocks A, resting on the cast-iron wheels J. The reason for the excessive weight of wheels J and for supports A is shown in Fig. 2, where a mold is shown in place on the frame with the flask filled with sand. The workman is jolting the flask, as shown, by operating the air valve so as to alternately admit air to the cylinder E and release it. As it is admitted, cylinder E rises slightly on the stationary ram. This alternately raises cylinder E and with it frame M and the mold, and on dropping it down again, supports A strike the heavy wheels J. This continuous jolting shakes the sand thoroughly into place around the platen, and makes a compact mold. The holes shown in M in Fig. 1 are for the purpose of attaching the pattern, as is more clearly seen in Fig. 6.

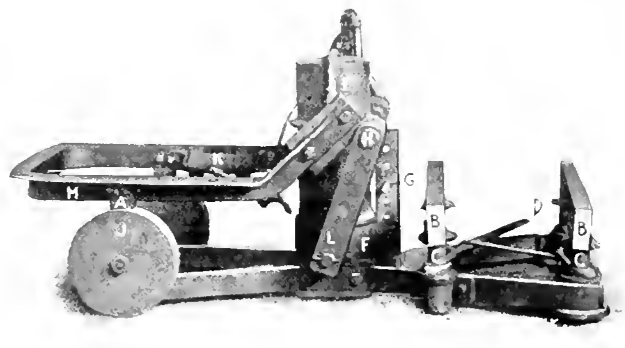


Fig. 1. Farwell Portable Pneumatic Roll-over Molding Machine

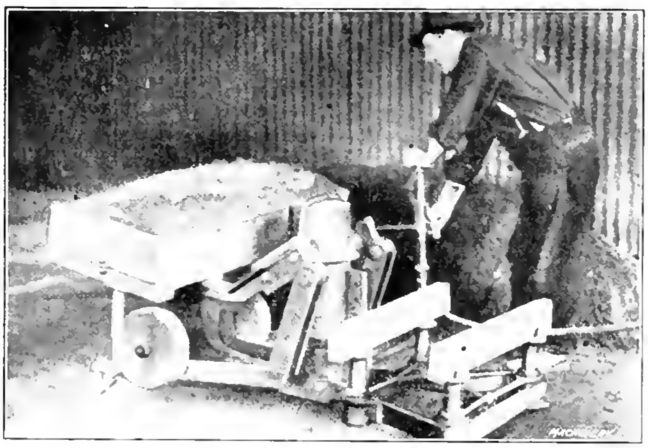


Fig. 2. Jolting the Mold

Operation of the Roll-over Machine

After jolting and striking off the top, the bottom board is placed in position and secured by adjustable clamps attached to the match-board. The molder then again opens the valve, as shown in Fig. 3, admitting air to cylinder E and raising the mold. As cylinder E rises, yoke F strikes stationary pin G (for all reference letters see Fig. 1) arresting its upward movement. The continuous movement of cylinder E then swings table M, and with it the flask and mold, about the pivot on the cylinder, through the action of the link L, which is pivoted to the frame at H. When the dead center is reached, the operator releases the air valve, allowing the mold to settle down on the other side of the dead center onto the supports provided for it, as shown in Fig. 4. This lowering can be done as quickly or slowly as desired.

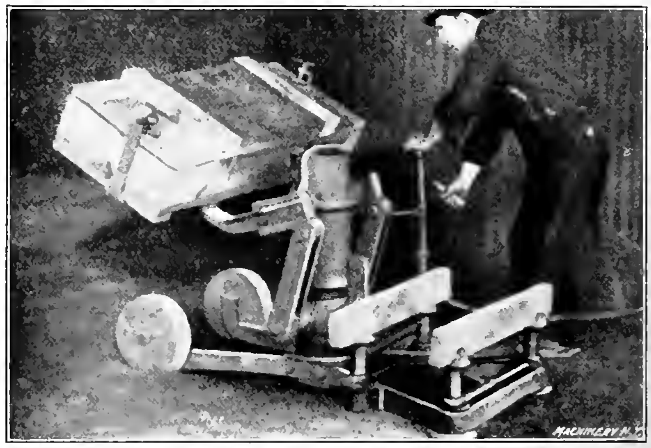


Fig. 3. Rolling over

Cross pieces B on which the mold now rests are supported on four plungers C, provided with springs so that they automatically equalize or adjust themselves at all four points to any irregularity of the bottom board. As soon as the mold rests on the cross pieces B, these plungers are locked in position by a single movement of lever D which is connected by links to all four plungers. This lever may be kicked into the locked position by the foot. The molder now releases the clamps and is ready to draw the pattern.

Fig. 5 shows the operation of drawing the pattern. With his left hand the operator opens a pet cock, admitting air to the Adams pneumatic rapper shown at K in Fig. 1, which is mounted on the frame carrying the pattern. Being thus loosened, the pattern is simultaneously drawn by the operator's opening the air valve for cylinder E, with his right hand. The pattern is drawn perfectly straight, as the movement is directly vertical so long as cylinder E and yoke F are rising together. When, however, yoke F strikes stationary pin G, the pattern again rolls as before, over to the dead center. The receding of the air causes it to settle back again onto wheels J, describing an arc in its progress as shown in Fig. 6.


Fig. 4. In Position for Drawing

By adjusting the position of pin G any desired straight vertical movement can be obtained before starting to roll over. This, in combination with the pneumatic rapper and the steady air control, insures a clean and careful lift. In addition to this advantage, it will be seen that this machine has the features of great simplicity, a method of instantly clamping the plungers so that the mold rests evenly on them, the elimination of concrete foundations, portability, hinged clamps for match-board, flask and bottom-board, and easy control. The wheels may be arranged to run on tracks embedded in the

floor, thus affording an ample foundation at small expense, and avoiding the necessity of a permanent location of the machine at one place.

New Machines of the Squeezer Type

The machine shown in Fig. 7 is of the squeezer type, intended particularly for use with the hinged match plate system invented by Mr. W. J. Keep of Detroit, Mich. This system employs hinged snap flasks and a match-plate, provided with lugs which fit into the hinges of the flask. This lines up pattern, cope and drag, and permits the whole to be turned over, so that both sides of the pattern may be molded at one time. In order to allow for this, the squeezer top is arranged so it will swing farther back, and the table is supplied with a special flask-supporting device not shown in the photograph. This device supports the back side of the drag while the cope is rolled up, and is required to prevent the drag from being tilted by the weight of the cope. The makers of this squeezer will supply it, together with all the special equipment re-

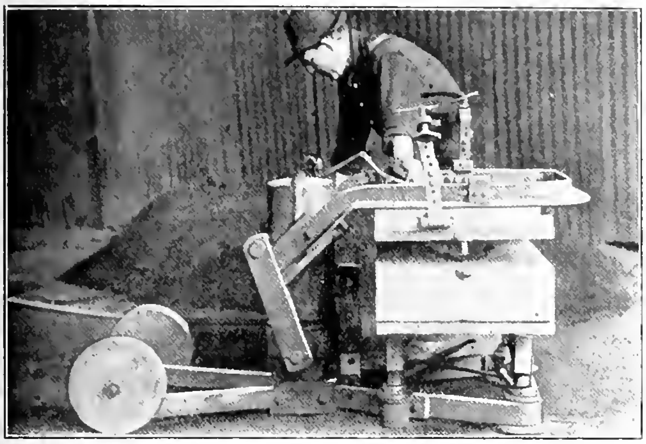


Fig. 5. Drawing the Pattern

quired, to any foundry licensed to use Mr. Keep's invention.

Another new product is a 34-inch portable low-down heavy-duty squeezer. This is an intermediate size between the 30- and 38-inch machines, but possesses some special advantages not found in the older designs. The principal improvement is a new style of counterbalancing spring which is adjustable to any tension. This can be set so that the squeezer top will come forward by itself, though it is ordinarily adjusted so

Fig. 6. Rolling Pattern Back to Molding Position

that the top stays out of the way until the mold is ready, when it will come forward with a very slight pull.

Still another addition to the line of squeezers is a 24-inch stationary machine similar in construction to others of the same make, except that the table is raised higher above the rocker shaft. With this table it is not necessary for the top to swing through so great an arc for clearing the table. This makes it easier to spring the top forward into the squeezing position. At the same time it brings the mold up above the operating links, so that a larger flask can be used in proportion to the width of the machine. This avoids all danger of

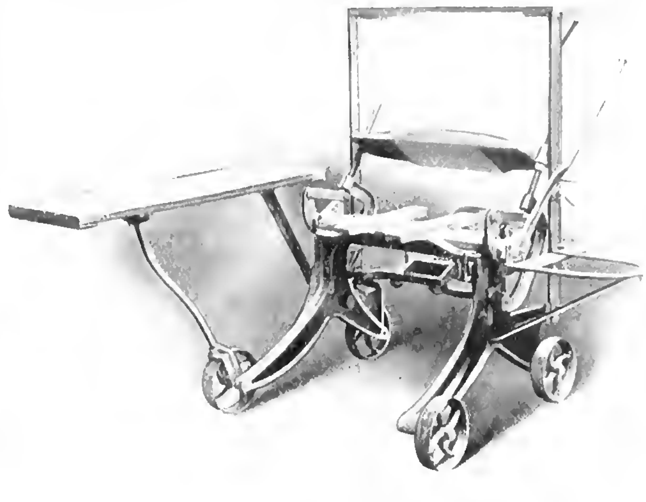
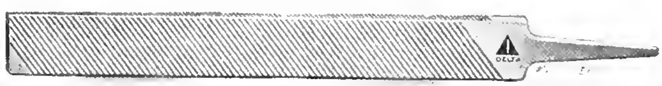


Fig. 7. A Machine of the Squeezer Type, adapted to the Keep Match-plate Process

the molder's striking his knuckles against the links when riddling the machine. This will take a flask 18 inches long, or within 6 inches of the total width; whereas on the ordinary 30-inch squeezer, measuring 30 inches between the side rods, no flasks longer than 22 inches are handled conveniently.

"DELTA" HAND UTILITY FILE

A new type of file has been placed on the market by the Carver File Co., Philadelphia, Pa. This file, known as the "Delta" hand utility file, is intended for general use among mechanics and more particularly for machine shops. In addition to being adapted for use on metals, such as soft steel,



"Delta" Hand Utility File for General Work

iron, brass castings, etc., it can also be employed on wood, marble and similar materials. These files are made of high carbon crucible steel, which is especially hardened and tempered. As the engraving shows, the teeth are very coarse or of large pitch, the file being designed to cut rapidly and smoothly and at the same time to clear freely.

RYERSON PORTABLE CYLINDER BORING-BAR

The portable boring-bar shown in Fig. 1 has been added to the line of machinery manufactured by Joseph T. Ryerson & Son, Chicago, Ill. This bar was designed primarily for boring locomotive cylinders, but it may also be used with satisfactory results for such work as stationary engine cylinders, steam hammer cylinders, air hoists and work of a similar character.

In addition to being of heavy construction throughout, this boring-bar possesses a number of novel features, prominent among which may be mentioned the feeding mechanism. The old, so-called "star" feed is entirely eliminated and a positive geared feed substituted; this gives a continuous feeding movement to the cutting tool which results in a smooth cut, as the tool does not dig into the metal. In the engraving the feeding mechanism may be seen at the right end of the bar. The feed-screw, which feeds the tool-head along the bar, is actuated by the gearing shown at the end. When the bar is set up for boring a cylinder, a weight is suspended from the handle of the crank inserted on the pinion shaft, so that when the boring-bar rotates, the feed-screw is caused to turn in relation to it. Were it not for this weight, the pinions on the shaft with

the crank, as well as the feed-screw, would remain stationary with relation to the bar. This simple method of obtaining the feed makes it possible to easily adjust the tool at any time by simply turning the crank, as the suspended weight would not seriously interfere. For rapid adjustment of the tool-head, however, a handwheel is provided which may be used to turn the feed-screw direct. By means of change gears, which are mounted on the shaft with the long crank, two feeds are obtained on the No. 1 or 4-inch bar, and three feeds on the No. 2 or 6-inch bar. Thus a light or heavy feed may be had by merely shifting the gears, or both gears may be disengaged and the feed thrown out entirely.

It will be noticed by referring to Fig. 2 that the tool-head is designed to permit the use of straight boring tools, the latter being set at an angle so that a cylinder may be bored without tearing down the guides and removing the back head. With some types of tool-heads it is necessary to use bent tools in order that the cut may be finished before the tool-head comes in contact with the head of the cylinder. The disadvantage of the bent tool lies in its flexibility and tendency to chatter. Tool-heads of different sizes may be easily attached to the bar, as there is a permanently located master-head so arranged that other heads may be positively fitted to it. This master-head has a long bearing which insures smooth cutting with a minimum of vibration.

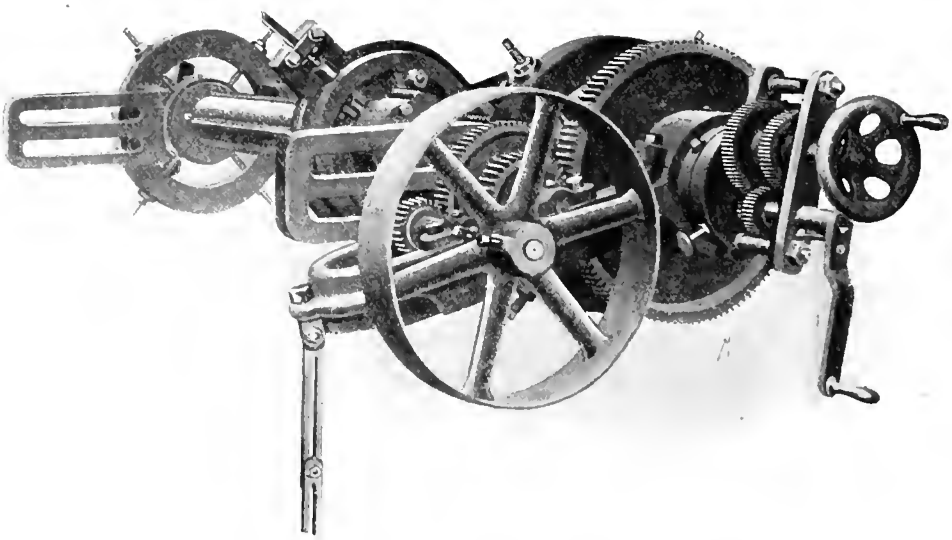


Fig. 1 Ryerson Cylinder Boring-bar with Adjustable Geared Feed

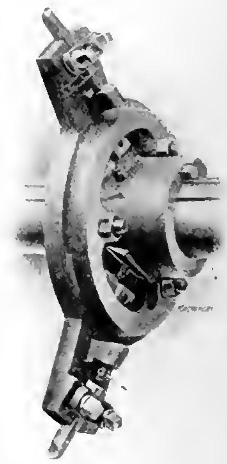


Fig. 2. Tool-head designed to permit Use of Straight Tools

All of the principal parts of this bar are made of steel. The frame containing the driving gears is of cast steel and it is so designed that it may be easily and quickly removed. The bar itself is accurately ground to size and cut gears are used throughout. These boring-bars are made in two standard sizes designated as Nos. 1 and 2. The manufacturers are prepared, however, to furnish special machines for boring cylinders of any length. The No. 1 machine will take cylinders from $9\frac{3}{4}$ to 30 inches in diameter and up to 44 inches in length where there are clearance blocks on one end of the cylinder only. If the bar is located in the stuffing-box of the back head, it will bore to a length of 50 inches. The No. 2 machine will bore diameters ranging from 20 to 50 inches, and lengths, with clearance blocks at one end, up to 35 inches. When the end of the bar is located in the stuffing-box, the maximum length is 46 inches.

These machines can be arranged for either pulley drive, direct gear drive, or with a Morse taper shank for operating with air or electric drills. It is customary in most railroad shops, to employ a motor with a capacity from $2\frac{1}{2}$ to $3\frac{1}{2}$ horsepower.

The approximate weight of the No. 1 or 4-inch bar with equipment necessary for diameters up to 13 inches is 1000 pounds. This machine, when furnished complete for boring to the maximum diameter of 30 inches, weighs 1500 pounds. The approximate weight of the No. 2 or 6-inch bar, varies between 3000 and 3700 pounds, depending upon its capacity.

REED QUICK-CHANGE GEAR MECHANISM

The accompanying illustration, Fig. 1, shows an engine lathe built by the F. E. Reed Co., Worcester, Mass., provided with a new patent quick change gear mechanism which may be applied to the company's 14-, 16-, 18-, and 20-inch lathes. The illustration, Fig. 2, shows a detailed view of the change gear mechanism proper. This illustration is a phantom view of the device so that all the gearing is indicated, although on the lathe itself it is carefully covered by suitable cast gear-guards. The simplicity of the design and the small number of parts are clearly indicated in this illustration. The gear case is securely fastened to the front of the bed and contains a shaft on which is mounted a cone of gears, any one of which can be instantly engaged by the movement of the lower lever shown. Another shaft is located above the cone of gears. This shaft is in line with the lead-screw and connects with it by means of the clutch operated by the knob at the right. When this clutch is released, it brings a gear into mesh with another gear on the feed-rod, this arrangement insuring that both the lead-screw and the feed-rod cannot be thrown into operation at the same time. On the same shaft a double clutch gear is provided which is operated by moving the upper lever to its three different positions.

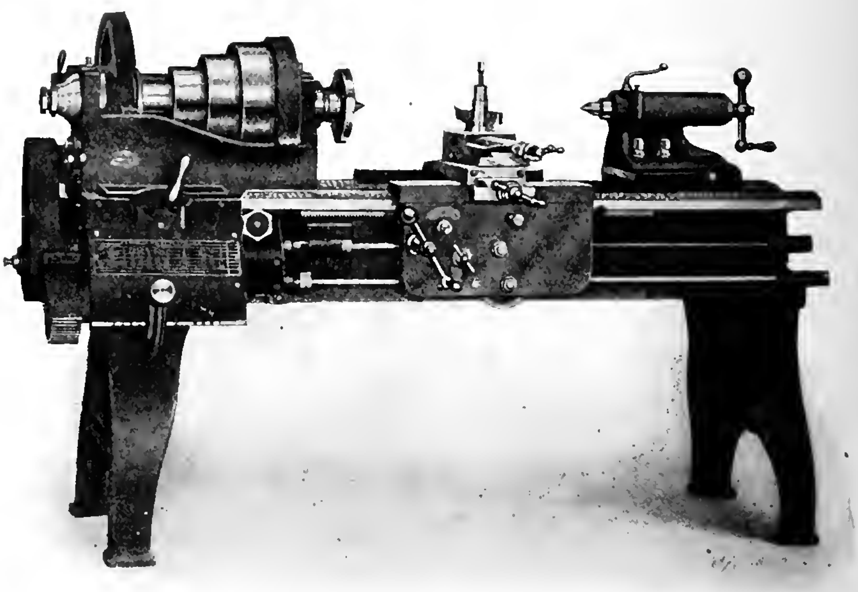


Fig. 1. Reed Lathe provided with Quick-change Gear Mechanism

The combination of the changes thus obtained with the two changes obtained by sliding in or out a gear at the end of the lathe provides for not less than sixty changes of speed for both lead-screw and feed-rod. This is an unusually large number of changes with so simple a mechanism. All gears in the front case are made of steel, are of coarse pitch and are practically unbreakable in service. The whole device is so designed that, in whatever position, the levers and sliding gears will not lock the mechanism and cause breakage. At the same time it is so simple in its arrangement and operation that it can be readily understood and operated by comparatively inexperienced workmen.

The index plate, not shown in the detailed view, but indicated in Fig. 1, is mounted on the front of the gear case. The plate clearly indicates the location of the levers for all

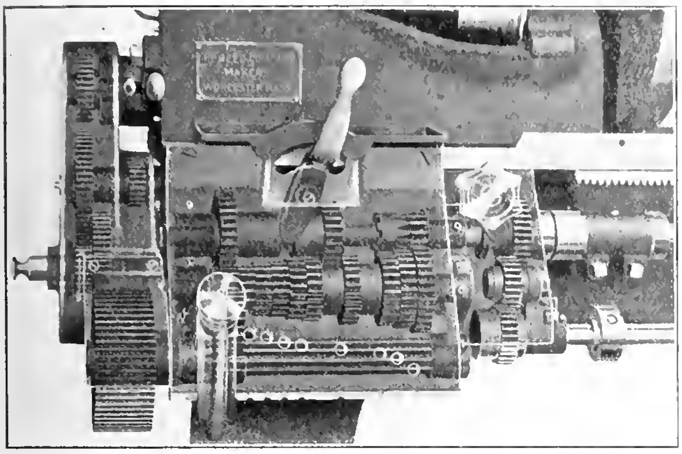


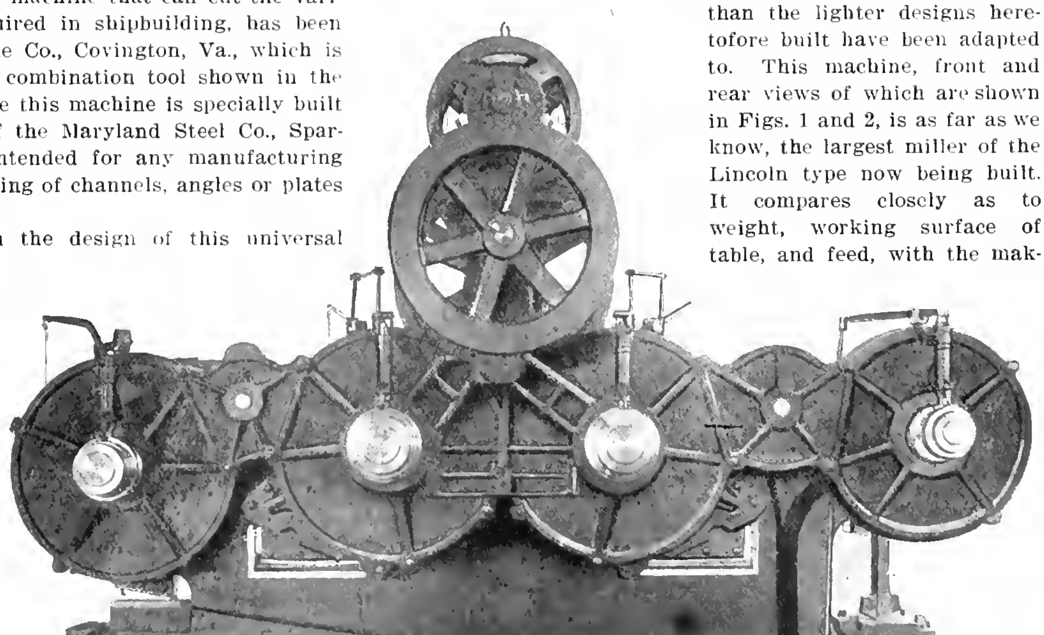
Fig. 2. The Quick-change Gear Mechanism of the F. E. Reed Co.'s Lathe

threads and feeds. Standard threads from 2 to 128 per inch, including 11½, can be cut, and feeds from 10 to 640 per inch can be obtained.

COVINGTON UNIVERSAL SHEAR FOR CHANNELS, ANGLES AND PLATES

The need in shipyards for a machine that can cut the various channels and angles required in shipbuilding, has been met by the Covington Machine Co., Covington, Va., which is now manufacturing the large combination tool shown in the accompanying halftone. While this machine is specially built for the marine department of the Maryland Steel Co., Sparrows Point, Md., it is also intended for any manufacturing establishment where the shearing of channels, angles or plates is done in quantity.

The most novel feature in the design of this universal shear, lies in the combination of four tools in one compact unit. It is provided with a coping attachment at one end, a plate shear at the other and two angle shears in the center of the frame. These angle shears operate at an angle of 45 degrees, thus securing a vertical and horizontal shearing action. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men all working at the same time without interfering with each other.



Rear View of Combined Angle, Coping and Plate Shear manufactured by the Covington Machine Co.

The angle shears in the center have a capacity for cutting channels up to 15 by ¾ inch, and 6 by 6 by 1 inch or 8 by 8 by ¾-inch angles. The plate shear has a capacity for material up to 1 inch in thickness. Channels or angles may be cut either square or at an angle for mitering.

The four tools are driven by one motor which develops 25 horsepower. This motor is mounted at the top of the machine in the center, as shown in the illustration, which is a view taken from the rear to more clearly show the general arrangement of the driving gearing and the automatic stop clutches. A pinion on the motor armature shaft engages a large gear located on an intermediate shaft on which two flywheels are mounted, one at each end. The motion is transmitted from this intermediate shaft to a second shaft just below it, which carries a pinion engaging with the two large gears which operate the central or angle shears. These two gears are also connected through pinions to the large driving gears of he coping and plate shears at the ends.

A patent stop motion is used, which automatically throws out a clutch on each shear when the latter reaches its highest point. To again start a shear, it is simply necessary to pull a chain, which is suspended at a convenient point. These chains are connected with the single-revolution clutches, through counterbalanced levers as shown. For the coping attachment, which may also be used for punching, the stop mechanism is adjustable so that the plunger may be stopped at any point of its own stroke. This allows the tool to be brought close to the work, so that the latter can be properly adjusted.

The frame, plungers, clutches, and all parts subject to shock, are made of semi-steel castings. Hammered steel shafts containing from 0.4 to 0.5 per cent carbon are used. The gears are provided with long sleeve hubs and are thoroughly protected by guards which are bored to receive them. The question of lubrication has been given special consideration. Arms, which are provided for supporting the angles or channels while they are being cut, are so designed and placed that they do not interfere with plates that are being sheared, as the latter pass under them. The weight of this machine is about 23 tons.

LARGE DOUBLE-HEAD LINCOLN MILLING MACHINE

The Hendey Machine Co. of Torrington, Conn., is now manufacturing a double-head milling machine of the Lincoln type, which is intended to handle a heavier class of work than the lighter designs heretofore built have been adapted to. This machine, front and rear views of which are shown in Figs. 1 and 2, is as far as we know, the largest miller of the Lincoln type now being built. It compares closely as to weight, working surface of table, and feed, with the maker's standard No. 3 plain knee type machine. A comparison of the two types shows, however, that the Lincoln machine has a greater capacity on some lines of work, as the direct mount-

ing of the table and saddle on the bed gives it a more rigid support than is afforded with the column and knee construction.

On the standard size machine, the table has a working surface of 15 by 54 inches. There is an automatic cross-feed of 36 inches and a longitudinal adjustment in line with the spindle of 12 inches. The table is fitted to the saddle with an angular lock and taper gib, and it has a length of bearing on the saddle of 34 inches. A bearing contact on the shoulders of the saddle supports the table clear to the edge, thus enabling work to be machined to its full width without any tendency to spring under the cut.

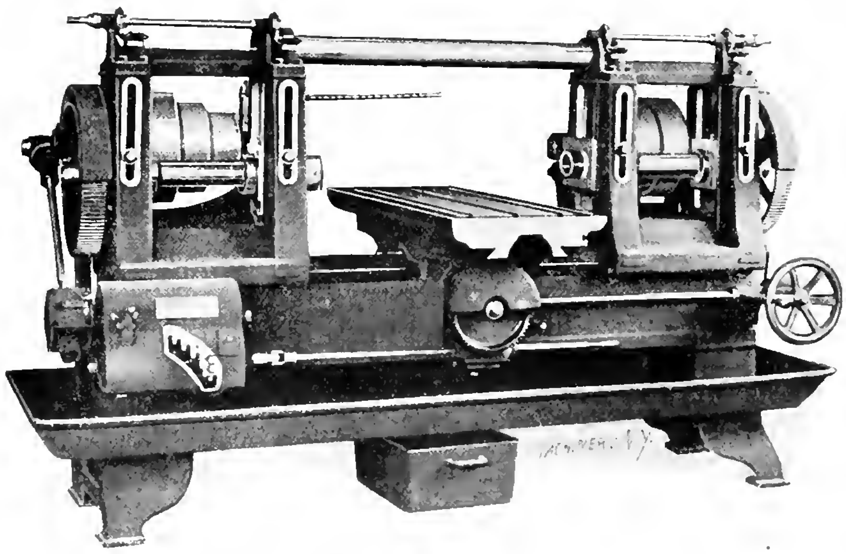


Fig. 1 Double-head Lincoln Milling Machine built by the Hendey Machine Co.

The feed movement is positively obtained direct from the driving spindle through gearing and shafts. There are twelve changes of feed available, ranging from 0.010 inch to 0.130 inch per revolution of the spindle. The feed motion is reversed by means of a toothed clutch operating between right and left bevels. This reversing mechanism is enclosed in the box at the left of the machine (Fig. 1), which receives the ends of the transmission shaft from the driving spindle and the gear-box cone shafts. The feed worm, which is free to slide on the splined feed shaft, is carried in a self-contained bracket, which takes all the end thrust from the feed shaft when a cut is being taken, and thus prevents any twisting strain on the saddle. This worm is well lubricated, as it runs in an oil bath in a pocket of the bracket. The feed mechanism is mounted entirely on the outside of the bed, thus making it unnecessary to core holes in the bed for feed connections.

The main spindles are made of hammered steel forgings and have 1¼-inch holes through their centers. Taper journals are provided at both the inner and outer ends, and the bearings are cast annular and are bushed with Lumen bronze. The ends or noses of the spindles are 3½ inches in diameter, and they are threaded 3½ per inch, left-hand. Slotted driving collars for arbors are fitted to the nose of each spindle, and No. 12 Brown & Sharpe taper holes are provided.

The cone pulleys on the driving shafts have three steps, and the driving belts have a width of 4 inches. The ratio of gearing between the driving shafts and spindles is 6 to 1, the width of the gear faces 2¾ inches, and the diametral pitch 6. The driving shafts are carried in rocking frames by which quick adjustment can be made when the spindles are raised or lowered, and which constantly maintain the shafts in parallel alignment with the spindles. Binding bolts are provided for locking these frames securely in place after an adjustment has been made.

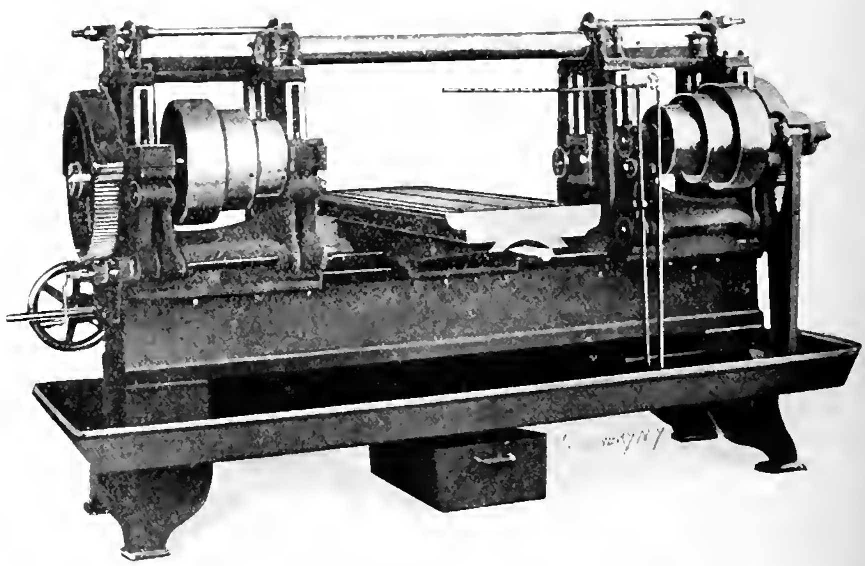


Fig. 2. Rear View of the Double-head Lincoln Milling Machine

The elevating and lowering mechanisms for the spindles, which are located on top of the head-blocks, are fitted with micrometer dials reading to thousandths of an inch, so that accurate vertical adjustments can be obtained. The spindles are held securely in a fixed position, after being set, both by means of the elevating screws and also by binding bolts which pass through the upper part of the boxes, as shown. These bolts serve to clamp both the uprights and the boxes firmly together, after the spindles are adjusted to the desired elevation.

Both the head-blocks and saddle are gibbed to the bed with angular locks to insure a perfect alignment of the spindles with the travel of the table. A hand adjustment of the table is secured by the large handwheel shown bracketed to the right end of the bed in Fig. 1, and the saddle adjustment is obtained by means of a screw which passes through the center of one head-block casting and is mounted in a bracket at the end of the bed. This screw, which is more plainly shown in Fig. 2, has a graduated dial reading to thousandths, thus permitting accurate longitudinal adjustment of the table.

These machines are built with six different lengths of bed, ranging from 62 to 97 inches, and with tables either 15 or 20 inches in width. The maximum distance between the heads for the six different bed lengths, ranges from 15 to 50 inches, while the maximum distance between the spindle noses varies between 9 and 44 inches.

* * *

NEW MACHINERY AND TOOLS NOTES

Quick-acting Swivel Vise: Charles Parker Co., Meriden, Conn. This is a swivel vise which may be adjusted instantly to any desired position and tightened by a single movement of the hand. It is mounted on a swiveling base, permitting it to be set at any position convenient to the operator.

Pressed Steel Gearing: Johnston Pressed Gear Co., Ottumwa, Ia. This firm is furnishing steel rims for gears, having teeth of successive folds made in a strip of steel. It is intended for slow, heavy work, and is said to be superior in strength to cast gears of the same pitch and width of face.

Oilstone Holding Handle: F. J. Badge, 286 Taaffe Place, Brooklyn, N. Y. This tool consists of a handle with suitable clips, whereby oilstones of various sections such as round, square, flat, triangular, etc., can be held for toolmakers' use. It should be very convenient in lapping dies, "touching up" fine tools, etc.

Self-contained Ventilating Outfits: B. F. Sturtevant Co., Hyde Park, Mass. These outfits comprise a small motor with a direct connected multiple vane blower, which may be quickly located in any position and connected with a lamp

socket. They can be used for exhausting vitiated air or supplying fresh air from the outside.

Double Inserted Blade Tool-holder: Colton Combination Tool Co., Chester, Vt. This tool-holder provides for the use of two blades, the second of which is set slightly ahead of the front one so that roughing and finishing cuts can be taken. With this arrangement a fine finish can be given, even while the leading blade is removing a heavy chip.

Power Hammer: New Metal Tool Steel Co., 338 Cumberland Ave., Portland, Me. This hammer provides for ready adjustment, both of the force of the stroke and of its length, while the machine is in operation. It is of the crank and pitman type, with a spring helve which gives the form of blow which has been found most desirable for machine forging.

Standard Punch and Holder: American Die & Tool Co., Reading, Pa. This is an improved construction which permits making the punch of smaller stock than usual, thus lessening its cost. As in previous designs, the strain is taken by the direct bearing of the punch on the stub of the ram, so that full strength for resisting the cutting strain is provided.

Portable Oxy-acetylene Welding Apparatus: F. C. Sanford Mfg. Co., Bridgeport, Conn. This outfit is a smaller size of the apparatus described in a note published in the December, 1908, number of MACHINERY. It is adapted to a wide range of work in welding, cutting, etc., with the high temperature flame. It operates on chemicals which may be bought in the open market.

Spring Controlled Collets for Speed Lathes: Garvin Machine Co., Spring and Varick Sts., New York City. With this design of collet mechanism the gripping of the sleeve at the rear end of the spindle, while the lathe is in motion, releases the work. When the sleeve is released the chuck is closed by spring pressure. It is very rapid in operation, as it is not necessary to stop the spindle on ordinary work.

Combination Wrench Set: C. M. B. Wrench Co., Syracuse, N. Y. This set of wrenches comprises a ratchet handle, sockets for bolts and nuts of various sizes, together with extension sockets, screw-drivers, etc. This permits a wide range of work to be done in all sorts of inaccessible places. The wrenches and universal joints are made of a non-rusting alloy, and the connections are of square section steel tube.

Self-Lubricating Bearing Metal: New Era Mfg. Co., Kalamazoo, Mich., has brought out an anti-friction alloy in which the metal portion is reduced to a sponge-like form, highly attenuated and of irregular or interrupted surface formation. The metal is treated with lubricating oil and is then coated with mineral lubricants making a compound mass of metallic packing. It is used for packing piston rods, valve stems, and as a bearing metal for lining journal boxes, bushings, etc.

High-speed Steel Treating Furnace: C. U. Scott, Davenport, Ia. This is a furnace of improved construction which, it is said, makes possible the heating of high-speed steel tools to the high temperatures required, without any scaling, pitting or blistering. Even polished steel can be treated so that it will be free from scale. This result is obtained by doing away with the door and the combustion chamber. Provision is also made for confining the heating to the cutting ends of tools.

Bench Milling Machine: B. C. Ames & Co., Waltham, Mass. This is a miller of the precision type, built on the general lines of the standard column and knee type machine, though, of course, of much smaller size. It is provided with a lever feed for the horizontal table movement, and is furnished with swiveling vise and index head. The latter may be set at any angle from 10 degrees below the horizontal to 5 degrees above the perpendicular. The table has a working surface of 12 by 3 inches.

Mica Annealing Mixtures: United States Mica Co., Chicago, Ill. This is a substance prepared from mica which is used for annealing in the same way in which charcoal, etc., are used now. Its inertness to chemical combinations and its non-absorbent qualities result in the production of a clean surface on the steel, without oxidization. The material is an exceedingly poor conductor of heat, so that the cooling takes place very slowly, giving the best results in annealing.

Inserted Tooth Milling Cutter: Union Twist Drill Co., Athol, Mass. These cutters use inserted teeth instead of blades. The teeth are set into drilled holes, and are made from round stock. They are held in place by being split longitudinally for the greater part of their length, and are provided with taper pins in the splits, the driving of which locks them firmly in place. To remove the teeth when they are all ground away, the taper pin is drilled out, it being left soft for this purpose.

Arch Type Press: Blake & Johnson, Waterbury, Conn. The distinctive feature of this press is the type of adjustment used for the ram. The ram is split in two parts, held together by a double, dovetailed wedge, which is controlled by a fine screw adjustment. This device puts into the hands of the operator a means for making minute changes in the depth of the ram stroke, which is controlled with the greatest delicacy. It will be seen, therefore, to be particularly adapted to sub-press work.

Automatic Buffing Machine: Automatic Buffing Machine Co., Buffalo, N. Y. This is a device for presenting plain cylindrical or other simple work to a wheel mounted on an ordinary buffing head, rotating it and moving it back and forth automatically so as to cover the whole surface. It does this with a uniform pressure, which is said to insure a longer life to the wheel than with hand buffing. It has the further and main advantage of permitting the operator to take care of several machines at once.

Pipe Expanding and Flanging Machine: Lovekin Pipe Expanding and Flanging Machine Co., Philadelphia, Pa. This is a machine which might be likened to a gigantic flue expander. It is intended for pressing steel piping into a tight fit with the flanges, rolling the metal into internal grooves in the latter. This process allows the use of a thinner pipe than is possible where threaded joints are used. The line of machines will handle all sizes from 2 to 24 inches in diameter. Larger machines will be built to special order.

Inserted Blade Boring-Head: George Braithwaite & Oscar B. Elder, Chicopee Falls, Mass. This is a boring-head of the inserted blade type, particularly adapted to finishing out cored holes preparatory to reaming. The blades are held in place by taper pins, bearing on the bottom sides of elongated slots, thus holding them to their seats in the head. A threaded collar serves to set all the blades forward together, changing the diameter adjustment slightly as may be required. The body of the tool is made of soft material, while the blades are made of high-speed steel.

Bethel Cutting-off Machine: Matson Machine & Tool Co., Bethel, Vt. This is a machine of the friction disk type for cutting off high-speed or other steels. The wheel is 12 inches in diameter by 3/32-inch thick, and should run at about 4,000 revolutions per minute. The machine has the capacity up to 1 1/8-inch round, and will cut flat stock up to 3 inches wide. A special feature of the machine is the fact that the cutting is done at the rear of the wheel, allowing the front to be guarded so as to keep the dust of the cutting operation from the operator's eyes.

Air Hoist: Weir & Craig Mfg. Co., Chicago, Ill. This firm has developed a form of geared air hoist which possesses a number of advantages, chief among them being the small head room required as compared with the plunger and cylinder type of hoist, and the provision made for holding the load at any given point irrespective of leakage. The best of material is used, the gears being cut from hammered steel and the crank being made of forged nickel steel. The bearings are bronze bushed and the machine is built on the interchangeable plan throughout.

All Geared Lathes: Niles-Bement-Pond Co., 111 Broadway, New York City. These lathes have the motor mounted directly on the enclosed headstock casting, and connected with the spindle by guarded gears. The quick change gear mechanism has 32 rates for feeding and thread cutting. This has previously been described and illustrated. (See article entitled "Assembling a 24-inch Engine Lathe" in the November, 1909, issue of MACHINERY, engineering edition). The lathes are built in sizes from 36 to 72 inches, and are furnished either with single pulley drive, or with motor drive.

Portable Electric Drill: Lamb Electric Co., Grand Rapids, Mich. This firm is developing a line of direct and alternating current electrical drills, of which the first size has recently been put on the market. This is a machine capable of drilling 3/8-inch holes in steel, or ½-inch holes in wood. It is provided with a ball thrust, and is furnished with the Jacobs No. 2A chuck. A special feature of the construction is the fact that no ventilating fan is provided, as the motor has been designed to keep cool without requiring a current of air, with the accompanying trouble of chips and dust blowing through the armature.

Sherardizing Equipment: Globe Machine and Stamping Co., Cleveland, Ohio. In the December, 1909, number of MACHINERY we describe an improved drum arrangement, dust hood, etc., for the process of sherardizing or dry zinc plating. The apparatus has been recently improved by the addition of two transfer tables, which permit a continuous movement of the work. This movement is from the loading platform, through the furnace, into the dust hood (where the work is dumped), and back to the loading platform again. This arrangement materially increases the output of a given size of furnace.

Gas Furnaces: Westmacott Gas Furnace Co., Providence, R. I. This firm has recently added three new furnaces to its line. One of these is a quick heating furnace for hardening by the barium-chloride process, obviating the long waits usually required for getting this substance to the hardening temperature. The second furnace is for oil tempering. It is provided with a pot of sufficient size to take a basket of 12 inches in diameter and 14 inches deep. The

third is a lead hardening furnace of rectangular shape, carrying a pot 20 inches long, 10 inches wide and 7 inches deep. It can be furnished either of cast iron or steel.

Double Cold Sawing Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This arrangement consists of two cold sawing machines, one right- and the other left-hand, mounted on a baseplate on which one of the units may be adjusted to give any required distance between the blades, from 1/4 inch up to any reasonable maximum, depending on the length of the baseplate. The use of a double machine of this kind is designed to reduce the idle time of the machine materially, as two cuts can be made at one setting of the work. The machines are of standard design, and belt-driven from the same cone pulley.

Surface and Wet Grinding Machines: Valley City Machine Works, Grand Rapids, Mich. One of this line of tools is a combination surface and tool grinder, comprising a disk wheel of the usual type with suitable work-table at one side of the frame, and an emery wheel at the other with tool-rest and surface grinding platen underneath. The grinding disk is 18 inches in diameter, and the work-table used with it has an angular adjustment. Another member of this line is a combination wet and dry grinder. The wheel for dry grinding is mounted on a heavy hanging arm away from the column, and is provided with a tool-rest.

Ashcroft Valve Grinder, Breast Drill, etc.: Ashcroft Mfg. Co., 85-89 Liberty St., New York City. This device resembles a breast drill in its appearance, but is provided with certain special features adapting it particularly to valve grinding. By the operation of the mechanism provided, the valve is given a rotary motion back and forth, but advancing with each movement a little further to the right, thus bringing it into a new position at each stroke. The surfaces are thus ground to a bearing under the conditions best adapted to prevent scoring, and to give a true seat. It can also be used for a breast drill, or for a right- or left-hand ratchet drill or screw-driver.

Transfer Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This line of transfer presses is designed on the arch type, and comprises four sizes, ranging from 700 to 4,200 pounds each in weight. As implied in its name, the machine is particularly adapted to double operation work in which the blank is cut out and drawn or simply cut out in the first operation, and then transferred to a second position where it is again drawn, while a new blank is being formed in the first position. It is provided with an adjustable roller feed of improved construction. The transfer mechanism is adjustable to give any stroke from 1 to 3 inches.

Automatic Tapping Machine: Garvin Machine Co., Spring and Varick Sts., New York City. This is a power tapping machine with vertical spindle, having forward and reverse pulleys driven by a single belt. A special feature of the machine is the provision of an automatic reverse for the spindle, set to operate at any required depth of tapping by means of an adjustable stop, and of a friction slip incorporated in the driving clutch. The machine will tap holes from 1/4 to 3/4 inch in diameter in cast iron, to a depth of 1 1/2 inch. The automatic reverse cannot be accidentally thrown out of operation, even by the continued pressure of the operator on the feed lever.

"Oil Drag" Speed Changing Mechanism: Robert E. Newcomb, Holyoke, Mass. In this apparatus a familiar principle, employed in the common multiple disk automobile clutch, has been used to operate as a speed changing device. A series of alternate disks is fastened, one to the driving and the other to the driven member, spaced slightly apart, and submerged in oil. The drag between the driving and driven disks, effected by the oil, is used to permit relative motion between the two members. By means of a piston arrangement the level of the oil in the chamber is raised or lowered, increasing or decreasing the drag, and the speed in proportion.

Four-spindle Cylinder Boring Machine: Moline Tool Co., Moline, Ill. This is a machine of the same general design as others of this line we have previously described. (See, for instance, the multiple spindle drill in last month's department of New Machinery and Tools.) The drive, however, is made unusually heavy, and two spiral gears are provided, allowing the alternate spindle gears to overlap each other so as to permit their being of large diameter, suited to the heavy service required. The spindles are bored for No. 5 Morse taper; the ends will be threaded to fit cutter-heads, or left blank, as required. The machine is back-geared and provided with a double countershaft, giving six changes of speed.

Fuel Oil Crucible Furnace: Alfred Fisher, 103 West Monroe St., Chicago, Ill. This furnace is built in four sizes to hold crucibles from No. 30 to No. 350. The two smaller sizes are equipped with one burner, and the two larger ones with two burners apiece. The fire brick is so arranged as to draw the heat upward and close to the crucible, and also to permit the use of charcoal to prevent oxidization of the charge. As compared with the coal furnace it is intended to replace, it is always ready; it will melt alloys of brass and copper without burning out the brass borings; and its use results in a saving in fuel and shrinkage. It is stated that it will melt any kind of metal from scrap to sheet zinc, at an operating cost of 6 1/2 cents for 100 pounds.

Rotary Elastic Blow Riveter: Charles Greiner Co., New Haven, Conn. In the December, 1909, number of MACHINERY, we published a note describing a riveting machine in which a series of hammer blows was struck on a spring cushioned hammer by projections on a revolving flange. The hammer was rotated at the same time so as to distribute the action around the head of the rivet and make a symmetrical and thorough job. The present design of this machine is a larger size, and is provided with a vertically adjustable table for accommodating work of various heights. The hammer is brought down to the work by a foot-treadle, which regulates the force of the blow. When the treadle is released the hammer rises, clearing the work automatically.

Rim Friction Clutch: Lehigh Clutch Co., Denckla Building, Philadelphia, Pa. This is a clutch of the type in which the rim of one member is grasped between two or more sets of double jaws on the opposite member. A separate set of toggles is provided for each jaw, drawing the outer ones toward the center and forcing the inner ones outward, gripping the rim between them. Turnbuckles are used to maintain the proper adjustment. The operation is entirely positive, no springs being employed. The friction blocks or wooden shoes can be renewed very expeditiously without dismantling the chuck. The device is made on the interchangeable plan, permitting repairs to be easily effected. Twenty-six sizes are made, of capacities ranging from 4 to 128 horsepower, and in sizes of from 12 to 36 inches diameter.

Squeezer Type Molding Machine: Arcade Mfg. Co., Freeport, Ill. This machine, which is adapted to the use of the double-faced match-plate system of molding, is notable among other things for the convenience provided for the molder. A table for flasks and bottom-boards is mounted on the machine at the left. A support for the riddle is provided at the right, while convenient shelves are mounted on the top of the machine for the parting sand, tools, etc. A gage at the rear of the table serves to locate the flask accurately under the ramming head. The ramming is accomplished by a double-geared toggle device of original design. A vibrator is furnished, operated by a knee pad. The whole machine is mounted on three wheels, so as to always be firmly supported even though the floor be uneven.

Bevel Gear Hobbing Machine: Carpenter-Kerlin Gear & Mch. Co., 77 White St., New York City. This firm has taken the agency for the Chambon gear hobbing machine which is now built by the Société Francaise des Machines-Outils of Paris. This machine was illustrated on page 12 of the September, 1908, number of MACHINERY (engineering edition) where the principles of its operation were fully described. It employs a hob for a cutting tool, and the process of generation is continuous from start to finish, the same as for hobbing spur gears. Owing to the approximate character of the generation, this machine is particularly adapted to roughing out bevel gears which are to be finished by planing. For such work it is very rapid, and cuts closer to the finished shape than any other roughing process hitherto employed.

Plate Planing Machine: William Sellers & Co., Inc., Philadelphia, Pa. This machine for planing the edges of steel plates will take in work 3 inches thick and 24 feet long at one setting. The shape of the housings permits any greater length to be machined by shifting the work as many times as may be required. The carriage is so arranged as to permit its ready removal when necessary, without dismantling the end housings or taking out the driving screw. The feeds are hand controlled, and the tool-holder is turned over by the operator at each end of the stroke. An improved clamping construction makes use of a series of air cylinders. These have the advantage over hydraulic or screw actuated jacks in that they automatically follow up any distortion in the beam due to the pressure gripping the plate from one end to the other equally at a single movement of the operating valve. The machine is intended for heavy duty in planing vanadium steel plates.

Motor-driven Roll Grinding Machine: Norton Grinding Co., Worcester, Mass. It was for a long time supposed that rolls as accurate as those required for paper machinery and similar work could only be successfully ground by the double-wheel calipering process. Modern improvements in grinding machinery, however, have demonstrated that they can be finished accurately in machines similar to the standard plain grinding machines for regular work. In the special roll grinder built by the Norton Grinding Co. the only radical changes made have been in the provision of supports for the neck bearings of the roll (so that they revolve on their own journals in the grinding process) and in the provision of a self-contained motor-drive. Two motors are used, one at the back for driving the wheel, pump and feed, and one mounted directly on the headstock for revolving the roll. A floating device is used for connecting the roll and the headstock faceplate. The

work may be ground on centers as usual, if desired. This machine weighs 18,500 pounds, and will grind rolls from 12 to 22 inches in diameter.

Multiple Spindle Automatic Screw Machine: Davenport Machine Tool Co., New Bedford, Mass. This screw machine incorporates a great number of radical improvements in design for machines of the multiple spindle type. These improvements include separate cam control for each of the five turret tools and the four cross-slide tools; separately adjustable rate of feed for each of the five turret tools and the four cross-slide tools, and individual stops for each of the five spindles and four cross slides, making 20 in all. These individual stops give accuracy in cross-slide operations in spite of irregularities due to the wear of the spindle. The quick-acting, idle movements, such as stock feeding, turret revolving, etc., are performed at the highest rate of speed. Special provision is made for rapid and precise indexing of the spindle head. Other features are wide range of speeds and feeds, single belt drive and removable plate cams for the cutting operations. These various improvements have been applied to a machine capable of taking in ½-inch round rods, feeding up to 2½ inches in length, and turning up to 2 inches in length. The provision of the independent adjustable control for each of the five spindles and four cross-slide tools is especially important in that it permits shortening the time of the longest operation, thus materially increasing the production of the machine over other types not provided with this feature. From the size of the machine it will be seen that it is expected to be used on the finer grades of work, for which the multiple spindle idea has often been considered unsuited.

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APPRENTICESHIP CERTIFICATE

The accompanying halftone shows the apprenticeship certificate granted by the Bantam Anti-Friction Co., Bantam, Conn., to its apprentices when they have completed their full three and one-half years term in its shop. The certificate is

Apprenticeship Certificate issued to Journeymen by the Bantam Anti-Friction Co.

shown about one-third size, its dimensions being about 9 x 11 inches. The company finds that the certificate is an incentive to the completion of the apprenticeship term, and that the boys highly appreciate it. It states that the journeyman to whom issued has received instruction in the operations of lathes, milling machines, drills, tool-making, bench work and other practical shop work. It is signed by the works manager and approved by the president.

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PATENT OFFICE PRACTICE LEGISLATION

The Board of Managers of the Patent Law Association of Washington, D. C., has published a small pamphlet in which objections are made to two bills now pending in Congress relating to certain changes to be made in the tribunals of appeal in the patent office. The passage of these bills apparently would place too much power in the hands of the Commissioner of Patents without any specific benefit being gained. In the place of these two bills the Patent Law Association recommends the provisions contained in the House Bill No. 23,916 recently introduced, which provides that the present courts of appeal in *ex parte* cases shall remain undisturbed, but that appeals in interference cases shall be taken directly from the Examiners-in-Chief to the Court of Appeals of the District of Columbia, and that only in case of a temporary disability of one or more of the members of the Board of Examiners-in-Chief, the Commissioner of Patents may designate a primary examiner to sit temporarily upon the board. This bill removes one of the objectionable features of the former bills which gave the Commissioner power always to designate the three members on the board. As it, of course, does not seem desirable to give to one man the power to designate the members or judges in the appeal cases, it would undoubtedly be to the interest of the efficient conduct of the patent office if the bill approved by the Patent Law Association were passed, and the two previous bills rejected.

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EDISON STORAGE BATTERY STREET CAR

In the March number of MACHINERY some details were given relating to the operation of a street car in New York by the storage battery with which Mr. Thomas A. Edison has been experimenting for a number of years. Some figures were deduced, estimating the size of a storage battery for a street car of the common type, and on account of the weight of the battery for a car of this kind, the opinion was advanced that the additional power required for hauling the dead weight of the battery would likely make the storage battery street car proposition impracticable. Additional information since furnished by Mr. R. H. Beach, 10 Fifth Ave., New York, who is conducting experiments with the Beach street cars using Edison storage batteries, puts the developments in another light.

Mr. Beach found that when the Edison storage battery was applied to an ordinary street car the current consumption was about 125 watts per ton mile. Storage battery operation was out of the question unless the consumption could be reduced. An excellent opportunity to improve the design of the cars, however, offered itself, inasmuch as there has been little improvement in street railway cars during the past twenty years except as regards increasing the size and capacity. Practically nothing had been done to increase the mechanical efficiency of the trucks or the motor. The first important improvement made in the Beach car was the introduction of the differential axle. This device permits the wheels to run independently, and cuts down the current consumption very materially, especially on tracks with many curves. The superstructure of the car was lightened, while the underbody was made as heavy or heavier proportionally than that of standard cars. Instead of chilled cast-iron wheels weighing 500 pounds or more, manganese steel wheels weighing only 125 pounds were used. Instead of a three-to-one gear reduction motor a six-to-one reduction chain drive motor was used, thus reducing motor weight and increasing efficiency of drive. By these and other improvements made in an endeavor to fit the storage battery proposition to street cars a considerable improvement in mechanical efficiency has been brought about, and the current consumption has been cut down to 70 watts per ton-mile, with possibilities remaining for further reduction.

Under these conditions the proposition of using storage batteries assumes a different aspect, although it must also be conceded that if the same improvements are introduced in cars using current from a central station directly, they too will prove much cheaper to run than at present. It should be understood, however, that while the lighter construction can be profitably used for underground conduit system, it could not be used so successfully for trolley systems taking power from an overhead wire, as then a stronger superstructure is necessary to support the trolley and its accompanying mechanism and withstand the racking stresses. Whatever the ultimate outcome of the experiments with storage battery cars, much credit is due to Mr. Beach for inaugurating the improvements in mechanical efficiency and construction which have resulted from his desire to utilize the Edison storage battery.

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Another large ocean liner will soon be built by the Hamburg-American Line at the Vulcan works at Stettin, which will rival, if not exceed in size, the giant White Star liners now under construction. The vessel will be 800 feet long, with a displacement of from 45,000 to 50,000 tons and a speed of 20 knots.

NATIONAL METAL TRADES ASSOCIATION CONVENTION

The twelfth annual convention of the National Metal Trades Association was held at the Hotel Astor, New York, April 13 and 14, with the following official organization: Howard P. Eells, Bucyrus Co., president; J. H. Schwacke, William Sellers & Co., Inc., first vice-president; H. W. Hoyt, Great Lakes Engineering Works, second vice-president; William Lodge, Lodge & Shipley Machine Tool Co., treasurer; Robert Wuest, commissioner. The membership numbers 738, there having been a net gain of twenty during the past year. The association is in a most flourishing condition, and its influence is broadening far beyond the original conception of its charter members. Originally it was almost purely a defensive organization designed to resist the aggressions of union labor, and that work is still its principal function, but now the policy is constructive as well as defensive.

The members generally have recognized the great need for industrial education, and the convention reflected the common desire to promote it in the papers presented. The recognition of the employers' responsibility to workmen worn out in service or disabled was also reflected in papers on old-age pensions and insurance against unemployment. The program of papers following was one of the best ever presented before the association, comprising the subjects of industrial education, compensation of workmen, old-age pensions, liability insurance, shop management, cooperation, etc.:

"The Old-Age Pension Problem and Its Relation to the Industries," by M. W. Alexander.

"The Compensation of Workmen," by H. L. Gantt.

"The Premium System; Some of its Drawbacks," by Carl G. Barth.

"Employers Liability Insurance," by Miles Dawson.

"Modern Method of Shop Management," by Frederick A. Waldron.

"The Fitchburg Plan of Industrial Education," by W. B. Hunter.

"Cincinnati's Continuation School," by Dr. Frank B. Dyer.

"The Necessity for Continuation Schools to Develop Higher Intelligence," by J. Howard Renshaw.

"The Manufacturer's Point of View," by Fred A. Geier.

"The Originator of the School," by B. B. Quillen.

"The Growth of the Cooperative System," by Prof. Herman Schneider.

"Insurance Against Unemployment," by John L. Griffiths.

Prof. W. B. Hunter of the Fitchburg High School, Fitchburg, Mass., described the "Fitchburg Plan" (see MACHINERY, October, 1908, August, 1909, and November, 1909), which is based on the cooperative engineering school and shop work course originated by Prof. Herman Schneider of the University of Cincinnati, and described by him at the N. M. T. A. convention in April, 1908. This plan provides for high school boys what the Cincinnati plan provides for its engineering students.

Dr. Frank B. Dyer, superintendent of schools, Cincinnati, Ohio, described the Cincinnati continuation school work, begun last September. This plan provides for the education of regular apprentices in the Cincinnati shops without loss of time or pay. The school is in session eight hours a day, four and one-half days a week and forty-eight weeks a year. The boys attend one-half day a week and are paid regular wages for the time of attendance. Dr. Dyer said in part:

"Some years ago in Cincinnati we opened night classes for apprentices," said Dr. Dyer. "Pattern making may be taken as an example. We advertised a course for apprentices in every shop in the city. There were fewer than thirty responses. The attendance was irregular and capricious, though the teaching was excellent. Though the courses were continued they did not appeal to those we were wanting. The night school fills a need with older workmen, but the apprentice is a day-time proposition. He must come regularly and through a series of years. The employer must make it worth his while to come, and, in fact, must see that he does come.

"Some of the progressive manufacturers of our city for several years tried to cope with the problem by employing teachers for their apprentices, but such teachers are scarce, and only very large concerns could afford it. The obstacles to the extensive operation of such a plan are too obvious to

Fig. 1. Graduate Apprentice at Work on Milling Machine, Cincinnati Milling Machine Co.

Fig. 2. Apprentice at Work on Engine Lathe, Cincinnati Milling Machine Co.

Fig. 3. Apprentice Erecting a Shaper, Steptoe Shaper Co.

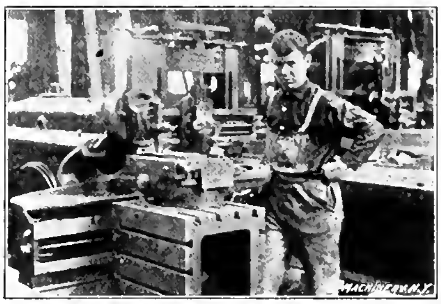


Fig. 4. Apprentice at Work on Shaper, Lodge & Shipley Machine Tool Co.

Fig. 5. Renshaw Jig Protractor used in Teaching Geometry

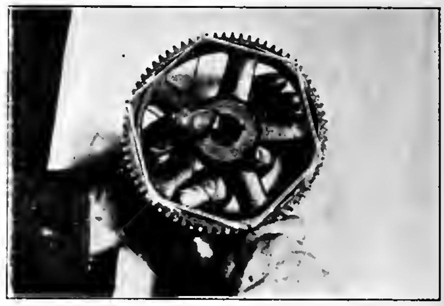


Fig. 6. Application of the Jig Protractor Principle to Gear

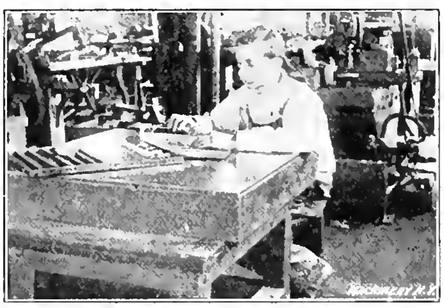


Fig. 7. Apprentice Testing Dovetail Slide with Hardened Plugs and Micrometer

Fig. 8. Apprentice making Practical Application of Trigonometry to Jig Work

Fig. 9. Draftsman Apprentice, E. Greenwald Co.

need discussion. The only agency that is adequate to cope with the situation is the state, and the state will cooperate when it understands that it is the great industrial class that is to be helped. Employers may have to make some slight sacrifices. They may have to concede to young workmen a little time for their intellectual betterment, but in the end it will be money well spent as an investment. If authority is not given to require employers to send their apprentices to receive the instruction which is the right of every youth, in a democracy at least, it is the privilege of every city to offer an opportunity to such youth in part-time day schools as well as in night schools.

"These ideas ripened in the minds of some of our wisest Cincinnati manufacturers, and thus it came about that the Board of Education of Cincinnati last summer proposed to offer continuation courses for apprentices in any trade, and proceeded to open a school for machine shop apprentices as soon as 150 students were guaranteed. More than 200 students were registered by eighteen manufacturers, and the school started September 1. A man was placed in charge who had been a teacher, a practical shop man, and for many years an instructor of apprentices. He trained his own assistant. The average attendance has been 180 per week. The boys came four hours per week, a new squad coming each half day. The employers pay them for their time, and if they do not show up at school they are reported and docked. The school runs forty-eight weeks a year, eight hours a day, four and a half days a week, and the instructors spend two half days a week, besides, visiting the boys in the shops, talking with the foreman and keeping a line on the needs of the boys. The school is costing the board about $15 a year per boy.

"The course of study is arranged to cover four years. The greatest difficulty was encountered in getting the boys classified correctly and placed in similar groups. While this was gradually accomplished with the assistance of the foremen, it is still necessary to do considerable individual instruction, thus requiring an assistant, though there are but twenty boys in a group. The course taken by the boys is not narrow, nor it is without cultural elements. It includes mathematics, mechanics, drawing, civics, and reading, writing, and spelling. The interesting thing about it is that every study is given a practical coloring, and is made to function in the shop or experience of the boy. The boy sees the purpose of what he is studying, and has a motive in mastering every difficulty. The end of all this is not, as some suppose, simply to send him back next day, able to turn out more and better work; it is to awaken his dormant powers and make him alert, thoughtful, original, and competent.

"These mental exercises relieve him of the monotony of shop routine. As he learns of the great industry in which he is engaged, and of its captains and inventors, and as he discusses its relations with other occupations and with human life, his interest in his work increases, and he comes into sympathy with the great body of the world's workers. As he learns to find new problems in his shop experience, and applies his knowledge to them, his work becomes transformed into a fascinating art. He ceases to be a mere hand, and aspires to be a free master of an honorable craft.

"A great many expert educators from different parts of the world have visited the school and examined carefully into the course and the methods of instruction and have questioned the boys at length. They pronounce the course as one of the most significant efforts yet made to adapt education to vocation, and the method used as representing the most advanced pedagogical views.

"We think so much of the plan in Cincinnati that the Board of Education has offered to open a continuation school for any other classes of apprentices that may be sent, and also for young saleswomen in stores, or girls working in trades. A bill is now before the Ohio State Legislature empowering boards of education to require the attendance of all youth under 16 at part-time continuation schools. If I had the determining of it, there would be a law requiring the attendance of all apprentices through their apprenticeship. Such schools will do much to elevate the standard of work, the degree of intelligence, and the moral character of young workers, and will lift them in the scale of living so that they may be what they should be—the strength of our nation and the envy of the world."

J. Howard Renshaw, the originator of the jig sheet system of mathematical instruction for apprentices, and Dr. Dyer's assistant, illustrated, with a large number of lantern slides, typical apprentice classes sent from the Cincinnati shops, and boys at work (see Figs. 1 to 9, inclusive); also jig sheets used in teaching geometry, trigonometry, analysis of machines, etc.

J. H. Schwacke, of the William Sellers & Co., Inc., was elected president of the association for the coming year; F. C. Caldwell, of the H. W. Caldwell & Son Co., first vice-president; Paul B. Kendig, of the Seneca Falls Mfg. Co., second vice-president; H. P. Eells, of the Bucyrus Co., treasurer. The commissioner is Robert Wuest, New England Building, Cleveland, Ohio.

PERSONALS

F. X. Cleary has been appointed advertising manager of the Western Electric Co., 463 West St., New York.

Harry F. Mesener has been promoted to the position of superintendent of the Grant Automobile Co., Orange, Mass.

W. F. Hittle, who for the past four years has been in charge of the machine department of the Dayton Motor Car Co., has resigned.

B. D. Jackson, for the past five years with Walter H. Foster Co., 50 Church St., New York, is now with the Modern Tool Co., Erie, Pa.

W. C. Wilcox has been appointed manager of the Chicago branch store of the Reeves Pulley Co. to succeed Mr. E. O. Winterowd, resigned.

Louis I. Howard has resigned from a position with the Lamb Knitting Co., Chicopee Falls, Mass., to become manager and treasurer of the National Scale Co. of the same city.

Walter M. McFarland, acting vice-president of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has resigned to take an official position with the Babcock-Wilcox Co., New York.

H. C. Fay, foreman of the chucking, punching and shaving department of the Remington Arms Co., Ilion, N. Y., has been appointed to succeed Mr. A. C. Brown in the tool and gage department.

Henry T. Merriam, manager and engineer of the R. F. Hawkins Iron Works, Springfield, Mass., has resigned the position to assume the management of the Grip Coupling Co., Ware, Mass.

Matthew Harrison has resigned the position of superintendent of the Grout Automobile Co., Orange, Mass., to become assistant superintendent of the Stevens-Duryea Automobile Co. at Chicopee Falls, Mass.

George E. Tiffany, foreman of the drop forge and die sinking department of the Remington Arms Co., Ilion, N. Y., will assume charge of the chucking, punching and shaving department, succeeding Mr. H. C. Fay.

Benjamin K. Hough has been appointed Boston sales manager of the Wisconsin Engine Co., Corliss, Wis., with offices in the Oliver Building, Boston. Mr. Hough will represent the company in the New England states.

E. G. Matter, who has been with the National-Acme Mfg. Co., Cleveland, Ohio, in the Ohio and Chicago territory for the past five years, has been put in charge of the newly-opened Detroit office at 1222 Majestic Building.

C. A. Nourse, for the past three years with the Alden Sampson Mfg. Company, Pittsfield, Mass., as superintendent, has resigned to take a position with the American La France Fire Engine Co., Elmira, N. Y., as machine shop foreman.

Alfred C. Brown, for the past four and one-half years foreman of the tool and gage department of the Remington Arms Co., Ilion, N. Y., has resigned to take a position as superintendent with the Denver Rock Drill & Machinery Co., Denver, Col.

George S. Perkins, Springfield, Mass., who for the past four years has been draftsman for the Fisk Rubber Co., Chicopee Falls, Mass., designing molds and special machinery, has resigned to take a position in the drafting department of the Confectioners' Machinery & Mfg. Co., Springfield, Mass.

J. A. Brown, who has been employed in the ordnance department as mechanical engineer and as chief draftsman, and for the past five years as constructing engineer, at the Frankford Arsenal, Frankford, Pa., has resigned to engage in private practice. Mr. Brown will also represent several well-known manufacturers of machine shop equipment.

Morgan K. Barnum, who was recently appointed superintendent of motive power, for the Illinois Central R. R., is a graduate of Syracuse University. He began his railway career as a machinist apprentice with the Erie R. R. Mr. Barnum will have charge of the entire mechanical department of the Illinois Central R. R.

F. Mueller, partner of A. Engelman & Cie, Liège, Belgium, is in the United States on a business trip. He will call upon manufacturers of machine tools and accessories in order to learn of new inventions and improvements and to make contracts for representation abroad. His address while in the United States will be the Waldorf-Astoria Hotel, New York.

Jonah E. Titus, an employe of the New Home Sewing Machine Co., Orange, Mass., for forty-three years, over thirty-five of which were spent as foreman, recently resigned on account of continued ill health, his resignation to take effect on his sixty-fifth birthday. Mr. Titus had more men under his supervision than any other department foreman in the building.

James Cordner has resigned the position of general foreman at the Stevens-Duryea automobile factory, Chicopee Falls, Mass., to become general foreman of the Locomobile Co. in Bridgeport, Conn. Mr. Cordner was tendered a farewell banquet at the Haynes Hotel, Springfield, by about sixty-five of his associates and was presented with a full jewelled gold watch suitably engraved.

The personal in the March number of MACHINERY stating that Frank A. Foster had sailed to China as representative of the American Locomotive Co. in Tientsin was erroneous as regards his connection with that company. Mr. Foster held a position with the American Locomotive Co. in Providence, R. I., but went to China to take another position in which he will have considerable to do with the machinery and mechanical part of railway work.

Charles H. Norton of the Norton Grinding Co. was recently elected president of the Worcester Mechanics Association, Worcester, Mass. For several years Mr. Norton has been prominent in this association, which was formed about the middle of the last century by those interested in mechanical trades as a means of mutual improvement. This association owns its own building, library, etc., and by means of its activities has done much to develop the industries of Worcester.

* * *

OBITUARIES

Eugene Stuart Bristol, president of the New Haven Mfg. Co., New Haven, Conn,. died April 2, in his sixty-seventh year.

David A. Jones died at Springfield, Mass., April 4, aged eighty-five. Mr. Jones had been employed by the United States Government for more than fifty years, working at Windsor, Vt., and Springfield, Mass. He gave up work at the United States Armory at Springfield, Mass., about a year and a half ago.

Lucien F. Bruce, for more than fifty years an employe of the United States Armory, Springfield, Mass., died at his home March 13, aged seventy-six years. Mr. Bruce had been assistant foreman, and was the inventor of many improvements on guns and machinery for making them, the most important of which was a mechanism for feeding cartridges in the Gatling gun. He was an expert engraver on metal. Mr. Brnce had charge of the government armory exhibit at the Centennial Exposition at Philadelphia, Pa., in 1876.

* * *

COMING EVENTS

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 10-13.—Seventeenth annual convention of the Air Brake Association, Indianapolis, Ind., Dennisson Hotel, headquarters. An interesting program has been prepared on air brake construction, air pumping, piping inspection and cleaning, triple valves and brake cylinders, recommended practice, etc. F. M. Nellis, secretary, 53 State St., Boston, Mass.

May 11-13.—Joint convention of the American Supply and Machinery Manufacturers' Association and the National Supply and Machinery Dealers' Association at Atlantic City, N. J. F. D. Mitchell, 309 Broadway, New York, secretary-treasurer, American Supply and Machinery Manufacturers' Association.

May 16-18.—Fifteenth annual convention of the National Association of Manufacturers, Waldorf-Astoria Hotel, New York. George S. Budinot, secretary, 170 Broadway, New York.

May 24-25.—Spring convention of the National Machine Tool Builders' Association at Rochester, N. Y., Hotel Seneca, headquarters. Charles E. Hildreth, secretary, Worcester, Mass.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-4.—Second annual state convention of Pennsylvania engineers, for the furtherance of the organization of the Engineers Society of Pennsylvania, Hall of Representatives, Harrisburg, Pa. Engineers Society of Pennsylvania, Gilbert Building, Harrisburg, Pa.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich. C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 15-17.—Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-July 6.—Detroit Industrial Expositiou, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

August 16-19.—Annual convention of Traveling Engineers Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

NEW BOOKS AND PAMPHLETS

THE BELOIT COLLEGE BULLETIN. Catalogue for 1909-1910. 152 pages, 5½ x 7½ inches. Published by the Beloit College, Beloit, Wis.

COLUMBIA UNIVERSITY BULLETIN OF INFORMATION. Announcements of summer sessions, 1910. 90 pages, 6 x 9 inches. Published by the Columbia University, New York City.

THE WEATHERING OF COAL. By S. W. Parr and W. F. Wheeler. Bulletin No. 38. 43 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. Announcements of summer courses, 1910. 20 pages, 6 x 9 inches. Published by the Massachusetts Institute of Technology, Boston, Mass.

BULLETIN OF THE UNIVERSITY OF NEW MEXICO. Catalogue for 1909-1910, and announcements for 1910-1911. 136 pages, 5½ x 7½ inches. Published by the University of New Mexico, Albuquerque, New Mexico.

UNIT COAL AND THE COMPOSITION OF COAL ASH. By S. W. Parr and W. F. Wheeler. Bulletin No. 37. 67 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

THE PENNSYLVANIA RAILROAD AND THE FARMER. The Creating of Traffic through the Cooperation of Farmer and Railroad. 14 pages, 5½ x 7½ inches. Published by the Pennsylvania Railroad, Philadelphia, Pa.

BULLETINS OF REVENUES AND EXPENSES OF STEAM ROADS IN THE UNITED STATES. Nos. 8, 9, 10 and 11, covering the months September-December, 1909. Prepared by the Bureau of Statistics and Accounts, and published by the Interstate Commerce Commission, Washington, D. C.

ENGINEERING INDEX ANNUAL. 471 pages, 6½ x 9½ inches. Published by the *Engineering Magazine*, New York and London. Price, $2.

This well-known publication fills an established place in the reference library of the engineer. It is compiled from the monthly indexes of periodical literature in the *Engineering Magazine*, and gives the title, a brief statement of the contents of the article, the approximate number of words in the article, and the name and date of the publication in which it appeared. The subjects covered include civil, electrical and mechanical engineering, mining and metallurgy, railway engineering, marine and naval engineering, street and electric railways, and industrial economy. The usefulness of the new and simpler method of classification adopted has been proved by the extraordinary demand for last year's annual as compared with that of previous years.

ENGINEERING THERMODYNAMICS. By C. F. Hirschfeld. 157 pages, 3¾ x 6 inches. 22 illustrations. Published by the D. Van Nostrand Co., New York City. Price $0.50.

This book, which is now in its second revised edition, is one of the numbers in the Van Nostrand science series. The author, who is assistant professor of power engineering at the Cornell University, has treated the important subject of thermodynamics as applied to engineering in nine short and concise chapters on Heat, Gases, Entropy, Cycles, Flow of Gases, Vapors, Expansions and Compressions of Vapors, Vapor Cycles, and Flow of Vapor. The science of thermodynamics is based upon a few fundamental principles. The difficulties met with in the study of thermodynamics are usually due to the fact that the average student in his first attempts to obtain a working knowledge of this science fails to thoroughly observe and fix these fundamental principles in his mind, and build up a superstructure on this basis. In the present book the author has presented the subject in such a manner that the underlying principles may be clearly recognized. The study of this book will enable the engineering student to more easily follow the generalized and complicated cases considered in larger standard works on the same subject.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland L. Kneass. 175 pages, 6 x 9 inches. 53 illustrations. Published by John Wiley & Sons, New York City. Price, $1.50.

This book, now in its third revised edition, has been prepared with a view of presenting solutions of some of the more interesting problems met with in injector practice, and of describing in detail the functions of the different parts. Complex formulas have been avoided in the mathematical discussion; the treatment, in general, is direct and simple, and is based on carefully conducted laboratory tests. The third edition has been improved by including an additional chapter on the requirements of modern railroad practice. This chapter has been made necessary by the marked changes in the construction of locomotives during the last few years, which changes have reacted upon the method of feeding boilers and upon the injector design. The book treats of the early history of the injector and its development and describes the important parts of the device; detailed attention is then given to the delivery tube, the combining tube and the steam nozzle, and complete reference is made to the action of the injector. One chapter is devoted to the application of the injector in American and foreign practice, and another to the determination of sizes, based upon practical tests. The methods of feeding locomotive boilers, as already mentioned, have been touched upon, and the subjects of feed water heating, efficient feeding, scale-bearing water, check valves, etc., have been given some attention. Owing to the lack of books upon this subject which have been based directly upon experimental research, this book should be of especial interest to steam engineers who are interested in the practice and theory of injectors.

APPLIED MECHANICS. By David Allan Low. 551 pages, 5½ x 8½ inches. 850 illustrations. Published by Longmans, Green & Co., London and New York. Price, $2.75.

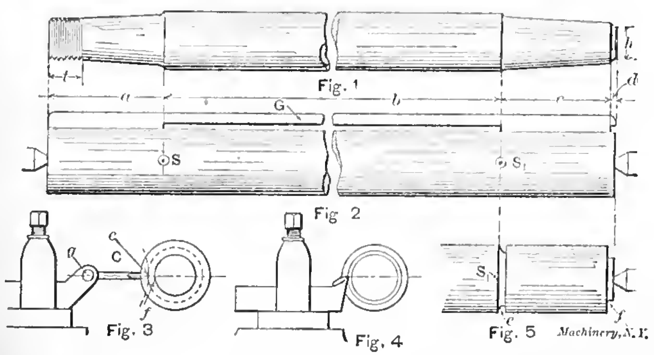
This book includes a treatise on the strength and elasticity of materials, the theory and design of structures, the theory of machines and hydraulics, and is especially intended as a text-book for engineering students. The author, who is professor of engineering at the East London College of the University of London, England, has given particular attention to the matter of exercises, of which not less than 780 are given, 600 of them being original. The remaining 180 exercises have been selected with great care from the examination papers of various examining bodies. The answers to these exercises are given at the end of the book and will be useful to students who study at home without the aid of a teacher. The subject matter is as clear and concise as is possible in a work of this kind, and covers a wide field. It pre-supposes, however, a considerable knowledge of mathematics, as calculus is freely used in the demonstrations and examples whenever necessary. The scope of the work is best indicated by a general review of the contents. The book opens with a preliminary chapter reviewing the most fundamental mathematical formulas, then deals with motion, force, work and energy, the polygon of forces, moments, stresses, beams and bending; the deflection of beams, columns and struts; testing materials, stress diagrams, design of roofs, plate girders, braced girders, etc.; acceleration, velocity diagrams, piston and crank effort diagrams, governors, brakes and dynamometers; belt, rope and chain drives; gearing and balancing. Several miscellaneous mechanisms are also treated in a chapter by themselves, and considerable attention has also been given to friction and lubrication. The book is concluded with five chapters on hydrostatics, hydraulics, water wheels, turbines, pumps, and some other hydraulic pressure machines. On account of its highly technical nature and its exceedingly thorough treatment of the subjects involved, it is recommended rather to the student who wants to make a thorough and fundamental study of the subjects than to persons who would use it merely for occasional reference.

Supplement to MACHINERY, June, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Laying Out and Machining a Piston-rod Key-slot"

SHOP OPERATION SHEET NO. 136

Franklin D. Jones MACHINERY, June, 1910



Machining a Locomotive Piston-rod—I
Turning the Rod

NOTE.—We shall assume that the steel stock from which the rod (Fig. 1) is to be made, is cut off to the correct overall length, and that deep centers have been drilled in each end.

1. First turn the body b of the rod to the finish diameter; then locate and mark with a punch as at S, S_1 (Fig. 2), the piston and crosshead shoulders, locating the latter next to the tailstock. The required dimensions a, b and c may either be taken directly from a standard gage G or from a drawing.

2. Caliper carefully the largest diameter of the hole in the crosshead, and turn a groove (cutting shoulder mark S_1) to three or four thousandths over this diameter. The tool used should have a rounded corner so as to leave a fillet as shown in Fig. 5. Next with a square-nose tool, reduce the end d, for about 3/16 inch, to say three thousands larger than the diameter of the crosshead hole at a distance c from the end.

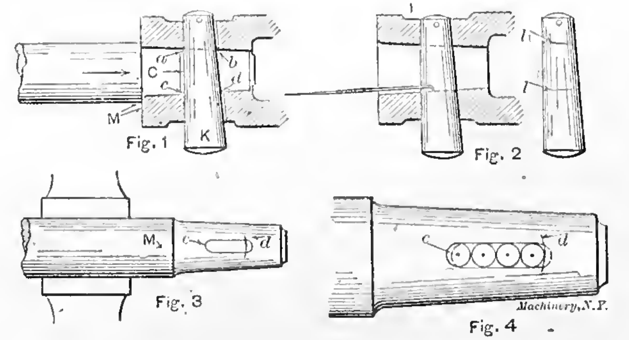
3. The taper attachment (or tailstock if there is no taper attachment) must now be set so that the tool's cutting edge, when to the height of the centers, moves parallel to a line passing through points e and f. This can be accurately done by using a caliper tool as shown in Fig. 3. The caliper C swings about pin g which should be set to the height of the centers. When the end of C just touches at e and f, the taper attachment is correctly set. If such a tool is not available, inside calipers may be used instead, the measurements being taken between the squared end of a tool and the work.

4. With the tool set to the height of the centers as in Fig. 4, turn the taper end to within say 1/64 inch of the finish size; then reduce end d to diameter h, and drive the rod tightly into the crosshead. A piece of soft metal should be held against the rod end to prevent damaging the center. When the rod is removed, the bearing marks will show whether or not the taper is correct. If the bearing is uniform, take a finishing cut with the tool set to just graze points e and f, and finish by filing until the rod can be driven in against its shoulder.

5. Proceed to fit the opposite end in the piston, getting the correct taper in a manner similar to that described for the crosshead end. The thread t for the nut which holds the piston and rod together, should not be cut until the taper fitting is finished, as otherwise it is likely to be damaged when driving the rod out of the piston. The body of the rod is next filed and polished with emery cloth.

SHOP OPERATION SHEET NO. 137

Franklin D. Jones MACHINERY, June, 1910



Machining a Locomotive Piston-rod—II
Laying Out the Key-slot

NOTE.—After a locomotive piston-rod has been turned, the keyway or slot for the key which holds the rod into the crosshead is laid out. This key or cotter K, Fig. 1, has a straight side which bears against the crosshead and a taper side which bears against one end of the slot in the rod which has a corresponding taper. When the key is driven in, it tends to draw the rod, as shown by the arrow, thus wedging it tightly into place. It is desirable to have the key, which is usually machined to a standard size, in approximately the position shown when it is driven in tightly.

1. To lay out this slot for drilling, first insert the key in the crosshead with the narrow end flush with the inner side I as shown in Fig. 2; then holding the key against the front side of the slot, draw lines across one side of it so that they coincide with the inner sides of the crosshead, using a hook scriber.

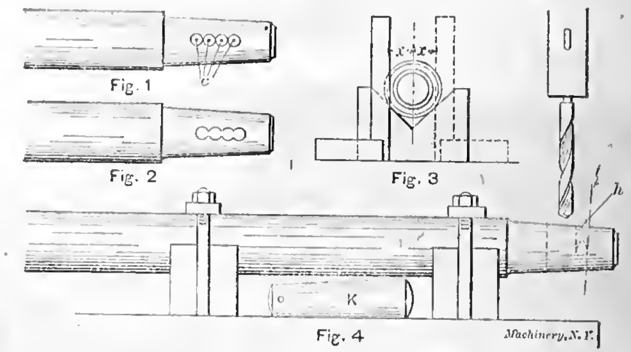
2. After the key is removed, insert the piston-rod, drive it home, and with a fine-pointed scriber, transfer the outline of the crosshead slot, on both sides, to the rod. Next mark the crosshead and rod lightly (as at M, M, Fig. 1) so that the scribed line representing, say the outer half of the crosshead slot may be known after the rod is removed.

3. After removing the rod clamp it between copper-protected vise jaws (Fig. 3) with, say the outer side M up. Then caliper the exact width of the key at the point where the outer line l was previously scribed. Set a pair of dividers to this width and with one point of the dividers on the end c of the scribed slot on the rod, draw a line d which represents the point d, Fig. 1. Caliper the width of the key at l_1 and locate a point on the opposite side of the rod which will correspond to point b, Fig. 1.

4. With the dividers set to a radius of one-half the slot width, scribe a circle just within the line d as shown in Fig. 4. Scribe another circle 1/8 or 3/16 inch beyond the end line c, and between these two circles scribe as many others as will come within the length of the slot. Proceed in the same manner on the opposite side of the rod, first scribing a circle just within the point corresponding to b (Fig. 1) and then another say 3/16 inch beyond the end line a; this 3/16 inch is to provide the clearance C for the straight side.

SHOP OPERATION SHEET NO. 138

Franklin D. Jones MACHINERY, June, 1910



Machining a Locomotive Piston-rod—III
Drilling and Finishing the Key-slot

1. After the keyway has been laid out as described in the preceding sheet, make deep punch marks c (Fig. 1) in the center of each circle on both sides of the rod, so that a drill can be started more easily. Then clamp the rod, which should rest in two V-blocks, to the table of a drill press, as shown, with say the inner or shorter side of the slot up. Before clamping the work tightly, set the laid-out slot vertical by turning the rod until the dimension x (Fig. 3) from a square blade to the center line, is the same with the square set on first one side and then the other, as shown.

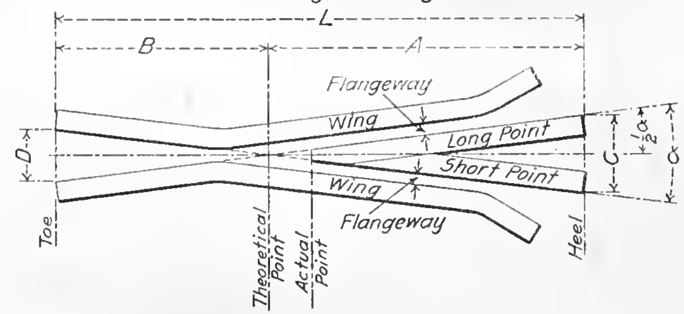
2. Next drill each alternate hole and then the remaining holes about half way through the rod. Care should be taken that the drill does not run to one side when starting, as it is likely to do, particularly on a curved surface. After the holes are drilled half way through from one side, the rod should be turned so that the remainder of the drilling can be done from the opposite side. This is a quick and easy method of machining the slot to conform to the scribed lines. When drilling the last hole h in the longest side of the slot, the piston end of the rod should be lowered until the cylindrical part is parallel with the taper key K when the latter is placed on the table in the position shown. This is done so that the drill will follow the line t of the finished slot, and not remove any metal outside of this line.

3. When the slot is drilled, it will appear as in Fig. 2. The ridges which have been left on the sides are next removed by chipping and filing, and the ends of the keyway are straightened with a round file. When filing these ends, the work should be held in a vertical position in the vise. The finished end of the rod should, of course, be protected from the hard vise jaws by copper or other soft metal.

4. After the burrs have been carefully removed from the edges of the slot, the rod should be inserted in the crosshead and the key driven in. If the ends of the slot have been filed straight and to the lines, the small end of the key should project through the crosshead far enough for a cotter pin. After the key has been driven in tightly, it should be removed and the bearing marks in the slot end examined. If these marks do not show an even bearing across the slot, the "high" spots should be filed until the key fits the slot perfectly.

FROGS, SWITCHES AND CROSS-OVERS—I

Rigid Frogs.



Formulas for Rigid Frogs

N = no. of frog,
L = length over all,
C = heel spread,
D = toe spread,
α = angle of frog.

$$N = \frac{L}{C+D} \qquad \tan\frac{1}{2}\alpha = \frac{1}{2N}$$

$$C = 2A \times \tan\frac{1}{2}\alpha = \frac{A}{N}$$

$$D = 2B \times \tan\frac{1}{2}\alpha = \frac{B}{N}$$

There are three types of rigid frogs.

1. Bolted: Filling in flangeway and held together by bolts.
2. Clamped: Filling in flangeway and held together by clamps.
3. Riveted: Rail bases riveted to a base plate.

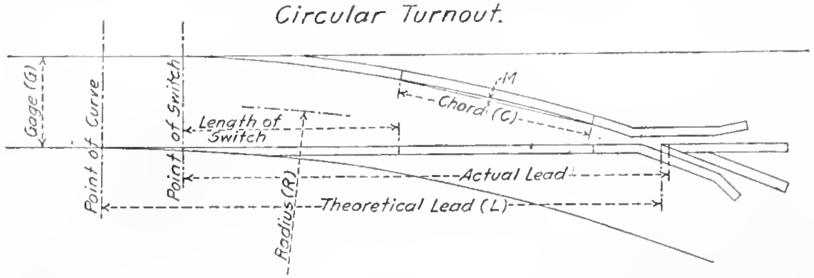
Table of Frog Numbers and Angles.

Number	Angle	Number	Angle	Number	Angle	Number	Angle	Number	Angle	Number	Angle
$1\frac{1}{2}$	36°52′	3	18°55′	5	11°25′	8	7°09′	12	4°46′	18	3°11′
$1\frac{3}{4}$	31°53′	$3\frac{1}{4}$	17°30′	$5\frac{1}{2}$	10°23′	$8\frac{1}{2}$	6°44′	13	4°24′	19	3°01′
2	28°04′	$3\frac{1}{2}$	16°16′	6	9°32′	9	6°22′	14	4°05′	20	2°52′
$2\frac{1}{4}$	25°03′	$3\frac{3}{4}$	15°11′	$6\frac{1}{2}$	8°48′	$9\frac{1}{2}$	6°02′	15	3°49′		
$2\frac{1}{2}$	22°37′	4	14°15′	7	8°10′	10	5°43′	16	3°35′		
$2\frac{3}{4}$	20°37′	$4\frac{1}{2}$	12°41′	$7\frac{1}{2}$	7°38′	11	5°12′	17	3°22′		

Contributed by Frank W. Holcomb

FROGS, SWITCHES AND CROSS-OVERS—II

Circular Turnout.



G = gage (inside width between rail-heads),
R = radius of curve,
L = theoretical lead of switch,
C = chord (see illustration above),
M = middle ordinate (see illustration),
N = number of frog (see Sheet I),
α = frog angle (see Sheet I),
δ = degree of curve.

$$L = 2G \times N = (R + \tfrac{1}{2}G)\sin\alpha$$

$$R = 2G \times N^2 = \frac{50}{\sin\frac{1}{2}\delta} = \frac{L^2}{2G}$$

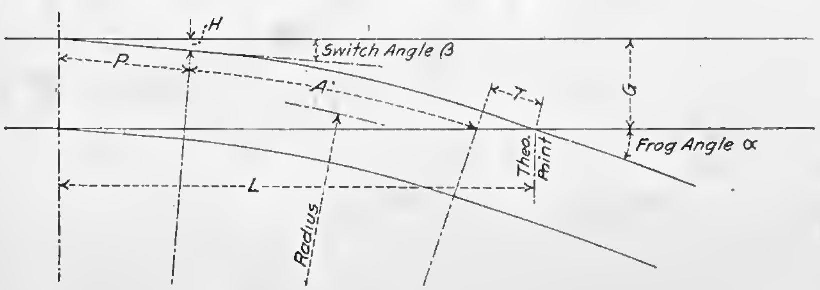
$$\cos\alpha = \frac{R - \frac{1}{2}G}{R + \frac{1}{2}G}\ ;\ \tan\frac{1}{2}\alpha = \frac{G}{L}$$

$$R = \frac{1}{2}\left(\frac{(\frac{1}{2}C)^2}{M} + M\right)$$

$$\sin\frac{1}{2}\delta = \frac{50}{R}$$

$$R = \frac{G}{\text{vers}\,\alpha} - \frac{1}{2}G$$

Turnout Using Straight Frog and Switch.



H = heel spread of switch,
T = distance from theoretical point to toe of frog,

P = length of switch,
β = switch angle.
Otherwise same notation as above.

$$R + \frac{1}{2}G = \frac{G - H - T\sin\alpha}{\cos\beta - \cos\alpha}$$

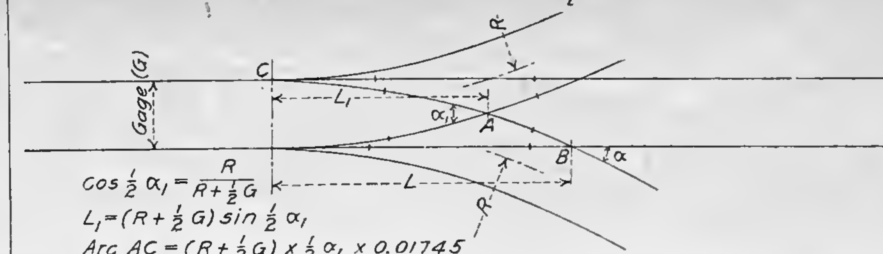
$$L = (R + \tfrac{1}{2}G)(\sin\alpha - \sin\beta) + (T \times \cos\alpha) + P$$

Length of arc $A = (\alpha - \beta)(R + \frac{1}{2}G) \times 0.01745$
(α and β are expressed in degrees)

Contributed by Frank W. Holcomb

FROGS, SWITCHES AND CROSS-OVERS—III

Three-Throw Turnout with Equal Radii.



$\cos \frac{1}{2}\alpha_1 = \frac{R}{R+\frac{1}{2}G}$

$L_1 = (R+\frac{1}{2}G)\sin\frac{1}{2}\alpha_1$

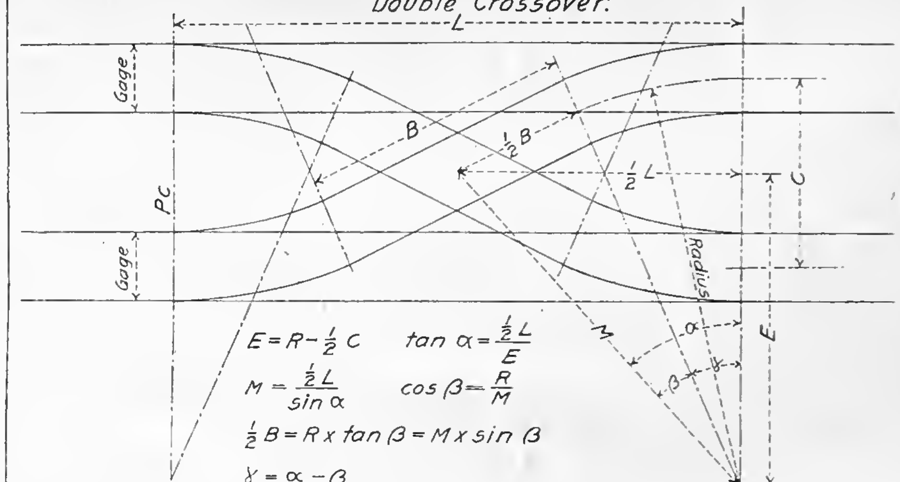
$\text{Arc } AC = (R+\frac{1}{2}G) \times \frac{1}{2}\alpha_1 \times 0.01745$

$\text{Arc } AB = (R+\frac{1}{2}G) \times (\alpha - \frac{1}{2}\alpha_1) \times 0.01745$

(α and α_1 are expressed in degrees)

Angle α and lead L are found by the formulas given on Sheet II.

Double Crossover.



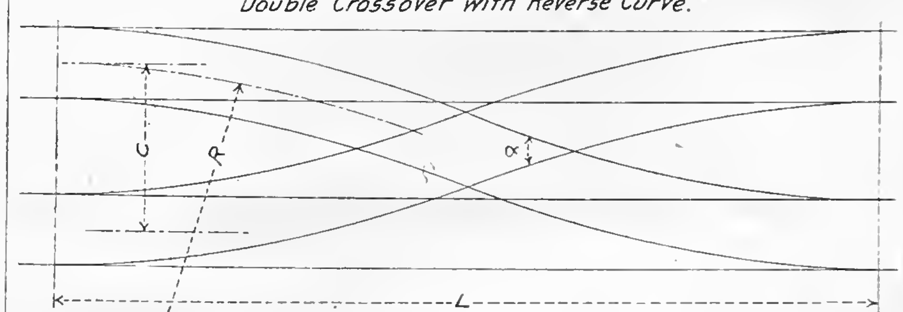
$E = R - \frac{1}{2}C \qquad \tan\alpha = \frac{\frac{1}{2}L}{E}$

$M = \frac{\frac{1}{2}L}{\sin\alpha} \qquad \cos\beta = \frac{R}{M}$

$\frac{1}{2}B = R \times \tan\beta = M \times \sin\beta$

$\gamma = \alpha - \beta$

Double Crossover with Reverse Curve.



$L = \sqrt{4RC - C^2} \qquad R = \frac{L^2 + C^2}{4C} \qquad \tan\frac{1}{2}\alpha = \frac{C}{L}$

FROGS, SWITCHES AND CROSS-OVERS—IV

Radius, Feet	Gage 2'6" Angle	Gage 2'6" Theo. Lead	Gage 3'0" Angle	Gage 3'0" Theo. Lead	Gage 3'4" Angle	Gage 3'4" Theo. Lead	Gage 3'6" Angle	Gage 3'6" Theo. Lead
10	38°57'	7'1"	42°21'	7'9"	44°25'	8'2"	45°24'	8'4"
12	35°46'	7'9"	38°57'	8'6"	40°53'	8'11"	41°48'	9'2"
14	33°16'	8'4"	36°15'	9'2"	38°05'	9'8"	38°57'	9'11"
16	31°14'	8'11"	34°03'	9'10"	35°58'	10'4"	36°36'	10'7"
18	29°32'	9'6"	32°12'	10'5"	33°51'	10'11"	34°38'	11'3"
20	28°04'	10'0"	30°38'	10'11"	32°12'	11'7"	32°57'	11'10"
25	25°13'	11'2"	27°32'	12'3"	29°00'	12'11"	29°38'	13'3"
30	23°04'	12'3"	25°13'	13'5"	26°32'	14'2"	27°09'	14'6"
35	21°24'	13'3"	23°24'	14'6"	24°37'	15'3"	25°13'	15'8"
40	20°03'	14'2"	21°55'	15'6"	23°04'	16'4"	23°38'	16'9"
50	17°58'	15'10"	19°39'	17'4"	20°42'	18'3"	21°12'	18'8"
60	16°26'	17'4"	17°58'	19'0"	18°56'	20'0"	19°23'	20'6"
70	15°13'	18'8"	16°39'	20'6"	17°33'	21'7"	17°58'	22'2"
80	14°15'	20'0"	15°36'	21'11"	16°26'	23'1"	16°50'	23'8"
90	13°27'	21'3"	14°42'	23'3"	15°30'	24'6"	15°53'	25'1"
100	12°46'	22'4"	13°58'	24'6"	14°43'	25'10"	15°04'	26'5"

Radius, Feet	Gage 3'8" Angle	Gage 3'8" Theo. Lead	Gage 4'8½" Radius, Feet	Gage 4'8½" Angle	Gage 4'8½" Theo. Lead	Gage 4'8½" Number	Angle	Theo. Lead	Radius	Degree of Curve
10	46°21'	8'7"	30	31°18'	16'10"	4	14°15'	37'8"	150.6'	38°46'
12	42°42'	9'5"	40	27°16'	19'5"	4½	12°41'	42'4"	190.6'	30°24'
14	39°47'	10'2"	50	24°29'	21'8"	5	11°25'	47'1"	235.4'	24°32'
16	37°24'	10'10"	60	22°24'	23'9"	5½	10°23'	51'9"	284.8'	20°13'
18	35°24'	11'6"	70	20°47'	25'8"	6	9°32'	56'6"	338.3'	16°58'
20	33°41'	12'1"	80	19°28'	27'5"	6½	8°48'	61'2"	397.8'	14°26'
25	30°18'	13'6"	90	18°22'	29'1"	7	8°10'	65'11"	461.3'	12°27'
30	27°46'	14'10"	100	17°27'	30'8"	7½	7°38'	70'7"	529.6'	10°50'
35	25°47'	16'0"	110	16°39'	32'2"	8	7°09'	75'4"	602.6'	9°31'
40	24°10'	17'1"	120	15°57'	33'7"	8½	6°44'	80'0"	680.3'	8°26'
50	21°41'	19'2"	130	15°20'	35'0"	9	6°22'	84'9"	762.6'	7°31'
60	19°50'	21'0"	140	14°39'	36'4"	9½	6°02'	89'5"	849.7'	6°45'
70	18°23'	22'8"	150	14°17'	37'7"	10	5°43'	94'2"	941.6'	6°05'
80	17°13'	24'3"	160	13°50'	38'10"	11	5°12'	103'7"	1139.3'	5°02'
90	16°15'	25'8"	170	13°25'	40'0"	12	4°46'	113'0"	1355.9'	4°14'
100	15°26'	27'1"	180	13°03'	41'2"					

MACHINERY

June, 1910

LIMITATIONS OF THE COMMON THEORY OF FLEXURE

THE DESIGN OF CURVED MACHINE MEMBERS UNDER ECCENTRIC LOAD

By JOHN S. MYERS

THE article in the December number of MACHINERY on "The Design of Curved Machine Members Under Eccentric Load," as well as the original paper and the discussion in the *Journal of the American Society of Mechanical Engineers*, opens up an interesting subject to designers and draftsmen. The article referred to shows a remarkably close agreement between the results of the tests cited and the stress at the elastic limit as calculated by the formula of Messrs. Andrews and Pearson; however, the readers of MACHINERY will undoubtedly welcome further discussion of this and kindred subjects.

Stress Proportional to Strain

All analysis for the supporting power of members subjected to flexure is based upon Hooke's law of the proportionality of stress to strain, and hence is applicable only within the elastic limit, which "limit" is not always sharply defined. In fact, there exists no method of analysis whereby ultimate or breaking loads may be calculated for such members, and if it be desired to proportion such parts by basing the working load upon the breaking load, which is the usual conception of the significance of the factor of safety, it can only be accomplished by empirical formulas based upon tests of the ultimate strength of parts similar in form, of the same material and similarly loaded.

It is unfortunate that so many designers do not seem to thoroughly understand the limitations of the common theory of flexure, and persist in applying it beyond its obviously intended range of application. It cannot be too strongly emphasized that the common theory of flexure must be limited to stresses within the elastic limit, and that factors of safety for such parts do not show true ratios between the load at which ultimate failure would occur and the working load, as would be the case in simple tension members. For flexure, we should consider a factor with regard to the elastic limit instead of with regard to the ultimate strength of the material.

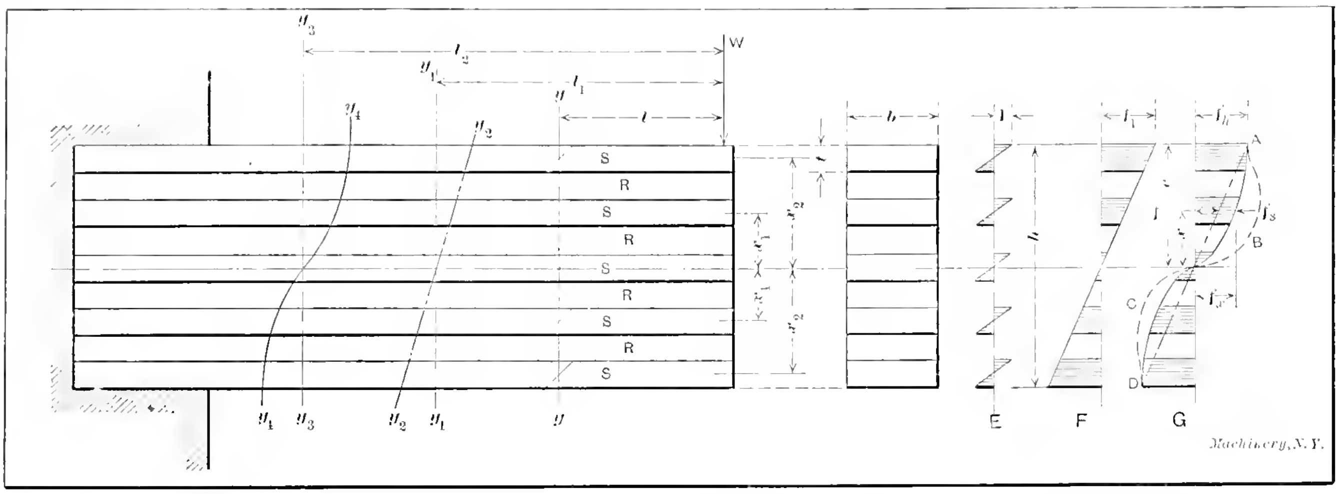


Fig. 1. Composite Beam for Illustrating the Influence of Horizontal Shear on the Distribution of Stresses over the Section

Effect of Horizontal Shear on the Distribution of Stresses

The common theory of flexure *assumes* that a section which is plane before flexure remains plane after flexure. While this may be practically true for beams with a span comparatively great in proportion to the depth, it does not necessarily hold true for short beams heavily loaded. For this reason it is not uncommon to find in bridge specifications an allowable fiber stress in pins about 50 per cent higher than that in tension members. One of the prime reasons for this will be found in the deformation due to shear parallel to the neutral axis. To give an elementary explanation of what is meant, pick up this magazine by grasping it at the back in one hand and attempt to hold it in a horizontal plane. It is found to be quite flexible—will not remain flat when so supported, be

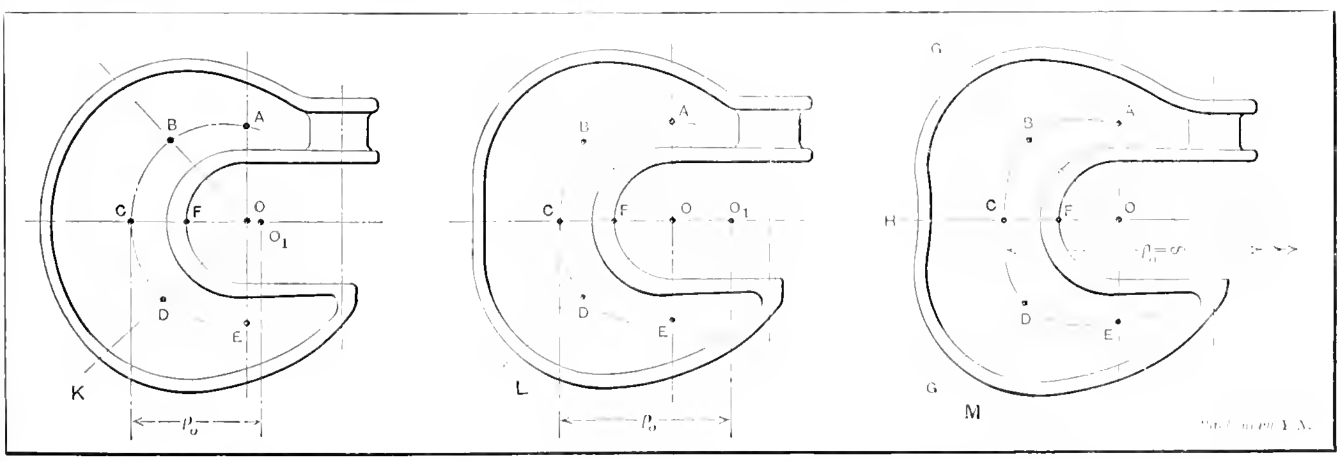


Fig. 2. Illustrations showing that the Curvature of the Gravity Axis does not bear a Direct Relation to the Flange Curvature

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cause the leaves are free to slide laterally upon each other; but if mucilage be applied to each leaf, and the whole thus united together, it would become quite as strong as a beam, and would be able to sustain considerable load.

A bundle of fibers such as a rope or a layer of leaves in an unbound book does not constitute a beam, because in neither case does there exist capacity for resisting shear parallel to the neutral plane. In any beam sustaining a vertical shear there exists also a shearing stress on all planes parallel to the neutral plane, this horizontal shear being zero at the extreme fibers and a maximum at the neutral axis; without such a horizontal shear there can exist no difference of tensile or compressive stress in successive layers of the material. (For a discussion of the intensity of this shear, based upon the common theory of flexure, see "Applied Mechanics," by Gaetano Lanza, pages 319 to 321.)

Any stress, be it tension, compression or shear, always produces a corresponding strain or deformation; consequently this horizontal shear is accompanied by a sliding of the "fibers" upon each other, and if this action were pronounced, it would completely demoralize the analysis for the extreme fiber stress as based upon the assumptions of the common theory of flexure.

To illustrate the foregoing, let Fig. 1 represent a cantilever of composite structure in which the layers S are of steel and the layers R of India rubber. Assume that the layers of rubber are not attached in any way to the layers of steel, and neglect any friction which may exist between them. The distribution of stress over the five layers of steel at any cross-section is then as indicated at E, and with five layers as shown, the extreme fiber stress in any lever at section yy, for these conditions, is $f = \frac{6Wl}{5bt^2}$, and, if N = number of layers of steel, $f = \frac{6Wl}{Nbt^2}$, or the supporting power is $W = \frac{fNbt^2}{6l}$. Now if h = height of section, and the thickness of the layers R be negligible, then $t = \frac{h}{N}$, and $W = \frac{fbh^2}{6lN}$, or with a given height of section the supporting power varies inversely with the number of layers and if the number of layers were infinite, corresponding to an infinitesimal thickness, the supporting power would be zero. The precise meaning of this is that a bundle of fibers does not constitute a beam.

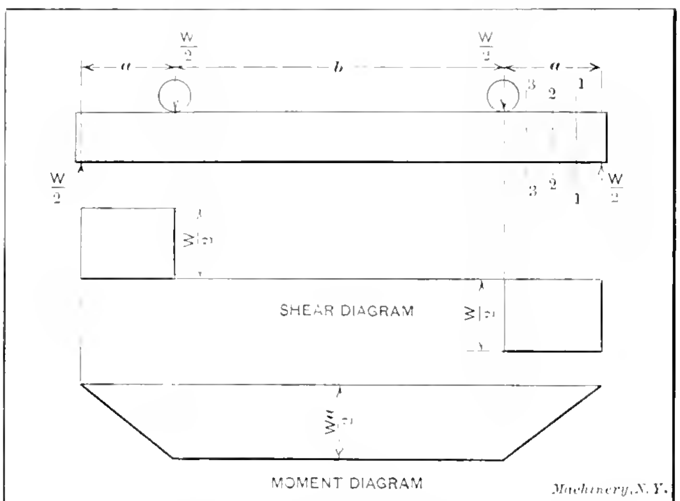

Fig. 3. Beam with Portion of the Span subjected to neither Vertical nor Horizontal Shear. The Stress in this Section, however, is built up at Sections where there is such Shear

Now assume that the layers of rubber R are firmly cemented to the layers of steel S, and that the rubber is absolutely rigid as regards shear in the horizontal plane but so elastic in tension or compression, when compared to the steel, as to be entirely negligible in this respect. Then any section, such as y_1y_1, which was plane before flexure, would remain plane after flexure, shifting to position y_2y_2, under action of the load W. This is one of the assumptions upon which the common theory of flexure is based, and for the case of the composite beam under consideration the distribution of the stress over the section would be as indicated at F. The assumption that the layers of rubber R are absolutely inflexible as regards horizontal shear is, however, obviously an assumption which cannot exist in fact, for in an actual beam of this nature the rubber would distort under this shearing action, and a section such as y_3y_3, which was plane before flexure, would not be plane after flexure, but would assume some position such as y_4y_4, and the stress in successive layers of the steel would not vary directly as the distance from the neutral plane. The distribution of stress over the section would then be somewhat as indicated at G. If f_h = the stress at the extreme fiber, and f_x = the stress on any fiber located at a distance x from the neutral plane, it is then obvious that the stress f_x is made up of two parts: first a stress f_t, which varies directly as the distance from the neutral plane; and second, a stress f_s, which is such as to cause a sliding of one layer upon another sufficient to transmit the horizontal shear. Then $f_x = f_t + f_s$ in which $f_t = \frac{f_h x}{e}$ while f_s is a function of several quantities, the precise mathematical relation of which has not as yet, so far as is known to the writer, been deduced. It can be stated, however, that the greater the vertical shear as compared to the bending moment, the greater the depth of section compared to its breadth, the greater the coefficient of elasticity for tension and compression as compared to the coefficient of elasticity for shear, and the smaller the value of x, the greater will f_s be in comparison to f_t. It is even within the range of possibility that for exceptional cases the maximum fiber stress may not occur at the extreme fibers but that the distribution of stress over the cross-section of the member may be as indicated by the dotted line $ABCD$, shown at G, Fig. 1.

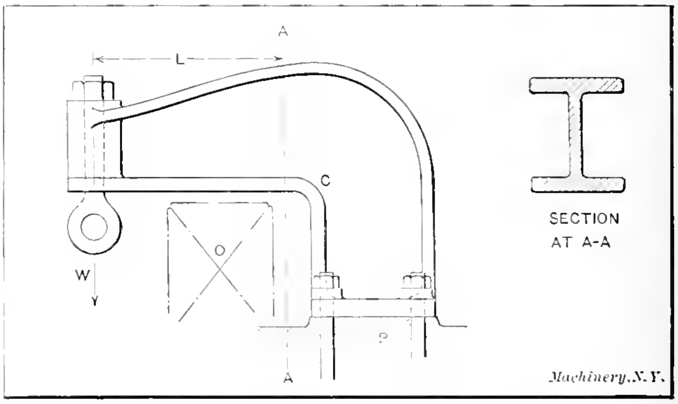

Fig. 4 The Mechanical Designer's Method of Constructing a Bracket

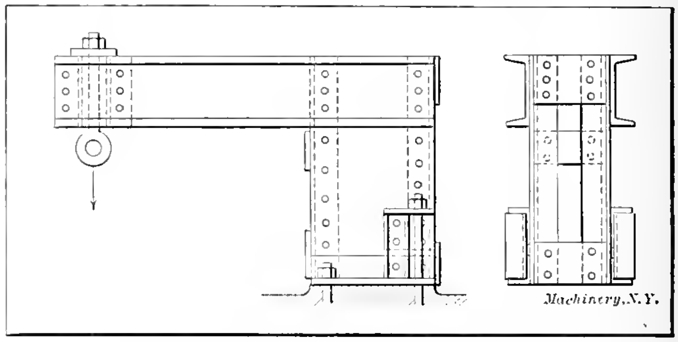

Fig. 5. The Structural Designer's Method of Constructing a Bracket. This Bracket is more Correct in Principle than that in Fig. 4

In any ordinary beam composed of homogeneous material, although it is not composite in structure as the example illustrated in Fig. 1, there are analogous conditions which the common theory of flexure entirely ignores because it is based upon the assumption that any section being plane before flexure remains plane after flexure. This assumption could only be justified by assuming the coefficient of elasticity for shear to be infinite when compared to the coefficient of elasticity for tension and compression, or else by assuming the length

of the beam to be infinite in relation to the height of the section. But as both of these assumptions are entirely at variance with facts, we must concede that the horizontal shear may have an important influence on the distribution of stresses over the cross-section; hence it is to be expected that the resisting moment of a short, heavily-loaded beam for a given maximum fiber stress would be considerably in excess of that given by the common theory of flexure, even when the stresses were well within the elastic limit. This accounts for the high allowable fiber stress in pins, as given in bridge specifications, as well as the apparent excess in strength of other short members subjected to flexure.

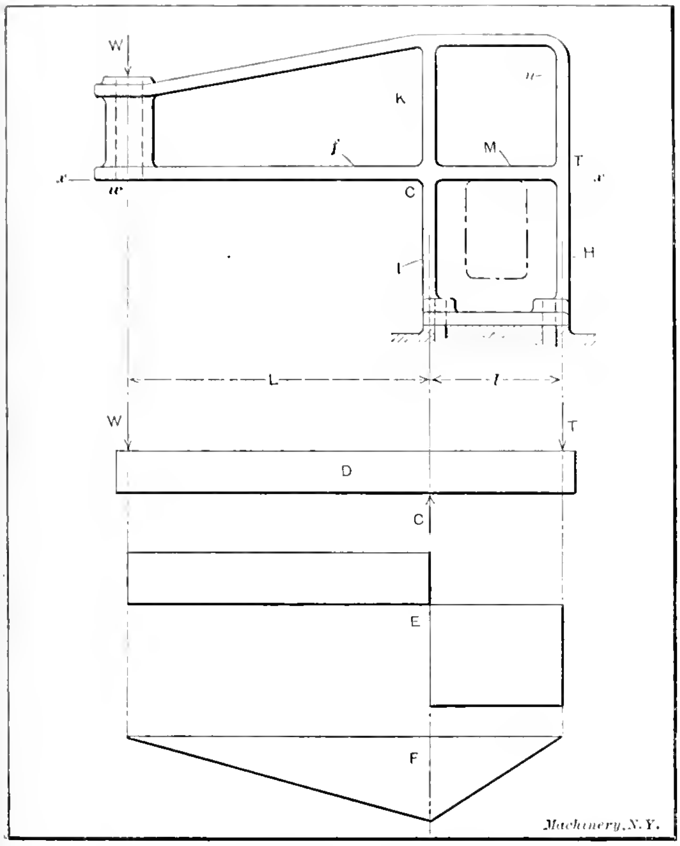

Fig. 6 A Cast Bracket designed along the Lines of a Structural Bracket

Stress Dependent Upon Conditions Outside the Plane of the Actual Section Under Consideration

Certain beams are, by reason of the nature of their loading, subjected to a constant bending moment over a considerable portion of the span upon which there is no vertical shear, and consequently no direct horizontal shear. One might be led to believe that for this portion of the member deformation due to horizontal shear could not possibly enter into the problem. Fig. 3 represents such a beam, and, while there is neither vertical nor horizontal shear between the two loads there is a heavy shear between each load and its adjoining support, as illustrated in the shear diagram. Now the stresses at section 1-1 are those incident to transmitting the vertical shear from the support to section 1-1. The stresses at section 2-2 are equal to those at 1-1 plus the additional stress induced by transmitting the shear from 1-1 to 2-2, etc. From this it is seen that anything affecting the distribution of the stress over the cross-section at 1-1 would also affect the distribution at section 2-2, 3-3, etc. The significance of the foregoing is that no stress due to flexure springs suddenly into being but is the result of a process of growth, and even though there be no vertical shear on a section, the stress in that section has been built up by reason of the transmission of such a shear in adjoining sections.

Crane Hooks

A crane hook is an exceedingly short beam very heavily loaded and, while there is no shear on the principal section, there is a heavy shear on the preceding sections which should be expected to affect the distribution of the stress over the principal section, so that, instead of this section remaining plane under load, it would be distorted. This, taken in conjunction with the fact that it is also a curved beam, is sufficient to completely demoralize the analysis if based upon the assumptions of the common theory of flexure. The analysis of Messrs. Andrews and Pearson takes cognizance of the curvature of the member through the theory of lateral contraction, yet assumes that the section remains plane after flexure, and therein the writer believes it to be at fault, notwithstanding the close accord between the calculated supporting power for a stress equal to the elastic limit and the supporting power at which the total deflection of the hook ceased to be proportional to the load as determined by tests.

The tabulated results of these tests given in the December, 1909, issue of MACHINERY, are here reproduced with the addition of factors of safety based upon the elastic limit. It will be noticed that five of the hooks were rated at capacities higher than the actual elastic limit as determined by the tests, while the other five were given rated capacities perilously near to this limit. It may also be observed that the sustaining power corresponding to an extreme fiber stress equal to the elastic limit, when that sustaining power is calculated by the usual Unwin formula, varies from 1.3 to 5.23 of the rated capacities, the average being 2.79. If we neglect the two strongest ones, the average of the remaining eight have a *calculated* sustaining capacity at the elastic limit of 2.23 times the rated capacity. This seems to indicate that the manufacturers of these hooks have been guided largely by experience rather than by an implicit but mistaken faith in the Unwin formula, and that they were proportioning and rating their hooks upon a basis of ultimate strength as determined by tests. The attitude of some designers is that they wish to design their hooks with a factor of safety based upon *ultimate* sustaining capacity, but they know the Unwin formula will not give this ultimate sustaining capacity, yet consider it to be the only well-known formula to apply. They therefore do the best they can with the available data by allowing a high working stress. If they were to concede that the analysis of Messrs. Andrews and Pearson was a more correct one than the usual Unwin formula, but yet desired to design with a view to safety against actual rupture only, instead of safety against the possibility of giving the material at the extreme fibers a slight permanent set, they would be little better off, if any. However, neither theory was intended to apply beyond the elastic limit and it is quite illogical to attempt to apply them in conjunction with factors of safety, so that if manufacturers wish to design crane hooks based upon ultimate sustaining loads, the only proper method of doing so is by using empirical formulas derived from actual breaking tests of a large variety of shapes and sizes.

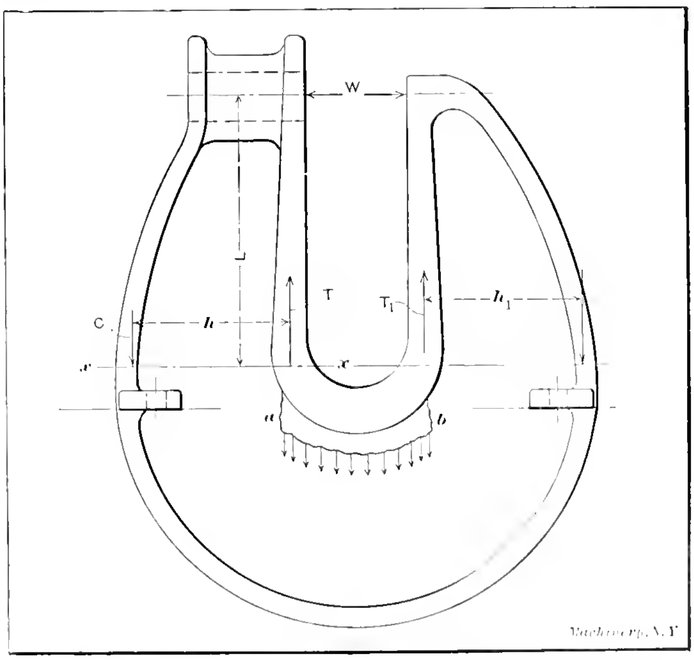

Fig. 7. A Riveter Frame Improperly Constructed Forces T and T_1 are concentrated upon the Web between the Points a and b

Curved Members of Machine Frames

The frames of all such machines as punches, presses, shears, riveters, etc., which are under heavy load, are invariably box or I-beam sections, in which the major portion of the load is carried by the flanges. This makes the problem considerably different from that presented by a member of solid section, such as a crane hook and, even if we grant that the analysis of Messrs. Andrews and Pearson is correct for the former, it by no means follows that it is correct for the latter; for, while the radius of curvature of the gravity axis would bear a fairly well-defined relation to the radius of curvature of the most strained fibers in the case of such members as the crane hooks experimented upon, it bears no such relation in the case of machine frames in general. It follows that while the radius of curvature of the gravity axis may be a logical quantity to insert in a formula for crane hooks, it is not the curvature of the neutral axis we are interested in when it comes to general work, but the curvature of the flanges where most of the stress exists.

To illustrate the foregoing, Fig. 2 represents at K a frame with semi-circular throat in which curve $ABCDE$ is the gravity axis of successive sections. Point O is the center of the throat radius while point O_1 is the center of a circular arc which approximately coincides with the gravity axis curve for points near to C. Then $O_1C = \rho_0 =$ radius of neutral axis as it would be determined for insertion in the Andrews and Pearson formula, and this radius being comparatively small would give us a high fiber stress.

In Fig. 2 at L the throat radius OF remains the same as before but a portion of the rear flange is now straight, in consequence of which ρ_0 has been materially increased, thereby reducing the extreme fiber stress. If we now go a step farther and actually make the rear rib concave, of such a curvature as to make the gravity axis at point C a straight line, as shown at M, we have $\rho_0 =$ infinity, and for this case the new formula reduces to the same form as the usual Unwin formula.* This would give an extreme fiber stress for the case at M of possibly one-third that at K if calculated by the new formula. Now in all three cases the throat radius remains the same and there would undoubtedly be as rapid a transition of stresses for the case at M as for that at K or L, yet the formula would give quite different results. This is because the quantity ρ_0 in the formula has absolutely no mathematical relation to the flange curvature as it may exist in general work. Stated concisely ρ_0 is not a function of OF. This, in the opinion of the writer, is sufficient reason for the rejection of the formula in its present form, at least for general work.

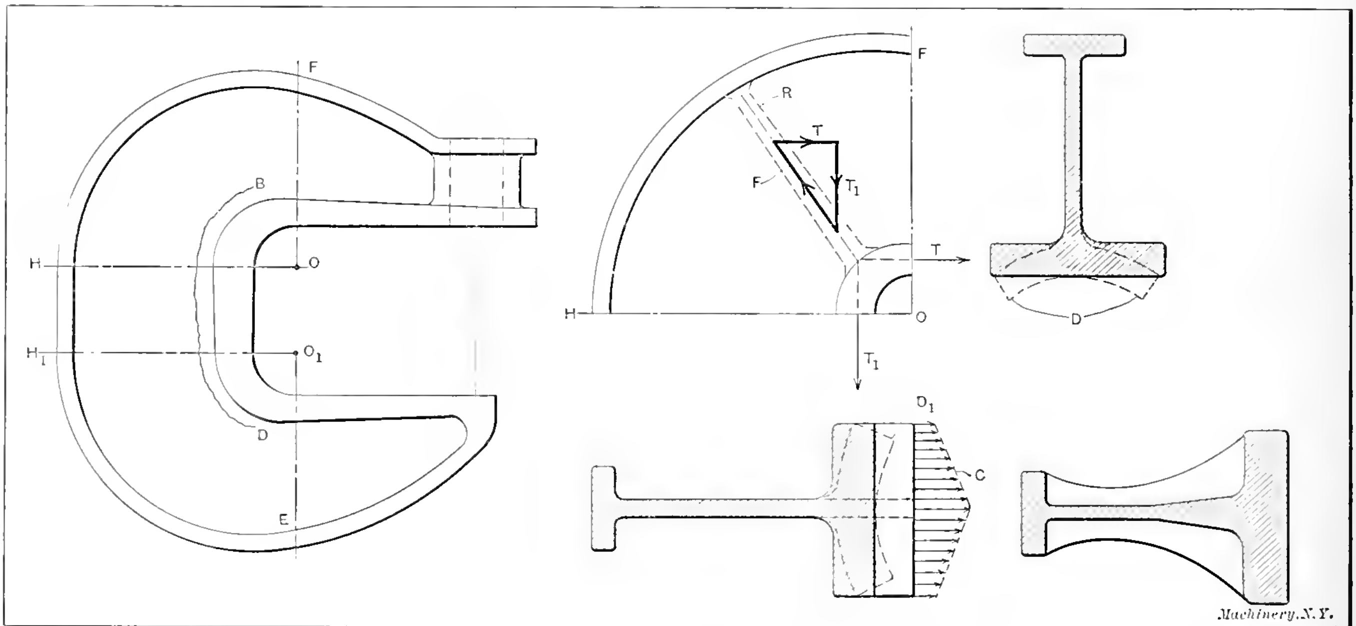

Fig. 8. A Small Portable Riveter Frame used for the Purpose of Illustrating Proper Design as indicated in Fig. 9

Fig. 9. Analysis of Stresses in Riveter Frame and a Proposed Rib for Partially Eliminating the Concentration of the Stresses in the Web

ANALYSIS OF HOOKS TESTED

Material of Hook	W_R Rated Capacity in Pounds	W_T Load at which Permanent Set Occurred as Determined by Test	W_S Load at which Permanent Set would Occur as Calculated by Standard Formula	W_N Load at which Permanent Set would Occur as Calculated by New Formula	$\frac{W_T}{W_R}$ Factor of Safety against Permanent Set by Test	$\frac{W_S}{W_R}$ Factor of Safety against Permanent Set by Standard Formula	$\frac{W_N}{W_R}$ Factor of Safety against Permanent Set by New Formula
Cast Steel	60000	56000	115000	55080	0.93	1.92	0.92
	40000	30000	70000	29925	0.75	1.75	0.75
	30000	48000	145000	50570	1.60	4.83	1.69
	20000	18000	43000	16500	0.90	2.15	0.83
	10000	18000	52300	18950	1.80	5.23	1.90
	6000	8500	14900	8600	1.42	2.48	1.43
	4000	4700	14900	4400	1.17	3.72	1.10
Average of Cast Steel					1.22	3.15	1.23
Wrought Iron	30000	16000	73000	15000	0.53	2.43	0.50
	20000	16000	26000	15000	0.80	1.30	0.75
	10000	14000	20800	14100	1.40	2.08	1.41
Average of Wrought Iron					0.91	2.91	0.89
Total Average					1.13	2.79	1.13

* This is, of course, an abnormal construction, but while improbable is not at all impossible; in fact the compression flange is often considerably less in area at point H than at points G, which has an effect upon the curvature of the gravity axis similar to a reverse curve in the rear flange, although not so readily seen.

Structural Engineering Versus Mechanical Engineering Methods

Generally speaking the use of curved members is improper construction when it is possible to avoid them, and structural engineers never put in curved tension or compression members, excepting in portals, or for ornamental effect, because they consider that force travels in straight lines or else produces bending stresses. On the other hand, designers of machinery seem to delight in curved ribs, bent levers and the like. In fact the average mechanical draftsman makes layouts as though he held the opinion that force travels along

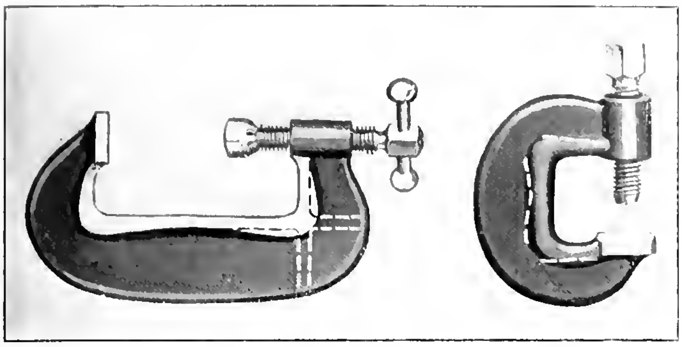

Fig. 10 Fig. 11
C-clamps as commonly designed and Indication of Suggested Improvements

a curved rib in a manner somewhat similar to water flowing in a pipe, and that it will, therefore, follow any course in which he may choose to distribute the material. The average structural draftsman may be absolutely helpless when confronted by some simple mechanical details, such as a shaft with its bearings or a set of bevel gears, but he would not be guilty of some of the improperly disposed curved members found in ordinary mechanical details.

To illustrate the foregoing, if a mechanical draftsman had a load W to be supported and a convenient place to put a pad

If the mechanical draftsman were to study the principles of structural engineering, he would make this bracket more like that shown in Fig. 6. With this construction the portion of the bracket above line xx may be considered a simple beam as shown at D, the shear diagram for which is shown at E and the moment diagram at F. With this construction I is a compression member sustaining a load $C = \frac{W(L+l)}{l}$ while H is a tension member the load on which is $T = \frac{WL}{l}$. The members K and n are stiffeners and serve to transmit the shear at C and T to the web. Note that flange f is not interrupted at the corner, as in Fig. 4, but is continuous, as it should be. The load on this flange is zero at w and T; it gradually increases to its maximum at C and it would be obviously improper to suddenly discontinue the flange right at its point of maximum load, which would be the case if member M were omitted, as was the case in Fig. 4.

A Riveter Frame

There is considerable analogy between the bracket of Fig. 6 and a punch or riveter frame, and the application of a little common sense should make it apparent that if we have a flange in tension or compression we must not suddenly give it a 90-degree or 180-degree bend and expect the stress in that flange to "go shooting around the corner like a cable car," but we must *provide means for the distribution of that stress* and carry it where it may meet an equal and opposite load to balance it; for no stress induced by flexure springs suddenly into existence or dies out suddenly; it is gradually built up and gradually dies out again.

The conception that no stress due to flexure springs suddenly into being is a direct result of the fact that all stresses due to bending are a function of length, *i. e.*, are the result of transferring the vertical shear from one point on the member to some other point.

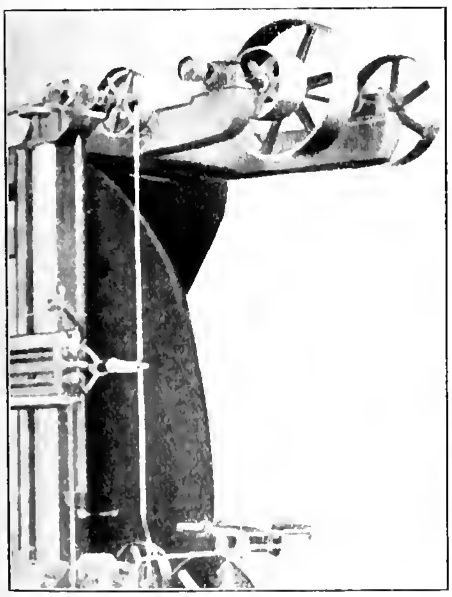

Fig. 12

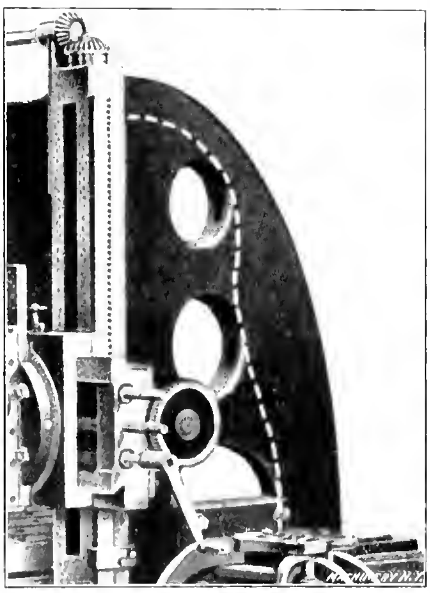

Fig. 13

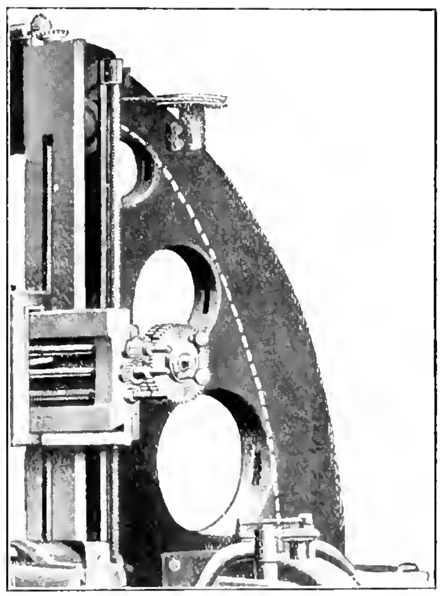

Fig. 14

Examples of Different Designs of Planer Housings

P, but an obstruction O between the load and pad, he would probably construct a bracket similar to that shown in Fig. 4. For the stress on section AA he would apply the usual formula $S = \frac{WLc}{I}$ but would probably not give the second thought as to just how the stress "got around the corner" at C. Give the same conditions to a structural draftsman and he would produce something like that shown in Fig. 5. Here the corner is eliminated, as far as transition of stresses around it is concerned, the flanges are continuous, and, as shown, the rear bolts are not attached to a little lug ¼ inch thick, as one frequently sees, but the nuts rest upon a shelf angle supported by stiffener angles riveted to the vertical member with sufficient rivets to transfer in shear the calculated load on these bolts.

As an example of improper construction, take the bull riveter frame shown in Fig. 7. Here it is quite obvious that if the web were to part along the line ab there would be nothing to balance the loads T and T_1 in the tension flanges, and failure to balance these forces would mean failure for the entire frame. The total flange loads are, approximately, $T \simeq \frac{WL}{h}$ and $T_1 \simeq \frac{WL}{h_1}$, and if w = thickness of web, the average unit tension distributed over the web along line ab is $t \simeq \frac{2\,WL}{hw\,(ab)}$, or, if h_1 does not equal h,

$$t \simeq \frac{T + T_1}{w\,(ab)} = \frac{WL}{w\,(ab)}\left(\frac{1}{h} + \frac{1}{h_1}\right)$$

From this it would appear that the sectional area of the web along line *ab* should be approximately equal to the combined area of the *two* tension flanges and, were it not for the fact that it is necessary to thicken up the web at this point in order to avoid shrinkage cracks, there would probably be more frequent failures due to this improper construction.

In the case of a frame having a wider gap, such as shown in Fig. 8, the conditions are more favorable in this respect, for failure from this source would require that the web rupture from some point near B to some other point near D, which brings into action more sectional area of the web in proportion to the flange area than in the case shown in Fig. 7. This is, however, none the less an improper construction, because the sharp bend of the tension flanges between sections OF and OH, and between sections O_1H_1 and O_1E destroys the continuity of these flanges for the direct transmission of stress.

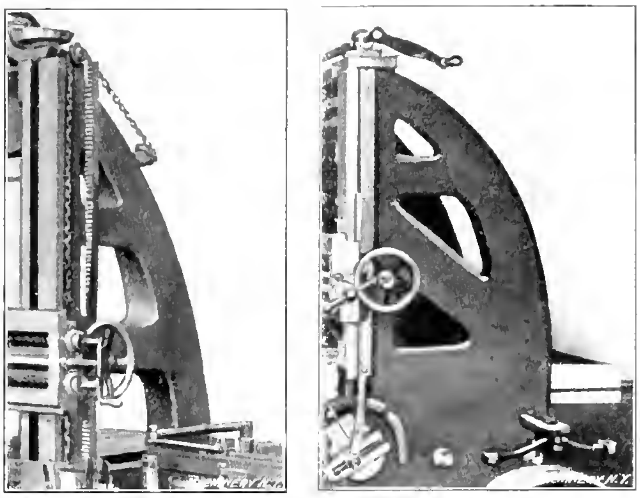

Fig. 15 Fig. 16
Additional Examples of Designs of Planer Housings

To illustrate the foregoing, Fig. 9 shows that portion of the frame of Fig. 8 which lies between lines OF and OH. Now, let T and T_1 represent the total tensions in the flanges on sections OF and OH, respectively. By combining T and T_1 graphically, it is seen that a resultant force F must, in some manner, be supplied to establish equilibrium. The most direct way of supplying such a force is by the addition of a rib as indicated by the dotted lines at R, which will distribute part of F into the web, and deliver part of the force at the compression flange where there is a smaller opposing resultant force. In the absence of any such rib the necessary resistance must be supplied by the web, partly through a local bending and distortion of the flanges as indicated in an exaggerated manner by the dotted lines at D and D_1, and partly by a concentration of stresses towards the central portion of the flanges as indicated at C, this concentration being a direct result of the deformation at D_1.

In designing a rib R, if it were intended to carry the entire force F, it would be necessary to make it about 1$\frac{3}{8}$ times the average thickness of the flanges, but since the web can readily take half or more than half of the load, it would seem that a rib of $\frac{5}{8}$ or $\frac{1}{2}$ of the flange thickness, narrowed down at the center as shown in the lower right-hand corner of Fig. 9, would be entirely sufficient if the web were judicially thickened and liberal fillets used; however, it could scarcely be considered as correct in principle as the construction given for analogous conditions in the bracket of Fig. 6.

Steel C-Clamps

Another method of taking care of the local stresses induced at a bend in a flange is to thicken up the metal at the corner. This method is well illustrated by Fig. 10, which illustrates a clamp regularly on the market. Instead of thickening up the flange at the corners, the surplus metal so used could be put into two ribs forming a continuation of the flanges, as indicated by the dotted lines at A, and thus, instead of trying to transfer the stress around the corner, permit it to gradually "die out" in a natural manner. This would be the same in principle as the construction of the bracket shown in Fig. 6.

Fig. 11 shows a shorter clamp of standard manufacture. Here the weakest place on the clamp is obviously the corner, so that it would be possible to take away some material, as indicated by the dotted lines, without weakening the clamp. But the saving so effected would, in this case, be but a small percentage of the total weight, and such a form would detract from the appearance of the clamp; and anything which detracts from the appearance of a tool hurts its sale. For, notwithstanding the fact that when a part *is* right it *looks* right it is sometimes difficult to educate the eyes of those not conversant with analytical mechanics.

Planer and Boring Mill Housings

Figs. 12 to 16, inclusive, illustrate five designs of planer housings. These are of the same general design as used on large vertical boring mills and illustrate a misconception of the principles of mechanics. In Fig. 13 the designer evidently considered the housing as a cantilever with the load applied at the end, and aimed at a uniform extreme fiber stress, hence the parabolic form as indicated by the fullness of the curve at the top. Just what mental processes led him to place the holes through the housing in the irregular manner brought into prominence by the dotted line is, however, a mystery. The designer of the planer in Fig. 12 evidently realized that material is useful at the neutral plane, and the writer agrees with him in that respect.

In Fig. 14 the rear contour is noticeably flat at the top, as compared with Fig. 13, which indicates that the designer did not follow the parabolic form supposed to give uniform strength in such cases. The disposition of the holes shows that he aimed at a gradual increase in the sectional area of the rear flange, which, in this respect, is an improvement over that in Fig. 13.

Just what the actual distribution of stresses over the various sections of a member so formed might be, constitutes a very complicated problem which, at best, would be attended with considerable uncertainty. It can, however, be stated in a general way, that they are both designed upon the erroneous conception that the material at the neutral plane of a beam is not under strain—hence is of no consequence, and should be removed if possible, on the score of economy. This is only another phase of the proposition that capacity for resisting shear on the neutral plane, and all planes parallel to it, is usually disregarded, notwithstanding the fact that it is a prime requisite in any member subjected to flexure.

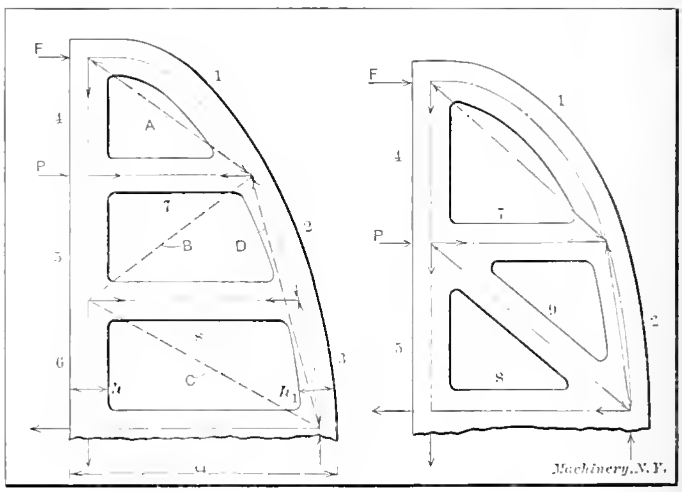

Fig. 17 Fig. 18
Analysis of Stresses in Planer Housings

Fig. 17 is an attempt at illustrating the internal forces in the housings of Figs. 13 to 15. When loaded at the top, as at F, members, 1, 2 and 3 are in compression and, in consequence of being curved, are eccentrically loaded struts. Members 7 and 8 are in tension while members 2, 3, 4, 5, and 6 are subjected to local bending in addition to direct stress. When the load is applied at P, members 2, 3 and 5, 6 are subjected to heavy bending action, and instead of having a beam of depth H it is more a case of two shallow beams of depth h and h_1. No such construction would be tolerated in structural engineering.

In Fig. 16 is shown a more modern type of planer housing in which the designer has pulled away from the stereotyped form and has approximated a true truss. He has not, however, had the temerity to eliminate the curved contour or make the center lines of his members intersect, and, while it is a step in the right direction, it does not go far enough to accomplish the ideal distribution of material.

Fig. 18 shows the principles underlying the construction of this housing. Members 1 and 2 are still eccentrically loaded struts, especially member 1, but members 4 and 5 would be plain tension members with the load at either *F* or *P*, if actually constructed as here shown. But in Fig. 16 it is seen that the center lines of members 7 and 9 do not intersect on the center line of members 4 and 5, and thus, as there constructed, members 4 and 5 are still subjected to a local bending action which might be avoided. For the application of the load at *P*, which is the usual run of work on a planer, this housing is almost ideal in its construction and should be very rigid.

The housing of Fig. 17 could be made a true truss by the straightening out of member 1, and the placing of members 2 and 3 in a straight line coinciding with *D* and the adding of members whose center lines are *B* and *C*. Member 8 could then be omitted.

Conclusion

To sum up the matter briefly:

1. No formula for flexure holds good beyond the elastic limit; hence ultimate supporting power cannot be calculated excepting by empirical formulas based upon tests.

2. No beam, unless a true truss, can sustain vertical shear without also possessing capacity for resisting horizontal shear; hence, do not cut away all the material from the neutral plane.

3. Horizontal shear must, of necessity, produce a corresponding sliding upon each other of the "fibers"; hence a section which is plane before flexure does not necessarily remain plain after flexure, and stress does not vary exactly as the distance from the neutral plane.

4. Short, heavily-loaded members should be expected to have a greater supporting power than that calculated by the common theory of flexure, unless crippling of the web be the determining feature.

5. No stress, due to bending, springs suddenly into being, but is built up from zero to a maximum by the transference of the vertical shear from section to section; hence anything which affects the distribution of stress on one section affects the distribution on succeeding sections.

6. Force travels in straight lines or else produces bending or other local stresses; hence curved members are to be avoided and it is entirely wrong construction to suddenly curve a flange without providing for the proper transference of the load in that flange.

7. A formula to take into account the stresses induced by curvature of flanges in compound sections should take into account the curvature of these flanges rather than the curvature of the gravity axis of the entire section.

8. Designers of machinery would do well to study the principles of structural engineering, use more straight members, fewer curved ones, and more nearly approximate true truss forms, thus securing more rigid members with less material.

* * *

An interesting method of making composite metal car wheels is in successful operation. The wheel produced has a manganese steel tread and a cast-iron web and hub. The practical result of the process is to produce an integral car wheel having a tread approaching in durability and strength a shrunk steel tire and costing much less. The principle of the process is substantially as follows: The mold is mounted on a vertical spindle and is rotated at a high speed when the molten metal is poured. The manganese steel is poured first and flows to the outside of the mold forming the flange and tread. Then the cast iron is poured to form the web and hub. The metals unite perfectly, making a sound casting, which, though variable in composition, is integral in physical structure. The wheels when struck with a hammer ring like a bell.

INEXACT MACHINERY TERMS

By T. S. BENTLEY

No one who has had much to do with machine tool specifications can have failed to remark the great lack of uniformity commonly met with in the descriptive terms employed. In many cases this merely shows curious variations without causing inconvenience or ambiguity, but in others it renders the meaning obscure and occasionally quite misleading. The desirability of adopting recognized and uniform standards in matters calling for the cooperation of many separate individuals, has been generally felt and has led to the formulation of definite rules in many instances for the guidance of those concerned. Such standards have repeatedly proved their value and are daily growing in favor and in use.

T. S. Bentley†

There is room for a similar understanding in the naming and identification of machine tools and their various component parts. This would make for clarity in description, save much unnecessary correspondence, obviate a great amount of uncertainty and prevent many mistakes. In short, a number of definitions of terms relating to mechanical matters are urgently required.

A few cases in point will serve to illustrate what I mean and to suggest numberless other instances of things which call for definite settlement on some uniform basis. The first example which presents itself relates to that most common of all machine tools—the lathe—whose description shows striking differences of usage between engineers in England, America and the continent of Europe. English manufacturers invariably designate their lathes by "centers" (that is, the height of the center points above the flat topped bed which is regarded as standard form) and "length of bed." This description fails to give any really vital information either as to the capacity of the machine or even the amount of space which it requires. The nominal "centers" multiplied by two would indicate the maximum diameter that can be turned were it not for the fact that the bed is commonly made with a gap whose depth must be taken into account. The length that can be turned is less than the "length of bed" by a considerable but unspecified amount, while the over-all length exceeds it to an equally indefinite extent.

The American practice classifies a lathe by the "swing" and the "length of bed." The latter, as we have just shown, is useless for the purpose of conveying any precise information either as to capacity or extent; and the former is in reality almost equally indefinite. The swing is supposed to be the lathe's maximum capacity in diameter, but in practice there is often a considerable discrepancy between the nominal and the actual swing—so much so, that some lathes styled 16-inch will, in reality, accommodate work larger than can be turned in others that are designated 18-inch.

Continental practice usually gives "height of points"—corresponding with the English "centers"—and "distance between points," which latter does give a definite piece of useful information, *viz.*, the maximum length that can be turned.

As lathes are mostly bought primarily to do work of certain known dimensions, the best description would seem to be that which clearly indicates the actual swing and maximum distance between the centers. This information is required in order to judge whether the lathe under consideration is of sufficient capacity for the work which has to be done. If this

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is not directly stated, it must be arrived at by some form of computation or estimate—and the direct statement is certainly preferable from every point of view.

If we turn to planing machines, we shall find a similar want of uniformity in terms relating to them. Customers will mail a manufacturer inquiries for "a 4-foot planer," and leave him to guess whether width or length is intended. In either case the other dimensions should have been stated also, to make the description complete; and it would be no more trouble to ask for a 22-inch by 22-inch by 4-foot or a 48-inch by 48-inch by 10-foot planer, as the case might be, and leave nothing to chance. In such descriptions, the figures themselves usually indicate the order in which the dimensions are given, but it would be well to have a clear and general rule as to the order which shall be recognized as correct and assumed if not definitely stated. This would preferably be: First, width; second, height; third, length—which is already adopted by many makers of repute.

An understanding of this kind is now generally current with regard to the dimensions of articles such as emery wheels, pulleys, and milling cutters of ordinary form; and much unnecessary writing is saved thereby. The order adopted is: First, diameter; second, face; third, bore.

How essential it is that any such practice should be based upon a generally acknowledged rule, is exemplified in the matter of dates when expressed in the common and convenient form of say 9/1/09. To an American, this is merely a concise way of saying September 1, 1909, but an Englishman would read it as ninth January, 1909, unless well aware of the differing practice on the two sides of the Atlantic. Of course there can be no mistake about dates later than the twelfth of the month, but there is ample scope for misunderstanding among the dates which bear no internal evidence of their sense. Probably each method would be upheld by those accustomed to it, and neither party would desire to give way, but a uniform standard is certainly to be desired. Personally, I prefer the English method because of what seems to me its natural sequence, *viz.*, first the figure which changes daily and which gives the closest indication of the time referred to, then the figure which holds good for a month at a time, and lastly, the figure which needs changing only once a year.

But to get back to machine tools; perhaps no single word is more loosely used in this connection than "automatic," and its meaning is frequently open to misconception. Strictly speaking a machine is automatic when all its functions are performed by mechanism which is self-acting instead of being dependent on an operator; but the term is also used in a partial sense referring to some single feature only, such as feed-motion, throw-out, etc., and there is often uncertainty as to which idea is to be understood.

In drilling machines there are always two elements to take note of, *viz.*, power and capacity; both are important and either may be allowed to take precedence. Inquiries for drilling machines frequently give no more information than say "with a 2½-inch spindle," leaving type and capacity to the imagination of the person addressed. Of course, where there happens to be only one machine with that dimension, it may be all right, but often there are several dissimilar tools having this particular feature in common, in which case the matter becomes altogether vague. Another indefinite inquiry will call for a "5-foot radial"—which may mean one having an arm measuring 5 feet overall, or one which will drill to the center of a 10-foot circle, and the difference in price will be considerable. The latter interpretation is really the more legitimate, but there is a temptation (especially where price is known to be the deciding factor) for the maker or merchant to adopt that meaning which will come within the wording at the lowest figure. The result is that many times the customer eventually gets what he does not want, and the maker who offered what was really desired, loses the sale to the one who quoted rather to secure the order than to supply what the customer required.

In connection with milling machines, there is now substantial unanimity of description. A "universal" machine is now always understood to mean one having a swiveling table and spiral cutting apparatus, whereas some years ago at least one maker applied the term "universal" to millers such as are now dubbed "plain." There is one curious diversity, however, in naming the miller's horizontal slides, although the dimensions being so dissimilar, no misconception is occasioned thereby. The table being long and narrow, it seems only natural to describe its lengthwise motion as "longitudinal feed" and the one at right angles as "cross or transverse." Some people reverse this practice and call the short feed longitudinal and the long one transverse, cross or in-and-out. Evidently the one view is based upon the position and shape of the table, while the other labels all motions in relation to the spindle.

It is interesting to note, in passing, the conflicting practice in the arrangement of universal millers of the usual type, some being right- and some left-handed. Apparently this disparity has arisen in a similar way. The lathe was doubtless the parent of the milling machine and it can be employed for milling in two ways: Either the cutter can be mounted in the lathe spindle while the work is clamped to the carriage, or the piece to be milled can be held between the centers and a cutter-spindle rigged up on the rest. In the former case the cutters would naturally be made to run counter-clockwise—the normal direction of the lathe spindle—and the work centers made to suit; but the latter method would suggest the use of left-hand cutters.

The very terms "right- and left-hand" are particularly subject to confusion, and depend entirely upon the point of view. It would therefore be a distinct advantage to have some definite and simple rules drawn up for regulating their application and use. In the first place it should be clearly determined whether the terms right- and left-hand should be stated in relation to the machine itself or with reference to the operator who usually faces it and whose right hand is towards the left side of the machine. If we say that a lathe is in the right-hand corner of the shop, we mean the side corresponding to our own right hand as we look down its length; but if we speak of a right-hand side tool in that same lathe, we mean one which faces to our own left hand, *i. e.*, towards the right side of the lathe. [In American practice, a right-hand side-tool operates on the right-hand side or end of the work, the right-hand side being to the right of the operator when in the working position.—Editor.] The "front" of a lathe is the side on which the operator stands and is never a matter of doubt, but the "front" of a milling machine may stand for the end view of the spindle or either side according to design.

That this whole matter requires revision and standardization is plain from the misunderstandings which are constantly occurring, and from the fact that the terms right- and left-hand, whether relating to the rotation of a fan, electric motor, etc., the hanging of a door, or the objects in an illustration, are always matters of uncertainty or guess-work unless determined by some additional indication. To suggest a remedy which is at once practicable and effective is no easy matter, but we are told that "difficulties are made to be overcome," and some of the achievements in the direction of standardization which have already been accomplished looked at the outset far more hopeless.

It is useless to expect buyers of machine tools to be precise in their descriptions until the makers set the example of careful and accurate phraseology. Undoubtedly the machine tool builders must lead the way, and the first step towards the desired end will be in the direction of a standard system among themselves, preferably on an international basis. Their catalogues and printed matter would then do much to extend the result among buyers and others who could not be directly reached. The subject is one that might with advantage be taken up by the machine tool builders' associations with a view to some practical action, and I trust that they may be induced to take an active interest in the matter and endeavor to bring about its accomplishment.

* * *

The largest part of the world's supply of asbestos is provided by Canada. The total amount of asbestos produced yearly in the world is about 75,000 tons, of which Canada produces about 65,000 tons. Russia produces practically the remainder, or about 10,000 tons.

GRITS AND GRINDING CHIPS*

Whether grinding the roughest work, such as draw-bars, alloy steel railroad switches, frogs, etc., or the finest and most delicate instruments of precision, the abrasive used, whether it is a grinding wheel, oilstone, or razor hone, removes the metal by cutting off minute chips. Each little particle of grit on the abrading surface is a cutting tool, which severs the chips on the same principle that the lathe tool removes metal.

The secret of the success of any abrasive wheel or stone is in the adaptability of its structure for the work on which it is used. The efficiency of aluminous abrasive materials used in the manufacture of grinding wheels depends largely on their purity and structure. By aluminous abrasives is meant those which depend for their abrasive action on the alumina content. The chief impurities found are the oxides of iron and titanium and silica. In some cases these minerals are merely intermixed with the abrasive and can easily be separated mechanically. In other cases the impurities are chemically or mechanically combined with the abrasive grain, so that purification is practically impossible. In all aluminous abrasives, the abrasive efficiency is directly proportional to the amount of crystalline alumina present. When silica is combined with alumina, it makes a brittle grain of weak structure which is unsatisfactory, and when iron oxides are present the grain lacks the necessary abrasive qualities; the tendency of such a wheel is to heat or burn the material being ground, and it also consumes a great deal of power.

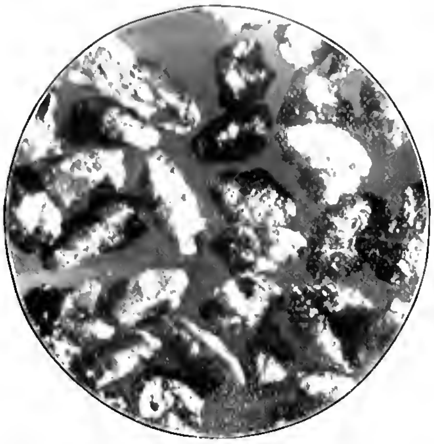


Fig. 1. Microscopic View of Emery Grains containing 50 Per Cent Crystalline Alumina

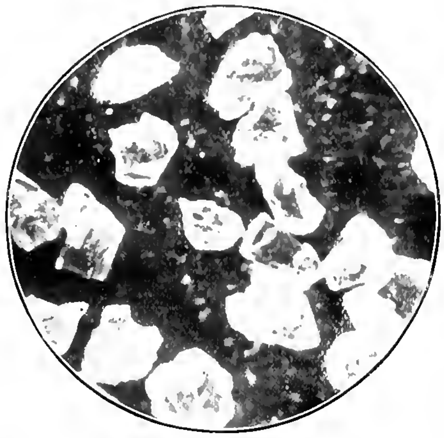


Fig. 2. Alundum Grains containing from 92 to 98 Per Cent Crystalline Alumina

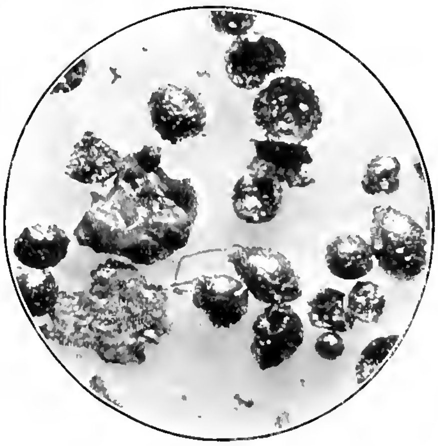


Fig. 3. Manganese Steel Chips produced by Dry Grinding with an Emery Wheel

Fig. 4. Manganese Steel Chips produced by Dry Grinding with an Alundum Wheel

Fig. 5. Razor Edge after Honing but before Stropping—Enlarged 750 Diameters

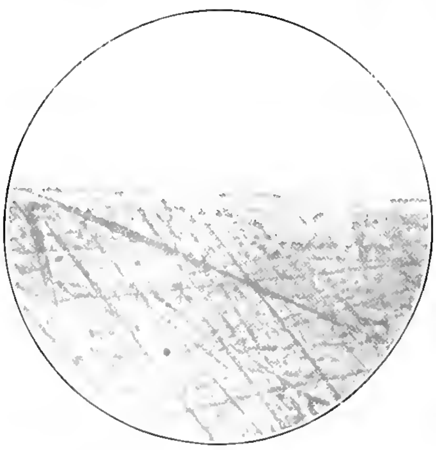


Fig. 6. Razor Edge shown in Fig. 5 after Stropping

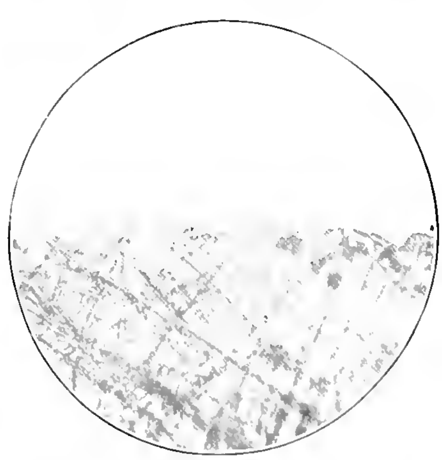


Fig. 7. Edge of Razor shown in Figs. 5 and 6 Honed on Coarser Hone and Stropped

In Fig. 1 some grains of Naxos emery are shown as they appear under the microscope. These grains have a considerable quantity of foreign minerals and they may be compared to a sponge, the interstices of which have been filled with impurities. The abrasive shown in Fig. 2 has only a small amount of combined impurities, none of which are mechanically mixed and it will be noted that these grains show a tendency toward crystallization, whereas those in Fig. 1 are entirely amorphous, that is, they have no determinate shape.

It is evident that the more round or blunt grains shown in Fig. 1 are not as good for abrasive purposes as those of Fig. 2, which have sharper cutting edges. All the commercial forms of natural abrasives have impurities of foreign material to a greater or less degree. They seldom have more than 85 per cent crystalline alumina and those that run as high as 80 per cent or over are considered exceptionally good. The common grade of emery used has only from 40 to 50 per cent crystalline alumina. In the artificial aluminous abrasives it is possible to get any degree of purity desired, as the purity depends on the electric furnace treatment. Alundum has from 92 to 98 per cent pure alumina.

In Figs. 3 and 4 are shown two lots of grinding chips as they appear under the microscope. Those shown in Fig. 3 were taken from under a grinding wheel made of an abrasive material similar to that illustrated in Fig. 1. The other chips shown in Fig. 4 were produced by a grinding wheel composed of an abrasive material of a high degree of purity. The material from which these chips were ground was the same in both cases and the grinding was done under the same conditions. Fig. 3 shows that there was so much heat generated that portions of the chips were melted as indicated by their

* Abstracted from the March and April numbers of *Grits and Grinds*, published monthly by the Norton Company, Worcester, Mass.

globular form, while those of Fig. 4 are seen to be, in form, identical with the chips from steel metal cutting tools, except that there are many different shapes, widths and lengths due to the fact that the cutting points of the grinding wheel are differently shaped and have different clearance angles. It is not intended to infer that the cutting properties of a wheel depend entirely on the abrasive, for there are many conditions that should be considered, as for example, the grade of hardness. That the quality of the abrasive is of considerable importance, however, is shown by these microscopic views.

The microscope and camera also furnish evidence that in the act of grinding, the principle of the cutting action is the same, whether a grinding wheel, oilstone, polishing and buffing wheel, or razor hone is used. For example, a keen edge on a knife or razor is produced by cutting from the side of the blade minute chips until the blade is worn down to a thin edge, and the chips differ from those produced by a coarse wheel only in size. Chips from two widely different forms of grinding are shown in Figs. 4 and 5. The first illustration shows the chips obtained from grinding with a coarse open wheel, while the second shows the edge of a razor that has been honed but not stropped, the photograph being taken under the microscope and enlarged 750 diameters. What is seen on the edge of this razor are minute particles of metal or chips clinging to the slightly magnetized edge. Fig. 6 shows the same razor after having been stropped. It will be seen that this operation removes the tiny particles of metal shown in Fig. 5. The even edge of the razor after honing is evidence that it was sharpened on a fine hone of even structure. Fig. 7 shows the same blade with a different edge, but having been honed on a stone of coarse and uneven structure and then stropped. It is plainly evident by these illustrations, which are magnified the same, that the hone used on the blade of Fig. 7, is made of coarser grit than that used on the blade of Fig. 6, as the edge is rougher and the marks on the side of the blade are deeper.

The form of chips produced by metal grinding indicates to a certain extent the temperatures at the point contact. If the chips are spherical instead of being long and curly, the heat generated has been excessive and a cooler cutting wheel should be substituted, as energy in the form of motive power is being consumed unnecessarily. Where there is too much heat generated, there is also danger of overheating and burning the work. Excessive heat and waste of power frequently result from the use of wheels that are too hard or too fine for the work. The combination of a hard bond and fine grit makes a wheel so dense that there is little opportunity for the particles to project enough to cut and there is no room for chips if they were removed. Such wheels, however, last longer than the proper grade and for this reason there is a tendency on the part of those economically inclined to use hard, fine wheels on work which calls for wheels which are coarse and soft, but this is poor economy. In this connection the microscope and camera have proved valuable in determining the proper wheel or stone for the various kinds of work. It is possible by this means, together with a similar examination of the surface ground, not only to select the grade and grain of wheel that does the work most effectively, but in many cases to improve grinding conditions in general.

* * *

IS THIS TRUE?

"It is a curious fact that it is immensely more difficult to write a good news article about a subject of which you yourself know much, than about a subject on which you are looking for information, as well as everybody else. I myself once wrote a book on how to run a steam engine (published anonymously) and though I had never touched a steam engine in my life, my book at once took precedence in popularity over all the other books on the market written by experts and was adopted in colleges as a text book."—*Sherwin Cody.*

* * *

The French army department has recently acquired an automobile which is capable of running as well in water as on land. It can be instantly changed from a land to a water machine. It has a speed of twenty-five miles on land and about eighteen miles in water, and can carry four persons.

REORGANIZING A RUN-DOWN ASSEMBLING DEPARTMENT—2

By ALFRED SPANGENBERG

In the previous installment of this article, the necessity for analysis of existing conditions, the relation of the machine departments to that of assembling, the value of an efficient stock tracing system, the importance of an inspection department, and wage systems, received consideration. The present installment will deal with problems encountered in the assembling department itself.

2.—DEFECTS OF ASSEMBLING SYSTEM AND METHODS FOR IMPROVEMENT

Arrangement and Equipment of an Assembling Room

The efficient organization of a shop requires the division of the shop into departments according to the machines used; for instance, the lathes should all be in one department, and so with the planers, milling machines, etc. A large number of concerns, however, still machine a part of the work in the assembling room, even though regular machine departments have been established for the machining operations. This leads to inefficient methods of machining in the assembling room, as the machines can generally be used to better advantage if installed in the proper machine department. This matter was fully treated in an article by the writer appearing in the August, 1909, issue of MACHINERY.

Again, the average assembling room is small, and the space taken up by operating machinery is generally needed for assembling work or for storage. In most cases, the reason given for having machine work done in the assembling room, is that difficulties arise in getting the parts promptly to the assemblers; if the machines are in the assembling department, delays will be avoided, because the assembling foreman will take particular care to get the work out in time. While this, no doubt, is true, yet, with an efficient stock tracing system, there should be no difficulty in obtaining the work from the machine departments in time.

Occasions will also arise in the assembling when it is necessary to adjust some of the parts, and it is then advantageous to have machines convenient to the assembler. Upon investigation it will generally be found, however, that much of this work is unnecessary and can be eliminated by the employment of a few simple gages.

In describing the arrangement and equipment of the machine tool assembling department, we will assume that the operations involved will include the cleaning and chipping; drilling; filling, rubbing down, and painting; assembling the small units; scraping; and erecting. As these operations differ widely, each being performed by a different class of workmen, a proper system requires their segregation. In large shops devoted exclusively to building one article these operations usually are carried on in separate departments, each under a different foreman. The usual plan where the product is of a varying character, is to have a separate assembling department for each class of machines; thus, in the machine tool line the lathes are erected in one department, the planers in another, etc. The last-mentioned plan is the one that will be considered here.

Cleaning and Chipping Operations

In some shops the cleaning and chipping is done in the assembling room, although it is more economical to clean the castings in the foundry, owing to the cheaper class of labor employed and the better facilities for this work. However, when this work is done in the assembling department, a suitable space should be provided, so as to keep the "muss" and dirt in one place. The old-time method of cleaning large castings by rubbing them with a file or emery brick should be supplanted by the more economical method of using an emery wheel driven by a portable motor and flexible shaft. The equipment should also include stationary emery wheels for grinding the small parts, and pneumatic hammers for chipping the heavier work. Vise benches and vises are needed by the chippers, and suitable stands or bins for the small parts will economize space.

* Address: 951 W. Fifth St., Plainfield, N. J.

As all castings should be cleaned thoroughly before any drilling or assembling operations are started, this work should be located near the receiving depot and convenient to the drilling machines, as nearly all castings require some drilling operation.

The filling, rubbing down, and painting, can be done to advantage in the cleaning space; these operations should be completed immediately after the drilling, and before the assembling operations are commenced. In many shops, however, the painters are allowed to fill and rub the finished or partly finished machines, to the annoyance of the assemblers, and with the certainty of getting dirt in the bearings. Of course, some of the painting and touching up with filler must be done on the assembling floor, but in most cases it can be confined to one place.

Drilling Operations

If special shop conditions render it advisable to have the drilling machines in the assembling department, they should be located near the place where the work is received. The

DATE	DEP'T	NAME	CLOCK NO	CARD NO	CLASS

ORDER	LOT OR CLASS	JOB NO.	DAY WORK NO.	TOTAL FOR DAY HOURS	TOTAL FOR DAY WAGES

PIECE NO.	OPERATION OR REMARKS	MACHINE TAG NO.	MACHINE COM	MACHINE STOP D	HOURS	SHOP EXPENSE

Excess Machine Hours					
ASSEM.	BORE	DRILL	F. A F	GRIND	MILL
POLISH	PLANE	SHAPE	SET UP	TURN	TAP

APPROVED	COMMENCED	LEFT OFF	HOURS	AMOUNT
	DAY	DAY		
.... FOREMAN	NIGHT	NIGHT		

Fig. 4. Card which accompanies the Work until it reaches the Stock Room. The Necessary Operations are numbered consecutively and checked off as completed.

general arrangement of the machines and the requirements for their operation were outlined in the writer's article in the August, 1909, issue. Rapid drilling is essential, as some one of the assemblers will always be found waiting for the drilling operations to be completed. High-speed steel drills and *machines powerful enough to drive them to their maximum capacity* are, therefore, required.

Assembling

Even when the assembling and erecting processes are carried on in one department, it is best to provide a separate location for each, because the equipment for each differs widely. For assembling the small units it is convenient to have long benches on which to place the parts; these benches are provided in addition to the regular wall benches with vises, and should be arranged convenient to the latter and with aisles between them for trucking the work. These aisles should always be kept clear. When the parts are made in large quantities, it pays to provide fixtures for holding the parts that cannot be conveniently clamped in the ordinary vises during the assembling process. For holding the heavier pieces, as, for instance, lathe headstocks, trestles or wooden horses are required, which may be made of sufficient length to hold three or four headstocks. The space under the trestles can be utilized for keeping the smaller assembled units until needed.

The practice of allowing the benches to be littered up with small parts and stock supplies such as screws, pins, keys, etc., is a source of loss and waste. One of the greatest causes of annoyance to a foreman when this system, or rather lack of system, is followed, is that the workman soon forgets what members the stock supplies belong to, with the result that screws are used that are either too long or too short, or not of the right type. This defect may be overcome by providing boxes of uniform dimensions for keeping the small parts. These boxes should be made with a partition at one end for the stock supplies, and with a tin pocket on the side in which to place cards giving the necessary information, as will be explained in detail later.

Much time will be saved in the assembling department by having a specific place for such tools as wrenches, pneumatic drills and hammers, clamps, etc. While the men should be permitted to help themselves to these tools, they should be returned upon completion of a job. Little or no trouble will arise from lost tools if the foreman insists upon this rule being enforced. When there is a departmental tool-supply room, it is better, of course, to keep all tools there. Ratchet wrenches with removable sockets fitting different sized nuts, bolts, and screw-drivers, are most convenient for assembling work.

All parts to be assembled should be arranged in logical order and placed convenient to the workmen, so that their sole attention can be concentrated upon the assembling operations, thereby making it unnecessary for them to waste time in running around to find the parts. Every facility should be provided for the quick handling of the work.

Scraping Operations

The work of scraping usually does not receive the attention that its importance demands. The accuracy of the work produced by any machine tool is almost entirely dependent upon the accuracy with which the planed surfaces are scraped; it is essential that a proper equipment of straightedges, surface plates, test indicators, squares, etc., be provided for testing the truth and alignment. Each individual member should be tested separately, and it is often advisable to have special straightedges or surface plates which can be used both for testing the planing and scraping. Then the planing is easily tested, and if not within the allowable limits, the part can be sent back for replaning before any scraping is done. This is an important feature, since it is far more economical to plane work true than it is to scrape it.

Without the aid of such devices for gaging the work, errors may exist in the machining that may necessitate the use of a file before the scraping operation. These special straightedges or surface plates are, however, not intended to make the parts interchangeable in all respects. It is practicable only to carry out this feature in the planing process and up to a certain point in scraping, after which the pieces are scraped together and numbered accordingly.

In addition to trestles for the heavy parts, scraping trucks are convenient for supporting the movable members during the scraping. These trucks are portable benches mounted on castors, so that they can easily be moved about and turned around to any position that will secure good light on the work. Motor-driven, rotary oil stones should be provided for the sharpening of the scrapers. Each scraper-hand should be provided with a number of properly hardened scrapers. The necessity for ample crane facilities is too well recognized to need comment. Simple and inexpensive pulling devices, such as those described by the writer in the April, 1909, number of MACHINERY (reprinted in MACHINERY'S Reference Series No. 50, "Principles and Practice of Assembling Machine Tools"), will greatly facilitate this work, and enable the workmen to devote their energy to the actual operation of scraping.

Erecting

The arrangement of the erecting floor will vary with the character of the work; however, a few general principles may be stated. Where it is the practice to build machines in large lots, the beds are placed in rows with aisles between. Crowding should be avoided; in case there is not sufficient room to arrange all the beds in a lot on the erecting floor at one time, fill the available space without crowding, and store the remaining beds in some convenient place.

Suitable erecting pits are required for such machines as large boring mills and planers, which have driving works reaching below the floor line. The bottom of the pits is usually lined with concrete, with sides of the same material or brick, while cast-iron plates are placed all around the mouth. These pits are generally provided with movable girders or supports, to accommodate various sizes of machines. When a pit is not in use, it is covered with a plank floor made in sections, supported upon the girders set in pockets in the sides of the pits.

Emery wheel stands, speed lathes, small drill presses, and

portable vise stands should be located at convenient points on the erecting floor. Chalk, emery cloth, machine oil, and all special appliances used by the workmen should be handy, so as to avoid running to the tool-room. In regard to waste for cleaning purposes, it may be of interest to note that many shops are now abandoning it for raw silk towels which can be washed in a machine, and, besides being cheaper in the end than waste, are far more sanitary.

The relative importance of handling facilities, such as electric cranes, hoists, etc., varies according to the character of the work. What may be the most important feature for one class of work may not be essential in another class. In some cases it pays to have specially designed jib cranes with power hoists, so that the workmen need not wait for the over-head crane after the work is once placed within reach of the former.

In the handling of light work there are several points of importance that must be considered. Whenever possible the stock should be carried in boxes. These boxes should be of some standard sizes. For very small work it pays to arrange the boxes with removable trays so that the stock can be easily handled and better protected in carrying it through the shop. Erecting trucks with one or more shelves, and ordinary two-wheeled trucks are necessary for moving the light pieces. The features mentioned in this brief outline apply to the entire assembling department, and are of vast importance because an astonishingly large proportion of lost time can be attributed to lack of proper facilities and methods for handling work.

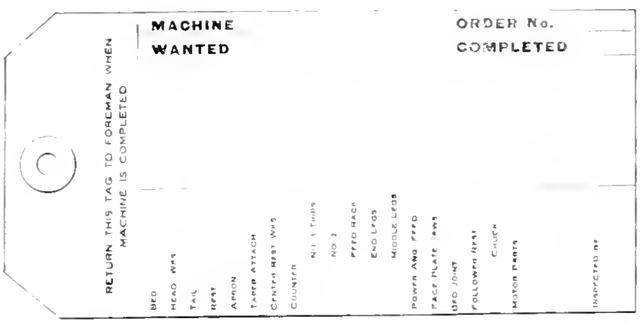


Fig. 5. Tag showing Data required by Erectors. The Tag Illustrated is for Engine Lathes, when properly filled out, it is placed on the Lathe Beds on the Erecting Floor

As all power-driven machinery requires to be "run off" when completed, some convenient source of power is necessary. This problem is easily solved in the case of motor-driven machines, but for belt drives, instead of moving each machine under a countershaft, it is more convenient to provide portable electric motors, which can be moved to any machine by the crane. If required, these motors may be back-geared and provided with different-sized pulleys, and in the case of small units the entire outfit can be mounted on a truck. When the machines to be run off require the application of power to more than one pulley, a suitable countershaft can be supported above the motor by braces bolted to the truck. Each outfit should be provided with a controller, as variable speed motors are best adapted to this work.

Necessity for a Departmental Stock-supply and Tool-room

One of the principal factors in the efficiency of an assembling department is the stock-supply and tool-room—the "heart of the department." Added to the loss of time in looking for lost or missing parts, due to haphazard methods of checking up and taking care of the parts as they are received, it is the usual custom in run-down assembling departments not to provide any regular place for keeping the work, but to dump it down anywhere. Frequently the only place provided for the small parts is under or on top of the vise benches.

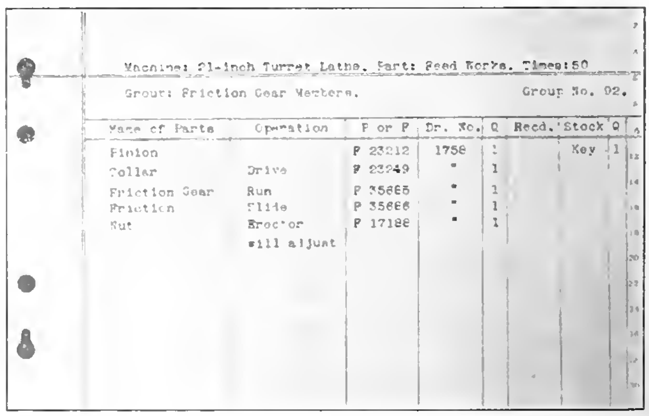
When sufficient space is available for a stock and tool supply room in the assembling department, it is advisable to establish one immediately. In equipping this department, adjustable metal shelves and bins can be used, and for storing many of the small parts carried in the boxes already referred to, racks can be so arranged that any box can be placed directly into the rack in the same manner as a drawer. This arrangement saves extra handling of the work, and is better than piling boxes one on top of another, as any box is instantly accessible. The shelves and bins in the stock room are only for keeping the smaller parts, such as can be easily handled by the stock clerk; the larger pieces, not being so apt to get lost or misplaced, can be taken directly to the assemblers without passing through the stock room, although care should be taken in checking up this material when received.

Sufficient space should be assigned in the tool-room for storing all tools used in the assembling department. Some simple system must be inaugurated for keeping track of the work and avoiding delays in giving it out, for taking proper care of the tools and keeping them in good condition, and for charging up to the workmen the tools in their possession. A part of the space assigned to the stock and tool supply room should be partitioned off and fitted up for the foreman's office, as the foreman necessarily must keep in close touch with this department.

When the size of the department precludes the establishment of a stock-supply and tool-room some other place with suitable equipment must be assigned for keeping the small parts until wanted by the assemblers. Either wooden or metal shelves and bins should be erected near the receiving depot, and they should be numbered consecutively to facilitate putting the parts into the bins and locating the work when wanted. All of the larger pieces should be stamped with their order number and pattern or forging numbers for the purpose of identification in the shop and for the customer's convenience in ordering repairs. As it would not be feasible to stamp the stock supplies, such as screws, pins, etc., with their piece number, it is of advantage to have the stock supplies put up in suitable packages properly tagged. This can be done at odd times by the stock clerk, and the packages placed in the proper bins together with the members to which they belong. In case there are too many pieces belonging to any particular group for one bin, two or more bins can be assigned to the large groups. This matter should be determined in the beginning.

Methods of Routing the Work

In shops without established methods of routing the work, it frequently occurs that work reaches the assembling department without having all the machining operations completed, and if this is not discovered before the parts are put away,



Machine: 21-inch Turret Lathe. Part: Feed Works. Times:50

Group: Friction Gear Members. Group No. 02.

Name of Parts	Operation	P or F	Dr. No.	Q	Recd.	Stock	Q
Pinion		P 23212	1758	1		Key	1
Collar	Drive	P 23249	"	1			
Friction Gear	Run	P 35665	"	1			
Friction	Slide	P 35666	"	1			
Nut	Erector will adjust	P 17188	"	1			

Fig. 6. Specification for Friction Gear Members shown on the Assembly Drawing in Fig. 7

time will be lost when the work is finally delivered to the assembler, and, in addition, unnecessary trucking is required. This is particularly likely to happen where there is no system of inspection, and the sequence of operations is not mapped out in the beginning on cards or tags, as shown in Fig. 4, which accompany the work in its course through the shop.

The receiving depot in the assembling department should consist of a long bench about the height of the moving trucks, for convenience in placing the small parts; the truckers who bring the work to the assembling department are merely required to put it on this platform, as the stock-room clerk may not always be in a position to immediately check up and dispose of the parts. He should, however, give a receipt for all work entering his department, these receipts being returned by the truckers to the respective machine departments, to be placed on file as evidence that the work had reached its destination. Cards for this purpose must accompany the work, and

the receipt may be given in the form of a distinctive punch mark, or with a rubber stamp. The data this card should contain are shown in Fig. 1, in the May issue.

As soon as possible after the work reaches the assembling department it should be disposed of in a proper manner. All small pieces that require cleaning and painting are sent to the cleaner's bench; those requiring drilling and no cleaning or painting are sent to the drilling machine and piled in a convenient place; all other small parts are placed in the stock-room bins. After being cleaned, the work is sent to the drill presses, and all small work as soon as drilled, is delivered to the stock room. Thus no work enters the stock room until ready for the assemblers. Large, heavy pieces are sent directly to the drilling machines and from there to the assembling or erecting floor. A regular place should be provided also for the large parts, as otherwise much unnecessary handling will result. It is advisable to mark or tag these parts, for identification, with their group number in addition to the piece and order numbers.

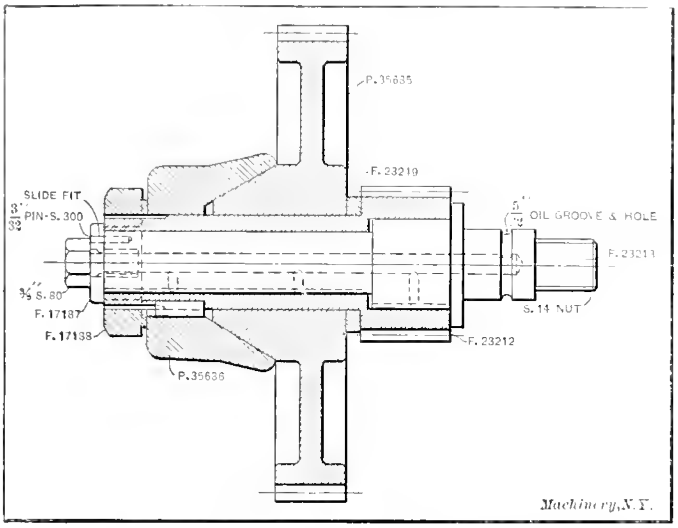


Fig. 7. Assembly Drawing of Parts Classified in Fig. 6

The Assembling Operations

When work is to be delivered to a workman who is nearly ready for his next job, the foreman or the job-boss sends a helper to the stock room with a work card properly filled out. This card contains the date, workman's name and number, group number, piece numbers, names of the parts to be assembled, operations, contract price, and estimated time for assembling. The stock room clerk delivers the parts to the helper, who, in turn, delivers them to the workman together with the card just mentioned, any shortages being noted on the card. All small pieces are carried in the boxes mentioned, which remain with the workman until empty, when they are returned to the stock room. The writer believes it unwise to provide the workmen with assembly drawings except under special conditions, as considerable time is wasted in studying the drawings. Better results are obtained by a proper subdivision or classification of the parts that can be assembled independently, each group containing a small number of pieces, so that only a few verbal instructions on the part of the foreman are necessary. This opinion is strengthened by the fact that comparatively few workmen can read an assembly drawing. Moreover, instructions should only be necessary in the case of new work or new men. All assembly drawings should be kept in a suitable cabinet in the foreman's office.

After each group is assembled, any parts requiring scraping are taken apart and sent to the scraper-hands, while all the remaining pieces are taken directly to the erecting floor and placed convenient to the bed of the machine to which they belong. Thus the erectors are supplied with work as soon as it is assembled. The parts that require scraping are immediately sent to the erectors upon completion of the scraping operations. This, of course, applies to the smaller members; the heavy members and beds of the machines are scraped on the erecting floor to save extra handling. The scraper-hands and erectors are furnished with contract tickets similar to those given to the assemblers.

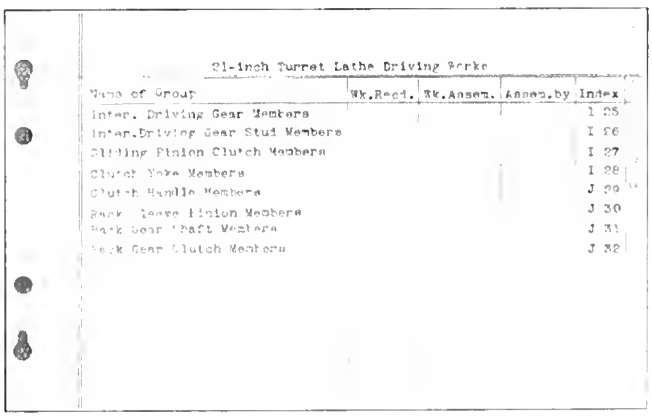
On some classes of work, as, for instance, large lathes and planers, it is the practice to duplicate only the *parts* in quantities, because machines of this character have beds made to order, the lengths varying considerably. In this case, the parts when assembled are sent to a stock room for finished work, and kept there until a machine is ordered, when they are sent to the erectors to be fitted to the bed. The completed machines having passed final inspection, are then placed in the hands of the shipping department. The tag which is placed on each machine on the erecting floor is shown in Fig. 5.

It will be observed from the foregoing that the workmen are always supplied with jobs, and the work is not allowed to remain with a workman after he has finished his operations on it; it is immediately sent to the next operator. This condition fulfills a fundamental principle underlying the management of men—that they should ever feel the pressure of work yet to be done, and their inability quite to meet the demand ahead of them.

Method of Assigning the Work

Two fundamental principles of economical assembling must be recognized in the apportioning of the work among the workmen so as to secure a rigid subdivision of labor, and in the avoiding of unnecessary delays in getting work to the men, *before they are ready for it*. In fact, if nothing more were accomplished in reviving a run-down department than the constant supplying of the workmen with plenty of work and the necessary tools, and having the jobs classified and arranged in logical order, the productive capacity of the department would be considerably increased. Yet, in average cases the foreman gives these matters little consideration, resulting in work being assigned to high-priced workmen that could as well be performed by cheaper men, and in wasted time while the foreman hurriedly chases around looking up jobs for men who are out of work. In this way, work is often assigned and commenced without regard to whether or not it is wanted first, and without ascertaining the fact that all the parts belonging to any particular job are received and ready for the assembler.

It now remains to formulate plans whereby the work can be assigned and distributed with the least amount of attention on the part of the foreman. At the outset it will be necessary to group or classify the parts which are to be assembled. This task can best be accomplished by the assembling department foreman, since no one is as well qualified to successfully carry out this important work as he.


21-inch Turret Lathe Driving Works

Name of Group	Wk.Recd.	Wk.Assem.	Assem.by	Index
Inter. Driving Gear Members				I 25
Inter.Driving Gear Stud Members				I 26
Sliding Pinion Clutch Members				I 27
Clutch Yoke Members				I 28
Clutch Handle Members				J 29
Back Sleeve Pinion Members				J 30
Back Gear Shaft Members				J 31
Back Gear Clutch Members				J 32

Fig. 8. Part of a Group Index Page from which the Work is assigned

The most convenient way to make the classifications is to take the assembly drawings and thoroughly analyze the operations necessary to assemble the machine. The classification of grouping of the parts and assembly operations will be made with reference to the correlated members, *i. e.*, members which can be assembled or fitted independently of other parts. In making these classifications, it is advisable to make as large a number of divisions or groups as possible; for instance, a large semi-automatic turret lathe easily would comprise 150 to 200 groups.

The primary objects in making such a large number of groups are to provide for a rigid subdivision of labor, and to enable the rate setter to arrive at a more accurate determination of the time required to assemble the various parts. The secondary advantages derived from the system are that exces-

sive time spent on any particular operation can be detected at once and the cause located; there is likely to be less discrepancy between the estimated time and actual time; it enables all the small members constituting each group to be kept in a separate bin in the stock room so that the parts can be delivered to the workman in logical order, thereby avoiding the necessity of sorting over a large number of pieces when giving out the work; and the task of assigning the work becomes a comparatively simple matter, as only a small number of parts are in each independent group; and a subdivision of this character facilitates the assembling operations by permitting different jobs to be started as soon as a few parts are received.

In mapping out this work, effective use can be made of a loose-leaf book, which enables rapid arranging and indexing of the groups. The general classification of the data may be seen from Fig. 6, which shows the tabulation of the friction gear members in Fig. 7. The stud F. 23213, washer F. 17187, 3/8 screw No. 80, and 3/32 pin No. 300, are not included in the form shown as they belong to another group of parts. As will be seen by referring to Fig. 6, the parts are arranged in logical order the same as they are to be assembled, which is the plan that should be followed in preparing the part lists for all the groups. The column marked "Recd." is to be filled in with lead pencil, so that the same page can be used for any number of machine lots, provided no changes in design are made.

After tabulating all the groups belonging to one machine, they should be arranged in logical order, classified, numbered consecutively, and a list compiled for ready reference. From the specimen page shown in Fig. 8, it will be seen that columns are provided for "Wk. Recd." and "Wk. Assem.," which furnish the foreman with a continual record of the condition of the work, and enable him to ascertain instantly just what groups are ready to be assembled, and when the work is ready for the erectors. This record is kept up-to-date from data secured from the stock-room records and piece-work tickets. As occasion requires, the foreman fills in the column marked "Assem. by," from which his clerk is enabled to make out the proper contract, which should accompany the work when it is delivered to the workman. Another index is required giving the pattern and forging numbers in numerical order together with their group number. This is to facilitate putting the work into the proper stock bins. A copy of this index, together with a list of parts belonging to each group, is needed for the stock room, but the loose-leaf record book must always be kept in the foreman's office.

General Requirements for Efficient Work

It is the intention to here but briefly show the practical working of an inspection system in the assembling department for insuring efficient, economical, and accurate production. At the outset it will be necessary to provide the inspectors with the necessary tools and gages for the rapid and accurate inspection of the work assembled and erected. There should be some regular system whereby the gages, both those in use by the workmen and those in the inspector's care, will be examined carefully at certain intervals and compared with the master gages to ascertain whether or not they have become worn. The reference gages or standards of comparison should be kept by the head tool-maker or by some one especially appointed for that work. This person should determine how often a gage must be examined to insure its being in the proper condition; and by arranging the examinations periodically, accuracy of the tools and gages can in this way be very easily insured. In addition to supplying the inspectors with the proper tools and gages, some safe and convenient means must be provided for keeping this equipment and transporting it around the department. This can easily be accomplished by furnishing each inspector with a portable desk, mounted on wheels, and having suitable drawers with lock and key in which to keep the various tools, gages, printed forms, writing materials, etc.

The inspectors' duties on the assembling and erecting floor consist primarily in examining the fit and alignment of the various shafts, gears, slides, guiding surfaces, etc., and to see that every part of the machine functions properly. This, of course, necessitates the constant and watchful attention of the inspectors as the work proceeds, so that faulty workmanship is discovered in its early stages. Even the matter of looking after such seemingly unimportant details as the proper tightening of nuts and bolts should receive attention, for when this point is neglected, it often happens that through carelessness on the part of a workman, a machine "falls apart" after being used a short time, causing trouble and annoyance to the customer, with the result that the next time he is in the market for a similar machine, he in all probability buys another make. Steel stamps bearing a distinctive character should be furnished the inspectors for marking all work passed upon by them—these stamps, under no circumstances, to be out of their jurisdiction. This acts as a check upon the inspector, for if any defective work passes his hands and bears his stamp he is responsible for any future trouble arising therefrom.

In connection with the question of determining just what limits of error are allowable, it is interesting to note that in modern machine tool practice the tendency is to allow greater limits in running fits than was thought advisable a few years ago. Thus, for all rotating members, except main spindles carrying the work or tools, the practice is to allow from 0.002 to 0.004 inch for running fits, for diameters from 3/4 to 3 inches, according to the requirements of the case; to have a lateral clearance, or endwise motion, of 0.005 inch for shafts, gears, or pulleys, running between bearings, sleeves carrying gears, etc.; and to cut the teeth of all gears thinner than standard, so that two gears when in mesh will have a slightly perceptible amount of backlash.

The advantages of this practice are at once apparent; it not only results in ease and quickness of assembling, but the main feature to be considered is the fact that when the bed of a machine is under the severe strains of a heavy cut, the distortion likely to occur may cause the rotating members to bind in their bearings, if fitted too closely, and thereby consume an excessive amount of power, besides overheating in the case of high rotative speeds. Moreover, so much time will be saved in assembling these parts, that an extra amount of time is allowable for obtaining accuracy in the alignment and fit of vital members, such as main spindles, slides, and guiding surfaces.

Conclusion

Turning now to the subject of reports and their uses, it may be stated that much good can be secured from a simple yet thorough system of reports by the assembling foreman, based upon his actual experience in carrying through his department a newly designed product, these reports to contain criticisms and suggestions upon design, and ease and economy of assembling the parts. This will result in establishing comprehensive and business-like cooperation between the designing department and the assembling foreman and assurance will be obtained that when a new or re-designed machine is produced it will operate properly, and will be so designed as to be produced in the most economical manner possible.

The problems involved in reorganizing a run-down department must be solved with an absolutely unbiased mind and a determination to analyze the situation thoroughly and mercilessly. If any superintendent or foreman wants to determine the fact that many of the defects in methods and management mentioned in this article in all probability apply to his own shop, let him, *after ascertaining what should be accomplished make a comparison with his present methods and processes.*

* * *

HIGH-SPEED STEEL FILES

The expert file maker knows full well how easy it is to ruin a new file by a few quick strokes on hard castings. After a file has been used for some time the same treatment perhaps would not appreciably harm it. The delicate sharp edges of new file teeth are easily ruined by impact and heat, whereas after some wear, they are much less likely to be affected by injudicious use. A new file used on revolving work in the lathe, especially cast iron, is quickly worn out unless used with discretion. It would seem that for such purposes files made of high-speed steel would be much superior to the common brands, but, of course, much more costly, although not more expensive, perhaps.

LATHE BURNISHING OF METALS

By WILLIAM A. PAINTER*

The burnishing of metals while not requiring the skill of the spinner, or the multiple operations or tools used in that craft, still is a trade that is separate and distinct from spinning. Metal burnishing can be divided into three classes:

1. Hand burnishing of irregular shapes, such as tableware, jewelry, belt buckles, metal clocks, ornaments and all metal parts that cannot be revolved on the lathe, using steel hand tools of various shapes.

2. The burnishing of small round work in the lathe, such as buttons, ornaments, etc.—mostly plated ware that has already been surfaced and is operated on to brighten only—not requiring the heavy pressure of the tool, and being mostly done with blood-stone burnishers, a natural stone of small size mounted in a steel holder. These stones, some of which are very expensive, last for years.

3. The burnishing of unfinished or rough work in the lathe, which requires smoothing and polishing at the same time; this requires considerable pressure. The blood-stone burnisher would be ruined on this class of work. The tools used are of steel and the handles are short; they are held in the hand only. A strong wrist and muscular arm are required for burnishing, as well as a steady feed of the tool, which is partly accomplished by the movement of the body, in conjunction with the arm and wrist motion; the hand is steadied by being held against the body.

Burnishing may be described as an economical way to finish, polish or brighten the surface of metal, without wasting any of the material. It is also a means of strengthening the

Fig 1. View showing Method of Moistening Work with Finger Pads and also Position and Angle of Burnishing Tool

metal by tempering or hardening it; this is accomplished by pushing the tool over the work, beginning at the front end and pushing always against the chuck. The toolpost is used as a fulcrum and the tool, which is pressed against the work, as a lever. The tool is given a slight rotary motion, and only the thin edge or end is used.

While the pressure against the work does not seem great, still the area in contact with metal is so small, and the speed of the lathe so high, being from 3200 to 5000 revolutions per minute, that the tool leaves a bright mark. The skill of the operator lies in passing the tool over the metal so as to leave a continuous bright surface without any trace of the tool marks; to do this the tool must be fed with regularity and without overlapping or leaving any dull places.

After sheet metal is spun, or drawn in presses, the smooth, even surface which it has when it comes from the mills is changed to a rough, uneven surface having high and low spots which are hardly noticeable to the naked eye, but very easily distinguished under the magnifying glass. The working operations distend or elongate the molecules, and the annealing operation restores them to their original shape. Some shells are annealed several times before the burnishing operation is reached, besides being pickled after each annealing to remove the scale; this leaves the surface of the metal in a pebbly or matted condition, as well as soft and without temper.

A spun shell can be gone over with a planisher, and hardened, but the scale and dirt is crowded into the grain of the metal, and the only way to get a smooth surface is to buff or cut it down until this pitted face is removed, thus wasting about 10 per cent of the metal. The spinner can do this in another way, that is by skimming or shaving the uneven surface, but even more metal is wasted than by buffing, and the shell is also weakened by gouging the high places. This same shell could be left without polish, and the chuck transferred to the burnishing lathe, which runs at much greater speed than one used for spinning. After the shell is dipped bright to remove all spinning dirt and scale, it can then be polished to an even surface, the uneven face of the metal being amalgamated

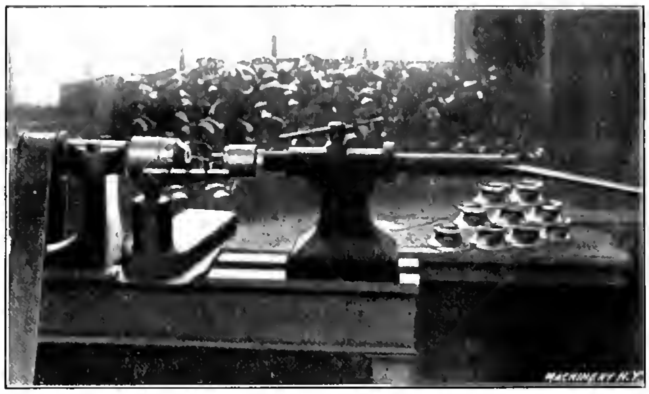


Fig. 2. Burnishing Lathe Equipped with Split Chuck

or smoothed down to a bright surface of the proper temper; it is then colored with a cloth buff to obtain a perfect finish. The gage or thickness remains the same as there is no dirt or scale to buff out.

Burnishing is economical, especially on pressed or drawn work made in large quantities, some work being finished at the rate of five hundred or more an hour. It is necessary to have a metal chuck in burnishing, and where the shell has been spun on such a chuck, the latter can be used for both operations. Some work can be lacquered without coloring on the buff wheel, the only operation after burnishing being to wash in hot water and dry at once in hot sawdust.

A burnishing lathe is smaller than a spinning lathe, and it has only one speed. The countershaft is fastened to the floor under the lathe; this is necessary on account of the great speed, besides a down-pull of the driving belt causes less vibration than the up-pull of a belt from an overhead countershaft. The speed of burnishing lathes is varied for different classes of work. In a group of four lathes in use in our factory one is belted to run at 5000 revolutions, two at 4000 revolutions

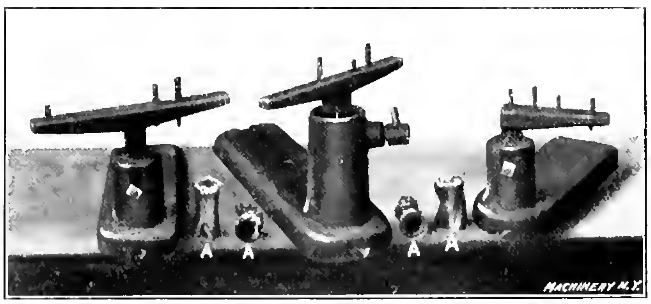


Fig. 3 Burnishing Lathe Steady-rests and Finger Pads

and one at 3200 revolutions a minute. Lathes for very large work of 12 inches and over in diameter have straight babbitted bearings, with a back screw and button to take up the end shake. The babbitt has to be renewed about once a year for continuous service, only the best grade being used. All threads on the spindles are of one standard size, the chucks being interchangeable for the burnishing and spinning lathes.

In some shops it is customary to have a small stream of water running on the work above the chuck, the connections being hinged, so that the stream can be guided above the tool. A back center is used to hold the work against the chuck. The operator wears a rubber apron to protect himself from the flying water, and stands in a shallow trough that has a drain. The great speed of the lathe throws off all surplus water, leaving only a thin film next to the metal all that is necessary.

This article describes a method of burnishing that is used in many shops. The shells are first dipped in a tank of

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water, which is on the bench back of the lathe head; they are then held on the chuck by the left hand, the thumb and first three fingers being covered with canvas pads. These pads are dipped in the water and are held opposite the burnishing tool and slightly in advance of it to keep the metal moist, thus leaving no surplus of water to be thrown off. The hand also holds the work against the chuck instead of the back center. Sometimes on large work it is necessary to dip the pads in the water a second time; also where a very fine polish is wanted it is necessary to pass the tool over the work twice, roughing it down on the first pass and finishing it on the second, using the same tool without taking it off the chuck.

Fig. 1 shows the method of using the pads on the fingers and also the proper position and angle of the tool, as well as the height of tool-post or rest. The chuck shown is $8\frac{1}{2}$ inches in diameter and weighs 36 pounds; it runs at 4000 revolutions per minute. The shell has been gone over twice.

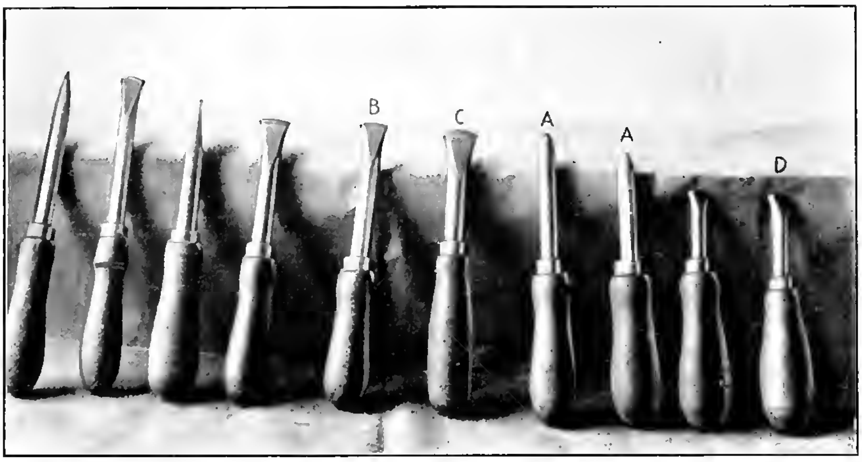


Fig. 4. Group of Tools used for Burnishing

Fig. 2 shows a burnishing lathe equipped with a split chuck, one part being in the tail-spindle and having a roller end bearing similar to the one described in the preceding installment of this article. All chucks for burnishing are like the spinning chucks, except that greater care must be taken in machining them to have them perfectly balanced.

Fig. 3 is a view of the steady-rests that are used on burnishing lathes. These are different from the spinning rests, for while the spinner uses only one pin as a fulcrum, changing it from one hole to another as the work advances, the burnisher uses several pins of much smaller size, inserting as many pins as he needs positions for the sweep of his tool. These pins are about 1/4 inch to 9/32 inch in diameter and are tapered $2\frac{1}{2}$ degrees on the end which is inserted in the cross-bar of the steady-rest, the holes also being tapered and the pins driven in tight. The canvas finger cots that are used on the left hand to moisten the work, are shown at *A*.

Fig. 4 shows a group of burnishing tools, some of which are of high speed steel, and others of regular tool steel. These tools are made extremely hard and no temper is drawn. They project out of the handles from $2\frac{1}{2}$ to 5 inches and are 3/8, 7/16, 1/2, and 5/8 inch in diameter. The handles are 4 to 5 inches long and $1\frac{1}{4}$ to $1\frac{1}{2}$ inch in diameter. The round tools *A* are used on heavy work; also to get in sharp corners and to burnish shells which are part plain and part embossed, requiring the tool to be lifted from one part of the work to another to avoid the embossed area. *B* is a flat tool with a slight curve on the end; it is used mostly on straight work and convex surfaces. *C* is a flat tool with a greater curve on the end, and it is used mostly on concave surfaces, while *D* is a flat tool with a still greater curve on the end, for use on small curved work, such as that shown in Fig. 5. These tools have to be polished when they get coated with metal, the interval between polishings depending on the texture of the metal worked and its temper, a shell that has been annealed several times coating the tool more than one that has not. It is a quick operation to polish the end of a burnisher. A board of soft wood or a strip of leather fastened to a board and to the bench, in a position convenient to the operator, is used. Grooves are worn into the leather or board, and flour of emery and oil, or flint flour and water is used to clean the tools, a few passes of a tool being all that is necessary to polish it.

Fig. 5 shows samples of burnished work; some of these are spun but most of them are drawn in presses. The bright dip which is used to clean work before burnishing is composed of: Oil vitriol (sulphuric acid), 2 parts; aqua fortis (nitric acid), 1 part. This solution should be kept in a crock set in a tank of running water, and mixed 7 or 8 hours before using, as the acids when combined heat up. It is best to mix the acids the day before using. In dipping brass, copper and German silver, the parts are strung on a wire whenever possible. If there are no holes in the metal that can be used for stringing, they can be put in a metal or crock basket, but they cannot be handled to good advantage as it is very difficult to thoroughly wash and dip them. After stringing the work on a stiff brass or copper wire, it should be washed in boiling potash, and then dipped in cold water to clean the potash off and cool the metal.

After cooling in the water, they are dipped for a few seconds in the acids, keeping the work constantly in motion, so that the surfaces will be all exposed equally; they are then shaken thoroughly above the acid and immediately washed in two separate cold-water baths, then in hot soap water, and then in hot water, after which they are dryed at once in hot sawdust. This operation will leave a bright, clean surface free from acid.

Common yellow soap, dissolved to thick paste, is used as a lubricant when burnishing brass. The shells and the finger pads are dipped in clear water, and the tool is dipped in the soap paste before burnishing each shell.

A lubricant for copper is made by dissolving about one ounce of ivory or castile soap in a gallon of water. The shells and pads are dipped in this solution, no lubricant being used on the tool. Yellow soap should not be used on copper, as the action of the rosin on copper is different from that on brass, the metal being so glazed or greased that the tool works badly.

For copper plate on steel, such as copperized steel oilers, etc., about one-half ounce oil vitriol to four gallons of water should be used. The burnishing tool should be dipped in a mixture of mutton tallow that has been melted with 5 per cent of beeswax, and the work and the finger pads should be dipped in the acid mixture. The tool is lubricated in the tallow mixture before burnishing each shell.

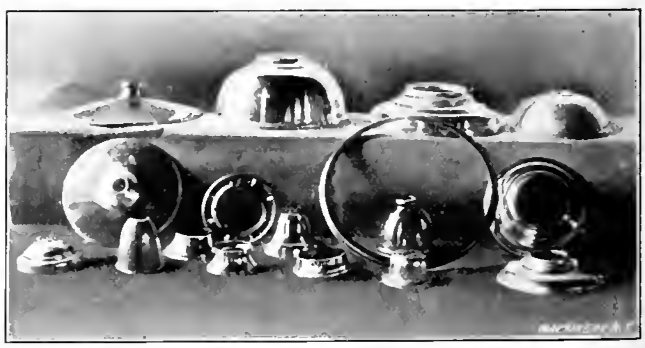


Fig. 5. Samples of Burnished Work

For German silver, the shell should be dipped in clear water, the finger pads in sour beer, and the tool in yellow soap paste.

For white metal or Britannia, use ivory or castile soap in the paste form for the tool, and sour beer or ox gall in water (4 ounces to the gallon) for the finger pads. Wash the work in hot alkali water (a spoonful of cream of tartar, saleratus or soda to a pail of water), and dry in hot sawdust.

For burnished work which is to be lacquered, without coloring on the cloth buff, use thin glue for a lubricant, and also on the finger pads. When the part is burnished put it in saleratus water to keep it from tarnishing; then wash in hot water and dry in hot sawdust. Most plated work can be burnished with the sour beer mixture for the finger pads, and castile or ivory soap paste for the tool lubricant.

THREADING OPERATIONS*—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The subject of threading on the Brown & Sharpe automatic screw machine forms a very interesting topic for discussion both in regard to the designing of the cams and the setting up of the machine. This is a subject which confuses the beginner on account of the calculations necessary for determining the rise on the cam due to the relation between the speed of the spindle and the driving shaft. The various reversing devices, tripping devices and threading attachments also

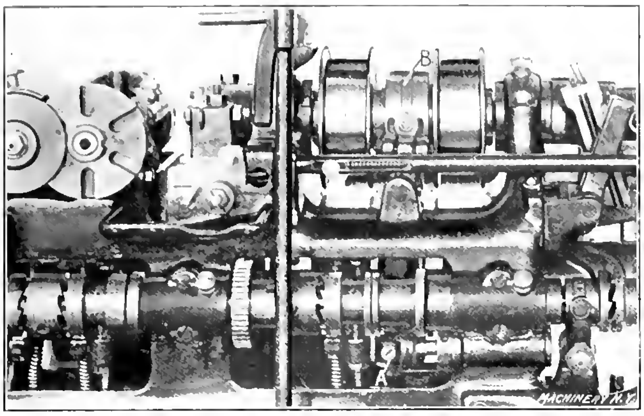


Fig. 1. (Rear View) Number 00 Brown & Sharpe Automatic Screw Machine showing Reversing Mechanism

play an important part in regard to threading. Until the various devices and arrangements used are fully understood, good results cannot be expected. Considering the difficulties encountered, the writer will discuss and illustrate methods and devices for overcoming same.

Reversing the Spindle

On the No. 00 Brown & Sharpe automatic screw machine the spindle is reversed to run backward by means of a spring plunger shown at *A*, Fig. 1; this plunger acting through the medium of the friction clutch *B* reverses the spindle instantaneously. But, to reverse the spindle from backward to forward, onto a slow speed (as is sometimes necessary when cut-

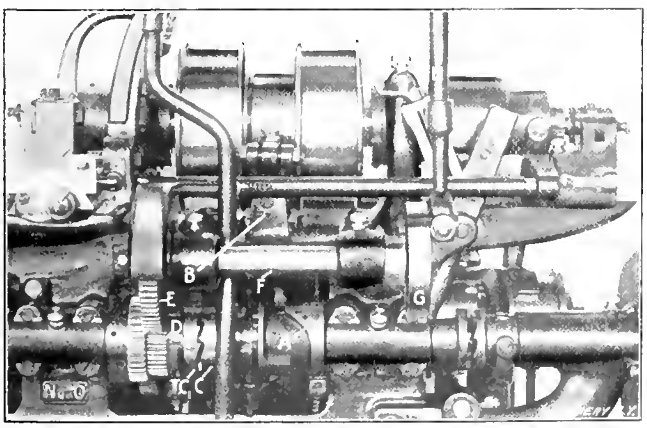


Fig. 2 (Rear View) Number 0 Brown & Sharpe Automatic Screw Machine showing Reversing Mechanism and Belt Shifting Attachment

ting a thread) requires one revolution of the driving shaft, which is equal to 1/120 of the speed at which the spindle is running. For example, let the spindle speed equal 2400 revolutions per minute and the speed of the driving shaft equal 120 revolutions per minute. Then the revolutions required for reversing the spindle $= \frac{2400}{120} = 20$ revolutions. The 20 revolutions used for this purpose is lost time, so to obviate this the Brown & Sharpe Mfg. Co. has provided a speed ratio threading attachment which is used in the turret. This attachment will be described later. On the No. 0 and No. 2 Brown & Sharpe automatic screw machines, the spindle is reversed from forward to backward by means of cam *A* and lever *B*, Fig. 2, which reverses the spindle instantaneously. The spindle is reversed from backward to forward by means of the same cam *A*, situated on the driving shaft, and considering that there are two lobes on this cam, it requires one-half revolution of the driving shaft to reverse the spindle. For example, let the spindle speed equal 1800 revolutions per minute; let the speed of the driving shaft equal 180 revolutions per minute. Then the number of revolutions required to reverse the spindle $= \frac{1800}{180 \times 2} = 5$ revolutions. To reverse the spindle from forward to backward and then forward again (as would be necessary where two threading operations come in succession) requires 4¾ hundredths of the cam surface on account of the tripping dogs on the drum which cannot be placed any closer together. This will be described under the heading "Setting the Tripping Dogs for Threading."

On the No. 2 Brown & Sharpe automatic screw machine, the spindle is reversed in the same manner as on the No. 0, but the ratio between the spindle speed and the driving shaft is different, being 1/240 instead of 1/360 of the speed at which the spindle is running. For example, let the spindle speed equal 1200 revolutions per minute; let the speed of the driving shaft

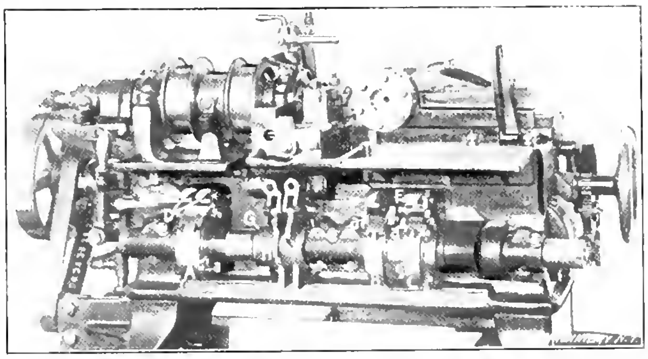


Fig. 3. (Front View) Showing Feeding, Reversing and Revolving Devices

equal 120 revolutions per minute. Then the number of revolutions required to reverse the spindle $= \frac{1200}{120 \times 2} = 5$ revolutions. But to reverse the spindle from forward to backward and forward again (as we explained regarding the No. 0 machine) requires 3¾ hundredths of the cam surface.

Setting the Tripping Dogs for Threading

The tripping dogs *a* which are used for reversing the spindle, feeding the stock, and revolving the turret are placed on the various drums on the front shaft as follows: The dog for reversing the spindle is placed on drum *A*, for feeding

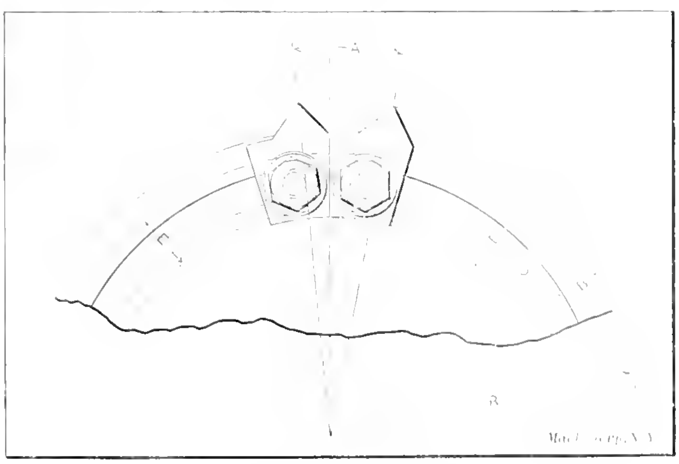


Fig. 4 Reversing Dogs in Position on Drum

the stock on drum *B* and for revolving the turret on drum *C*, as shown in Fig. 3. These dogs operate the levers *D*, *E*, and *F*, respectively, which, in turn, disengage a clutch on the driving shaft on the rear of the machine, thus operating the re-

* For further information on Brown & Sharpe automatic screw machine practice, see "Circular Form and Cut-off Tools," MACHINERY, March and April, 1910, and other articles there referred to.
† Associate Editor of MACHINERY.

versing, feeding and revolving devices. Where two threading operations follow in succession, the time required to revolve the turret is not always sufficient to bring the second tap or die into position. This is illustrated in Fig. 4, where two tripping dogs are shown in position on the drum. To illustrate the method of determining whether extra time should be allowed for clearance, take a practical example. Assume that a set of cams is required to be used on the No. 2 Brown & Sharpe automatic screw machine. Let the spindle speed equal 1200 revolutions per minute; let the time required to complete one piece equal 20 seconds. Then the number of revolutions to complete one piece $= \dfrac{1200 \times 20}{60} = 400$ revolutions.

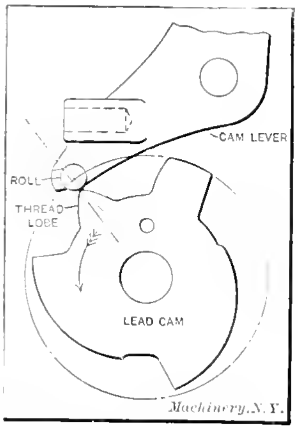


Fig. 5 Position of Roll on Thread Lobe when Spindle is reversed

Referring to the table for laying out cams in the Brown & Sharpe book we find that it requires five hundredths to feed stock, plus one hundredth for clearance. This gives 6 hundredths to revolve the turret. Referring to Table I we find that the angle A is 14 degrees. Then if the number of hundredths of the cam surface utilized in revolving the turret is less than 14 degrees, we would have to add more hundredths for clearance. In this case it requires 6 hundredths to revolve the turret. Then reducing 14 degrees to hundredths $= \dfrac{100 \times 14}{360} = 3.88$ hundredths. Therefore, it would not be necessary to add extra hundredths in this case.

Setting Dies and Taps

Before the reversing mechanism can operate, the clutch G must engage with clutch H. (See Fig. 3). After engaging these clutches, we set the reversing dog a so that the spindle will reverse just as the roll passes over the highest portion of the thread lobe on the rear cam, as shown exaggerated for clearness in Fig. 5. When the spindle is reversing at the exact point as mentioned, the die or tap holder containing the die or tap is placed in the turret, and brought into position as shown in Fig. 6. The cam roll is set on the thread lobe in the position shown. Here a button die holder A (draw-out type) is shown in position ready to start on the work. The face of the die should be set equal to the distance a, which varies from 1/16 to 3/16 inch, depending on the pitch of the thread and the length of the threaded portion. If the die does not travel on the work far enough at the first setting, the holder can be brought further out of the turret. The same procedure can be followed in setting the tap, except that it should be set more carefully, only going into the work a slight distance in starting, and then moving the holder out of the turret until the desired depth is reached. It is sometimes found necessary after setting the tripping dog, to adjust it slightly, especially when using a draw-out die or tap holder. The turret should not be revolved until the die or tap is clear of the work.

TABLE I GENERAL DIMENSIONS OF DRUM AND REVERSING DOGS

No. of Machine	A	B	C	D	E	R
00	20	$\frac{15}{64}$	$\frac{1}{4}$	$\frac{15}{16}$	$\frac{1}{2}$	2
0	17	$\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{32}$	$\frac{1}{2}$	$2\frac{3}{4}$
2	14	$\frac{13}{32}$	$\frac{5}{16}$	$1\frac{1}{4}$	$\frac{9}{16}$	$3\frac{1}{4}$

Finding Revolutions for Threading

When calculating the revolutions of the spindle required for threading, a greater number of revolutions should be allowed than the exact number of threads required on the piece, depending on the pitch of the thread (and in some cases on the length of the threaded portion, as when a short thread has to be produced necessitating the threading of a longer portion and then facing it off). This is to allow the die to approach the end of the piece on the rise of the thread lobe. The actual number of revolutions required for threading can be found by the aid of the following formulas:

$$\text{From 14 to 24 pitch } R = \frac{L}{p} + 1.5$$

$$\text{From 28 to 48 pitch } R = \frac{L}{p} + 3 \qquad (1)$$

$$\text{From 56 to 80 pitch } R = \frac{L}{p} + 4.5$$

Where L = length of the threaded portion, p = the pitch of the thread, or $\dfrac{1}{\text{number of threads per inch}}$, and R equals the revolutions of the spindle required for threading.

Converting Revolutions into Hundredths

Owing to the inconvenience of dividing the cam surface into the same number of equal parts as the revolutions required to complete one piece, the Brown & Sharpe Mfg. Co. has adopted the system of dividing the cam surface into one hundred equal parts, the hundredths being obtained by dividing the number of revolutions for each operation by the total number of revolutions required to complete one piece, taking the nearest decimal with two places. For example, if the number of revolutions required for the die to advance on to the work is 10, and the total number of revolutions required to complete one piece is 200, then $\dfrac{10}{200} = 0.05$ or 5 one-hundredths of the cam surface.

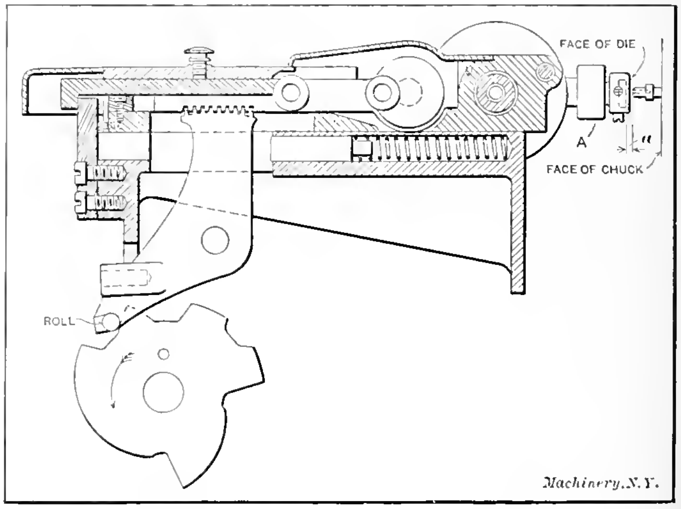


Fig. 6. Position of Roll on Thread Lobe when setting Die or Tap

Constructing the Thread Lobe

The method of laying out the cam lobe as described in the Brown & Sharpe book on the construction of their automatic screw machines, is shown at Fig. 7. The outer circle A indicates the relation between the center of the fulcrum of the lead lever and the cam. This circle represents the path which would be described by the center of the lead lever if it were revolved around the cam. The radius B equals the distance from the center of the roll to the center of the fulcrum on the lead lever. C equals the vertical distance from the center of the cam to the center of the fulcrum on the lead lever, and D equals the horizontal distance. Before constructing the thread lobe, the number of hundredths, the rise on the cam for threading, and the amount that the thread lobe is cut below the outer circle of the cam have to be determined. Then, after having drawn the various circles and lines necessary for the construction, we can proceed as follows: First, from the starting point a, the highest point b and the finishing point c, of the cam lobe, with a radius equal to B describe arcs cutting the outer circle A at the points d, e, and f. Then divide the spaces between the points d, e, and f into the same number of equal spaces as the number of revolutions required

TABLE III. SPINDLE REVOLUTIONS AND CAM RISE FOR THREADING*

Number of Threads per Inch — First Line: Revolutions of Spindle for Threading; Second Line: Rise on Cam for Threading

Length of Threaded Portion	80	72	64	56	48	40	36	32	30	28	24	20	18	16	14
$\frac{25}{32}$	67.00	61.00	54.50	48.50	40.50	34.50	31.00	28.00	26.50	25.00	20.50	17.00	15.50	14.00	12.50
	0.754	0.763	0.767	0.779	0.742	0.759	0.758	0.770	0.777	0.786	0.726	0.723	0.732	0.743	0.759
$\frac{13}{16}$	69.50	63.00	56.50	50.00	42.00	35.50	32.50	29.00	27.50	26.00	21.00	18.00	16.00	14.50	13.00
	0.782	0.788	0.795	0.804	0.770	0.781	0.794	0.798	0.807	0.817	0.744	0.765	0.755	0.770	0.789
$\frac{27}{32}$	72.00	65.50	58.50	52.00	43.50	37.00	33.50	30.00	28.50	26.50	22.00	18.50	16.50	15.00	13.50
	0.810	0.819	0.823	0.836	0.797	0.814	0.819	0.825	0.836	0.833	0.779	0.786	0.779	0.797	0.819
$\frac{7}{8}$	74.50	67.50	60.50	53.50	45.00	38.00	34.50	31.00	29.50	27.50	22.50	19.00	17.50	15.50	14.00
	0.838	0.844	0.851	0.860	0.825	0.836	0.843	0.853	0.865	0.864	0.797	0.808	0.826	0.823	0.850
$\frac{29}{32}$	77.00	70.00	62.50	55.50	46.50	39.50	35.50	32.00	30.00	28.50	23.50	19.50	18.00	16.00	14.00
	0.866	0.875	0.879	0.892	0.842	0.869	0.868	0.880	0.880	0.895	0.832	0.829	0.850	0.850	0.850
$\frac{15}{16}$	79.50	72.00	64.50	57.00	48.00	40.50	37.00	33.00	31.00	29.50	24.00	20.50	18.50	16.50	14.50
	0.894	0.900	0.907	0.916	0.880	0.891	0.904	0.908	0.909	0.927	0.850	0.871	0.873	0.876	0.880
$\frac{31}{32}$	82.00	74.50	66.50	59.00	49.50	42.00	38.00	34.00	32.00	30.00	25.00	21.00	19.00	17.00	15.00
	0.923	0.931	0.935	0.948	0.907	0.924	0.929	0.935	0.939	0.943	0.885	0.893	0.897	0.903	0.911
1	84.50	76.50	68.50	60.50	51.00	43.00	39.00	35.00	33.00	31.00	25.50	21.50	19.50	17.50	15.50
	0.951	0.956	0.963	0.972	0.918	0.946	0.953	0.963	0.968	0.974	0.903	0.914	0.920	0.929	0.941
$1\frac{1}{16}$	89.50	81.00	72.50	64.00	54.00	45.50	41.50	37.00	35.00	32.00	27.00	23.00	20.50	18.50	16.50
	1.007	1.013	1.019	1.028	0.990	1.001	1.013	1.018	1.026	1.005	0.956	0.978	0.968	0.982	1.002
$1\frac{1}{8}$	91.50	85.50	76.50	67.50	57.00	48.00	43.50	39.00	37.00	34.50	28.50	24.00	22.00	19.50	17.50
	1.063	1.069	1.076	1.084	1.045	1.056	1.061	1.073	1.084	1.083	1.009	1.020	1.038	1.035	1.062
$1\frac{3}{16}$	99.50	90.00	80.50	71.00	60.00	50.50	46.00	41.00	38.50	36.50	30.00	25.50	23.00	20.50	18.00
	1.119	1.125	1.126	1.141	1.100	1.111	1.122	1.128	1.128	1.146	1.062	1.084	1.086	1.089	1.093
$1\frac{1}{4}$	104.5	91.50	84.50	74.50	63.00	53.00	48.00	43.00	40.50	38.00	31.50	26.50	24.00	21.50	19.00
	1.176	1.181	1.188	1.197	1.155	1.166	1.171	1.183	1.187	1.193	1.115	1.126	1.133	1.142	1.153
$1\frac{5}{16}$		99.00	88.50	78.00	66.00	55.50	50.50	45.00	42.50	40.00	33.00	28.00	25.00	22.50	20.00
		1.238	1.244	1.253	1.210	1.221	1.232	1.238	1.245	1.256	1.168	1.190	1.180	1.195	1.214
$1\frac{3}{8}$		103.5	92.50	81.50	69.00	58.00	52.50	47.00	44.50	41.50	34.50	29.00	26.50	23.50	21.00
		1.294	1.301	1.310	1.265	1.276	1.281	1.293	1.304	1.303	1.211	1.233	1.251	1.248	1.275
$1\frac{7}{16}$			96.50	85.00	72.00	60.50	55.00	49.00	46.00	43.50	36.00	30.50	27.50	24.50	21.50
			1.357	1.366	1.320	1.331	1.342	1.348	1.348	1.366	1.274	1.296	1.298	1.301	1.305
$1\frac{1}{2}$			100.5	88.50	75.00	63.00	57.00	51.00	48.00	45.00	37.50	31.50	28.50	25.50	22.50
			1.413	1.422	1.375	1.386	1.391	1.403	1.406	1.413	1.328	1.339	1.345	1.354	1.366
$1\frac{9}{16}$			104.5	92.00	78.00	65.50	59.50	53.00	50.00	47.00	39.00	33.00	29.50	26.50	23.50
			1.469	1.478	1.430	1.441	1.452	1.458	1.465	1.476	1.381	1.403	1.392	1.407	1.426
$1\frac{5}{8}$				95.50	81.00	68.00	61.50	55.00	52.00	48.50	40.50	34.00	31.00	27.50	24.50
				1.535	1.485	1.496	1.501	1.513	1.524	1.523	1.434	1.445	1.463	1.460	1.487
$1\frac{11}{16}$				99.00	84.00	70.50	64.00	57.00	53.50	50.50	42.00	35.50	32.00	28.50	25.00
				1.591	1.540	1.551	1.562	1.568	1.568	1.586	1.487	1.509	1.510	1.513	1.518
$1\frac{3}{4}$				102.5	87.00	73.00	66.00	59.00	55.50	52.00	43.50	36.50	33.00	29.50	26.00
				1.647	1.595	1.606	1.610	1.623	1.626	1.633	1.540	1.551	1.558	1.566	1.578
$1\frac{13}{16}$				106.0	90.00	75.50	68.50	61.00	57.50	54.00	45.00	38.00	34.00	30.50	27.00
				1.703	1.650	1.661	1.671	1.678	1.685	1.696	1.593	1.615	1.605	1.620	1.639
$1\frac{7}{8}$					93.00	78.00	70.50	63.00	59.50	55.50	46.50	39.00	35.50	31.50	28.00
					1.705	1.716	1.720	1.733	1.743	1.743	1.646	1.658	1.676	1.673	1.700
$1\frac{15}{16}$					96.00	80.50	73.00	65.00	61.00	57.50	48.00	40.50	36.50	32.50	28.50
					1.760	1.771	1.781	1.788	1.787	1.806	1.700	1.721	1.723	1.726	1.730
2					99.00	83.00	75.00	67.00	63.00	59.00	49.50	41.50	37.50	33.50	29.50
					1.815	1.826	1.830	1.843	1.846	1.853	1.752	1.764	1.770	1.779	1.791

TABLE II. SPINDLE REVOLUTIONS AND CAM RISE FOR THREADING*

Number of Threads per Inch — First Line: Revolutions of Spindle for Threading; Second Line: Rise on Cam for Threading

Length of Threaded Portion	80	72	64	56	48	40	36	32	30	28	24	20	18	16	14
$\frac{1}{32}$	7.00	7.00	6.50	6.50	4.50	4.50	4.00	4.00	4.00	4.00					
	0.079	0.088	0.091	0.104	0.082	0.099	0.098	0.110	0.117	0.126					
$\frac{1}{16}$	9.50	9.00	8.50	8.00	6.00	5.50	5.50	5.00	5.00	5.00	3.00				
	0.107	0.113	0.120	0.129	0.110	0.121	0.134	0.138	0.147	0.157	0.106				
$\frac{3}{32}$	12.00	11.50	10.50	10.00	7.50	7.00	6.50	6.00	6.00	5.50	4.00	3.50			
	0.135	0.144	0.148	0.161	0.137	0.154	0.159	0.165	0.176	0.173	0.142	0.149			
$\frac{1}{8}$	14.50	13.50	12.50	11.50	9.00	8.00	7.00	7.00	7.00	6.50	4.50	4.00	3.50	3.50	
	0.163	0.169	0.176	0.185	0.165	0.176	0.171	0.193	0.205	0.204	0.159	0.170	0.165	0.186	
$\frac{5}{32}$	17.00	16.00	14.50	13.50	10.50	9.50	8.50	8.00	7.50	7.50	5.50	4.50	4.00	4.00	3.50
	0.191	0.200	0.204	0.217	0.192	0.209	0.208	0.220	0.220	0.236	0.195	0.191	0.189	0.212	0.212
$\frac{3}{16}$	19.50	18.00	16.50	15.00	12.00	10.50	10.00	9.00	8.50	8.50	6.00	5.50	5.00	4.50	4.00
	0.219	0.225	0.232	0.241	0.220	0.231	0.214	0.248	0.249	0.267	0.213	0.234	0.236	0.239	0.243
$\frac{7}{32}$	22.00	20.50	18.50	17.00	13.50	12.00	11.00	10.00	9.50	9.00	7.00	6.00	5.50	5.00	4.50
	0.248	0.256	0.260	0.273	0.247	0.264	0.269	0.275	0.279	0.283	0.248	0.255	0.260	0.266	0.273
$\frac{1}{4}$	24.50	23.50	20.50	18.50	15.00	13.00	12.00	11.00	10.50	10.00	7.50	6.50	6.00	5.50	5.00
	0.276	0.291	0.288	0.297	0.275	0.286	0.293	0.303	0.308	0.314	0.266	0.276	0.283	0.292	0.304
$\frac{9}{32}$	27.00	25.00	22.50	20.50	16.50	14.50	13.00	12.00	11.50	11.00	8.50	7.00	6.50	6.00	5.50
	0.304	0.313	0.316	0.329	0.302	0.319	0.318	0.330	0.337	0.346	0.301	0.298	0.307	0.319	0.334
$\frac{5}{16}$	29.50	27.00	24.50	22.00	18.00	15.50	14.50	13.00	12.50	12.00	9.00	8.00	7.00	6.50	6.00
	0.332	0.338	0.345	0.354	0.340	0.341	0.354	0.358	0.367	0.377	0.319	0.340	0.330	0.345	0.364
$\frac{11}{32}$	32.00	29.50	26.50	24.00	19.50	17.00	15.50	14.00	13.50	12.50	10.00	8.50	7.50	7.00	6.50
	0.360	0.369	0.373	0.386	0.357	0.374	0.379	0.385	0.396	0.393	0.354	0.361	0.354	0.372	0.395
$\frac{3}{8}$	34.50	31.50	28.50	25.50	21.00	18.00	16.50	15.00	14.50	13.50	10.50	9.00	8.50	7.50	7.00
	0.388	0.391	0.401	0.410	0.385	0.396	0.403	0.413	0.425	0.424	0.372	0.383	0.401	0.398	0.425
$\frac{13}{32}$	37.00	34.00	30.50	27.50	22.50	19.50	17.50	16.00	15.00	14.50	11.50	9.50	9.00	8.00	7.00
	0.416	0.425	0.429	0.442	0.412	0.429	0.428	0.440	0.440	0.456	0.407	0.404	0.425	0.425	0.425
$\frac{7}{16}$	39.50	36.00	32.50	29.00	24.00	20.50	19.00	17.00	16.00	15.50	12.00	10.50	9.50	8.50	7.50
	0.414	0.450	0.457	0.466	0.440	0.451	0.464	0.468	0.469	0.487	0.425	0.446	0.448	0.451	0.455
$\frac{15}{32}$	42.09	38.50	34.50	31.00	25.50	22.00	20.00	18.00	17.00	16.00	13.00	11.00	10.50	9.00	8.00
	0.473	0.481	0.484	0.498	0.477	0.484	0.489	0.495	0.499	0.503	0.460	0.468	0.496	0.478	0.486
$\frac{1}{2}$	44.50	40.50	36.50	32.50	27.00	23.00	21.00	19.00	18.00	17.00	13.50	11.50	10.50	9.50	8.50
	0.501	0.506	0.513	0.522	0.495	0.506	0.513	0.523	0.528	0.534	0.478	0.489	0.496	0.504	0.516
$\frac{17}{32}$	47.00	43.00	38.50	34.50	28.50	24.50	22.00	20.00	19.00	18.00	14.50	12.00	11.00	10.00	9.00
	0.529	0.538	0.541	0.554	0.522	0.539	0.538	0.550	0.557	0.566	0.514	0.510	0.519	0.531	0.546
$\frac{9}{16}$	49.50	45.00	40.50	36.00	30.00	25.50	23.50	21.00	20.00	19.00	15.00	13.00	11.50	10.50	9.50
	0.559	0.563	0.570	0.579	0.550	0.561	0.574	0.578	0.587	0.597	0.531	0.553	0.545	0.558	0.577
$\frac{19}{32}$	52.00	47.50	42.50	38.00	31.50	27.00	24.50	22.00	21.00	19.50	16.00	13.50	12.00	11.00	10.00
	0.585	0.594	0.598	0.611	0.577	0.594	0.599	0.605	0.616	0.613	0.567	0.574	0.566	0.584	0.607
$\frac{5}{8}$	54.50	49.50	14.50	39.50	33.00	28.00	25.50	23.00	22.00	20.50	16.50	14.00	13.00	11.50	10.50
	0.613	0.619	0.626	0.635	0.605	0.616	0.623	0.633	0.645	0.644	0.584	0.595	0.614	0.611	0.637
$\frac{21}{32}$	57.00	52.00	46.50	41.50	34.50	29.50	26.50	24.00	23.00	21.50	17.50	14.50	13.50	12.00	10.50
	0.641	0.650	0.654	0.667	0.622	0.649	0.648	0.660	0.675	0.676	0.620	0.616	0.637	0.637	0.637
$\frac{11}{16}$	59.50	51.00	48.50	43.00	36.00	30.50	28.00	25.00	23.50	22.50	18.00	15.50	14.00	12.50	11.00
	0.679	0.675	0.682	0.691	0.660	0.671	0.684	0.688	0.689	0.707	0.638	0.659	0.661	0.664	0.668
$\frac{23}{32}$	62.00	56.50	50.50	45.00	37.50	32.00	29.00	26.00	24.50	23.00	19.00	16.00	14.50	13.00	11.50
	0.698	0.706	0.710	0.723	0.677	0.704	0.709	0.715	0.719	0.723	0.673	0.680	0.684	0.690	0.698
$\frac{3}{4}$	64.50	58.50	52.50	46.50	39.00	33.00	30.00	27.00	25.50	24.00	19.50	16.50	15.00	13.50	12.00
	0.726	0.731	0.738	0.747	0.715	0.726	0.733	0.743	0.748	0.754	0.691	0.701	0.708	0.717	0.728

* In the above tables which contain the pitches as adopted by the A. S. M. E., 22 and 44 threads per inch have been omitted, being rarely used.

for threading. With a radius equal to B and with centers where the divisions cut the large circle A, describe arcs cutting the thread lobe as shown. On the arc cutting the point g, describe the roll circle, this being the position of the cam roll when starting the thread. Then proceed in like manner from the center of this roll, laying off an equal number of spaces corresponding to the pitch of the thread and the number of revolutions required for threading. A series of circles of the diameter of the cam roll, drawn on these centers gives the form of the thread lobe. The form thus produced would not give satisfactory results as crowding of the tap or die would occur owing to the spindle speed and the speed of the driving shaft not being constantly in the same ratio. It is, therefore, advisable to cut down the cam lobe after the first couple of threads. This is shown in Fig. 7 as the actual rise required for threading. As will be seen this is a rather long and difficult method of constructing a cam lobe and can be simplified where a circular milling attachment is available for cutting the cam.

Improved Method of Constructing Thread Lobe

In the method just described the rise on the thread lobe was determined graphically, this being a very complicated and tedious method. The advantage of the following method lies in its simplicity, as the lobe is determined mathematically.

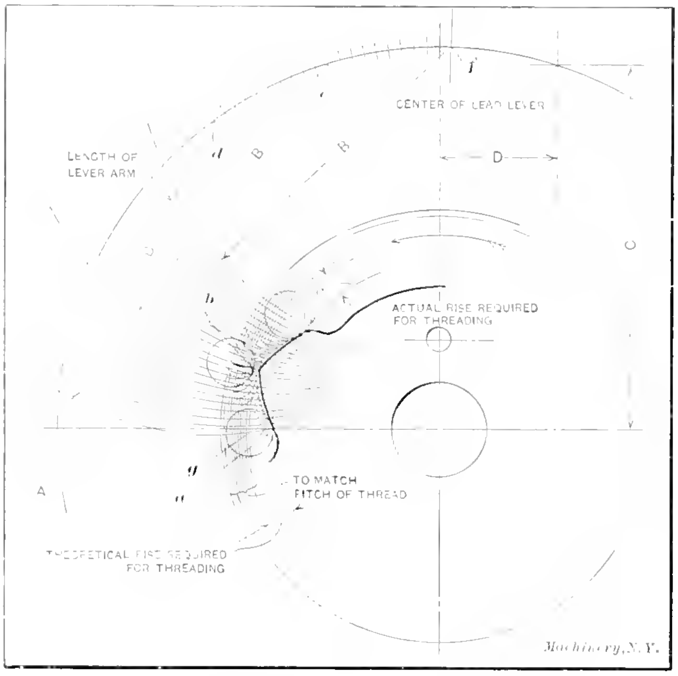


Fig. 7. Graphical Method of Constructing Thread Lobe

Before the thread lobe can be constructed, the length of the threaded portion, the pitch of the thread and the total number of revolutions of the spindle to complete one piece are required. When the number of revolutions for threading and the pitch of the thread are known, the rise on the cam can be found by the following formulas:

$$\begin{aligned}&\text{From 14 to 24 pitch, } r = R \times p \times 0.85,\\ &\text{From 28 to 48 pitch, } r = R \times p \times 0.88, \qquad (2)\\ &\text{From 56 to 80 pitch, } r = R \times p \times 0.90.\end{aligned}$$

Where R equals the revolutions required for threading, p equals pitch of thread, or $\dfrac{1}{\text{number of threads per inch}}$, r equals rise on cam.

In Tables II and III the results as obtained by formulas (1) and (2) for the various pitches are tabulated. To show the advantages of these tables, take a practical example. Assume that a set of cams is required for the No. 00 Brown & Sharpe automatic screw machine. To make the piece as shown at A, Fig. 8, let the spindle speed equal 2400 revolutions per minute, the number of revolutions to complete one piece, 400, time to make one piece, 10 seconds. Referring to A, Fig. 8, the length of the threaded portion is 3/8 inch and the pitch of the thread 1/32 inch, or thirty-two threads per inch. Referring to Table II, we find that the number of revolutions required is 15 and the rise on the cam 0.413. To construct the lobe, convert the revolutions into hundredths, or $\dfrac{15}{400} = 0.0375$ or $3\frac{3}{4}$ hundredths. Then draw the cam circle B, as shown in Fig. 8, and lay off on this circle $3\frac{3}{4}$ hundredths to advance on the screw and $3\frac{3}{4}$ hundredths to withdraw. Cut down the amount C below the outer cam circle B as required. Bisect the rise at E and with OE as a radius and a, b, and c as centers draw arcs intersecting each other at d and e. With d as a center and a radius OE, join the points b and a; with e as a center and radius OE join points c and a. This gives the shape of the thread lobe. For convenience in cutting, when a Brown & Sharpe circular milling attachment is available, the cam surface used by the tools is divided into minutes. Then to obtain the lead (or the number of minutes traversed for each 1/1000 inch rise) divide the number of minutes contained in that portion of the lobe used, by the rise. For example, $\dfrac{810}{0.413} = 1.96$, or approximately 2 minutes. The equivalents of hundredths and minutes are tabulated in Tables IV and V. The information as derived by the various formulas is recorded on the drawing as shown in Fig. 8, being used by the toolmaker when cutting the cam.

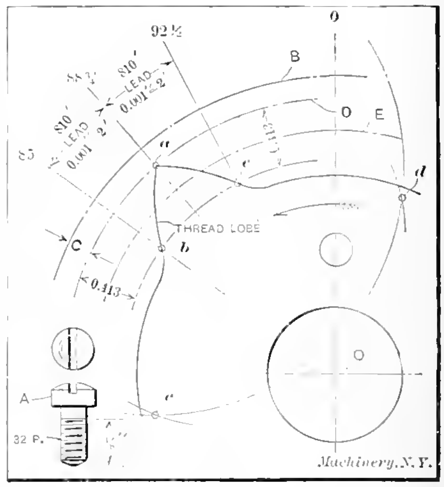


Fig. 8. Improved Method of Constructing Thread Lobe

Speed-changing Device

When threading brass, the spindle speed used for the other tools is generally suitable for taps and dies, but when threading gun-screw iron, Norway iron, machine steel, tool steel, etc., the speed used is too high. As has been previously explained under the heading "Reversing the Spindle," time would be lost in threading if the machine were reversed from forward to backward and then forward again (on the No. 00 Brown & Sharpe automatic screw machine). There are various methods of overcoming this difficulty, some of which are as follows:

One method of accomplishing this for the forming and cut-off operations is to run the spindle backward with the large

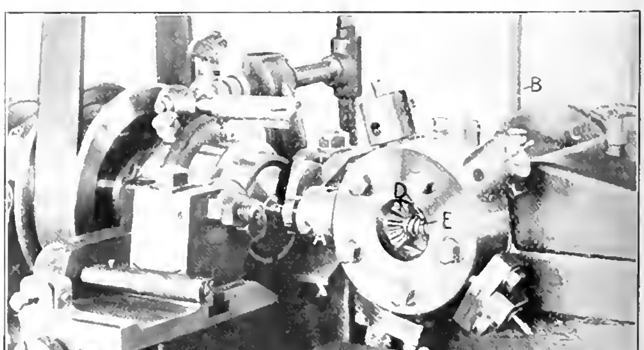


Fig. 9. Ratio Threading Attachment

pulley and forward with the small pulley on the countershaft. There is an objection to this, however, *viz.*, as there are generally other tools in the turret besides the die or tap holder, they would either have to be made to cut left-hand or else run at the same speed as the tap or die. It can easily be seen that in the majority of cases, the tools used in the turret would not be working at their maximum capacity if made to cut right-hand.

TABLE IV. HUNDREDTHS OF CIRCUMFERENCE EXPRESSED IN MINUTES

Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes
1.00	216	9.25	1998	17.50	3780	25.75	5562	34.00	7344	42.25	9126
1.25	270	9.50	2052	17.75	3834	26.00	5616	34.25	7398	42.50	9180
1.50	324	9.75	2106	18.00	3888	26.25	5670	34.50	7452	42.75	9234
1.75	378	10.00	2160	18.25	3942	26.50	5724	34.75	7506	43.00	9288
2.00	432	10.25	2214	18.50	3996	26.75	5778	35.00	7560	43.25	9342
2.25	486	10.50	2268	18.75	4050	27.00	5832	35.25	7614	43.50	9396
2.50	540	10.75	2322	19.00	4104	27.25	5886	35.50	7668	43.75	9450
2.75	594	11.00	2376	19.25	4158	27.50	5940	35.75	7722	44.00	9504
3.00	648	11.25	2430	19.50	4212	27.75	5994	36.00	7776	44.25	9558
3.25	702	11.50	2484	19.75	4266	28.00	6048	36.25	7830	44.50	9612
3.50	756	11.75	2538	20.00	4320	28.25	6102	36.50	7884	44.75	9666
3.75	810	12.00	2592	20.25	4374	28.50	6156	36.75	7938	45.00	9720
4.00	864	12.25	2646	20.50	4428	28.75	6210	37.00	7992	45.25	9774
4.25	918	12.50	2700	20.75	4482	29.00	6264	37.25	8046	45.50	9828
4.50	972	12.75	2754	21.00	4536	29.25	6318	37.50	8100	45.75	9882
4.75	1026	13.00	2808	21.25	4590	29.50	6372	37.75	8154	46.00	9936
5.00	1080	13.25	2862	21.50	4614	29.75	6426	38.00	8208	46.25	9990
5.25	1134	13.50	2916	21.75	4698	30.00	6480	38.25	8262	46.50	10044
5.50	1188	13.75	2970	22.00	4752	30.25	6534	38.50	8316	46.75	10098
5.75	1242	14.00	3024	22.25	4806	30.50	6588	38.75	8370	47.00	10152
6.00	1296	14.25	3078	22.50	4860	30.75	6642	39.00	8424	47.25	10206
6.25	1350	14.50	3132	22.75	4914	31.00	6696	39.25	8478	47.50	10260
6.50	1404	14.75	3186	23.00	4968	31.25	6750	39.50	8532	47.75	10314
6.75	1458	15.00	3240	23.25	5022	31.50	6804	39.75	8586	48.00	10368
7.00	1512	15.25	3294	23.50	5076	31.75	6858	40.00	8640	48.25	10422
7.25	1566	15.50	3348	23.75	5130	32.00	6912	40.25	8694	48.50	10476
7.50	1620	15.75	3402	24.00	5184	32.25	6966	40.50	8748	48.75	10530
7.75	1674	16.00	3456	24.25	5238	32.50	7020	40.75	8802	49.00	10584
8.00	1728	16.25	3510	24.50	5292	32.75	7074	41.00	8856	49.25	10638
8.25	1782	16.50	3564	24.75	5346	33.00	7128	41.25	8910	49.50	10692
8.50	1836	16.75	3618	25.00	5400	33.25	7182	41.50	8964	49.75	10746
8.75	1890	17.00	3672	25.25	5454	33.50	7236	41.75	9018	50.00	10800
9.00	1914	17.25	3726	25.50	5508	33.75	7290	42.00	9072	50.25	10854

TABLE V. HUNDREDTHS OF CIRCUMFERENCE EXPRESSED IN MINUTES

Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes	Hundredths of Circumference	Minutes
50.50	10908	59.00	12744	67.50	14580	76.00	16416	84.50	18252	93.00	20088
50.75	10962	59.25	12798	67.75	14634	76.25	16470	84.75	18306	93.25	20142
51.00	11016	59.50	12852	68.00	14688	76.50	16524	85.00	18360	93.50	20196
51.25	11070	59.75	12906	68.25	14742	76.75	16578	85.25	18414	93.75	20250
51.50	11124	60.00	12960	68.50	14796	77.00	16632	85.50	18468	94.00	20304
51.75	11178	60.25	13014	68.75	14850	77.25	16686	85.75	18522	94.25	20358
52.00	11232	60.50	13068	69.00	14904	77.50	16740	86.00	18576	94.50	20412
52.25	11286	60.75	13122	69.25	14958	77.75	16794	86.25	18630	94.75	20466
52.50	11340	61.00	13176	69.50	15012	78.00	16848	86.50	18684	95.00	20520
52.75	11394	61.25	13230	69.75	15066	78.25	16902	86.75	18738	95.25	20574
53.00	11448	61.50	13284	70.00	15120	78.50	16956	87.00	18792	95.50	20628
53.25	11502	61.75	13338	70.25	15174	78.75	17010	87.25	18846	95.75	20682
53.50	11556	62.00	13392	70.50	15228	79.00	17064	87.50	18900	96.00	20736
53.75	11610	62.25	13446	70.75	15282	79.25	17118	87.75	18954	96.25	20790
54.00	11664	62.50	13500	71.00	15336	79.50	17172	88.00	19008	96.50	20844
54.25	11718	62.75	13554	71.25	15390	79.75	17226	88.25	19062	96.75	20898
54.50	11772	63.00	13608	71.50	15444	80.00	17280	88.50	19116	97.00	20952
54.75	11826	63.25	13662	71.75	15498	80.25	17334	88.75	19170	97.25	21006
55.00	11880	63.50	13716	72.00	15552	80.50	17388	89.00	19224	97.50	21060
55.25	11934	63.75	13770	72.25	15606	80.75	17442	89.25	19278	97.75	21114
55.50	11988	64.00	13824	72.50	15660	81.00	17496	89.50	19332	98.00	21168
55.75	12042	64.25	13878	72.75	15714	81.25	17550	89.75	19386	98.25	21222
56.00	12096	64.50	13932	73.00	15768	81.50	17604	90.00	19440	98.50	21276
56.25	12150	64.75	13986	73.25	15822	81.75	17658	90.25	19494	98.75	21330
56.50	12204	65.00	14040	73.50	15876	82.00	17712	90.50	19548	99.00	21384
56.75	12258	65.25	14094	73.75	15930	82.25	17766	90.75	19602	99.25	21438
57.00	12312	65.50	14148	74.00	15984	82.50	17820	91.00	19656	99.50	21492
57.25	12366	65.75	14202	74.25	16038	82.75	17874	91.25	19710	99.75	21546
57.50	12420	66.00	14256	74.50	16092	83.00	17928	91.50	19764	100.00	21600
57.75	12474	66.25	14310	74.75	16146	83.25	17982	91.75	19818	......	......
58.00	12528	66.50	14364	75.00	16200	83.50	18036	92.00	19872	......	......
58.25	12582	66.75	14418	75.25	16254	83.75	18090	92.25	19926	......	......
58.50	12636	67.00	14472	75.50	16308	84.00	18144	92.50	19980	......	......
58.75	12690	67.25	14526	75.75	16362	84.25	18198	92.75	20034	......	......

Ratio Threading Attachment

The attachment *A*, shown in position in the turret in Fig. 9, serves to revolve the die or tap in the same direction as that in which the spindle is rotating, but at one-half the spindle speed. As before mentioned, it is used where no other slow movements are required except for threading, enabling the spindle to run at its maximum speed for all the other operations. The attachment is driven by a 3/8-inch round belt from the overhead works, the shaft passing through the turret head connecting pulley *C* with bevel gears *D*, thus driving the attachment *A*. The spring *E* acts in the same manner as the spring in the ordinary draw-out die or tap holder. The method of determining the shape of the cam lobe when using this attachment is as follows: Let the spindle speed for the forming and cut-off operations equal 2400 revolutions per minute, then the speed of this attachment will be 600 revolutions per minute. Assume the length of the threaded portion to be 3/16 inch and the thread 40 pitch. Referring to Table II, we find that it will require 10.5 revolutions. But considering that the speed of this attachment is one-half

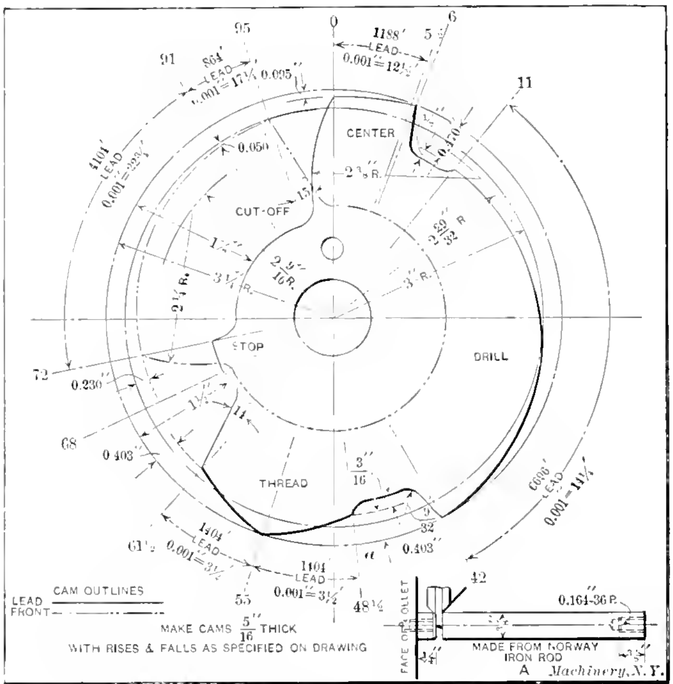


Fig. 10. Example of designing Thread Lobe when using Belt Shifting Attachment

the spindle speed, we would require $10.5 \times 2 = 21$ revolutions for cutting the thread. Again, as this attachment rotates in the same direction as the spindle, the speed of the attachment when backing off the work would be $2400 + 600$ or 3000 revolutions per minute. Then the number of revolutions required for backing off the work would be $\frac{2400}{3000} \times 10.5$, or 8.5 revolutions approximately. The same rise, 0.231, as given in Table II is used for each side of the thread lobe, but the number of hundredths contained in each part of the lobe is different, as it requires 21 revolutions to advance and only 8.5 revolutions to retreat.

Belt Shifting Attachment

The ratio threading attachment as shown in Fig. 9 is only suitable for cutting brass and fine threads on Norway iron, machine steel, etc. This attachment would not be entirely satisfactory for the No. 0 or No. 2 Brown & Sharpe automatic screw machine, as a more positive drive is generally required for these machines. In Fig. 2 is shown the No. 0 Brown & Sharpe automatic screw machine equipped with this speed-changing attachment. The countershaft is supplied with a large and a small pulley which will give the desired spindle speeds. This attachment is operated by the same dog and lever that reverses the spindle. When the dog on the cam shaft trips the lever, the clutches *C* and C_1 engage, thus driving gears *D* and *E*. The gear *E* being attached to shaft *F* revolves the disk *G* on which the eccentric connecting-rod *H* is attached. When the rod *H* is drawn up or down it shifts the belt from the large to the small pulley or *vice versa*. The system of gearing provided shifts the belt twice for every revolution of the driving shaft. Therefore, the number of revolutions required for changing the speed when the spindle is running at 1800 and 900 revolutions respectively would be as follows: When the spindle is running at 1800 revolutions per minute it would require $\frac{1800}{180 \times 2} = 5$ revolutions, but it is obvious that part of the time the spindle will be running at 900 revolutions per minute. Then the number of revolutions required to shift the belt when the spindle is running at 900 revolutions per minute $= \frac{900 \times 2}{180} = 10$ revolutions. Therefore, the actual number of revolutions required to shift the belt would be $\frac{10 + 5}{2} = 7\frac{1}{2}$ revolutions.

To explain thoroughly the method of designing the thread lobe, we will take a practical example. Assume that it is required to make the piece as shown at *A*, Fig. 10, the spindle speed being 1800 and 900 revolutions per minute respectively (using the 900 revolutions per minute for tapping). The cams for making this piece are shown in Fig. 10. The time required to make one piece being 17 seconds, or 510 revolutions, then the number of revolutions for threading found in Table II is 16.5; but as the tap will run at 900 revolutions per minute instead of 1800, we will require 16.5×2 or 33 revolutions for threading. Then the hundredths required equals $\frac{33}{510} = 0.0647$, or approximately $6\frac{1}{2}$, the rise on the cam being the same as that in Table II, 0.403. Referring to the table in the Brown & Sharpe book, we find that it will require 4/100 to feed the stock $+ 1 = 5/100$ to revolve the turret; this equals 25.5 revolutions to revolve the turret. Then the actual number of hundredths between the last operation and the starting of the thread lobe to revolve the turret and reverse the spindle is $25.5 + 7.5 = 33$ revolutions. Converting this into hundredths, we get 6.47 or approximately $6\frac{1}{2}$ hundredths. It is always good practice to allow plenty of clearance for threading, as the die or tap holder intended for the job may have to be replaced by one which would require more clearance.

* * *

In a note recently published in MACHINERY (see the January, 1909, and November, 1905, issues), attention was called to the limitations of sewing machine capacity. It was stated that the heating of the needle in thick goods prevents the needle exceeding a certain number of strokes per minute. On ordinary thin goods such as muslin the strength of the thread is the limitation of the capacity, however. If the cotton thread used on the average run of manufactured goods were of a higher tensile strength, the machines could be run faster. The Wilcox & Gibbs manufacturing machines are tested at about 3825 stitches per minute, and the common speed in use is somewhat less. The tests are made on a circular band of muslin which encircles the bench on which the machine is supported. The band of cloth is driven around and around over and under the bench at a speed amazing to one accustomed only to the work of the domestic sewing machine. If a stitch is 1/16 inch long the speed at 3825 stitches per minute is 239 inches per minute, or nearly 20 feet.

* * *

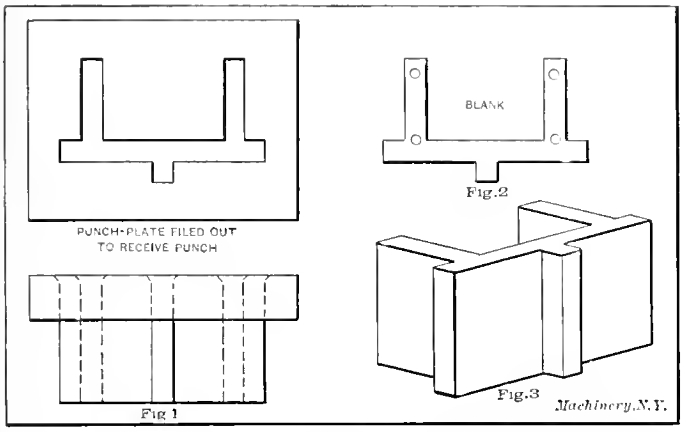
What is the limit of human endurance in handling parts? The answer depends on the shape, weight, and the distance that they have to be moved. Of a certain class of work, consisting of light objects, boys handle an average of one piece a second all day long, or 36,000 in ten hours. The object has to be picked up and mounted on a series of moving pins, the holes in the objects being comparatively small. Boys learn to do the work with ease and do not complain of weariness, but on the contrary seem light-hearted and cheerful. So expert do they become that the work is performed automatically—without thought—the operators being able to converse, laugh, joke and sing at their work. Curiously enough, if they stop to think what they are doing, they bungle and fall behind.

OUT-OF-DATE DIE-MAKING METHODS

By F. E. SHAILOR*

It seems as if die making has been known long enough for everyone engaged in sheet metal work to have found out the best methods and to use the best, instead of clinging to the original ideas such as filing out the punch holder to exactly fit the punch, making a large die (having many piercing dies in it) solid, and many other methods that have proved to be a source of trouble, extra expense for maintenance, etc. The following suggestions will be put in the form of comparisons and the reader can judge for himself which are the better:

First, let us take up various methods of forming the punch, and of securing it to the punch-plate. If we were to explore the junk boxes in the cellars of some of our best and oldest factories in which punches and dies are used, we would be very likely to find punches made as shown in Fig. 1, but long since discarded. Let us assume that we are about to make a punch and die to produce the blank shown in Fig. 2. The



Figs. 1, 2 and 3. Objectionable Method of Attaching Punch to Plate

method in vogue fifty years ago and still used by some large up-to-date (?) factories, is to machine the entire length of the punch as shown in Fig. 3. The punch-plate is then drilled and filed to fit the punch as tightly as possible and the back of the punch is upset as shown to prevent it from pulling out. Every die maker knows that it is "no cinch" to file out a die so that a templet fits absolutely even, though we have the advantage of the clearance in the die which makes it possible to enter the templet before the die is filed to size. This is not

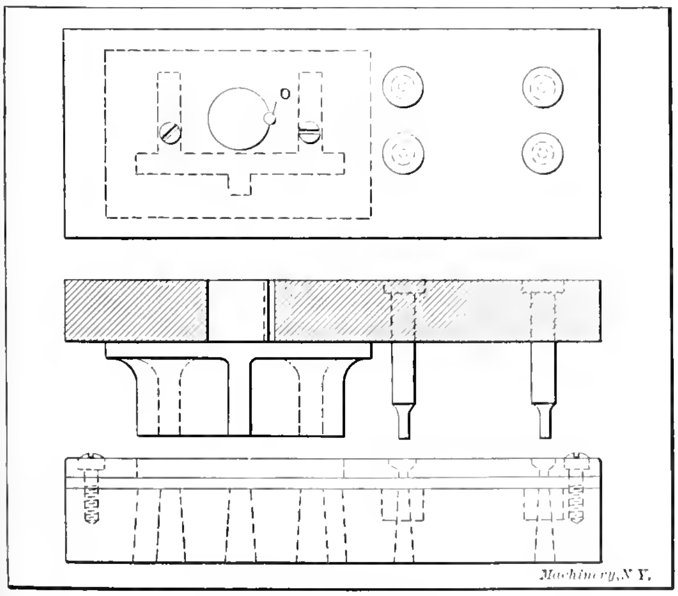


Fig. 4. Punch Attached to Die so as to obtain Greater Rigidity and Durability

the case, however, with the punch-plate shown in Fig. 1; this must be filed absolutely straight in order to secure a good fit.

The greatest objections to making a punch and punch-plate in this manner are the weakening of the punch and the difficulty experienced in making the fit good enough to rigidly hold the punch. We know that a plug and ring gage will "shake" if there is a difference of 0.0001 inch; can we expect to file perfectly straight and within one-tenth of a thousandth? After a greater length of time has been spent making the punch-plate than was necessary for making the die, we find we are obliged to peen the punch-plate in order to have it fit the

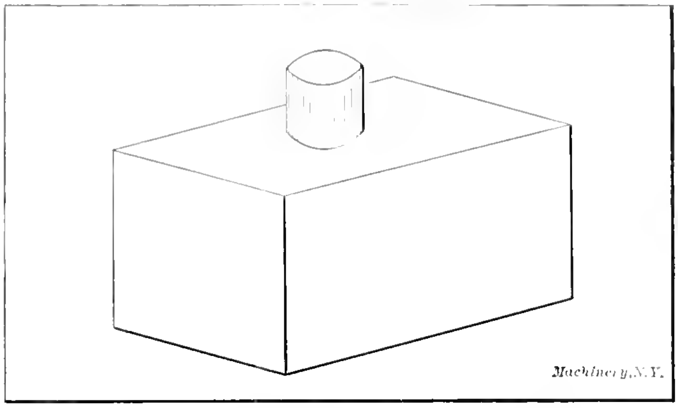


Fig. 5. First Step in Making Punch shown in Fig. 4

punch tightly. Then after the press operator makes one mis-cut, or a "half cut," the punch which is not sufficiently rigid, springs to one side, shears, loosens the peening effect, which causes the punch to "shake" in the punch-plate and this continues to cause trouble until the die is worn out.

Again, fitting the punch in the plate, necessitates fitting the entire length in the die, in order to allow the plate to come in contact with the die so that the holes for the piercing punches can be transferred from the die with some degree of accuracy. This latter method is a poor way to transfer, first because the piercing dies have clearance and the smallest diameter is in

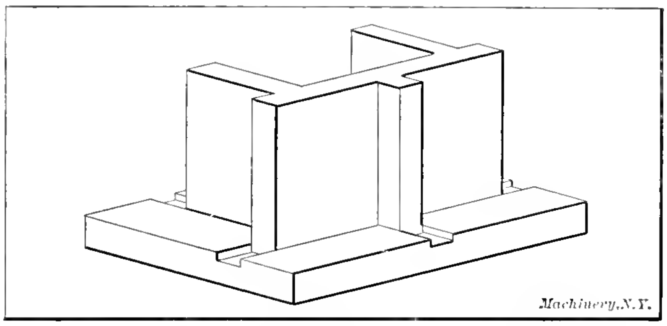


Fig. 6. Another Objectionable Method of attaching Punch to Plate

contact with the punch-plate so that whatever is used to transfer does not, of course, fit the dies. On the other hand, if the punch-plate is away from the die there are chances of error in transferring, one chance being in the truth of the parallels used and another and greater in the taper hole which is being used to guide a straight transfer point.

The style of dies referred to in the foregoing can be found in the cellar of the New Haven Clock Co. with forty years of rust thereon. Messrs. Thomas N. Gierding and T. Grady of the New Haven Clock Co. have done considerable toward bringing die making out of its infancy, as it were, for which they deserve due credit. The writer has seen in numerous shops types of dies and methods of making them that originated with these men.

An improved method of holding a punch is shown in Fig. 4. The way this punch and die is made will be described, so that the reader can judge which is the more practical, easier to make, and more durable. As there are piercing punches and dies, the punch-plate, stripper, and die would be doweled together, laid out, indicated, and the holes for the piercing punches drilled and bored, assuming, of course, that the die has been filed out for the blanking punch. The outline of the hole in the die for the blanking punch is then transferred to the punch-plate (a lead pencil is good enough for this purpose). A point approximately in the center of this outline is found, marked and indicated approximately true, drilled and bored, and at the same setting a light cut is taken to insure a perfect seat for the punch. The latter is turned up as shown

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in Fig. 5. The piercing punches are left 1/16 inch longer than the blanking punch so that the outline of the die may be accurately transferred to the punch. A dowel pin hole *D* is drilled and reamed in the shank and plate so that it will be possible to place the punch back in the same position after removing it. After the punch is milled to the scribed outline, the edge is slightly beveled. The punch is then returned to its seat in the plate and the piercing punches are entered and used as a guide to shear the blanking punch. It will be seen that the lead pencil was good enough for transferring the outline as the punch is guided entirely by the piercing punches when being sheared. Compare the simple and efficient method

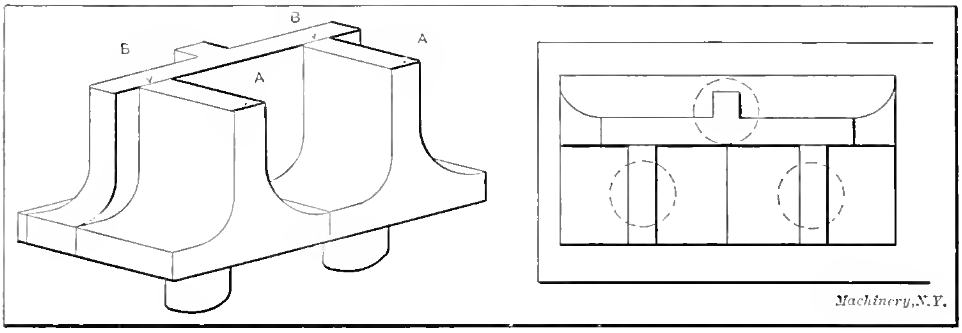

Fig. 7. Sectional Punch for Producing the Blank shown in Fig. 2

of securing the punch to the plate illustrated in Fig. 4 with that shown in Fig. 1; note in the former the rigidity of the punch, the absence of the possibility of springing on a "half cut," the strength of the punch-plate, and the reduced chances of the punch springing out of shape when being hardened. The method illustrated in Fig. 4 is the best that has come under the writer's experience of sixteen years for easily making a rigid, altogether satisfactory punch and die. If any reader knows of a better method we would all like to know of it, and I, for one, will adopt it.

Fig. 6 shows another method of making punches and securing them to the holder, which has several bad features: First, there is not sufficient seat. Imagine a punch one inch long by one-half inch wide, made in this way. A movement of 0.001 inch at the seat means enough at the cutting edge to cause it to shear. Then after the punch is hardened, will it fit the recess planed for it? Not much! But if it had a wide seat or flange, even though it was merely set on the plate, it would be far better as the flange helps wonderfully towards holding the punch in shape when hardening. A good way to make the punch shown in Fig. 1 is to make it in parts, as in Fig. 7. If the punches spring open or together, we have a means of bringing the ends back by rotating them about the shank. In this way quite a movement can take place at points *A* and what little the punch opens at *B* will not materially affect the cutting action.

Oftentimes the die to be made is, say, eight inches long and

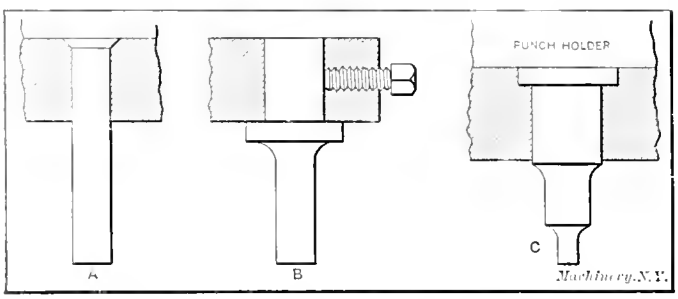

Fig. 8. Three Ways of Securing Piercing Punches

contains several piercing dies besides the blanking die. The writer has made such dies solid, but finds it better practice to make the die in halves, the blanking die being made of tool steel and the part containing the piercing dies of machine steel with tool steel bushings. It is much easier to harden a small die without perceptibly changing its shape than it is one eight inches long; besides, if the piercing dies demand accuracy between the centers, it is necessary to grind the holes after hardening, with a solid die, whereas with one having a soft machine steel block, changes in the center distances of the holes are eliminated. Another good feature of the sectional die is that if some change is made after the die is complete, whereby a smaller or larger hole is needed, a new bushing can easily be inserted; but not so if the die is solid and of tool steel, hardened. This same scheme can be employed on the punch-plate. [A die built on the plan referred to in the foregoing, is shown in Fig. 10. As the illustration shows, the piercing dies are independent of the blanking die, being in the form of bushings. This engraving was taken from one of the advertisements of the Firth-Sterling Steel Co.—Editor.]

The writer has found it good practice always to bore the punch-plate, stripper, and die together, when possible to do so. Some die makers insert the blanking punch as far as possible in the die, put parallels between the plate and die, and then, with a twist drill, "soak" the holes into the plate from the die. After the piercing punches are in the plate, they are knocked this way and that to line them up; but suppose those piercing punches were 1 inch in diameter or even ⅝ inch; such sizes are not knocked around so easily and this is a poor job at best. Peening is resorted to on punches that do not move easily; that is, the stock near the punches is indented with a blunt cold chisel, sufficiently to cause it to "flow" and force the punch over. But only a very few strokes in the press are

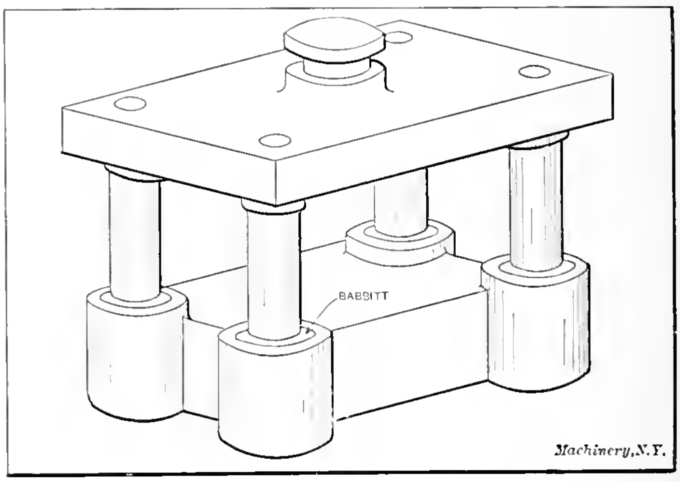

Fig. 9. Die with Guide Posts inserted in Babbitt Bearings

necessary to cause the stock to flow back again, and then there is a sheared punch, and a burr on the work. The die is then taken out and the stock peened again just to make the punch line up until it is off the maker's hands. A few dollars extra, expended in properly making the die, is a mighty good investment. The first cost of a die may be low, but it does not necessarily mean that it is a cheap die; it is a mighty expensive one in the long run, and a toolmaker that will knock punches, peen the punch-plate, or other "after-me-the-deluge" methods, ought not to be classed as a toolmaker—he's a "butcher" and should be treated as such.

The method of securing piercing punches varies in different shops. Some make a straight punch as at *A*, Fig. 8, and hold it in the plate by riveting; others make it as at *B* and secure it to the plate by means of a set-screw on the side; but the ideal method is shown at *C*. This punch has an excellent seat, it is easy to make, cannot be pulled out and is reinforced to eliminate all spring as far as possible. If this is the ideal method of making piercing punches, why is it that supposedly modern shops cling to set-screws that tend to displace the punch, to riveting the head, and to making punches the same size the entire length—the weakest construction of all.

When making dies having guide posts, as in Fig. 9, which shows a sort of sub-press construction, it is almost universally customary to bore the holes to fit the guide-pins. It is a long,

expensive, and difficult job to bore four one-inch holes in the top plate and four one-inch holes in the bottom plate and have the four pins line up with and travel freely in the holes. I have found it good practice to bore the holes in the plate to hold the pins, but the holes in which the pins are to travel can be drilled say 1/4 inch large and anywhere within 1/16-inch of the correct location. The punch is then entered into the die (the pins being first treated to a light coating of graphite and oil) and the holes are babbitted. This method insures absolute alignment, the work is easily done and no great attention need be paid to center distances or to the diameter of the holes. When bored holes are employed, it means absolute accuracy between the centers of the top and bottom plate; it means that the holes must be bored to fit exactly the pins which travel in them, as otherwise the die will shear; it means a lot of unnecessary work on the part of a skilled mechanic, because four one-inch pins will not spring here and there just to be accommodating, and, besides, the fit obtained by boring must of necessity be a trifle free in order to work easily when shearing the punches. With babbitted holes, however, the fit is excellent but it is not made until after the punch and die are entered, and the press can take care of a tight fit or, rather, perfect alignment.

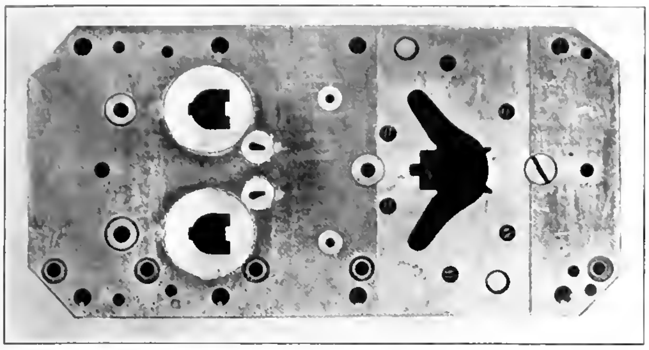

Fig. 10. Die Construction in which Piercing Dies are in the Form of Bushings and Independent of the Blanking Die—Taken from one of the Advertisements of the Firth-Sterling Steel Co

* * *

"DON'TS" FOR PLANER MEN

By DONALD A. HAMPSON

Don't cut into parallels.

Don't run a planer with a loose rack.

Don't put greasy fingers on finished work.

Don't brush dirt off the table into the ways.

Don't forget that a little grease is good for gears.

Don't let chips accumulate around the bull wheel.

Don't use a finger-clamp when a U-clamp can be applied.

Don't finish a piece of cast iron with anything but a broad flat tool.

Don't try to cut a keyway in a shaft without some positive stop for it.

Don't stick wrenches, tools, or hammers in the post holes in the table.

Don't try to true up the top of a badly worn planer table with just one cut.

Don't tighten on a clamp unless the bolt enters the nut for its full thickness.

Don't forget to bevel slightly both ends of a casting before taking a finish cut.

Don't leave a rough surface when that surface has to be used later to line up by.

Don't "clear a space" to put on a new job; a live man never has a littered-up planer.

Don't consider a job of angular cutting completed until you have set the head back to "zero."

Don't forget that an occasional drop of oil on bolts and nuts prolongs their life considerably.

Don't take a long "wind chip" because you are too lazy to set the dogs up for the short cuts at each end.

Don't forget that a spring tool, or a modified form of one, is best to finish a cast iron surface accurately.

Don't clean out T-slots without first running the table out so that no chips can fall into the oil drip cups.

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Don't put a clamp on a piece of finished work without a piece of heavy paper between the clamp and work.

Don't tighten a chuck so that a light piece is distorted and expect the planed surface to be true when taken out.

Don't set a tool to a height gage for any but the very lightest cuts, without allowing for the spring of the tool.

Don't neglect a belt that shows signs of coming apart; if you do you may get an ugly cut from it when it gives way.

Don't do all or half of your short work in the middle of the planer; let the wear be distributed to the ends as well.

Don't fail to look under the cross-rail and saddle for drops of oil and to wipe them off before finishing a cast iron surface.

Don't trust to the base and jaws of a chuck to make your work parallel and square unless you *know* that the chuck is right.

Don't throw away good wooden wedges and blocks; you can never tell how soon the same job will come up again and you may need them.

Don't do any unnecessary hammering on the planer; if clearances have to be cut, do that before placing the work on the machine.

Don't use any but a solid wrench, and one that fits, to set dogs; an adjustable one makes rounded nuts and may prove dangerous as well.

Don't work one head on a job simply because "it wouldn't pay to set the other head for just one piece"; do a little hustling and make it pay.

Don't fail to put bolts as near the work as possible, and in any case give yourself the benefit of 2 to 1 leverage when setting bolts, clamps and packing.

Don't stop the table by half shifting the belts without locking the shifting mechanism; many a man has been maimed by neglecting to do this.

Don't think that the elevating screws and their bearings never need oil; the top of the arch is too often thick with dust and the bearings completely dry.

Don't let the rear oil pockets fill up with chips, blocks and tools; the chips jar out on the ways and the tools may fall inside and "short circuit" the stroke.

Don't fail to try the ways of a planer at least once a year; no matter how carefully the machine may have been set, settling of the floor or foundation may have occurred.

Don't start a side cut downward without first making sure that all interferences in the way of work or bolts are below the plane of the head at the bottom of the cut.

Don't lubricate the cross-rail of your machine with a squirt can; saturate a piece of clean waste and oil with this; a film of oil on the sides is better than many drops on the table or work.

Don't pass a job lined up with the cross-rail as being square without proving it, unless the cross-rail and housings have been tested and found correct, within a reasonable length of time.

Don't be too particular about packing up a rough job, but remember that on a "perfect" one the minutes spent in shimming up and papering will save the hours that would have to be spent in fitting or recutting.

Don't forget that a box containing short lengths of drawn steel makes a valuable and handy set of gages for the planer; have, if possible, all sizes, by sixteenths, up to one inch, and larger sizes varying by one inch.

Don't forget that a man with an indicator can line up a job absolutely correctly, quicker than with a paper feeler; with the indicator there is the satisfaction of knowing at all times just how accurately the work is set.

Don't loosen bolts preparatory to raising or lowering the cross-rail before you have carefully wiped or scraped off all dirt on the face of the housings; the machine is often blamed for inaccuracies resulting from dirt behind the rail.

Don't forget that two straps and eight posts—two on each side—will allow you to take as big a cut on a heavy casting without its shifting as ten straps and no posts; the posts can also be set up quicker and their use gives more working surface on the top.

MAKING THE DeVILBISS PLIERS—2

By ETHAN VIALL*

The Cam Operations

The process through which the cams of the DeVilbiss pliers go, from the cold rolled steel strips to the finished article, is comparatively simple, the steps being:

1. Blanking.
2. Flattening.
3. Trimming.
4. Drilling and reaming.
5. Burring on the disk wheel.
6. Tumbling.
7. Assembling.

The first four steps are illustrated at *A*, *B*, *C* and *D*, Fig.

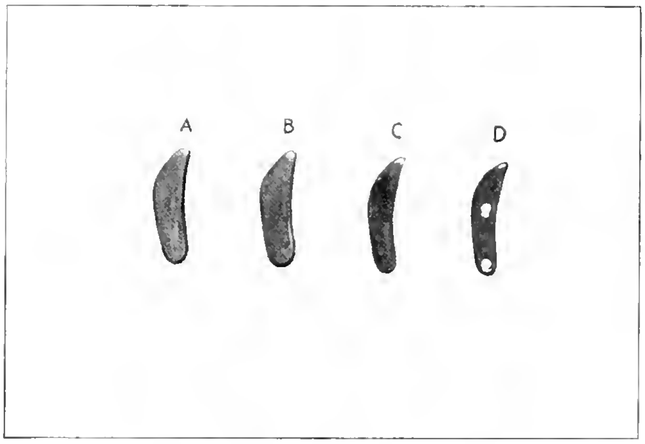

Fig. 24. The First Four Steps in the Making of a Plier Cam

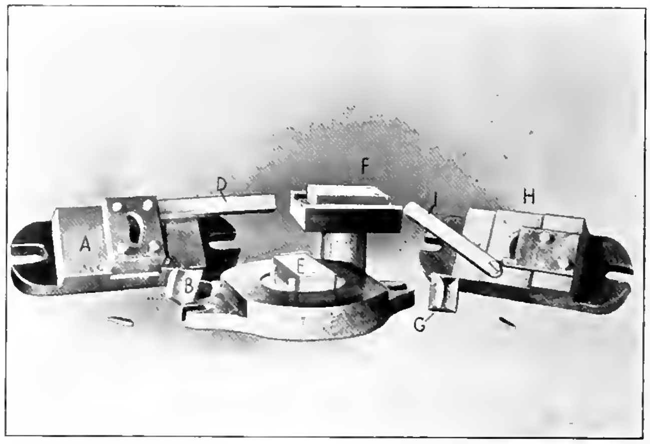

Fig. 25. The Blanking, Flattening and Trimming Dies

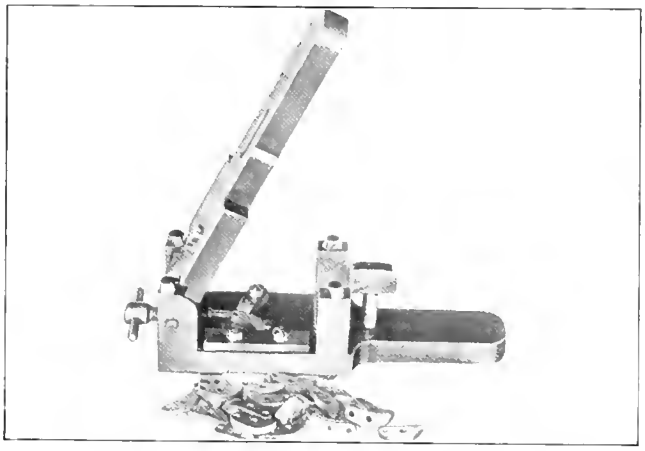

Fig. 26. Cam Drilling and Reaming Jig (Open)

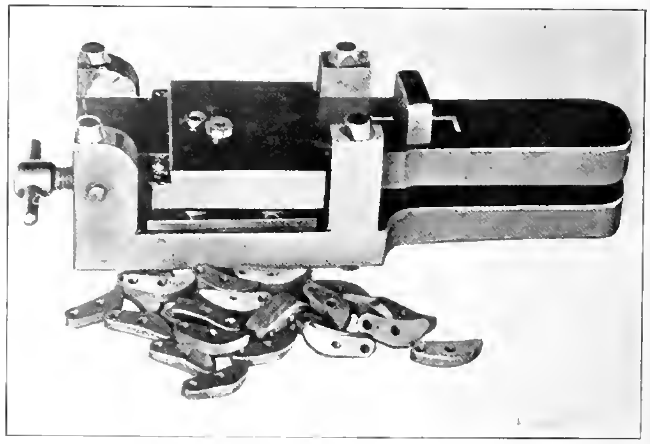

Fig. 27. Cam Jig Closed, Ready for Drilling

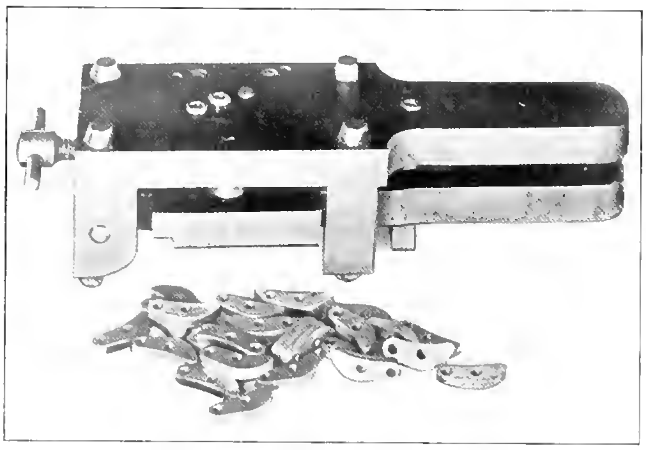

Fig. 28. Cam Jig Reversed, Ready for Reaming

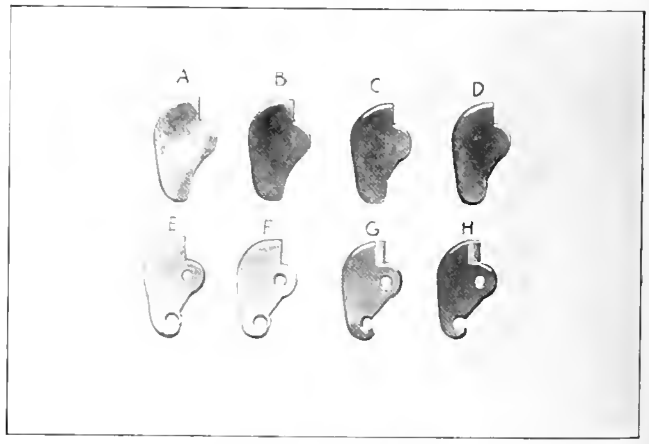

Fig. 29. Eight Steps in Making a Moving Cutter Blade

24, while at *A*, Fig. 25 is shown the blanking die, and at *B* the blanking punch; *D* is the stock guide, and a simple pin acts as a spacing stop. *E* and *F* are the flattening punch and die and *G* and *H* the trimming punch and die. In using the trimming die, the punch is not, of course, set to enter the die on the stroke, but is set about the thickness of thin paper above it, so that one blank pushes the previous one through, and in this way the keen edge of the die is preserved much longer. The lever *I* on die *H*, is used to press the cam blank firmly against the stops; the pin on the lever really forming one side of a triangle of stops.

Combination Drilling and Reaming Jigs

The practice of drilling and reaming flat pieces in the same jig, is not uncommon, yet the methods differ considerably and as there is no simpler method than the one here shown, the jigs will be described in detail. Fig. 26 shows one of these combination jigs open with the drilled cam in position. It will be noted that the cam is located in the jig by stops in contact with the point and rolling side, and that the clamping-screw point comes in contact with the rounded end in such a way as to wedge the cam in firmly. The hinged cover also has a pin in it that presses the cam down firmly onto the lower plate as the locking thumb-screw is turned. The thumb-screw just mentioned has the head slightly beveled on the underside and this together with the threaded end that screws into the lower plate, takes care of any possible difference in the thickness of the cams and produces a firm contact. An objection might be raised here, that this would throw the drilling bushings out of line, but the cams are flattened to such uniform thickness that the error is too

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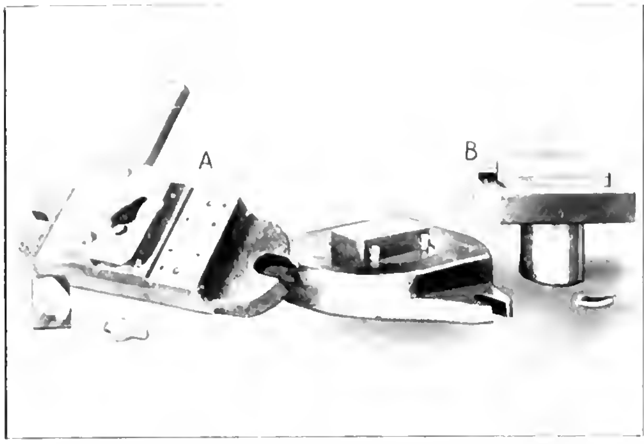

Fig. 30 Blanking and Flattening Dies for Moving Cutter Blades

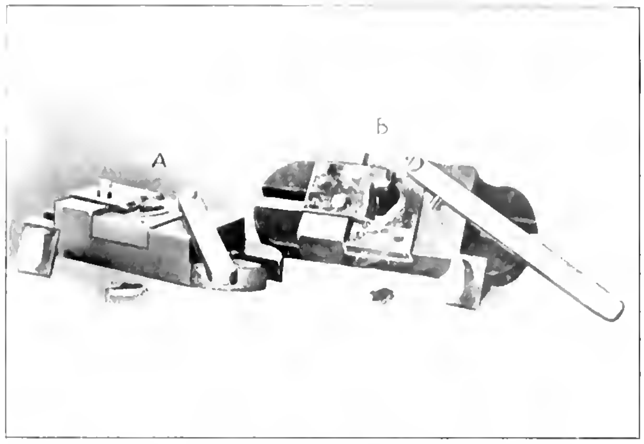

Fig. 31. Trimming and Shaving Dies for Moving Cutter Blades

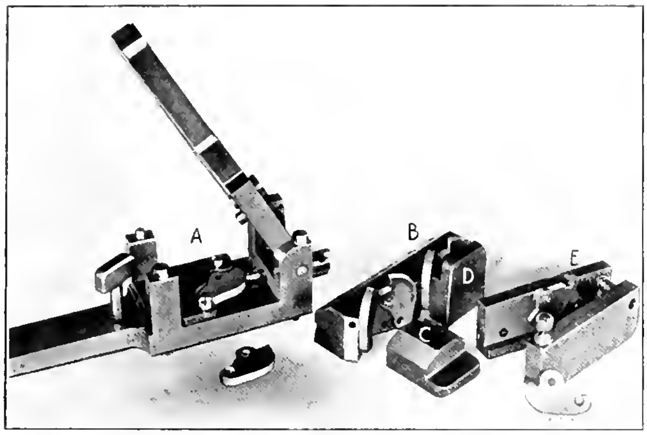

Fig. 32. Drilling, Reaming and Milling Jigs for Moving Cutter Blades

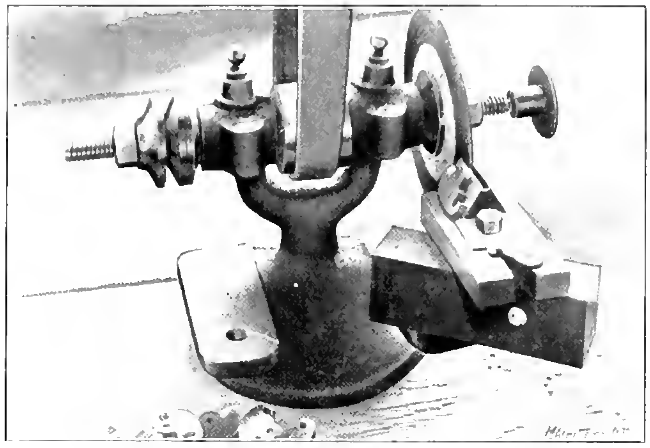

Fig. 33 Wheel and Fixture for Grinding Cutting Edges

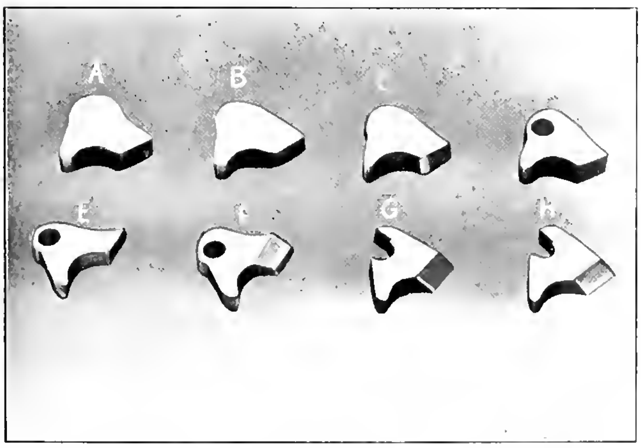

Fig. 34 Eight Steps in the Manufacture of the Fixed Blades

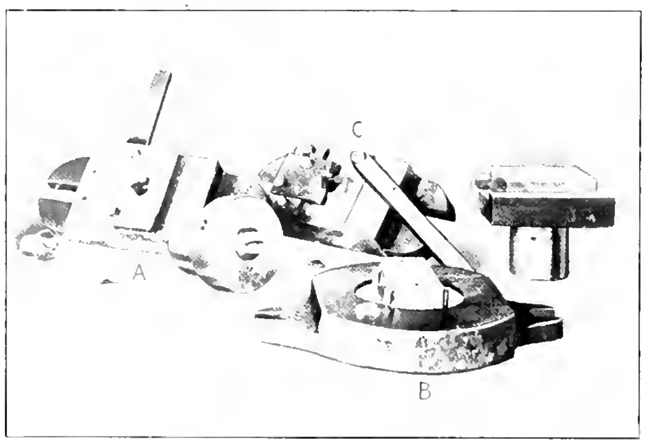

Fig 35. Blanking, Flattening and Trimming Dies for Fixed Blades

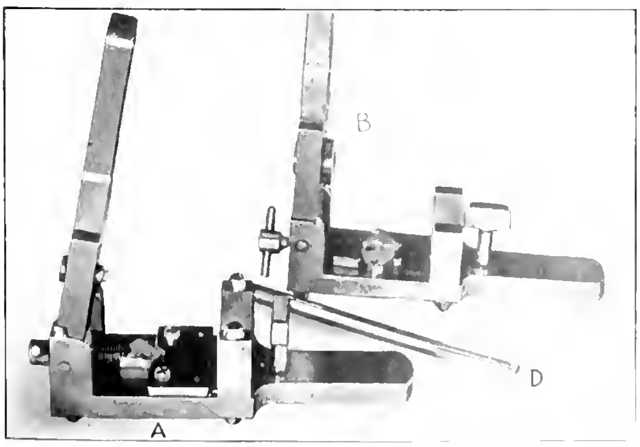

Fig 36 Drilling and Reaming Jigs for the Fixed Blades

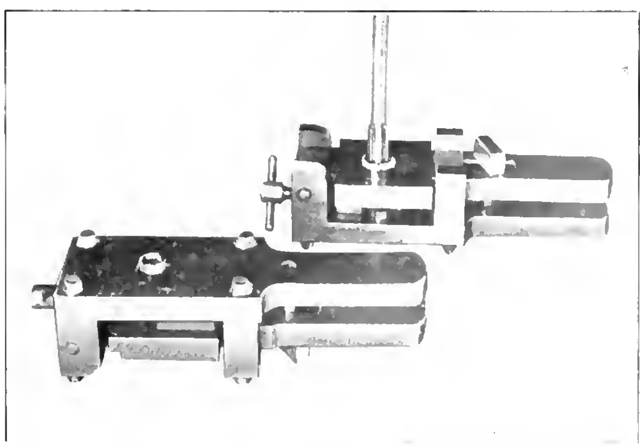

Fig 37 The Jigs shown in Fig 36 Closed and Ready for Use

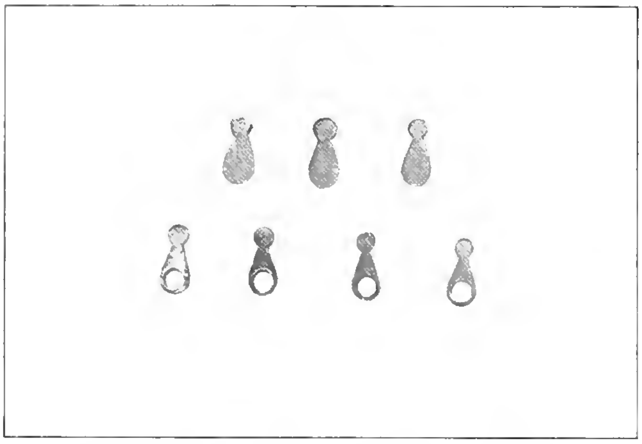

Fig 38 Various Steps in the Manufacture of Plier Links

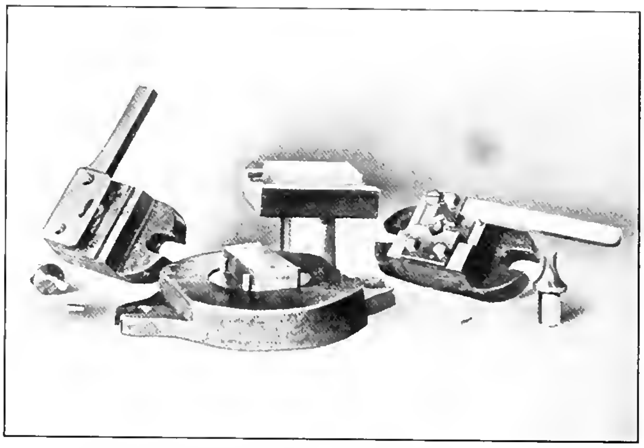

Fig. 39. Link Blanking, Flattening and Trimming Dies

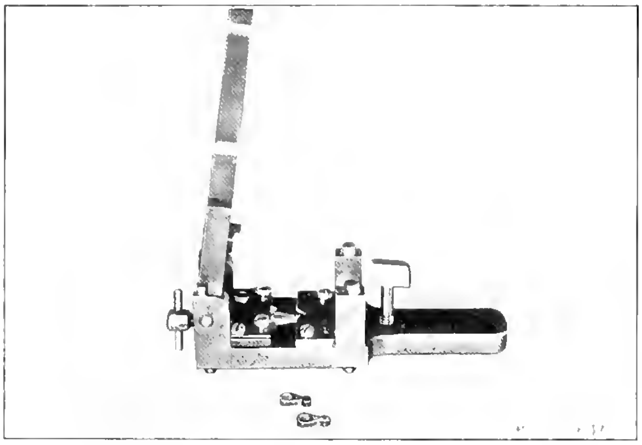

Fig 40. Link Drilling and Reaming Jig

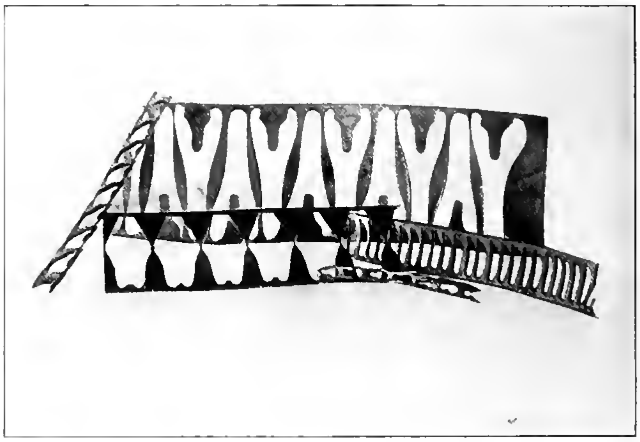

Fig. 41. Samples of Punched Scrap

slight to be reckoned with; indeed considerable variation can be allowed without causing any serious trouble. Fig. 27 shows the jig closed ready for drilling, and Fig. 28 shows it turned over ready for reaming. It will be seen that in the reaming operation, the jig rests solidly on its legs; there is no tendency for the bushings to be sprung out of line and the pin in the cover which holds the cam in place, allows enough space between the cam and the cover for end clearance as the reamers feed through.

After drilling and reaming, the cams have the burrs ground off by holding them on a disk grinder; they are then tumbled and sent to the assemblers.

Shop Operations on Moving Cutter Blades

The shop operations on moving cutter blades are as follows:

1. Blanking.
2. Flattening.
3. Trimming.
4. Shaving.
5. Drilling and reaming.
6. Burring on disk wheel.
7. Cutting edges milled.
8. Link hole slotted out.
9. Hardening in oil.
10. Tempering in oil.
11. Grinding cutting edges.
12. Grinding and polishing edges.
13. Polishing sides.
14. Assembling.

Fig. 29 represents these operations on each piece, as follows: *A*, blanked; *B*, flattened; *C*, trimmed; *D*, shaved; *E*, drilled and reamed; *F*, cutting edges milled; *G*, link hole slotted, and *H*, hardened and tempered.

Both the moving and fixed cutter blades are made of tool steel 15/64 inch thick, and after being blanked in the die *A*, Fig. 30, the moving jaws are flattened from 15/64 to 0.223 inch, which takes out the unevenness around the edges ready

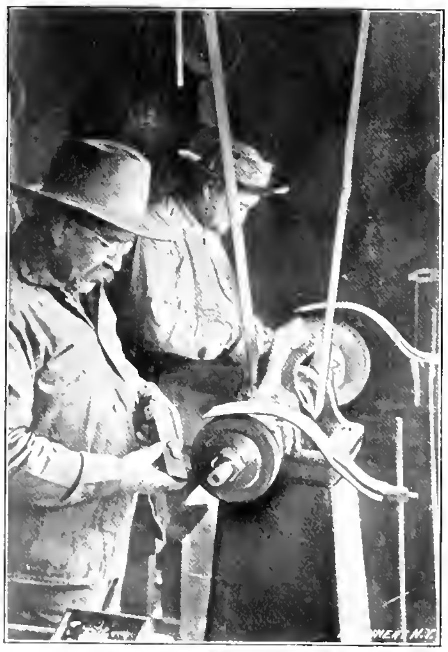

Fig. 42. Polishing the Sides of the Cutter Blades

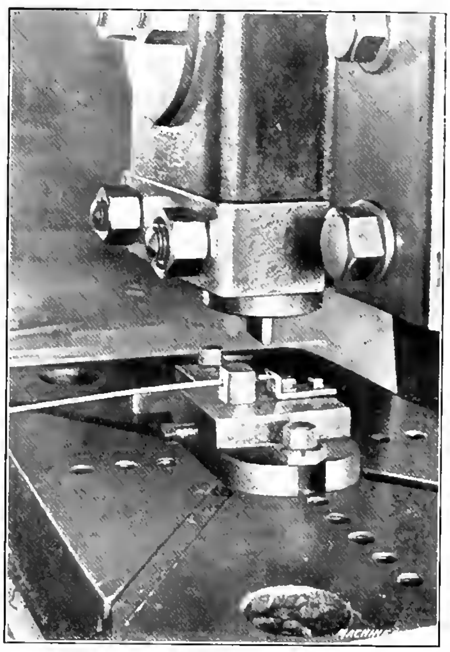

Fig 43. The Way Rivets are sheared in the Punch-press

Fig 44. Assembling the Cams and Jaws and Setting the Rivets

for trimming and obviates rough polishing, with a considerable saving. Next the flattened blanks are trimmed and then shaved to exact size in dies *A* and *B*, Fig. 31, respectively. As these dies are similar to those already shown, they will not be described. After the shaving operation, the blanks are drilled and reamed in the combination jig *A*, Fig. 32,

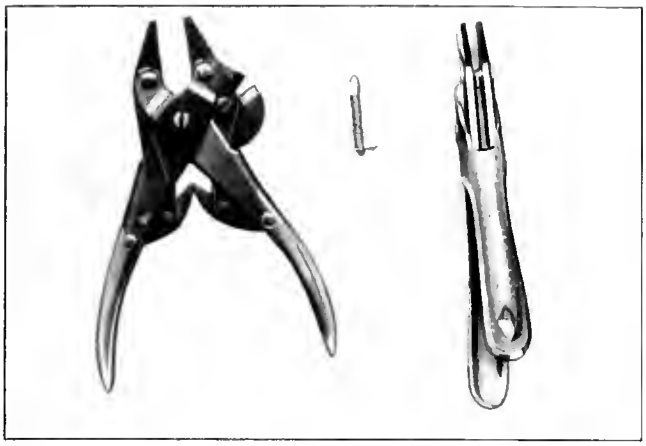

Fig. 45. View showing Position of Spring in a Spring Plier

which shows the retaining pin in the cover plainer than in the previously illustrated jigs for cams. Now the burrs are taken off on a disk wheel and then the blades are put in the milling machine vise jig *B*, and the cutting edges milled. In using this jig, four blanks are put in it, and with the clamping blocks *C* and *D* in place, it is put in the vise

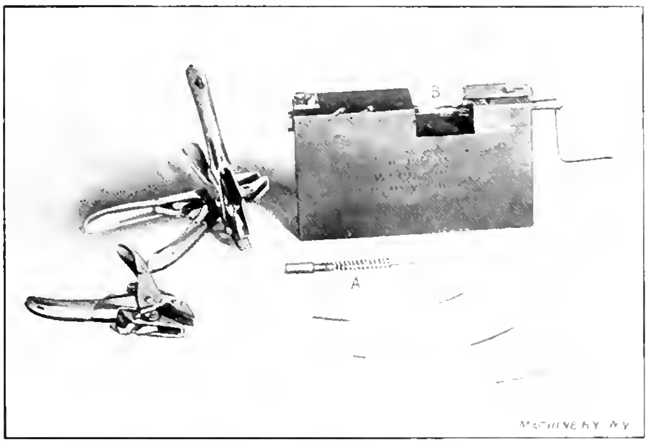

Fig. 46. Device for Winding Springs

and the vise tightened; then, using a small side cutting mill, one cut is taken which finishes the bevel for the cutting edge on one side of each blank, and then the blanks are switched in pairs and the final cut taken.

The link hole is slotted out, while the blank is held in the vise jig *E*, with an ordinary ½-inch milling cutter, the shape

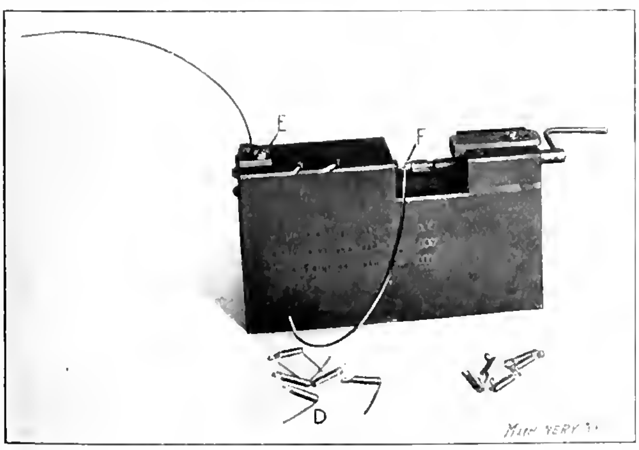

Fig. 47. Method of Starting a Spring

of the slot wanted and the position in which the blank is held making this possible. When the blades have been hardened and tempered, the cutting edges are ground by hand on a thin emery wheel, using the little slotted V fixture, Fig. 33, for a guide. The edges are next ground and polished and then the sides are polished as in Fig. 12, after which they are ready for assembling.

Cutter Blades (Fixed)

The fixed cutter blades differ not only in shape but also in many of the operations which are:

1. Blanking.
2. Flattening to size.
3. Trimming.
4. Drilling and reaming.
5. Reaming out circle for inset of moving jaw.
6. Burring on disk wheel.
7. Cutting edges milled.
8. Drilled hole slotted out.
9. Hardening.
10. Tempering.
11. Grinding and polishing.
12. Assembling.

A, Fig. 34, is the blank; *B*, the flattened blank; *C*, trimmed; *D*, drilled and reamed; *E*, inset reamed; *F*, cutting edge milled; *G*, slotted, and *H*, hardened and tempered. In Fig. 35 *A* is the blanking die, *B* the flattening die, and *C* the trimming die. It will be noted that this blade is only trimmed once and not shaved, which is all that is necessary,

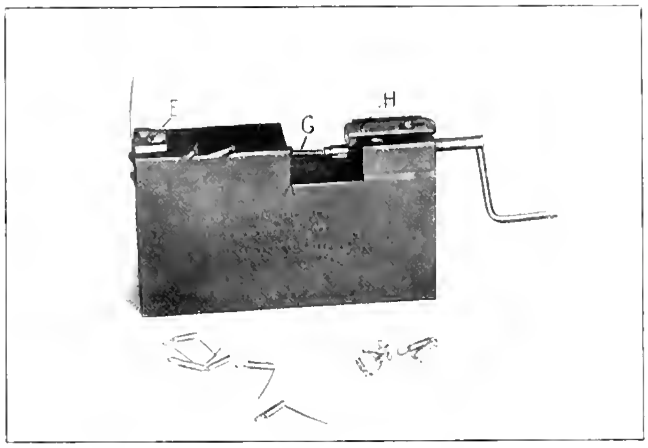

Fig. 48. View showing Device with Wound Spring in Place

as the parts that have any important bearing surface are reamed.

After drilling and reaming in the jig *A*, Fig. 36, the blades are put in the jig *B*, two at a time as shown, and the circle for the inset of the moving jaw is reamed out with the rose reamer *D*. The two jigs in this halftone are shown closed in Fig. 37.

The fixed blades are now burred on a disk wheel, the cut-

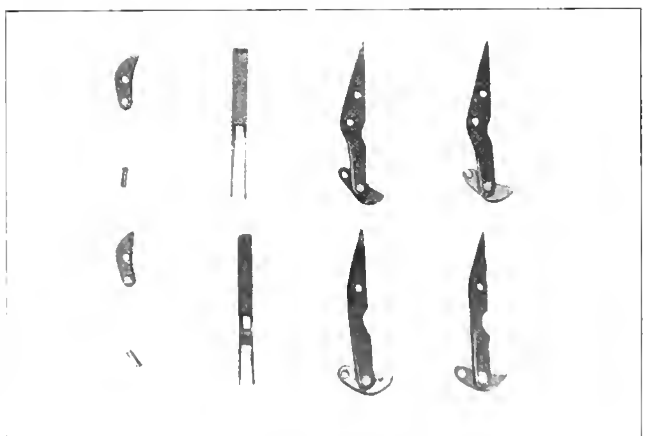

Fig. 49. Cams Assembled in the Jaws

ting edges milled as shown for the moving blades and the drilled hole slotted out as illustrated in the parts *G* and *H*, Fig. 34, by holding them in the vise and using a suitable mill. These blades are slotted out in this manner so that they can be removed from the pliers when dull or damaged, without removing the rivet or using a screw in place of the rivet, which would be unsatisfactory for a number of reasons. The blades are next hardened, tempered, ground, polished and assembled.

Links

The operations on the links in the order in which they follow are:

1. Blanking.
2. Flattening.
3. Trimming.
4. Drilling and reaming.
5. Carbonizing.
6. Burring.
7. Drawing to a blue color.
8. Assembling.

The seven shop steps are shown in Fig. 38 and the tools used are shown in Figs. 39 and 40. After carbonizing, the burring operation serves to rough polish the parts sufficiently to show the blue color in the drawing.

Fig. 41 shows some of the scrap from which the various blanks were punched, which will show the way the metal was economized. The harder metal requires more waste space between the blanks than the soft and in the case of the handles, the strip is run through one way and then reversed in order to save metal, without using a double punch and die.

Screws, Rivets and Springs

The screws used in the center of the pliers to hold the moving cutter blades, are not made in the shop but are purchased from a specialty firm, though the hardening is done

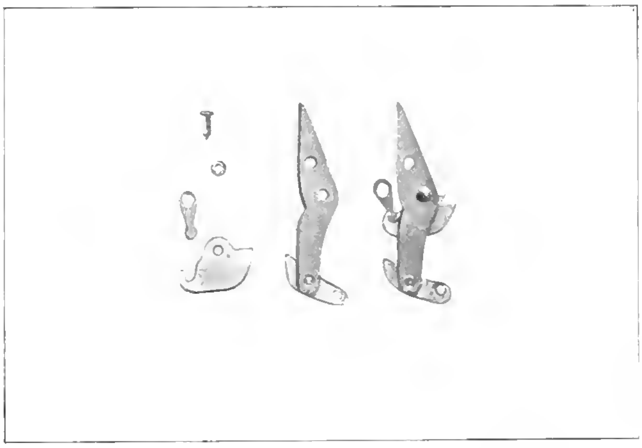

Fig. 50. Cutting Jaw with Cam, Blade and Link in Place

in the shop. The screws for the cutter blades are carbonized all through and then drawn just enough to prevent brittleness. An ordinary unhardened screw used in this place would be of no use whatever, as it would shear or wear out in no time.

The regular rivets used are cut from rods as shown in Fig. 43, though the rivets used in the spring pliers, have a groove

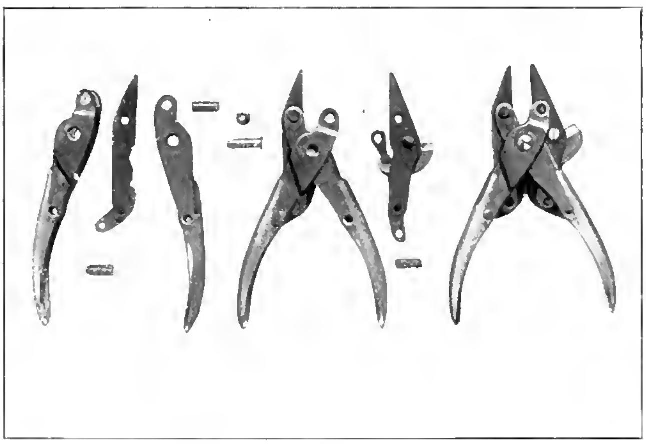

Fig. 51. Steps in the Assembling of Cutting Pliers

in the middle and so have to be cut off in a screw machine. The position of the rivet and spring is shown in Fig. 45.

Winding the Springs

A unique little spring winding device designed by Mr. DeVilbiss, by which a boy may easily wind accurate springs, is shown in Figs. 46, 47 and 48. Three different sizes of springs are wound with the device, a different sized winding mandrel being inserted for each size. One of the winding mandrels with its returning spring is shown at *A*, Fig. 46, and the projecting point of another, inserted and ready for use, is shown at *B*, while at *C* is a guide pin for the wire. A loop is first bent on the spring wire, like that shown on the springs in group *D*, Fig. 47, by bending in the little jig *E*. This loop is then inserted in the slotted end of the winding crank, as at *F*, which is pushed in far enough for the end of the winding mandrel to enter. The crank is now turned, winding the spring as shown at *G*, Fig. 48, the mandrel being drawn out by the tension of the spring coils as it is wound; but the instant the tension is released on the coils of the spring just wound, the mandrel flies back into its socket out of the way, allowing

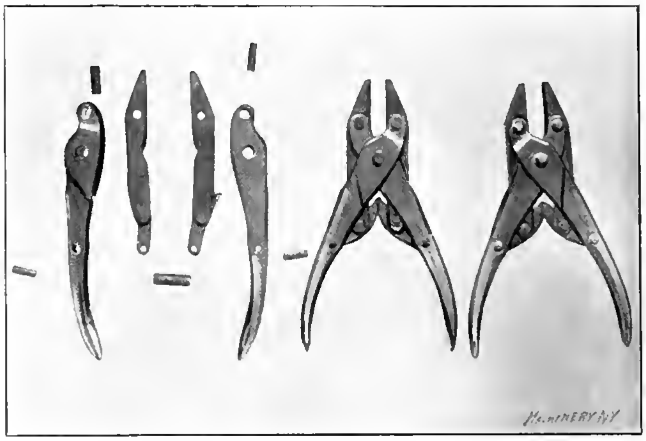

Fig. 52. Steps in the Assembling of Plain Pliers

the spring to drop down. The length to wind the various springs is gaged by the piece *H*, which points to a mark on the crank. The little loop on the opposite end of the spring is easily made by winding around a pin, when the small amount of superfluous wire is snipped off with a regular cutting plier the cutting blades of which have been left a little

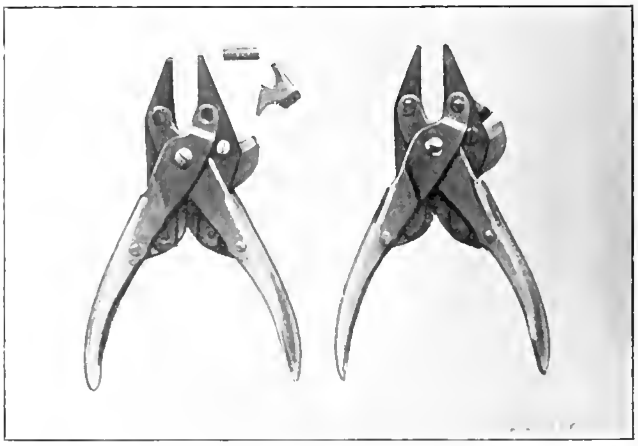

Fig. 53. The Fixed Blade before and after being placed in Position

harder than usual, which is necessary on account of the hardness of the wire used.

Assembling

The order in which the various parts of the pliers are assembled and made ready for shipping is as follows:

1. Putting cams in jaws.
2. Inserting moving cutter blade and putting in screw.
3. Putting in link.
4. Assembling complete, except fixed jaw and its rivet.
5. Fitting fixed jaw.
6. Spinning both ends of all rivets.
7. Inspecting, loosening, and testing cutters.
8. Burring center screw.
9. Polishing ends of jaws, screws and rivets.
10. Plating.
11. Buffing.
12. Washing.
13. Tumbling.
14. Inserting springs in the spring pliers.
15. Wrapping and packing.

Fig. 49 shows cams, jaws and rivets, separate and assembled, for both plain and cutting jaws, the parts being put together by a boy as in Fig. 44. The moving cutter blade and link are next put together as shown in Fig. 50, and then the cutting plier is assembled complete, as shown in Fig. 51, all except the fixed blade.

The plain plier having no cutter blades to fit, is assembled and the rivets spun down as illustrated in Fig. 52, but on the cutting pliers the fixed blade must be fitted as in Fig. 53, and the cutting edge brought perfectly in line with that of the moving jaw, which is done by inserting a pin in the hole in place of a rivet and then touching up the edge of the blade

on the little disk wheel, Fig. 54, which has one safe side. After the blades have been satisfactorily fitted and lined up, the rivets are spun down with a Grant rivet spinning machine Fig. 55, the plier as it looks before and after spinning being

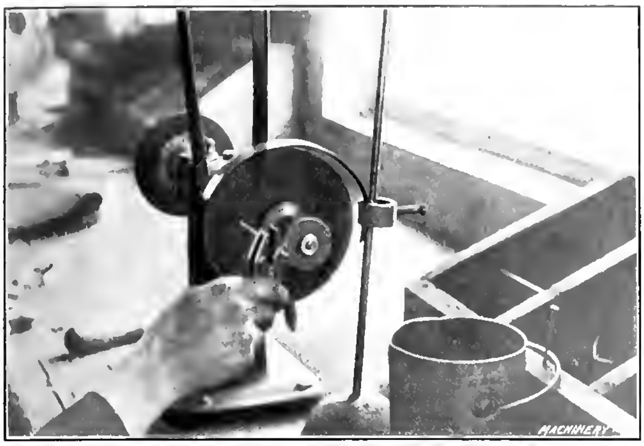

Fig 54. Lining up and Sharpening the Cutting Edges

shown in Fig. 56. Fig. 57 shows a group of assemblers at work. The inspecting consists of seeing that the plier looks and works perfectly and cuts properly.

Burring or slightly riveting the center screw, is done to prevent the nut from working loose, and after the ends of the jaws, screws, and rivets are polished, the pliers are plated for one-half hour open and one-half hour closed, in the plating room, one corner of which is shown in Fig. 58. When the pliers have been buffed they are washed in a mixture of kerosene and paraffine oil to cut and remove the polishing compound, and they are then tumbled in sawdust. In packing, the pliers are wrapped in a special rust-proof paper and placed six in a box ready for shipping.


Fig 55. Spinning down the Rivets on a Grant Rivet Spinning Machine

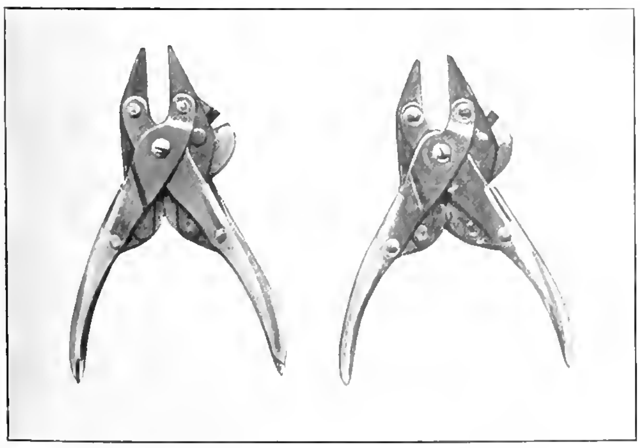
Fig. 56. Cutting Pliers with Rivets before and after being spun

In the general shop practice, high speed drills, reamers and tools of all kinds are used, and in the plier itself there are a few good points that it may be well to bring out, one of which is the making of the jaws of pressed steel instead of solid metal, which allows the cutters to be set in the middle where they belong, and it also allows the use of a high grade of tool steel for the cutters and a steel that can be carbonized, for the jaws, thus giving hard, but not brittle, serrations and edges.

* * *

THE CRACKING OF ALUMINUM CASTINGS

A few valuable hints regarding the prevention of the cracking of aluminum castings are given in *Castings*. To secure best results only new metal should be used. The aluminum should be melted rapidly, but the heat of the furnace should be kept low as compared with the heat of a brass-melting furnace. Just as soon as the metal is thoroughly melted, the crucible must be pulled, stirred, skimmed and the metal poured. If the metal is overheated or is allowed to soak in the furnace it will absorb gases which will fill the casting with pin holes. New graphite crucibles ought to be used, or such as have been used only for aluminum. When the crucible is pulled from the furnace, a small lump of sal-ammoniac or of chloride of zinc should be thrown on the surface of the metal before stirring and skimming. The pouring, at as low a heat as possible, should be rapid and through large gates, because aluminum chills with exceeding rapidity. The cores for aluminum castings should be either of green sand or, if made up with a binder they should be thoroughly baked and as soft as possible. Aluminum shrinks a great deal when cooling, and if it cannot compress the cores internal cracks are likely to result.

Fig. 57. Group of Assemblers at Work

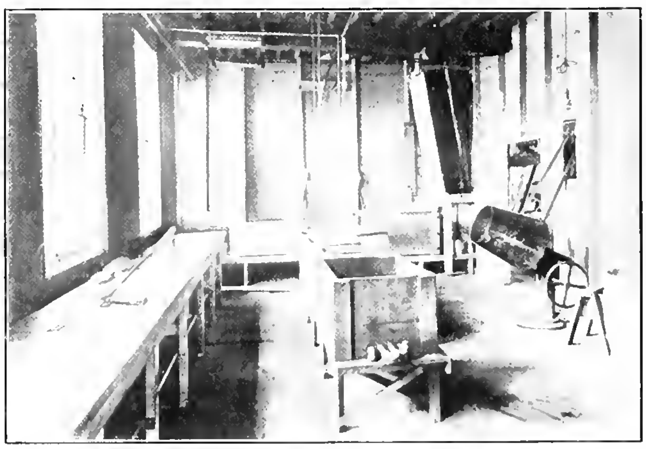
Fig. 58. View of Plier-plating Room

* * *

The Verein Deutscher Eisenbahnverwaltungen (Association of German Railway Administration) has offered a total of 30,000 marks ($7,500) in prizes for inventions and improvements of special importance in railway traffic as well as for writings of exceptional merit relating to railway matters. The inventions and improvements must have been carried out practically and the written works to be considered must have been published between July, 1905, and July, 1911. The amounts of the individual prizes vary from $400 to nearly $2,000

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MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

JUNE, 1910

PAID CIRCULATION FOR MAY, 1910, 26,349 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 300 pages a year of additional matter, and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE PISTON RING PROBLEM

Notwithstanding our conceded ability to solve problems in the manufacture of machinery, there seems to be no generally-known, first-class method of cheaply making piston rings for gas engines. By that we mean a method that can be depended on to turn out truly circular, well-finished, even tension rings at low cost.

The commercial methods in vogue are inaccurate, costly and unsatisfactory in result. The makers are not able to control all the factors entering the problem, and must follow more or less happy-go-lucky processes quite repugnant to the ideals of mechanics accustomed to precise methods of production. A practice that will turn out perfect rings, interchangeable and of uniform tension, is yet to be described.

* * *

FACE GRINDING

The grinding machine using a cup wheel is a machine tool of great present performance and of even greater possibilities. Already it has shown such marked superiority on certain classes of machine work that the milling machine is being discarded in its favor. It has some of the advantages over the axial grinding wheel that the face milling cutter has over the axial milling cutter. The power consumption is less and plane surfaces are produced with fewer passes of the wheel. There is also the advantage that the mean radius of the face grinding wheel remains unchanged until worn out. The economy of wheel material is high, inasmuch as a comparatively small part is wasted when the wheel is worn out, and moreover the cup wheel can be reinforced so that it is practically proof against bursting. For such work as machining the ends of machine legs, columns, joining the boxes of grinder frames and similar parts, the face grinder having a horizontal spindle with power-actuated table is unexcelled. The work is done quickly and with almost any required accuracy. If it should be of a comparatively rough nature, the grinder can be forced and the number of passes cut down to suit the most economical-minded manager. On the other hand, the finest class of work is performed with precision obtained only at much greater expense on the milling machine.

MAKING MACHINE PARTS WITHOUT WASTE

Mechanical progress is generally in the direction of saving labor, time and material, and improving the quality of finish and the durability of the product. Sometimes practice apparently moves backward as regards one factor, in order to gain greater advantage in another; and it is often hard to determine whether or not a new process has advantages in general. This is not the case with the process for making machine screws without waste, briefly described in the April number. The speed of production is unparalleled, the physical characteristics of the product are improved, practically no oil is used, there are no cutting tools to grind and set, except a cutting-off shear, and there is absolutely no waste of material. There is, however, a lack of desirable finish, which defect doubtless will be corrected when commercial machines are perfected. While now limited to small machine screws, the process will soon be applied to the manufacture of all ordinary commercial sizes of machine screws and wood screws. The possible saving of material and oil on all the machine and wood screws manufactured would amount to millions annually. It apparently means a revolution in the methods of manufacture of parts in which much capital is invested.

In the November number of MACHINERY, engineering edition, we referred editorially to the making of steel machinery chain without waste. The conclusions there drawn apply even more forcibly to the present development than to the manufacture of chain, and the saving of material and labor in the machine screw industry should add materially to our national wealth. The possibilities of cold forming machine screws, studs and similar products from wire and rod seem to be limited only by the ability of engineers to design and build machinery that will stand the stresses.

* * *

CLOSER RELATIONS BETWEEN DEPARTMENTS

As a manufacturing business grows, greater and greater difficulty is almost invariably experienced in keeping the various departments in harmony with the general spirit of the business and fully informed of one another's needs and activities. Unless an excellent system exists, deplorable differences in policy will develop, making it exceedingly difficult in some cases for other concerns to transact business satisfactorily with the purchasing department.

Take the case of an automobile manufacturing concern for an illustration: Certain parts are made by outside concerns to specifications furnished by its engineering department. These specifications state the character of materials, and are accompanied by blueprints giving dimensions, shapes, etc., some of which must be exactly as specified; but it is immaterial whether certain others be exactly reproduced or not. In making up their estimates, the engineers of the bidding concerns usually take into consideration the parts that must be made carefully and those on which less work is required, and figure the cost accordingly. If the work is to be strictly interchangeable throughout, using elaborate jigs and fixtures for all parts, immaterial dimensions would be faithfully reproduced; but in the class of work which is done in lots of a few hundred it is generally out of the question for the jobbing shops to build complete sets of jigs and fixtures. Everyone is familiar with the result of this system of manufacture—the essentials are right while the non-essentials are not wrong, although their dimensions may vary a sixteenth or an eighth inch one way or another; but when a shipment of parts made in this manner is received by an "unintelligent purchasing department" whose inspectors are held to a strictly literal interpretation of the specifications, trouble develops quickly. Cases are not unknown where goods have been rejected without consulting the engineering department, causing heavy losses to both the makers of the parts and the buying manufacturer. If a practical mechanic in authority had been shown the work it would have been accepted unhesitatingly, and every essential requirement would have been satisfied. The moral is that closer relations should exist between the purchasing and engineering departments, or that wide limits should be specified for immaterial dimensions so that work done in accordance with the spirit of the specifications will not be rejected by literal-minded inspectors.

THE HARDENING OF CARBON STEEL

The hardening of steel has always been considered an operation for which definite rules could not be laid down, but in which the experience and judgment of the hardener would almost exclusively have to be relied upon. Practically the only definite rules that have been laid down are that steel should be hardened at as low a heat as possible, and that there is a definite temperature for each kind of steel above which it must be heated to harden at all.

Apart from this meager information, a few generalities only have been furnished for the guidance of men doing this work, including directions for cooling, so as to minimize the risk of cracking; but definite information on the process of hardening is singularly lacking, and many have considered it impossible to shape rules for this operation, even as the result of careful experiments.

For this reason the experiments conducted by Mr. Shipley N. Brayshaw of Manchester, England, the results of which are recorded in detail in another part of this number, are all the more remarkable and of great interest to everyone engaged in mechanical work. These experiments appear to have been made with extraordinary care, and two of the points brought out in his investigations deserve to be particularly mentioned. One of them relates to the shortening or lengthening of steel in hardening. It has often been stated that steel is unreliable and not uniform in this respect, and that the same kind of steel has sometimes been known to shorten in hardening, and sometimes to lengthen. This phenomenon has been attributed to defects, or, at least, to special conditions in the steel, over which the hardener has no control. Mr. Brayshaw's experiments, however, show that the shortening and lengthening of steel in hardening follows a uniform law and that steel hardened below a given temperature, which he calls the "change-point," will shorten when quenched; whereas the same steel, if heated above this change-point before quenching, will lengthen. He also shows that by heating the steel in two furnaces, first bringing it up to a certain temperature in one, and then soaking it for a given time at a definite temperature in the other, it is possible to harden steel so that it will neither lengthen nor shorten when quenched. So far as we know, this is the first definite information that has been published on the change in the length of steel in hardening, the uncertainty of which has caused considerable difficulty in making accurate taps, dies, etc.

Another interesting point brought forth by Mr. Brayshaw's experiments relates to the proper hardening temperature. While it is possible to harden steel within a temperature range of about 200 degrees, and obtain what to the ordinary observer would seem to be good results, the *best* results are always obtained within a very narrow range of temperatures, approaching closely the decalescence point, or the temperature at which steel changes into a condition when it can be hardened by quenching. It is interesting to note that this result agrees with the old theory that steel should be hardened at as low a temperature as possible. In a number of cases certain tools are found to last exceptionally well, while other tools in the same lot show only ordinary durability, although no difference can be detected in the grain of the hardened steel. Such differences can now be accounted for by the slight variations in the temperature at which the various tools have been hardened.

These experiments open up an entirely new field for investigation and new possibilities in the hardening of tool steel. They indicate that in cases where it is important to prevent the cracking of tools in hardening and the deformation of tools due to internal stresses, they should be hardened at a temperature higher than that which gives the best results as regards hardness only. Thus we find that certain of the desirable qualities in a hardened tool are antagonistic; that is, we are unlikely to obtain a tool having extreme hardness and elastic limit and which at the same time is not likely to crack or lose its shape. Under these conditions one of the necessary qualities must be partly sacrificed to another, and a tool must be hardened so as to obtain good general results rather than the best specific one.

The influence of previous annealing on hardening is also of interest; and many of the points brought out in the abstract of the original paper are well worth considering. Those who are giving especial attention to the hardening of steel will find it worth while to obtain a copy of the original paper of 160 pages read by Mr. Brayshaw before the Institution of Mechanical Engineers of Great Britain,* which records his experiments in minute detail.

* * *

THE MANUFACTURE OF FROGS AND SWITCHES

By J. B. HASKELL†

The description of frog and switch manufacture which follows is taken from the methods used by some of the best known firms in this country engaged in the manufacture of this line of work, and is especially based on the practice of the American Frog and Switch Co. of Hamilton, Ohio.

The rails as they come from the mills vary somewhat in length and size, and a great deal in quality, some of them

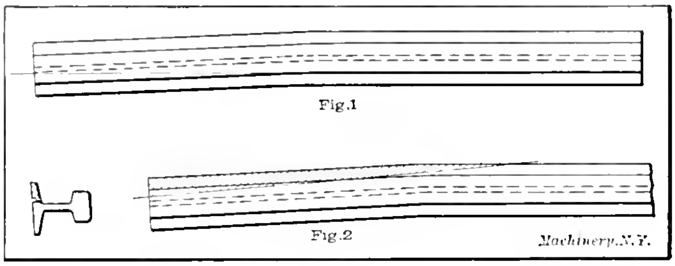

Fig. 1. Bent Rail for Switches Fig 2. Amount cut off Flange of Rail for Switches

being exceptionally hard; it often happens that a high-speed steel drill of good quality has to be reground for every two or three holes or even two or three times for one hole.

Switches

In the manufacture of switches, the rails are first cut to length by means of either an ordinary circular cold saw or a high-speed saw. When cut with a high-speed saw, the rail ends are made very hard by the action of the saw—often too hard for a tool to cut successfully if no means are employed to prevent the hardening. It is best prevented by running

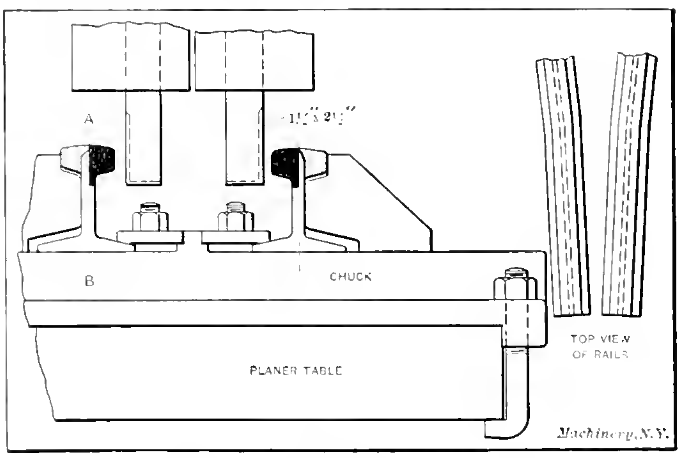

Fig. 3. Planing off Rails for Switches

the saw in water, the under side of the saw being covered to a depth of from two to six inches. Next the rails are drilled for the switch lug bolts and for the reinforcing bar rivets or bolts, if any reinforcement is to be used. The drilling is done in jigs or by means of templets. If the switch is to be reinforced the reinforcing bars are next riveted on.

In the next operation the rails are bent, as shown in Fig. 1, an amount sufficient to bring the side of the web at or near the gage line, the practice of different manufacturers varying somewhat; some place it at the gage line and others from $\frac{1}{8}$ to $\frac{1}{4}$ inch from it. The bend is made of such a length that the point of bend occurs at the intersection of the line of the stock rail and the line of the back of the switch point railhead. This length is usually increased by an allowance of

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½ inch for each foot of bend length, which allowance has the effect of giving a slight clearance between the two rails at the bending point, thus allowing the end of the point to close tight before the point further toward the heel closes. Some makers then shear the part of the flange shown sectioned in Fig. 2, while others place it base up on a planer table, and after cutting a groove in it as shown, break off the flange.

The rails are then placed on a switch planer in special adjustable chucks, as shown in Fig. 3. The chucks are so made that their position may be adjusted both vertically and horizontally. The means for this adjustment are shown in Fig. 4, where the chuck is illustrated in detail. The rails are held quite rigidly, but owing to the spring of the rail and the shape of the tool there is some chatter. The portion of the rail-head shown in black, Fig. 3, is planed off by feeding each tool out separately by hand, two tools being used at once. The feed is by hand chiefly because the widths of the cuts vary so much on the same switch.

The line *AB* of the planing is arbitrarily determined, some making it at the center line of the web and others even with the side. The widths of the cuts vary according to the depth of rail-head, but usually run from one inch to two inches, the total depth being taken in one cut, as the tools are fed in from the side. The average cut is from 1½ inch wide by 3/32 inch feed to 2¼ inches wide by 1/16 to 3/32 inch feed. The speed of the planer which has been found to give the best results is 30 feet per minute, the return of course being considerably faster—usually from 40 to 50 feet per minute. The tools are of the shape and size shown in Fig. 3 and are of Novo steel. These tools when taking these cuts sometimes break off at the bottom of the holder.

The rails are now moved to such a position that the line of the unbent portion of the rail is in line with the planer. Both tools are then fed, thus planing off the portion shown in section lining in Fig. 3. The rail is planed on top in such a manner that the point will be from ¼ to ¾ inch below the top of the stock rail when it is in position on the friction plates, the amount varying according to the practice of the maker or the railroad. This planing is accomplished by setting the chuck vertical in such a way as to bring the required line horizontal. The tools are then fed down, for as the point is narrow, feeding sidewise would bend it. The gage line corner is rounded off to a radius corresponding to the radius of the corner of the rail-head. When this planing is finished, the rails are moved by a trolley and hoist to the next planer, which is equipped with chucks as shown in Fig. 5 for holding the rail in the position shown.

The tools on this planer are set at the proper angle to plane the flange so that it will agree with the angle of slope of the stock-rail flange, this angle being 13 degrees for all A. S. C. E. section rails. The portion of the flange shown in section lining in Fig. 5 is then planed off. This amount varies with the thickness of the riser to be used and with the thickness of the flange of the stock rail. The in-and-out adjustment of the chucks allows for this difference in the planing. On this cut the width runs up to 3 inches; on the widest part of the cut the feed is 1/16 inch. A broken chip is produced, which drops off in pieces of the width and depth of the cut and from ¼ to ¾ inch long on Bessemer rail, but on open hearth rail it is a long spiral chip. This cut finishes the

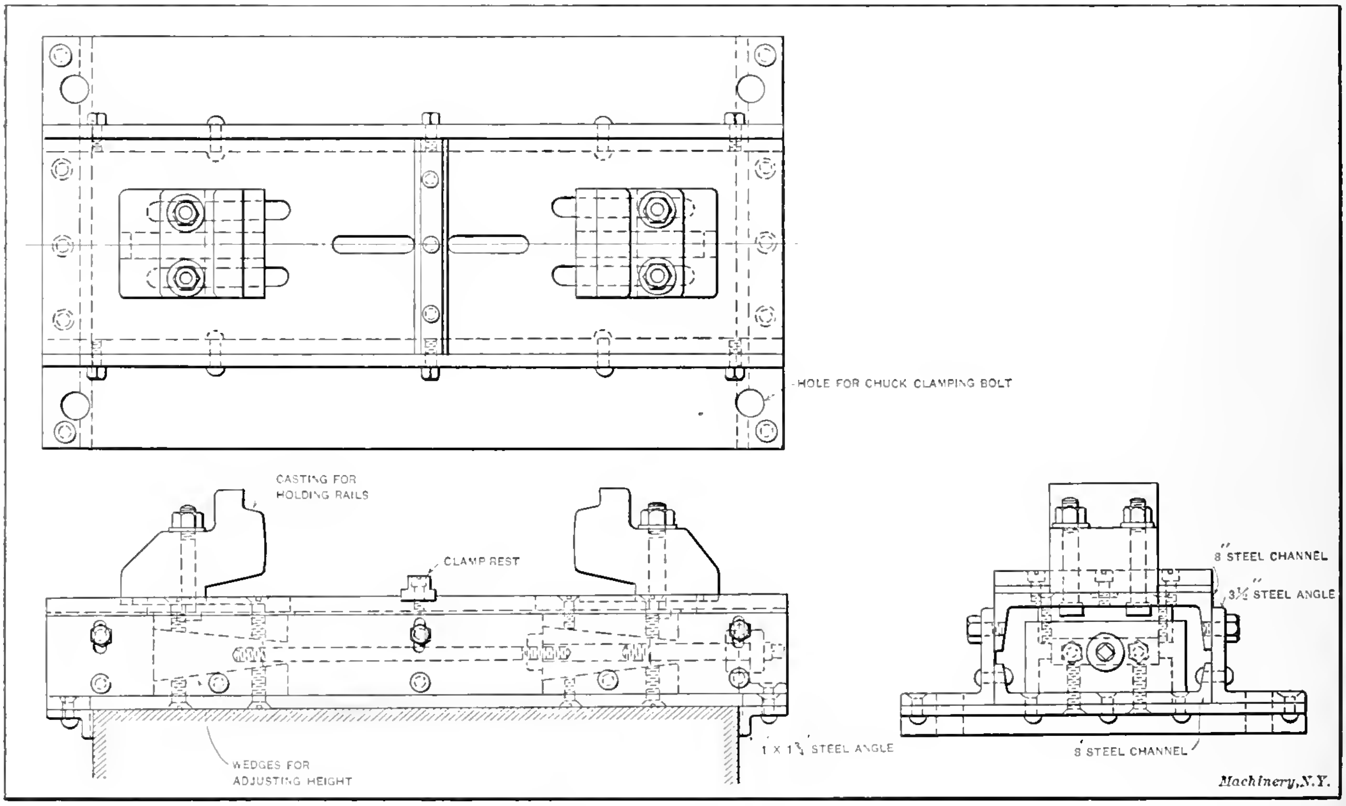

Fig. 4. Chuck for Holding Rails while Planing

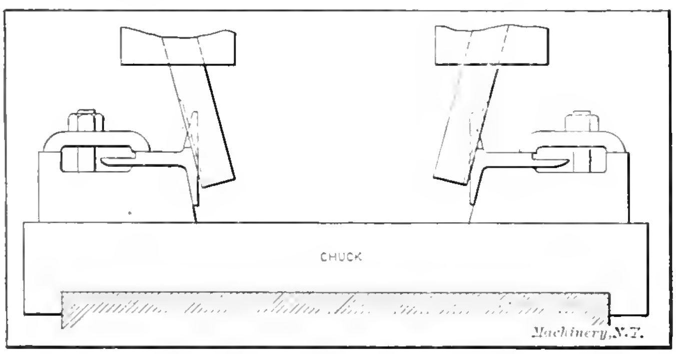

Fig. 5. Planing off Flanges

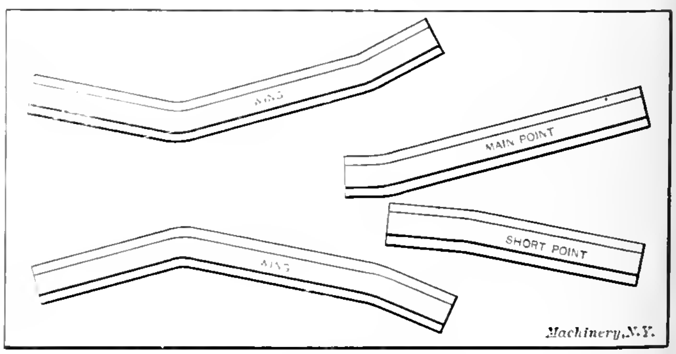

Fig. 6. Frog Parts Bent, ready for Planing

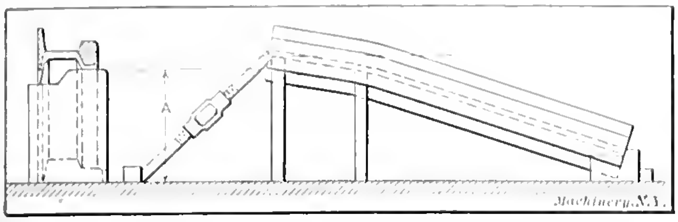

Fig. 7. Method of Setting up Main Point of Switch for Planing

switch except for grinding the top of the point end to a round corner.

Frogs

For the frogs as for the switches the rails are first cut to length. They are then heated and bent to the proper angle and shape. Each bend is made according to a templet, each

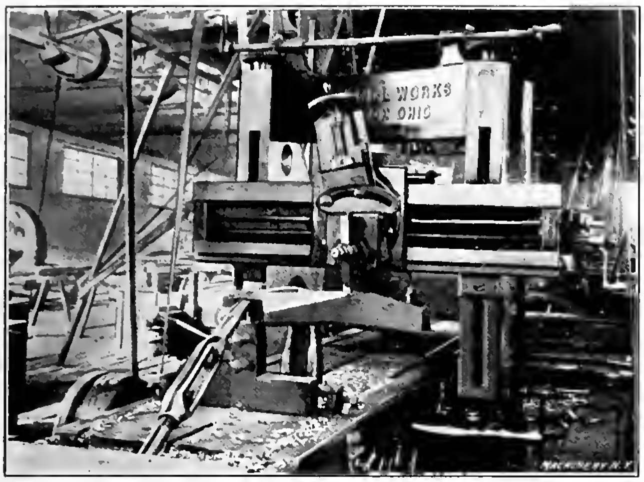

Fig. 8. "Balling out" Short Point of Frog

frog angle having its own set of templets. After the bending the rails appear as shown in Fig. 6. The wing flanges are then planed off the amount necessary to clear the flanges of the point rails. In doing this they are placed on the planer, base up, and two wings are planed at the same time. The short point is next planed out, the operation being called "balling out," to fit against the main point. The point is set up on the

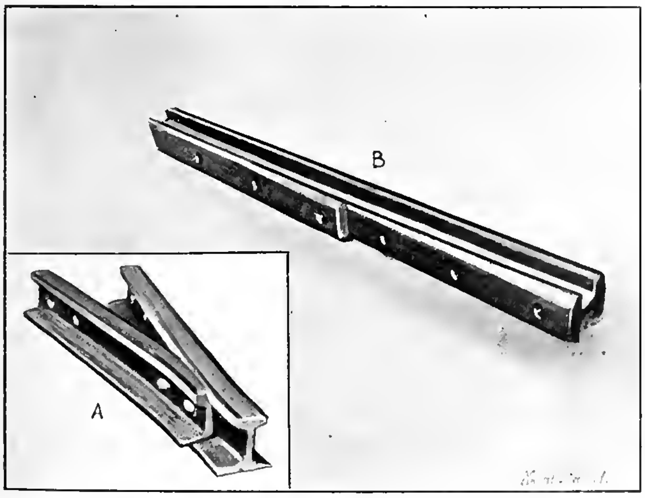

Fig. 9. Frog Point before Final Planing, and Frog Filling after Planing and Drilling

planer table as shown in Figs. 7 and 8, the distance *A* being governed of course by the frog angle. The planing line is marked on the end of the rail and it is then planed to this line. The cut in this case is not very heavy, it being 5/8-inch, with 1/32-inch feed. The two points after being drilled for two rivets and riveted together, as shown in Fig. 9 at *A*, are set on the planer and the bent part shown sectioned in Fig. 10 is cut off, thus forming the two intersecting gage lines.

Considerable planing is done on the filling, the approximate amount for an average standard frog being shown at *B* in Fig. 9, and in Fig. 11. As many pieces of a kind as there are, up to the capacity of the planer, are placed on it, set to the proper slope and are all planed at once as shown in Fig. 12. This work is done at a cutting speed of 25 feet per minute with a cut about 3/4 inch deep and a feed of 3/8 inch per stroke. The tool is 1 1/2 inch by 2 1/2 inches in size with a round nose. It is given a rake of from 5 to 8 degrees and a clearance of 2 degrees. Some makers instead of planing the filling do the work on milling machines.

The whole frog is next clamped up including filling, heel

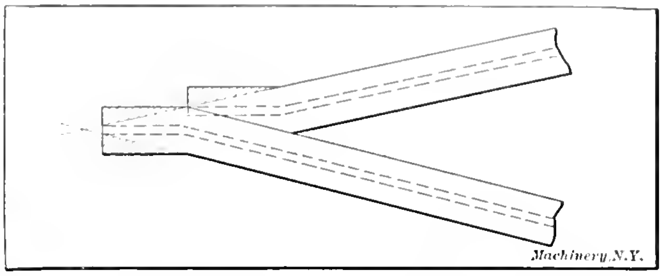

Fig. 10. Diagram showing Amount planed off Frog Point

risers and point fillers, if there are any, care being taken to secure proper alignment and length over all. It is then taken to a multiple spindle horizontal drill, whose spindles are set to the proper center distances for the frog being built, and the whole frog is drilled at once. This method avoids the reaming which is almost always necessary when the holes are drilled singly in the rails. Quite often when using an ordinary lubricant, the drills need considerable grinding when the rails are running hard. A mixture of camphor gum, turpentine and soft water may be used to avoid this trouble with

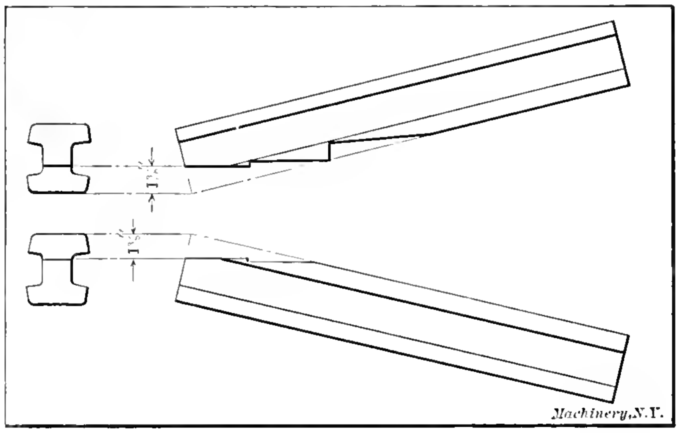

Fig 11. Frog Filling when Planed

hard rails. After being drilled the frog is bolted up. In frogs having foot guards, etc., the extra holes are drilled at the same time as the frog bolt holes. The foot guards, plates, etc., are next bolted or fastened in place, completing the frog.

Crossings

The rails in crossings are first cut to lengths given on the drawings. They are then bent as required and the flange of the guard rail planed off if necessary. They are then assem-

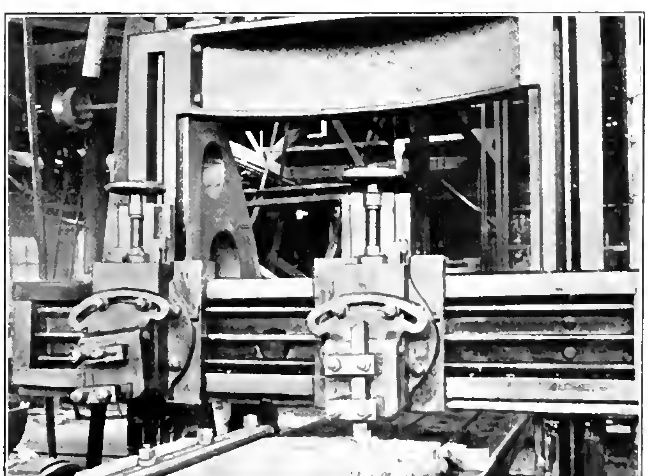

Fig. 12. Planing Frog Fillings

bled and clamped up in sections as shown in Figs. 13 and 14. Each section is drilled separately on a multiple spindle horizontal drill, all bolt and fishing holes being drilled at one setting.

The planing is next done, such as grooving out the flangeways, shaping the ends of the abutting rails, notching the backs of the heads, etc. This work is usually done on a drawcut shaper. The cuts are quite heavy, and even on the heaviest kind of shaper there is considerable spring in the table. The ordinary shaper has a brace supporting the outer side of the table, but it usually is so made that it has no holding-down power. When the heavy cut starts in on the rail it tends to raise the table. By altering this brace so that it also holds the table down, a big improvement is effected.

In setting rails to have the flange-way cut at an angle on the shaper, it is difficult to hold the rails properly, the cut

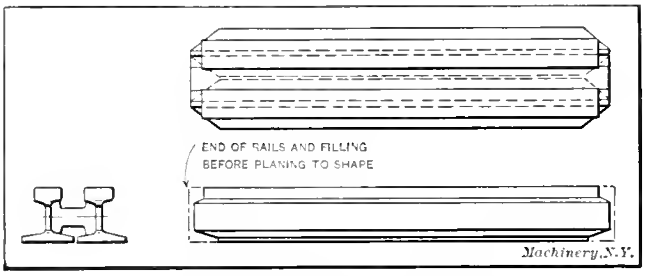

Fig 13. Rail Section for Crossings

tending to turn the rail and holder and thus throw the angle out. The flange-ways are grooved out by means of a broad round-nosed tool. On curved crossings, where all the angles vary, each one is determined by calculation and the groove is then cut to the required angle. In shaping the ends of abutting rails, it is necessary to make two settings of the rail to properly plane both top and bottom. The cutting of the slope on the top of easer rails is performed on the planer by setting up the rail to the proper slope to give the needed rise.

The crossing is then assembled, the straps, after forging to the proper angle, are put in place, marked off and drilled, and the crossing bolted up. The plates, foot guards, etc., are fastened on and the crossing is complete. All dimensions such as diagonals, etc., are carefully checked. Of course, in some details the practice of different makers varies considerably; the principal operations, however, are performed in much the same manner.

Use of Manganese Steel

Manganese frogs as now made consist of a manganese casting that forms the parts of the frog subject to the most severe wear. The wing and point rails are bolted to this casting. The bolt holes in the casting are cored 1/4 inch larger than the bolts to be used. The rails are drilled by jig and are then bolted to the casting. The space around the bolts is then filled by spelter poured in through holes cored in the casting for the purpose. The entire top of the frog is then finished to a true surface by grinding. The manganese steel can be cut by a planer tool, but it is very slow work and the tools will not stand up well to it, making it cheaper and more satisfactory to do all fitting and finishing by grinding.

Rolled manganese steel is coming into some use in track work in the shape of full-length rails where the service is extremely severe. But for frogs, crossings and switch points the cast manganese steel is used altogether.

The regular types of cast crossings require no fitting at all, as the crossing is cast complete in two parts with fish bolt holes cored in the ends, which are made to correspond with the rail section.

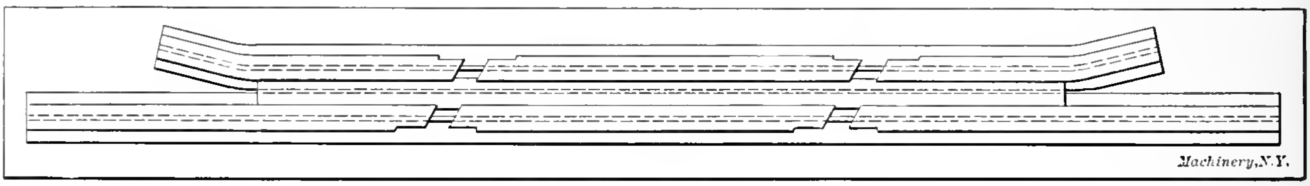

Fig. 14. Rail Section for Crossings

THE MAINTENANCE, CARE AND UP-KEEP OF PNEUMATIC HAMMERS

By GEORGE H. HAYES*

Having been connected for a number of years with the manufacturing end of the largest pneumatic tool company in the world, I have been asked to write a few words concerning the maintenance of pneumatic hammers and the abuses which they receive at the hands of the men on the job.

The material used in the construction of pneumatic hammers is the very best that money can buy and is the result of long periods of experimenting at an outlay of a great deal of time and money to get material that is best able to withstand the vibrations, jar and wear which pneumatic tools are called upon to withstand. The treating of the material, fitting up, and testing, must be done by experienced and competent men. Pneumatic tools are made with the most extreme care, the moving parts are accurately and closely fitted, and when the proper lubrication is neglected, which is the most unpardonable offense to which a piece of fine machinery can be subjected, the moving parts of a pneumatic hammer will wear rapidly and in a very short time refuse to work.

Another source of trouble is sometimes located in the pipe line. Moisture carried in the air will rust the pipes and if a hammer is connected up without first blowing out the pipes a sediment is liable to be blown through into the tool, causing the valve or piston to stick. Rubber deteriorates very fast and particles of the hose may blow into the valve box and stop up some of the parts. Many times we have had hammers that would not operate, sent in to the factory, and on dismantling them found the port holes plugged up with pieces of rubber, or sediment from pipes, which when thoroughly washed out with gasoline, reassembled and properly oiled, would operate perfectly.

Another abuse is practiced in taking a hammer apart and putting it together again. Some repair men, instead of using a wrench or soft hammer in loosening or tightening the handle, use a hard steel hammer, battering the parts badly and in many instances breaking them. The finished parts should never be struck with anything but lead or copper hammers, and even when this is done, good judgment should be used as to the strain put on the threads of the handle and the cylinder.

There are many abuses practiced in connection with the operation of pneumatic hammers which are hard to locate, one of the most flagrant being the use of short pistons in riveting hammers. The manufacturers, after long and careful experimenting, have decided on a piston of proper length to perform satisfactorily the work for which the tool was designed, and all parts are made in proportion to withstand the strain. Workmen who are anxious to perform their day's task in the shortest possible time, or to increase their volume of work where they work on a per-piece basis, have little or no regard for these labor-saving devices. Having discovered that a piston a fraction of an inch short will do the work more rapidly, they resort to all manner of means to secure them, even having them made in outside machine shops. They carry them in their pockets and when they take a hammer from the tool room, they substitute the short piston for the one of proper length, again making the exchange before returning the hammer to the tool room. The result is, sets and handles are broken and cylinders frequently split. Where these breakages are occurring at short intervals, it would be well to detail someone to go through the shop and examine the pistons while the hammers are in use, otherwise the cause of the breakages will not be definitely located.

Some of the large plants using pneumatic tools, have adopted the practice of issuing a given tool to the same workman con-

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tinually, which has had a tendency to cause better care to be taken of the tools. If breakdowns occur frequently, it enables them to compare the amount of work being accomplished by different tools, and the more careless workmen are located and disciplined. Where this practice is followed, many times when the output of the shop is being forced to such an extent as to require all tools in service, and a workman is delayed in completing his work, while the men who are more careful of their tools finish in good time, it has a tendency to cause others to exercise greater care, which accrues to the benefit of all parties interested, even back to the manufacturer.

A great majority of men who operate pneumatic hammers in the shops, know very little, if anything, about the construction of the tools, and it pays any large institution using pneumatic tools to employ a competent man to look after them, see that they are properly lubricated and returned for cleaning when through with their work. I have been in foundries using large numbers of hammers in cleaning and chipping castings, where, at the sound of the whistle the hammers would be thrown down, generally in the sand, and enough sand or grit would get into the tool, so that when the air was again turned on the piston would stick fast after one or two blows. This necessitates a cleaning of the tool causing a loss of time in its use of from twenty to thirty minutes.

In starting to drive rivets in cold weather, especially on structural or out-of-door work, the hammer should be warmed up enough to take the frost out of the steel, as a hard piece of steel full of frost is liable to break at the first blow; after a few rivets have been driven, there will be enough heat from the rivets to keep the frost out. On the other hand, never allow the temper in the rivet set to be drawn too low, as a soft set will break very quickly. When driving rivets rapidly, have a pail of water handy and put the set and end of the hammer cylinder in the water occasionally to keep from drawing the temper, or change the set occasionally.

The wearing of parts in a hammer will always take place, but the life of the tool can be prolonged greatly by proper care and attention. Crystallization of the steel takes place owing to the rapid blows of the piston and the vibration. The life of the hammer depends mostly on the care which it receives and the character of the work being performed with it. A piece of fine machinery, such as a pneumatic hammer can be ruined in a few minutes by ill usage and neglect.

It has been proved conclusively during the past few years, that pneumatic tools are invaluable in shop practice wherein they are adaptable. Either a small or a large installation of pneumatic equipment is the most economical in maintenance cost. The small installation does not require a special attendant, but can be looked after by the regular mechanical force, reducing the labor charge to a minimum. With an equipment consisting of forty tools or more, it should be put in charge of a special machinist whose duty it is to follow the equipment closely and to keep it in good repair. It has been clearly proved that one man can care for one hundred tools where the proper attention is given by the men handling them. We have recently had our attention directed to tools in service which have been working regularly for a period of seven years. These tools, of course, have been well cared for, and the workmen using them appreciate their value in aiding them in their labors and handle them as they should be handled.

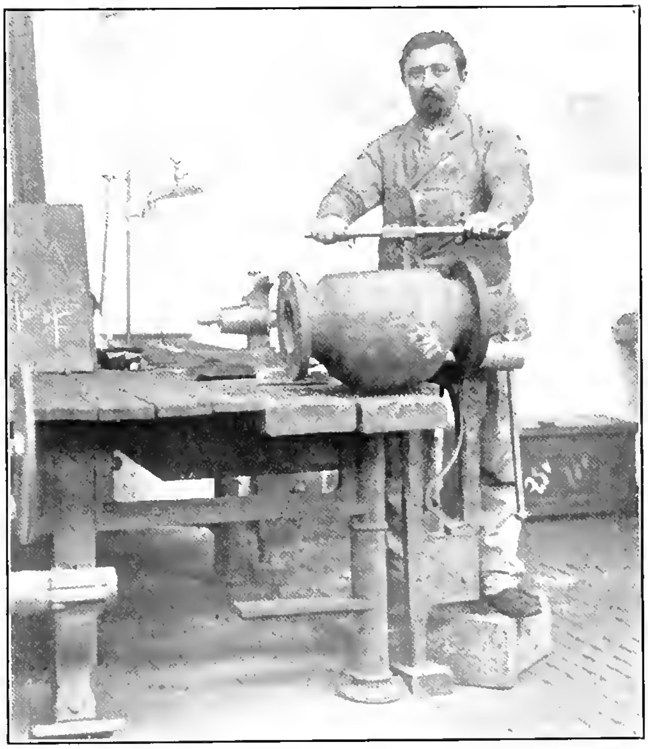
Pneumatic tools are outrageously abused in many cases without the knowledge of the management, and, at other times with their sanction, the latter being on account of these tools having such a large earning power that they are considered an economical investment even though their life be but three months. This latter remark may seem an exaggeration; however, it is borne out by actual knowledge. One of the largest steel concerns in the world is using chipping hammers where nine hammers in the hands of men skilled in their operation easily perform work which would require ninety unskilled men with mauls and cutters. The tools in this case are appreciated by both the management and the workmen and are well cared for. Even when the tools have a short life, a great many concerns having adopted them, state that the saving in wages and increased output make them an extremely economical investment.

Modern labor-saving machines are sometimes blamed for lowering the standard of skilled workmen by transferring him into a mere automaton a droning machine tender. Undoubtedly in some crafts there is less call for men of manual dexterity than there was before the invention of labor-saving devices, leading to a decreased demand for all-around mechanics, and an increased demand for men of only sufficient intelligence to guide an almost sentient machine. On the other hand, many types of labor-saving devices have counteracted this tendency by offering mechanical means for doing the drudgery of a shop, making necessary a higher average of intelligence than before. Pneumatic hammers and drills, portable electric drills and hydraulic riveters are in this class, as skill and judgment rather than mere brute strength and endurance are called for in their operation.

* * *

RATCHET TAP WRENCH

In our shops those holes which we cannot tap by power on the Pearn drill press are tapped by the method shown in the accompanying photograph. The tool consists of a ratchet tap wrench so made that the workman cannot turn the tap backwards, or to the left. From this there results the advantage of a greater rapidity of work as well as the obviating



Ratchet Tap Wrench used by Societe Anonyme des Ateliers de Construction H. Bollinckx, Brussels, Belgium

of the back and forth movement of the tap, which deteriorates the cutting edges; the workman is inclined to habitually give this objectionable movement. The ratchet wrench is reversible so as to permit the tap to be withdrawn with facility.

Société Anonyme des Ateliers de Construction H. Bollinckx

Brussels, Belgium.

* * *

Many problems in mechanism are best solved by avoiding them; that is, by resorting to other expedients that eliminate the troublesome feature. For many years various devices were tried in certain textile machinery to overcome the momentum of spools which caused them to over-run when winding was stopped. The consequent double reversal of motion when winding started again would often snap the thread before the inertia of the spool could be overcome. Thousands of dollars were spent on many devices designed to overcome the trouble, but with little success. At last the problem was solved by getting around it. In winding nowadays the spool does not turn. It is mounted with its axis parallel to the direction of the thread travel, and the thread unwinds from the end of the spool without rotating it. In this simple manner the effect of inertia is eliminated.

MAKING WALSCHAERTS VALVE GEAR PARTS

By RALPH E. FLANDERS*

Every mechanic really interested in mechanics, who chances to live near one of the great trunk line railroads, must have noticed a remarkable change in locomotive design which has taken place in the last three or four years. We refer to the increasing use of the Walschaerts valve gear. A locomotive equipped with this gear, as shown in Fig. 1, presents a distinctly different appearance from one furnished with the old-style Stephenson link motion, which is mounted out of sight between the frames of the engine. This difference in appearance is especially noticeable with the engine running at high speed when the lines of flashing light made by the flying steel work of the rods and links give a decidedly mazy and complicated appearance to the mechanism.

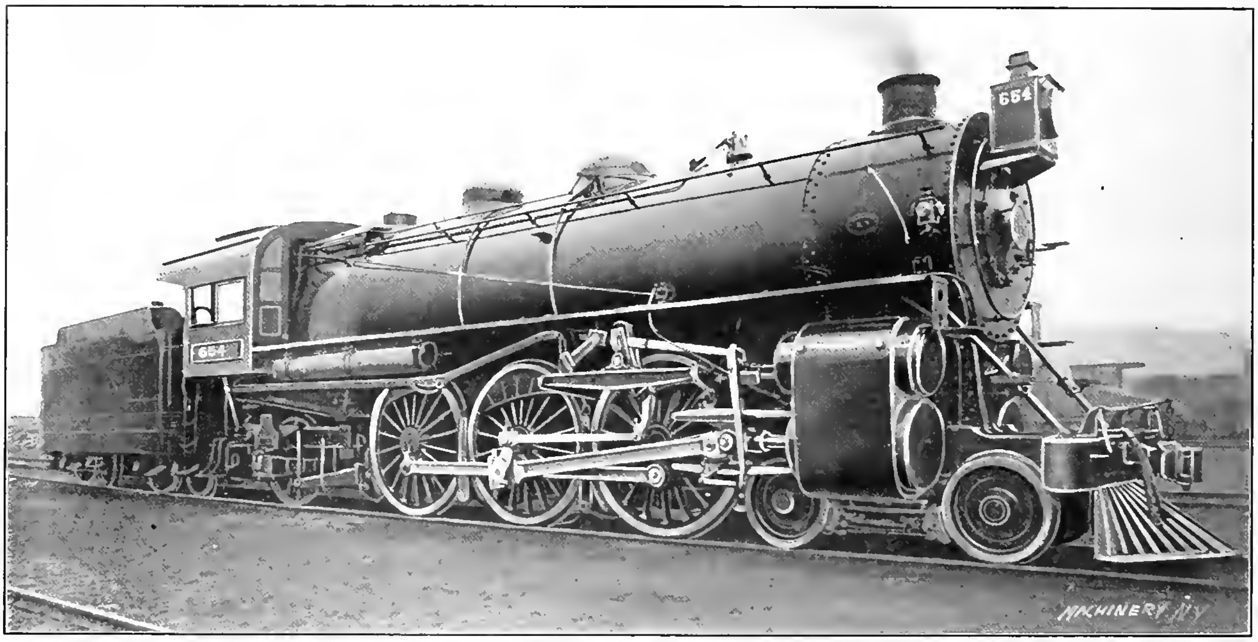


Fig. 1. Pennsylvania R. R. Pacific Type Passenger Locomotive with Form of Walschaerts Valve Gear used for Heavy Service

The Advantages of the Walschaerts Gear

In reality, however, the Walschaerts gear is not as complicated as the Stephenson type. The deciding factor in its adoption, as every railroad man knows, was not the matter of complication, but of dimensions. Of late years engines have grown so tremendously in size and power that it has become next to impossible to find room between the frames, for eccentrics and valve movements of sufficient size and wearing area to give strength and durability for the heavy service required of them. Besides this, the large diameter of the axles of heavy locomotives requires an eccentric of correspondingly large diameter; and with this, the surface speed of the bearing of the eccentric strap on the eccentric is so great as to practically nullify the effect of any increased area which could be given to it by careful designing. These considerations led to the adoption of a form of valve gear which was located entirely outside the wheels, where no serious dimensional limitations were placed on the parts.

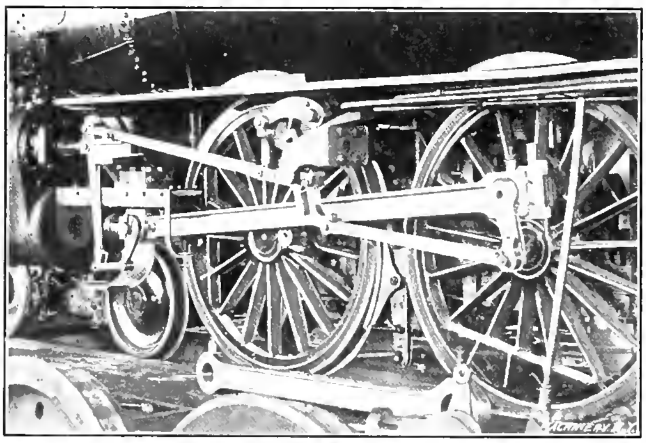


Fig. 2. Design of Walschaerts Valve Gear used on Atlantic Type Engines

When it came to the actual application of the new motion to the locomotive, it was found to have further advantages. One of them lay in the fact that it is always exposed to the view, making it very easy to erect and maintain, leaving it open for the constant inspection of the engineer. Besides this, it may be easily so designed that all its movements are in straight lines, without canting or side strains, thus particularly adapting it to heavy service. In the matter of steam distribution and economy, there is little to choose between the two, though the old gear may have a slight advantage.

We have referred to the Walschaerts gear as a "new" form of gear. This is true, however, only for American service. It has been used to a limited extent in England, but on the Continent it has been employed almost to the exclusion of any other form of valve gear ever since its invention by the Belgian, Egide Walschaerts, about 1844. Although we were so long in applying it in this country, its good qualities were rapidly recognized when once the start was made, as is evidenced by the fact that of 2448 locomotives ordered in this country last year, 1638, or about 67 per cent were of the Walschaerts type; 30 per cent were of the Stephenson type; while the remaining 3 per cent of the total number were furnished with other designs of valve movements, some of which were of a more or less experimental nature.

Two Designs of the Walschaerts Gear

The first two illustrations show the mechanism as applied to the locomotive. Different designs are shown in the two cases, that in Fig. 1 being used for the heavy service, while that in Fig. 2 is adapted to lighter work, being applied in this case to the standard Atlantic type passenger locomotive of the Pennsylvania R. R. The main difference relates to the method of raising and lowering the radius rod in the link, the connection between the radius rod and the link block, and the support of the link.

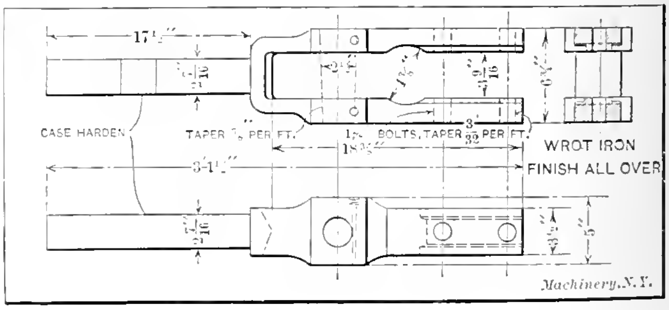


Fig. 3. Radius Rod Extension for Valve Gear shown in Fig. 1

* Associate Editor of MACHINERY.

In Fig. 1 the link is mounted on swinging yokes on each side, pivoted to bearings on a cast steel frame. The radius rod is provided with an extension, which spans the link on each side inside of the yokes and is provided with a finished square shank projecting beyond the link, which bears in the

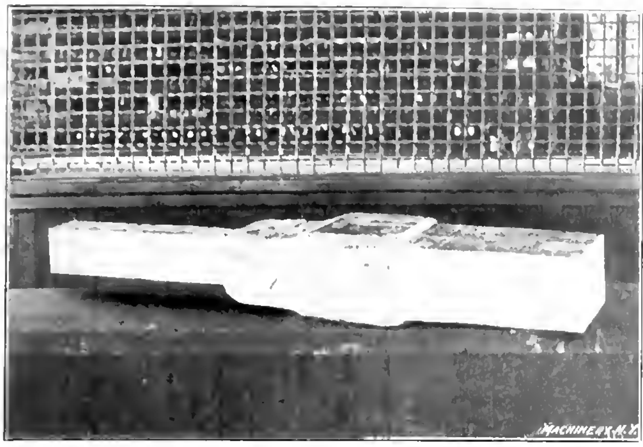


Fig. 4. Rough Forging for Radius Rod Extension

pivoted block on the end of the reversing arm, by which it is raised and lowered for forward and backward running. In Fig. 2 the link is supported in trunnions or saddles at the center, and the radius rod is hung from the reversing arm on a short link.

The operations on the rod work of the valve mechanism in the Juniata shops do not differ materially, except that the work is smaller, from the method of manufacture used in making the main and side rods, described in the February, 1910, number of MACHINERY, railway edition. In describing the shop operations on this valve gear, we will, therefore, confine the description to two particular parts of a special and peculiar design

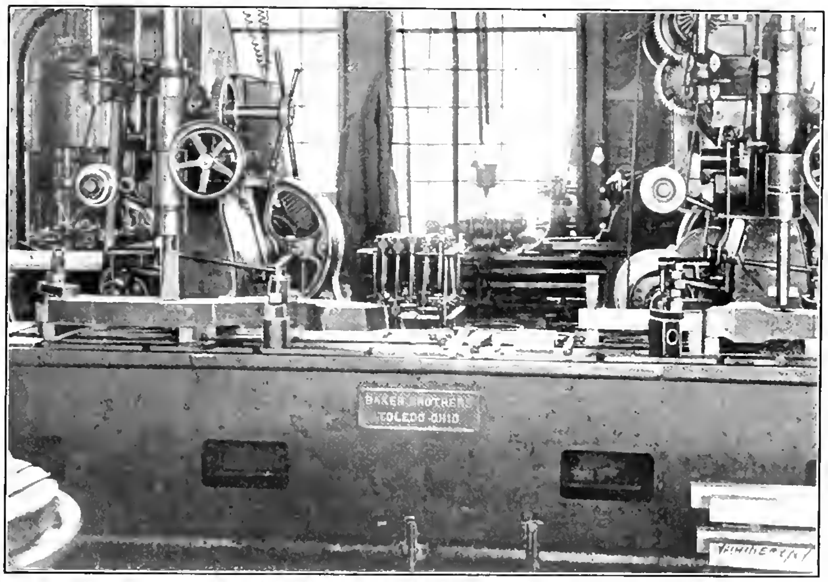


Fig. 6. Drilling Radius Rod Extension and Walschaerts Links

—namely, the links for both types of valve gear, and the radius rod extension for the heavier type of locomotive shown in Fig. 1.

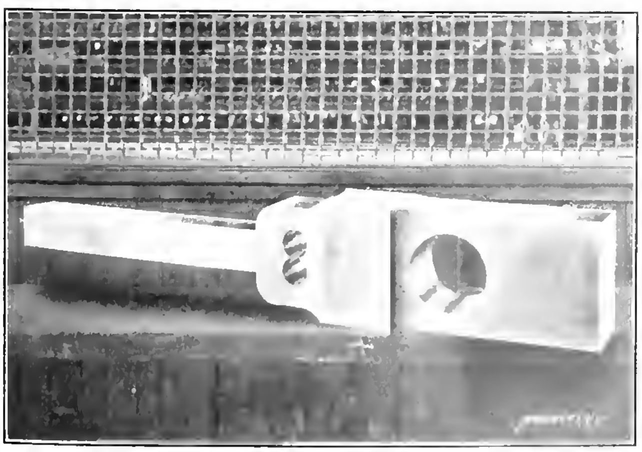


Fig. 7. Radius Rod Extension Drilled for Slotting

Roughing Out the Radius Rod Extension

A drawing of the radius rod extension is shown in Fig. 3. As may be seen, it is made from a wrought iron forging, and is finished all over. The square projecting shank, which bears in the pivoted block of the reversing arm is casehardened to give a durable wearing surface. This casehardening, as will be explained, introduced some difficulties in the course of manufacture. The overcoming of these difficulties gives the part its particular interest from the machinist's standpoint.

The rough forging from which the piece is made is shown

Fig. 5. Forging Roughed all over and Shank Finished

in Fig. 4. The illustration shows that the ends of this forging have been trimmed to size in the cold saw to practically the required length for the finished piece. Fig. 5 shows this forging roughed out all over. The various cuts shown have been taken in the slotting machine and the shaper. On the shank, which is to be casehardened, the finish marks show that the stock was necked out close to the connection with the body of the forging, the cuts being taken crosswise of the work on the four sides on the slotter. The forging was then taken to the shaper and the square was finished down to size. This, of course, is the obvious method of procedure.

The holes have next to be drilled for slotting out the interior of the blank to form the two arms which encircle the link. The machining of these holes is performed on a heavy drill press; or, as in the case shown at the left of Fig. 6, on a regular rod bor-

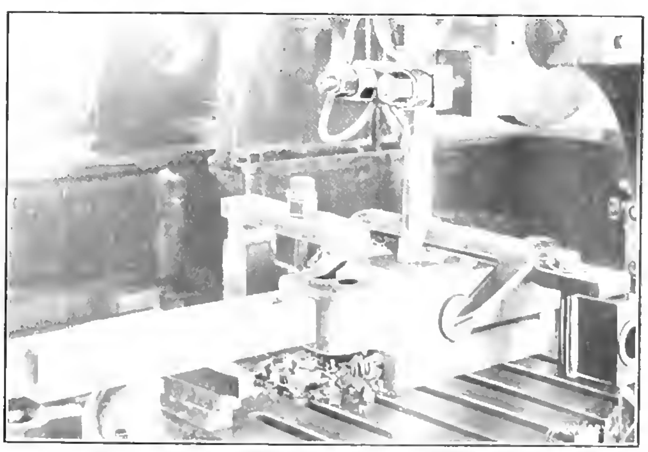


Fig. 8. Working out the Slot in the Slotting Machine

ing machine, using only one of the spindles, leaving the other free for other work. The larger hole is first drilled out, and then it is bored with a bar carrying a double-edged blade, as shown in the engraving. After these boring and drilling operations, the work has arrived at the stage shown in Fig. 7.

The forging is now taken to the slotting machine, where (see Fig. 8) it is mounted on parallels, so as to hold it firmly and accurately to the table of the machine. A square-nosed tool is used for cutting out the block of stock between the holes. The C-clamp, which is shown tightened in place on the forging, prevents the two sides of the newly formed opening from separating under the pressure of the cut. The state of the work at the end of this operation is shown in Fig. 9.

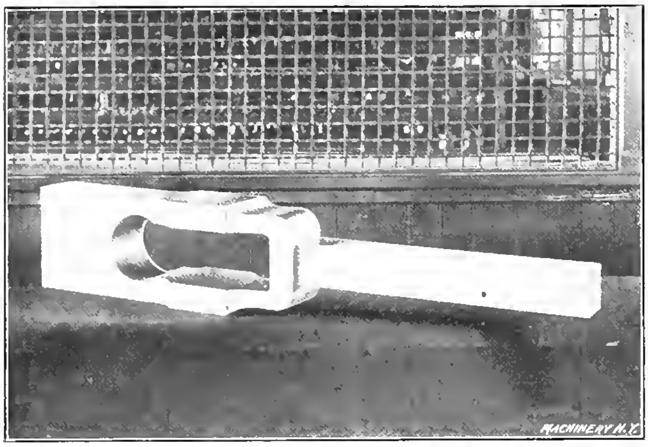


Fig. 9. Work with Center Slotted out ready for Casehardening

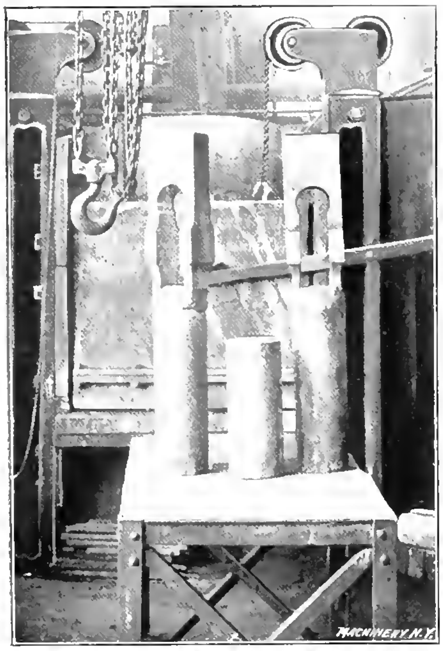


Fig. 10. Work and Test Piece Packed for Hardening


Fig. 11. Work placed in Furnace ready for Casehardening

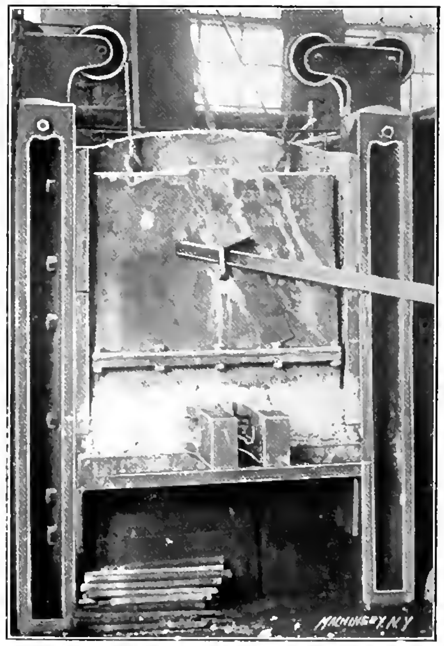


Fig. 12. Casehardening Furnace ready for the Heating

Casehardening the Shanks of the Radius Rod Extension

It has been found advisable to caseharden the shank at this point in the procedure. The advantage of doing it at this time lies in the fact that the remainder of the work is not yet finished to its critical dimensions, and the two sides are still tied together by the mass of material left between them at the outer end. Thus the distortion which is sure to take place in work of this kind in hardening, takes place at a time when it does no harm, as the finishing cuts will be taken with reference to the finished and casehardened surfaces of the shank, with which they will, therefore, be true and accurate. If the opening between the two sides was completely cut out, as shown in Fig. 5, before this hardening operation, they would almost certainly be sprung out of parallel with each other, or out of line with the casehardened portion.

Fig. 10 shows the casehardening furnace and two pieces of work ready for heating. The furnace is fired with oil, and supplied by a blast from the regular blower service of the forge shop. Provision is made, however, for an independent blast for keeping the fire up during the night or at times when the regular forge service is not in operation. This independent service is furnished by a small blower fan, which is itself operated by impingement on its blades of a jet of air from the high-pressure shop service line, used for the pneumatic hammers, riveters, etc. This latter is kept at pressure continually, day and night, so it is available any hour of the twenty-four, making it possible to use the furnace at any time or for any length of time.

As may be seen in Fig. 10, only that portion of the work which is to be hardened is packed. This is inserted in a section of wrought iron pipe, filled with the casehardening material, composed of 11 pounds of prussiate of potash, 30 pounds of sal-soda, 20 pounds of coarse salt and 6 bushels of powdered charcoal (hickory-wood charcoal preferred), thoroughly mixed with 30 quarts of water. The pipe is luted with fire-clay at each end to retain the carbonizing material and exclude the air. The work is placed in the furnace as shown in Figs. 11 and 12. The part that is not to be made hard is left projecting outside the furnace door. A wall of fire-brick and clay is built up to close the space between the lower edge of the door and the bottom of the furnace opening. After soaking for, say, fourteen hours more or less, the work is removed from the furnace and from its packing, and plunged into a tank of water as shown in Fig. 13, being suspended there until cool.

Test Pieces for Casehardening

Fig. 13 also shows a square block of hammered iron marked "Test piece." The use of this test piece gives an idea of the precautions which the Pennsylvania officials have found it wise to adopt, to make sure that all the material and treatment given to the vital parts of their locomotives, are up to the standard required of them. This test piece is forged at the same time and from the same material as the radius rod extensions. It is machined to the same dimensions as the square shank of

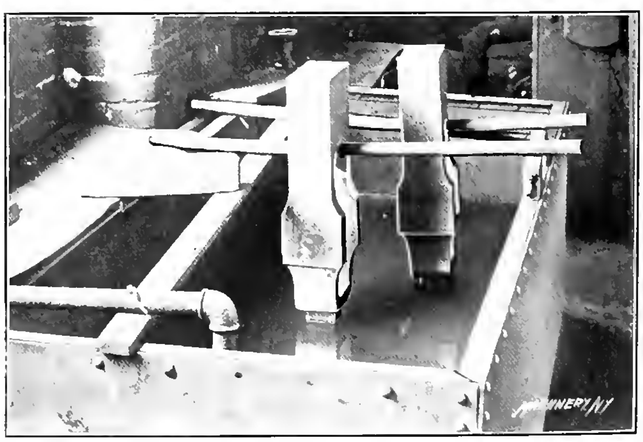


Fig. 13. Cooling the Casehardened Shank of the Work

the extension which is to be casehardened. It is packed in a similar wrought iron casing, as shown between the two pieces of work in Fig. 10, and is placed in the casehardening furnace next to the work itself, remaining there for the same time and subjected to the same degree of heat. It is then cooled and hardened in the same manner. It is evident, then, that the condition of the test piece should give an accurate index of the condition of the work itself, so far as the hardening operation is concerned.

The test piece, thus prepared, is now taken to a press and broken, in order that the condition of the interior may be noted. Figs. 14 and 15 show various examples of these broken test pieces. The examination shows the condition of the metal, the texture of the fiber, and the depth of the casehard-

Fig. 14. Broken Test Pieces for Showing Condition of the Work

ening. One-half of each test piece is thrown away. The other half is retained, marked with the date of hardening and the class and construction number of the engine on which the casehardened parts are to be used. These are kept two years to prove that the work is giving good results in service, and to make sure that no trouble is to be expected from it. It is held by the shop as a sort of guarantee of the good work done in the heat treatment.

Such precautions would be necessary or advisable in hardly any other kind of work, but there are many cases in locomotive practice where the extra expense and trouble is worth while. A defect in a locomotive is a serious matter. It may mean nothing worse than the delay of thousands of tons of valuable freight, or it may mean the loss of human life and serious damage to the prestige of a great railway system. Good steel properly treated is absolutely essential for the vital parts of a locomotive, and

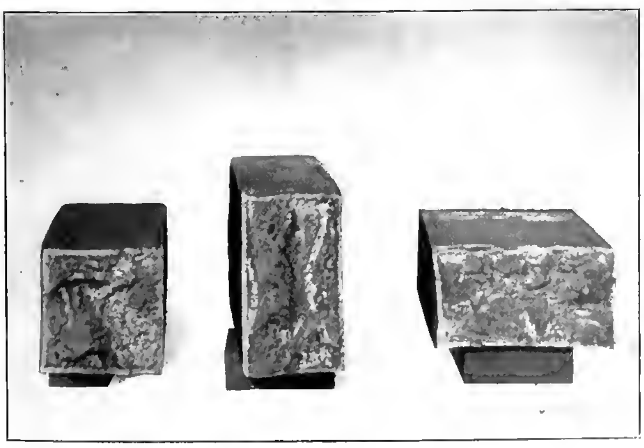


Fig. 15. End View of Test Pieces showing Depth of Hardness and Character of Fracture

every precaution is taken to insure reliability.

It was mentioned that ground coke is one of the ingredients used in casehardening. Fig. 16 shows the mill used here for grinding the coke. The coke had formerly been broken by workmen with hammers, in much the same primitive fashion that ice is pounded for the ice-cream freezer in the ordinary American home. The foreman got sick of this primitive process, however, and bethought himself of a bone grinding mill used on a chicken ranch in his neighborhood, which he pro-

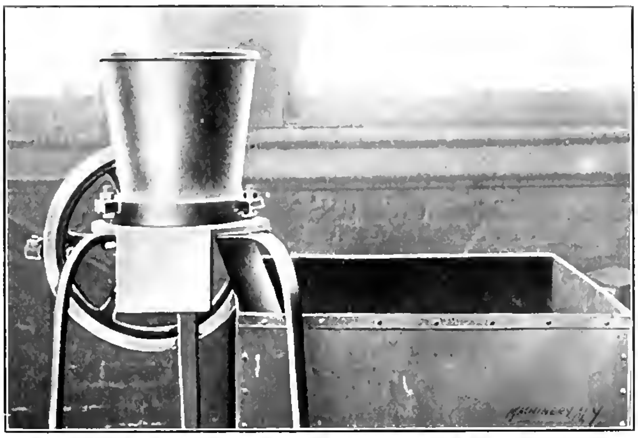


Fig. 16. Coke Crusher Built on the Bone Mill Principle

ceeded to copy. His copy is made of a few simple castings, and consists essentially of a hopper, as shown, having projections on the inside, alternating with similar projections on a revolving cone. The inner surface of the conical hopper and revolving cone taper toward each other, and as the coke passes down through the revolving teeth into this narrowing space, it is crushed finer and finer until it drops through a spout into the box. The fineness can be regulated by raising and lowering the hopper by means of the adjusting nuts on the studs by which it is supported. This crusher is operated by an air motor.

Finishing Operations on the Radius Rod Extension

Fig. 17 shows the completed radius rod and extension as-

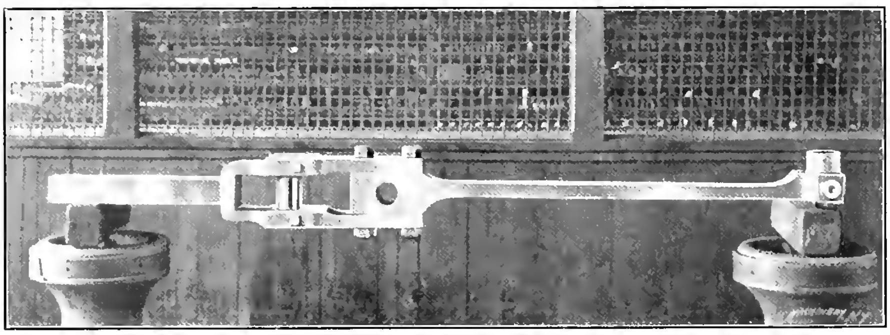


Fig. 17. Radius Rod Extension with Slotting Complete—Assembled with Radius Rod

sembled. The remaining machining operations have been performed, as required by Fig. 3, finishing out the slot between the two sides of the fork, and machining them for the tongue and groove joint of the radius rod head. These tongues are made with a taper, as shown, so that they bear on the sides only. When the bolts are tightened down to form the joint, assurance is given of a firm grip with no possibility of play or backlash.

Another point should be noticed in Fig. 3, which is a regular practice in locomotive construction, but one with which many machine-tool machinists are unfamiliar. This practice is the use of taper bolts. The two bolts shown, which hold the joint, are of 1¼ inch normal diameter, but they are tapered on the body of the bolt 3/32 inch per foot. This is the standard practice for all important bolts used throughout the whole locomotive. After the holes are drilled, the taper reamer is run through them to such a depth that, when the bolts are screwed home, they will draw in to a tight fit in the holes, and come solidly against the head. Each bolt thus serves as a well-fitted dowel, in addition to its duty of drawing the parts together. When the work is properly made, the joint thus formed is of a superior character.

Roughing Out the Link

A general drawing of the link used for the heavy form of Walschaerts gear is shown in Fig. 18. As was explained in connection with Fig. 1, this is of the kind in which the link

is supported by yokes which are attached to it at each end of the slot, and are provided with central pivots mounted in stationary bearings in the side frames. The two jaws of the radius rod span the link inside of the yokes in a way that will be understood by comparing Figs. 1, 17 and 18. The method of manufacture to be described applies in general to the light form of link shown in Fig. 2 as well as to the heavier type.

The first operation is the simple one of machining the sides of the rough forging from which the link is made. This is done in the planer, with the usual holding devices, as shown in Fig. 19. In Fig. 20 these forgings, which have been finished on each side to the required thickness, are laid out on horses, for marking off with a templet. The further one has the

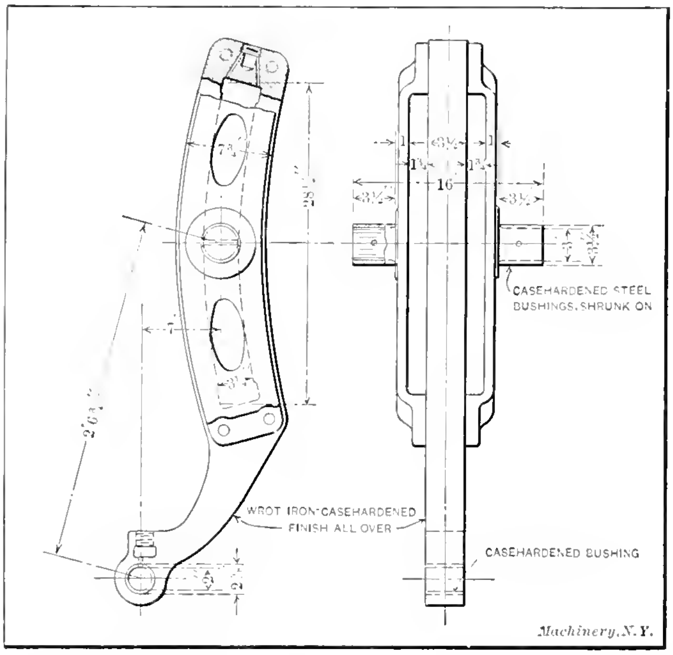


Fig. 18. Link and Mounting used for Heavy Type of Walschaerts Valve Gear

templet clamped to it as shown. From this the outline of the finished piece is scribed, together with the outline of the curved slot for the link block. The location of the pivot for the return crank rod is also indicated, as well as that of the four holes for holding on the yokes. This is an example of standard practice in this shop, where the use of an inexpensive templet saves a great deal of time in laying out work, and gives the assurance of proper location of the various machining cuts.

The slot has next to be worked out. As shown in Fig. 6, the forgings are first drilled through at the ends and in the middle of the slot, one end of the rod boring machine being conveniently employed for the purpose when not otherwise engaged. The links are then taken to the slotting machine, where the stock is roughly worked out by a parting tool as shown in Fig. 21. Two forgings are operated on at a time, with the holes lined up with each other. The parting tool is fed from one hole to the other on each side, removing thin slices of metal from the interior of the slot, and leaving it in condition for finishing to size.

Finishing the Slot of the Link

This finishing operation is performed on a link planing attachment of the usual construction, shown in use in Fig. 22. It would not be necessary to explain this device to railroad men, but for non-railroad readers the accompanying sketch, Fig. 23, will explain the principle. The link, shown at *A*, is mounted on a table *B* with T-slots on the top, which swivels about pin *C* fast in the base *D*. The swiveling of this table is governed by a stud *E* having a roller engaging a swivel guide *F*, clamped to the under side of the ram, or traveling head of the shaper. By setting the guide *F* to the proper angle, it so swivels the work about pivot *C* that the tool *G* will cut to a line closely approximating the true arc of a circle.

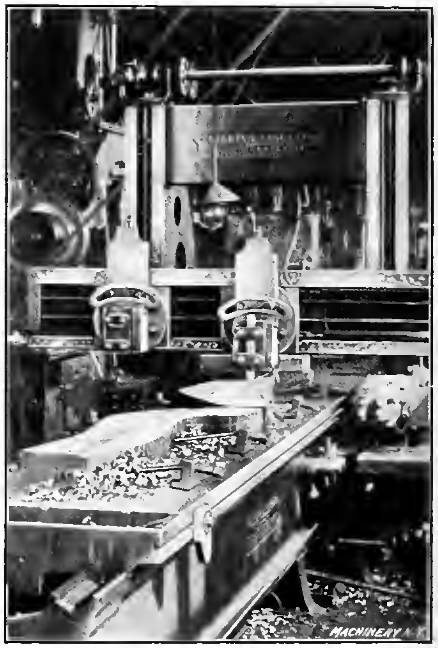


Fig. 19. Planing the Forging for the Links

The diagram Fig. 23 shows the mechanism as applied to the planer rather than to the open-side shaper, inasmuch as it shows guide *F* and tool-point *G* stationary, while the work *A* and work-table *B* are moving backward and forward. The principle is, of course, the same as in the case shown in Fig. 22, where the work-table *B* is stationary and the guide *F* reciprocates with tool *G*, swiveling table *B* and work *A* about stationary pivot *C*. It should be noted that whenever the tool is changed in this attachment for any reason, it must always be set up again with dimension *X* (the distance from the tool-point to the center of the swivel of guide *F*) always the same. If this distance is altered, the radius and position of the arc are changed.

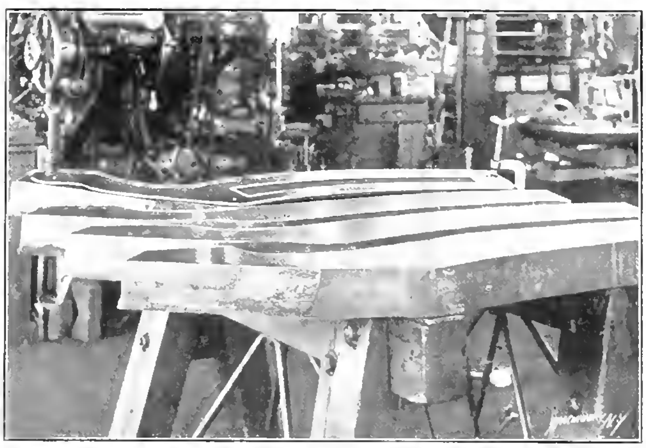


Fig. 20. Laying out the Links with Sheet-iron Templet

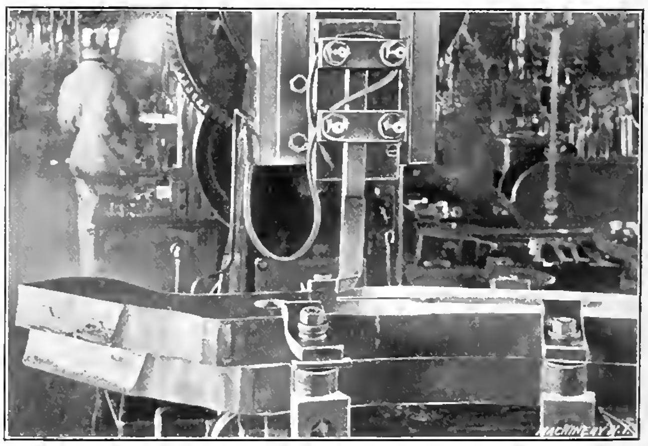


Fig. 21 Slotting the Links Two at a Time after Drilling as in Fig. 6

Inasmuch as the surfaces of the link, thus finished, are approximate and not exactly true, it is customary to finish them more nearly to absolute truth. This is done by grinding on the radius grinder to fit a good bearing with the templet shown in Fig. 24, which is itself accurately machined to the proper radius, and to the proper thickness. It should have been mentioned that the pockets at the ends of the slot have been cut out in a succeeding slotting machine operation to that shown in Fig. 21. These pockets give room for the shaper tool to run out into, as in Fig. 23.

Drilling and Finishing the Link

The slot in the link being the important surface, succeeding operations of importance are located from it. The next thing to be done is the drilling of the holes for the connection with the return crank rod. This operation, which is not shown here, is performed by means of a simple jig, located by a templet fitting the link slot, and carrying a bushing in the proper position for the hole.

The outline of the link has next to be finished. This is

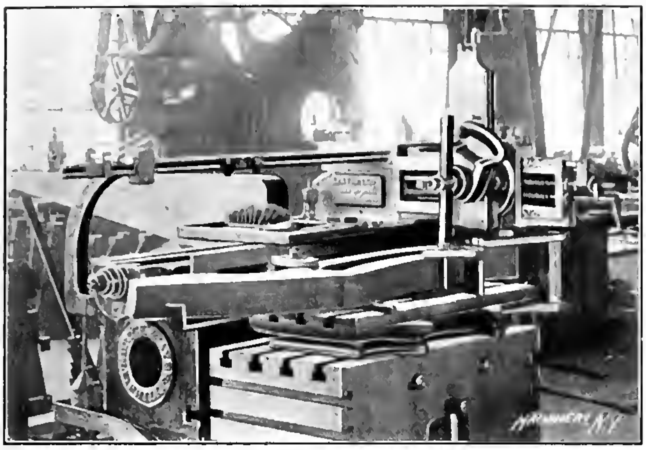


Fig. 22. Planing the Slots in the Links with the Special Planer Attachment

done as shown in Fig. 25 in a vertical milling machine, the table being rotated and fed by hand or power as required, following the outline scribed by the templet. Two links at a time are machined in this way, taking up nearly the full width of the cutter shown in use. They are lined up with each other by a pin through the return crank rod connection hole, and by lining up the sides of the slots.

The oil holes have next to be drilled, and the bolt holes for attaching the yokes. In the case of Fig. 18, the bolt holes are drilled in a way similar to that employed for drilling the return rod connection—namely, by means of a jig carrying a templet which fits the slot, and is provided with a bushing set at the proper relation to the templet. The yokes themselves, shown

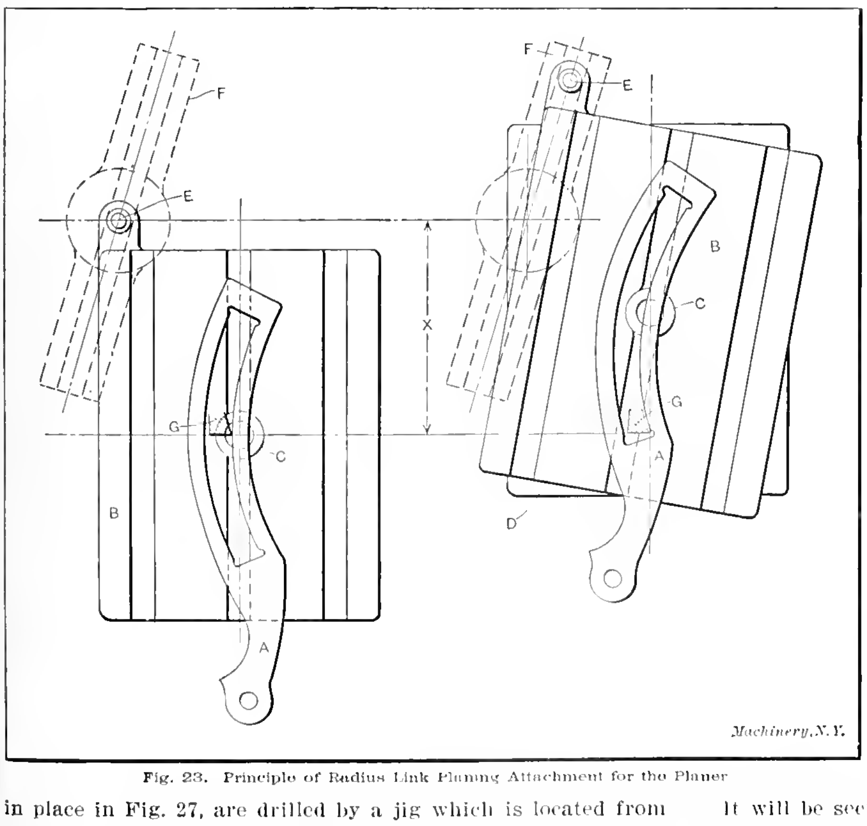


Fig. 23. Principle of Radius Link Planing Attachment for the Planer

in place in Fig. 27, are drilled by a jig which is located from the pivots on which the yokes swing. The holes for holding together the yokes and link are thus so located that the pivots are in the proper position with relation to the slot, and thus are in line with each other as well. These positions and the location of the holes for the return crank rod being the important dimensions, are all located from the slot of each link, and so are in the proper relation to each other.

Fig. 26 shows the method of locating the saddles or pivot supports used for the link on the light type of valve gear shown in Fig. 2. Here a fixture *J* is set into the link slot which fits it snugly, and is provided with pockets for receiving the saddles *H*, which are thus accurately located from the journals of the pivots. When thus located each is held in place by a set-screw as shown. The whole attachment is now slid along through the slot until it makes contact with the distance piece *K*, which is mounted on a stud fitted in the return crank rod hole. By this means, the pivots are located as they should be, with proper reference to the slot, and with proper reference to the return rod connection.

After the yokes in Fig. 27 and the saddles in Fig. 26 have been drilled and bolted into place, the outlines of these members are finished off to match evenly with the outlines of the link, making a good smooth job. Figs. 27 and 28 show a com-

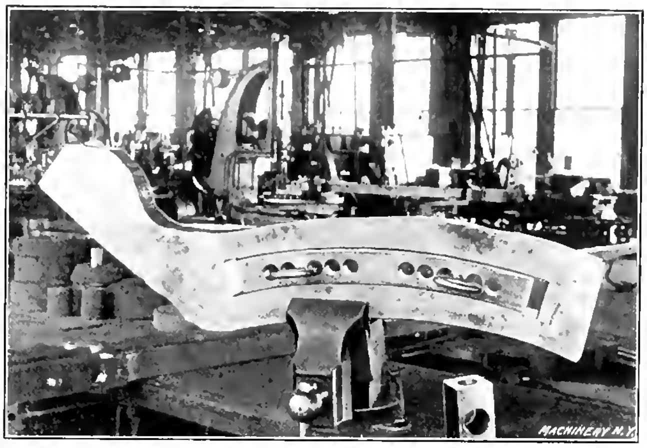


Fig. 24. Templet used for Finishing the Slot in the Link to accommodate the Radius Rod

pleted link of the heavy type, with the block in place ready for assembling in the locomotive.

Manufacturing Methods in Locomotive Building

Locomotives are built at Altoona on a manufacturing basis. When we make this statement, the words "manufacturing basis" mean something different than they do when we say that typewriters or machine tools are so built. In fact the term has a different meaning for all three cases. Manufacturing methods in building locomotives do not involve the use of jigs and fixtures for finishing all the massive parts of which the great machine is built. Jigs and fixtures large enough to do this would be prohibitive in size and cost, and practically no advantage would be gained from their use in any event.

The "manufacturing basis" on which the locomotive is built involves the use of templets for laying off all important outlines, holes, etc. Comparatively few holes are drilled in jigs, those so drilled being mostly the ones on which the accuracy of the valve gear lay-out depends, such as the radius rod and yoke connections in the link we have just described. In locomotive manufacture large use is also made of fixed gages for all the vital measurements of the frame, axles, etc., and for such other parts as are likely to require renewal. These parts are thus practically made on the interchangeable plan, though no such extreme of refinement is needed as that necessary in making typewriter parts interchangeable.

It will be seen that the tools required for this manufacturing work are of the simplest possible nature. The templets are made of sheet iron; the gages are made from bar steel, drawn down and ground at the points to the proper dimensions; and the fixtures are, in general, of a rugged and simple construction. By following this plan, the expense for tools is of comparatively small importance, even when building only

two or three locomotives of a kind. At the same time advantage is taken of about all the benefits of accuracy and interchangeability which can be secured on such large work.

The New K-2 Pacific Type Locomotive

It may be interesting to give a few particulars of the locomotive shown in Fig. 1. This is, as may be seen, of the Pacific type, which has come to be a standard machine for hauling the heavier high-speed passenger trains. The Pennsylvania R. R. has hitherto been able to maintain the schedules on its passenger runs with locomotives of the Atlantic type (see Fig. 2) of considerable lighter weight than other roads had found necessary for the same purpose. It was decided, however, a short time ago, to experiment with heavier machines, and the K-2 locomotive shown herewith is the result. This is probably the heaviest passenger locomotive ever built, outside of the Mallet articulated machines furnished to the Santa Fé, which are in a class by themselves.

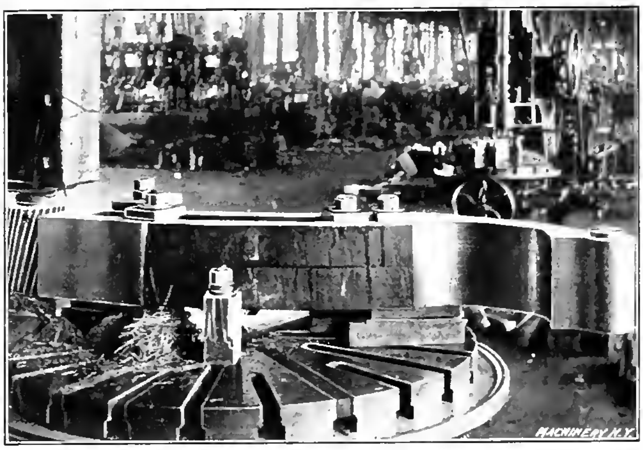


Fig 25. Outlining the Links in the Vertical Milling Machine

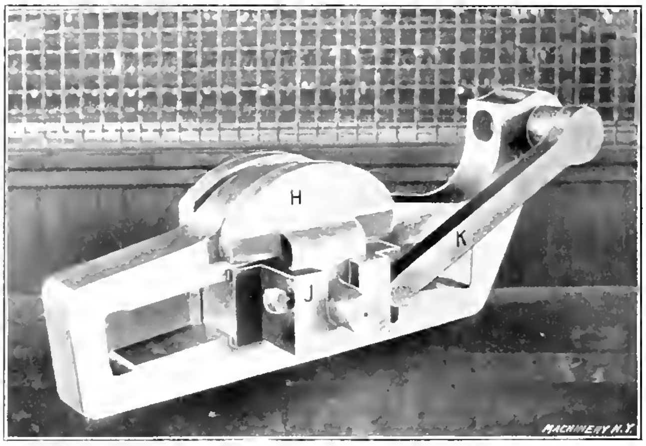


Fig 26. Jig used for Locating Pivot Saddles on Atlantic Type Link

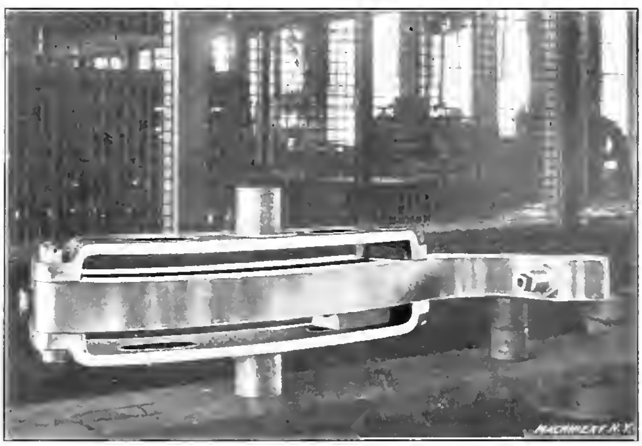


Fig 27. Complete Pacific Type Link with Yokes in Place

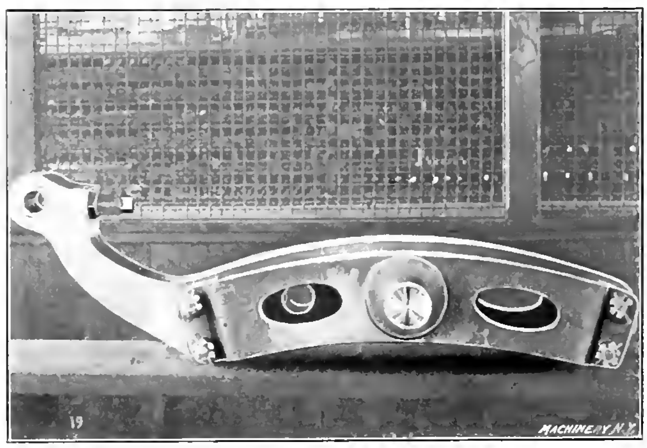


Fig. 28. Another View of the Finished Pacific Type Link

The total weight of the engine alone is 270,000 pounds, of which 176,500 pounds are on the driving wheels. The wheels are 80 inches in diameter. A straight boiler is used 80 inches in diameter at the front end. The grate area is 61.8 square feet. The total heating surface is 4427 square feet. The cylinders are 24 inches in diameter with a 26-inch stroke. The total cylinder horsepower developed is something over 2000, giving about 134 pounds weight per horsepower for engine and boiler. Comparison with any figures which might be taken from stationary practice of similar size would show a tremendously higher ratio than this, giving a good idea of the high degree of specialization which has been reached in locomotive design.

The diameters of the wheels and boiler are so large that even the liberal clearance allowed by the Pennsylvania R. R. have necessitated the shortening of the stack and domes to an unusual degree. On some roads, like the New Haven or the Boston & Albany, everything would be sheared off clean from the top of the boiler the first time the engine ran under a highway bridge. The engine does not show its size in the picture on account of the large diameter of the driving wheels and high clearances allowed. The writer saw it on the testing plant and there it looked imposing indeed. The experiments with the first example of this kind have been so satisfactory that a number are being built for service on various sections of the road, east and west of Pittsburg, with the idea of giving them a more extended trial.

* * *

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION CONVENTION

The sixth annual convention of the International Railway General Foremen's Association was held at the Grand Hotel, Cincinnati, Ohio, May 3-7. C. H. Voges, of the Big Four, Bellefontaine, Ohio, was elected president and L. H. Bryan, Duluth & Iron Range Ry., Two Harbors, Minn., was re-elected secretary-treasurer. A number of interesting papers were read and one of the star events was a talk on the apprenticeship question, by Prof. Herman Schneider, of the University of Cincinnati. Three important committees were appointed to prepare reports, for the next convention, on: Methods of Shop Organization; How Can Shop Foremen Best Promote Shop Efficiency, and Why Should the Press Fit of the Axle be Larger than the Journal; the respective chairmen being D. E. Barton, Santa Fé, Topeka, Kans.; F. C. Pickard, C. H. & D., Indianapolis, and Stephen Motta, Nat. lines of Mexico, Aguascalientes, Mexico.

About sixty supply men had machines and samples on exhibition. The next, or seventh, annual convention will be held in Chicago.

* * *

It is stated in the *Electrical World* that of the 5,000,000 horse-power actually represented by the Niagara Falls, only about 5.5 per cent, or about 270,000 horse-power, has been thus far utilized. Of this, 126,000 horse-power is employed in electro-chemical processes, 56,000 horse-power for railway service, 36,400 horse-power for lighting, and 45,500 horse-power for various industrial services. Nearly 125,000 horse-power is transmitted to points more than ten miles from the falls. Of this amount 12,300 horse-power is transmitted over a distance of more than 100 miles, while 33,500 horse-power is transmitted between 75 and 100 miles.

HARDENING OF CARBON AND LOW-TUNGSTEN STEELS

A research on the hardening of carbon and low-tungsten tool steels has been conducted by Mr. Shipley N. Brayshaw of Manchester, England, and the results of his investigations were presented to the Institution of Mechanical Engineers at the April 15, 1910, meeting. Some of the conclusions arrived at in these investigations are of general interest to all who have to do with the hardening of steel and the effect of this process on its structure, cutting capacity, and strength.

The paper deals exclusively with the results obtained from two kinds of carbon tool steel that, except for minute variations, differed only in the fact that one of them contained about 0.5 per cent of tungsten. The steel contained on an average of 1.16 per cent carbon, 0.15 per cent silicon, 0.36 per cent manganese, 0.018 per cent sulphur, and 0.013 per cent phosphorus. The whole work of investigation was devoted to questions directly connected with machine shop hardening, with the aim in view of throwing light on the many problems met with in daily practice.

Hardening Temperatures

The hardening point of both low-tungsten and carbon steel may be located with great accuracy, and the complete change from soft to hard is accomplished within a range of about 10 degrees F. or less. After the temperature has been raised more than from 35 to 55 degrees F. above the hardening point, the hardness of the steel is lessened by further increases in the temperature, provided the heating is sufficiently prolonged for the steel to acquire thoroughly the condition pertaining to the temperature. There is a "change-point" at about 1615 degrees F. in low-tungsten steel and at a somewhat higher temperature in carbon steel. One of the several indications of this change-point is the shortening of bars hardened in water at temperatures below that point, whereas the bar lengthens if this temperature is exceeded at the time of quenching. Practically the same results are obtained by heating low-tungsten bars to any temperature from 1400 to 1725 degrees F. and quenching in oil, as by quenching in water.

Length of Time of Heating

Regarding the effect of heating to various temperatures for various lengths of time before quenching for hardening, the following conclusions are drawn: Prolonged soaking up to 120 minutes at temperatures at which the hardening change is half accomplished in 30 minutes, does not suffice to complete the change. Prolonged soaking for hardening at a temperature of 1400 degrees F. has a slightly injurious effect on the steel, but does not materially influence the hardness. At a temperature of about 1490 degrees F. a great degree of hardness is attained by quick heating, but the hardness is impaired with 30 minutes soaking. Prolonged soaking for hardening at a temperature of about 1615 degrees F. has a seriously injurious effect upon the steel. A specially great degree of hardness may be obtained by means of soaking at a high temperature, such as 1615 for a very short time, but even as long a time as 7½ minutes is long enough to seriously impair the hardness.

The temperature of brine for quenching is of considerable importance. Both low-tungsten and carbon steel bars quenched at 41 degrees F. were decidedly harder than bars quenched at 75 degrees, and quenching at 124 degrees F. rendered the bars much softer.

Effects of Previous Annealing

The method of previous annealing affects the hardness of steel considerably. The elastic limit of low-tungsten bars hardened at either 1400 or 1580 degrees F. varies according to the annealing they have undergone. The elastic limit is high after annealing at about 1470 degrees F. for 30 minutes, or 1290 degrees F. for 120 minutes, but it is seriously impaired by annealing at 1470 degrees F. for 120 minutes. If low-tungsten steel is annealed at 1725 degrees F. and hardened at 1400 degrees F., the elastic limit is inferior, and the adverse effect of the previous annealing is much more pronounced if the hardness is done at 1580 degrees F. The elastic limit of carbon steel annealed at any temperature between 1290 and 1725 degrees F. and hardened at either 1400 or 1580 degrees F. does not vary by nearly such great amounts as the elastic limit of the low-tungsten bars, and the highest annealing temperature given above is not injurious so far as the elastic limit is concerned.

The hardness of low-tungsten bars hardened at 1400 degrees F. decreases from a high scleroscope figure to a low one as the temperature of annealing increases from 1290 to 1725 degrees F. The hardness is increased by prolonging the annealing at the lower temperature. The hardness of low-tungsten steel hardened at 1580 degrees F. is fairly constant at a moderately high scleroscope figure, whatever the temperature of annealing.

Effect of Heating in Two Furnaces

An interesting part of the experiments relates to the use of two furnace heats for hardening, heating the steel first in one furnace to a certain temperature for a given time, and then immediately, without cooling, soaking in a second furnace at a known temperature and for a definite time. These experiments show that low-tungsten and carbon steel bars heated for half an hour to temperatures between 1545 and 1650 degrees F. are not much affected so far as their elastic limit and maximum strength are concerned by a further immediate soaking for half an hour at 1400 degrees F. If, however, the temperature in the first furnace is 1725 degrees F., the low-tungsten steel is much improved by a further soaking at 1400 degrees F., but the carbon steel is much injured by the same treatment. Bars of low-tungsten steel heated for 30 minutes at 1616 degrees F. and then soaked at 1332 degrees F. for a further 30 minutes, give a high elastic limit and maximum strength, and are harder than if the second soaking were at a temperature of 1400 degrees F. The carbon steel, again, is but little affected by these variations in the second furnace.

The change of length in hardening, however, of both low-tungsten and carbon steel is much affected by the above variations in the temperature of the second furnace. Good results as regards elastic limit and maximum strength, and also as regards hardness, are obtained by very short soaking, first at a high temperature, say 1615 degrees F., and then at a low one, the results being best when the second temperature is near to or a little below the hardening point. If the furnace be at a sufficiently high temperature it is easy either by variations of the temperatures of the two furnaces, or by variations in the time of soaking, to arrive at a treatment of the steel, both low-tungsten and carbon, whereby they neither lengthen nor shorten. Under the same treatment carbon steel has a greater tendency to shorten than low-tungsten steel.

Miscellaneous Results

Other experiments showed that low-tungsten steel heated to 1580 degrees F. for 15 minutes and quenched in oil has a higher elastic limit and is harder than carbon steel similarly treated. As regards annealing, it was found that bars annealed at a temperature of 1470 degrees F. or below became slightly shorter by the annealing process, and its action was more pronounced in the case of carbon steel than tungsten steel. Annealing at a temperature of 1650 degrees F. causes both low-tungsten and carbon steel to lengthen.

It was found that recalescence of low-tungsten steel takes place gradually at a temperature of 1348 degrees F., and more readily at 1337 degrees F., and further that the recalescence at either of the above temperatures is very much retarded if the steel is cooled from a maximum heat of 1634 degrees F.

Regarding hardening cracks, it is shown that both for low-tungsten and carbon steel, such treatment as produced the highest elastic limit accompanied by the greatest hardness is frequently the most risky. The risk of hardening cracks is reduced if the steel is heated for a sufficient length of time to a temperature of 1650 degrees F. or a little above. Low-tungsten steel is more liable to crack in hardening than is carbon steel.

Effect of Tempering

Tempering experiments showed that little effect was produced by the tempering of carbon steel to 300 degrees F. for 30 minutes. Tempering the same steel to 480 degrees F. for 15 min-

utes, however, caused it to soften considerably and to shorten in length. For low-tungsten steel the elastic limit was increased considerably by tempering up to a temperature of 480 degrees F. The maximum strength of the same steel coincides with the elastic limit for bars either untempered or tempered at 300 degrees F. for 15 minutes, but it then rises rapidly with further tempering. The hardness, as measured by the scleroscope, was considerably reduced by tempering at 300 degrees F. and still more at 390 degrees F., but was not so much affected by further tempering at 480 degrees F. The length of the low-tungsten bars was reduced by tempering up to a temperature of 480 degrees F.; the higher the temperature, the greater was the reduction in length.

Effect of Tensile Strength

The following conclusions refer to low-tungsten steel, but there is no reason to doubt that they are also applicable to carbon steel. A variation in the hardening temperature of only 9 degrees F., the extremes being respectively above and below the proper hardening temperature or decalescence point, has a tremendous influence on the extension under load, but the maximum strength of the bars so treated did not differ much. A very good bar was produced by quenching from a temperature fully 108 degrees above the hardening temperature. A heat of only 5 minutes' duration produced a harder bar than a heat of 25 minutes, the maximum temperature in both cases being 1470 degrees F., or a little above; but the bar heated for a shorter time gave a much lower elastic limit. The maximum strength alone is not necessarily any indication of the condition of the steel in question, or of the treatment to which it has been subjected; nor is the hardness alone necessarily an indication of the condition of the steel or the treatment.

The following conclusions refer both to tungsten and carbon steels. Tempering up to a temperature of 570 degrees F. gradually increases the maximum strength and the elastic limit, although some irregularities enter which have not been fully accounted for. Tempering to this temperature reduces for a given stress the extension under load and the permanent extension.

Conclusion

In conclusion it may be stated, that these experiments show that steel of the quality treated in these experiments may be hardened within a temperature range of about 215 degrees F. The lower end of this range is very sharply defined, but the highest temperature allowable is difficult to determine, and as far as the appearance of the fracture is concerned there is little evidence of improper hardening until the temperature of the proper hardening point has been exceeded by 270 degrees F. So wide in effect is the margin of allowable variation for hardening that when the hardness is decided by the appearance of the fracture alone, any workman of average skill can easily keep within the limits and judge the temperature by sight alone, and as a matter of fact this is being done all the time in the manufacture of such articles as pocket knives, small files, etc., which are hardened by the thousands with practically no waste. But, of course, it must not be understood that articles so hardened reach anything like their maximum efficiency, because even small variations in the heat treatment previous to the quenching have a pronounced effect upon the condition of the steel, and even the previous treatment, such as the annealing to which the steel has been subjected, may influence the final result.

While it is thus easy to harden so as to obtain reasonably *good* results, the production of the *best* results given necessitates a degree of accuracy which can never be obtained by sight alone, and it is also important to notice that the difference between good hardening and the best hardening is very great.

As an example may be mentioned the hardening of razors. It is sometimes said that whatever price one pays for a razor, the buying is a game of chance. Occasionally one hears of a remarkable razor that holds its edge as if by magic, while others of the same make and type may not be anywhere near as good. All of them, however, would show to the eye practically the same fracture, and apparently seem to have been treated in the same way. The experiments referred to above, however, indicate that there may have been a slight difference in the hardening temperature and consequently in the subsequent condition of the steel, and also that it would be possible to harden every razor in a gross so that each one would be truly a duplicate of the best. The same, of course, holds true of a great number of other tools.

The author concludes by saying that there have, for some years past, been efforts of steel makers to discover new alloy steels, and splendid success has been obtained in this direction, but there is still a wide field for the steel users for discovering the best use of the material already known. It is of little avail that occasionally tools show marvelous results, unless the hardener can at any time produce the same results with the same steel. The time is likely to come when all the factors in the hardening of tool steel will be controlled with accuracy within predetermined limits, and any failure may be investigated and the cause located with as much certainty as if a mistake had been made in the machine shop.

* * *

FROGS, SWITCHES AND CROSS-OVERS*

As a rule, men who are primarily interested in machine construction are, for obvious reasons, not very well informed on track work. It often happens, however, that draftsmen, superintendents and others who have no training in this class of work are required to lay out, approve, or order industrial track systems to be used inside of a machine shop or in the yards outside. It is then necessary to decide upon the various details in connection with the frogs and switches, and some elementary information relating to this work will undoubtedly be of value to any man who is, or expects some day to be placed, in a responsible position where he may be occasionally called upon to carry out work of this character.

Switches are used for leading the wheels of cars from the main track onto a turn-out track. It is evident that when the outer switch rail reaches the opposite main rail, the wheel flange must pass through the main rail. The device by means of which the rail of the turn-out curve crosses the rail of the main track is called a frog, the general appearance of which is as shown in Table I of the accompanying Data Sheet Supplement. Frogs are made of various dimensions, determined by the angle of the frog, that is, the angle which the main rail gage line makes with the turn-out rail gage line at the point where these lines cross each other. Frogs of different angles are known by numbers, and a table is given in the accompanying Supplement of frog numbers with their corresponding angles, the numbers being given from $1\frac{1}{2}$ up to 20. Formulas are also given by means of which the frog number can be found when the angle is known, and the angle found when the frog number is known. As shown in the Data Sheet, dimension L is the length along the center line. This is, theoretically, the correct dimension to be measured for determining the frog angle. In practice, however, the length is usually measured along the gage line, because of convenience in taking the measurement in this way. As the angles are small, approximately correct results are obtained by inserting the dimension thus obtained in place of L in the formulas.

A circular turn-out is shown in Table II of the Data Sheet. In the illustration the various dimensions, such as theoretical lead, actual lead, radius, etc., are defined, and formulas for finding each are given. When a turn-out of this kind is being laid out, the angle can be determined when the radius and the gage are known, and when the angle has been found the corresponding frog to be used, as defined by its number, is determined from the table already referred to. The lower part of Table II gives formulas for a turn-out using straight frog and switch. In this case the formulas are somewhat more complicated than in the simple circular turn-out.

In Table III is shown a diagram of a three-throw turn-out, and formulas are given for determining the angle between the outer rails of the two turn-out curves. In the lower part of the same table is a diagram of a double cross-over with straight crossing and curved switches, and also for a double cross-over with reverse curve, formulas for the required angles and dimensions being given for both. In Table IV some of the dimensions which can be found by

* With Data Sheet Supplement.

the formulas given in the previous tables have been tabulated and collected for six different gages. These tables give the radius in feet, the angle in degrees and minutes and the theoretical lead in feet and inches. A special table for 4-foot $8\frac{1}{2}$-inch, or standard gage, is also included, which gives the number of frog, the corresponding angle, the theoretical lead, the radius of the turn-out curve and the degree of the curve.

The expression "degree of curve" may require some explanation to persons not familiar with railroad track work. The degree of a curve is the center angle that would be subtended by a chord 100 feet long. For curves from 1 to 10 degrees the radius may be found by dividing 5,730 feet, which is the radius of a one-degree curve, by the degree of the curve. The results are sufficiently accurate for all practical purposes, but for sharp curves, that is, for those exceeding 10 degrees, the following formula should be used:

$$R = \frac{50}{\sin D}$$

in which R = the radius of the curve, and

D = the angle of the curve in degrees.

It is evident that the degree of a curve has nothing to do with the length of the arc of the curve, but merely with the length of the radius. The shorter the radius, the greater the degree of the curve. The last-mentioned table may be used for finding the corresponding dimensions required for the use of a frog of a certain number, or it may be used for finding the required frog when any of the other dimensions are given. As the tabulated data in Table IV give the dimensions for the most commonly occurring conditions, it will save considerable calculation in laying out frogs and switches.

* * *

The gold production in 1909 exceeded that of 1905 by \$15,000,000. The total amount of gold mined is valued at over \$450,000,000, of which the United States furnished about \$100,000,000, Africa \$170,000,000, and Australasia \$72,000,000.

DRAFTING-ROOM OF THE TAFT-PEIRCE MANUFACTURING CO.

The Taft-Peirce Mfg. Co., located at Woonsocket, R. I., has recently refitted its drafting department, and now has a model drafting-room and equipment. This company is unique in New England in the respect that a very important feature of its business is the development of new inventions from ideas furnished by inventors and their promoters. Work of this character renders essential a highly organized engineering force, and to provide this force with adequate and suitable quarters the company established the conveniences described.

Two things are of prime importance in a drafting room, the lighting and the drafting tables. If the best work is expected, the draftsman must have a good table for his work, as well as adequate light, properly distributed. In the case of the Taft-Peirce Mfg. Co., the lighting has been provided for by placing the room in a second-story wing, thus affording natural lighting on three sides through large windows located at even intervals which make the wall space about equal in width to the window. The artificial lighting is provided for by Cooper-Hewitt mercury vapor lamps hung from the ceiling and by tungsten drop lights, two for each table. The drop lights are all at a fixed height, and remain in that position at all times. It is expected, however, from what has already been learned by use that the drop lights will probably be dispensed with and that the vapor lamps will be sufficient for all artificial lighting. The walls and ceiling are painted with white enamel waterpoof paint, which can be wiped clean, and which does not absorb light.

The tables, which are the most striking feature of the equipment, were built by the Washburn Shops of the Worcester Polytechnic Institute. An illustration and description of this table was published in MACHINERY, November, 1909. Each table is provided with an automatic releasing and locking rise and fall device which permits tilting to any angle.

Drafting-room of the Taft-Peirce Manufacturing Co.

between the horizontal and the vertical planes. The table top is provided with a parallel ruler, as will be seen in the installation shown; if desired, a drafting machine can be readily attached. In the installation shown the table tripods are screwed to the floor, a light shelf is attached to the rear of the tripod posts, and is used to lay handbooks, extra drawings and tools upon. With the automatic rise and fall device, it has been found more convenient to raise or lower the table top to or from the drop light than to adjust the cord, and the absence of loops or adjusting devices in the cords greatly improves the appearance of the room.

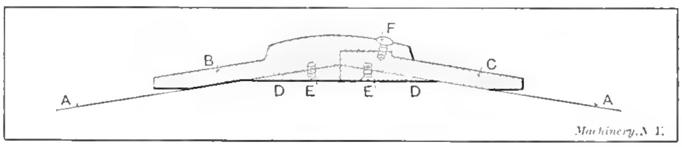
Toilets, wash- and coat-rooms are provided. It will be noted that each draftsman wears a white laundered coat. The blueprinting equipment consists of a continuous blueprinting machine using Cooper-Hewitt lamps. As the printing room is above the level of any nearby roofs, sun printing can be readily accomplished if desired. In taking the photograph for the illustration the camera was set up near the chief draftsman's office which occupies a corner of the main room. This office is provided with the necessary equipment for a complete system of indexing, comparing and cost-keeping so essential in engineering drafting.

* * *

THE TRANSMISSION OF POWER BY STEEL BELTS

In a paper on the transmission of power by belts, recently read by Mr. R. Krall before the British Institution of Engineers, a number of interesting details regarding the transmission of power by steel belts were given. The use of steel belts for power transmission is a recent development, being thus far mostly applied in Germany and Belgium, and has previously been referred to in MACHINERY in the February, 1908, issue, engineering edition.

The thickness of the steel belts varies from 0.2 to 0.9 millimeter (0.008 to 0.035 inch) and the width of the belt varies from 22 millimeters to 200 millimeters (⅞ inch to 8 inches). For a 200-H. P. drive at a given speed, for example, one belt 6 inches wide by 0.024 inch thick is used. For a 440-H. P. drive at the same rate of speed, again, two belts are used, each being 6 inches wide by 0.027 inch thick. One of the first difficulties met with in the production of steel belts was that of producing a perfectly homogeneous metal. The material for the belts now is made of specially manufactured steel of high tensile strength. Another difficulty met with has been the proper construction of the joint between the ends of the belt. An ideal drive would, of course, be obtained by the employment of a continuous steel band, but there are many difficulties in the way of the production of such a belt and its cost would be prohibitive. It would be more difficult to handle and transport, and would often present great difficulties in mounting on the pulleys. A joint as shown in the accompanying illustration is, therefore, adopted. The belt is soldered to the joints at the factory, and the user, when putting the belt in place, has only to insert a few screws. In the illustration, *A* indicates the steel driving belt, *B* and *C* are the two halves of the joint, and at *D* are shown two small triangular filling pieces. Two rows of small screws *E* secure these triangular pieces to the belt and to locking pieces *B* and *C*. At *F* is indicated a row of larger screws uniting the locking pieces. All that has to be done when putting the belt in position is to insert the screws *F*.



Construction of Joint for Steel Belts

It will be noticed that the locking pieces are prolonged for a considerable distance beyond the joint proper. This construction is the result of experience, as it was discovered that when this additional length of the locking pieces was not provided the belt broke near the small triangular pieces *D*. A small curve is provided on the under surface of the joint, but it is very slight, the joint being nearly flat. In order to determine the length of the belt a special apparatus is used by means of which a light tape of steel is placed over the pulleys and subjected to a predetermined tension, the two ends being drawn together and permitted to overlap. Both ends are then cut through at the same point and a band the exact length of the required belt is obtained. The manufacturers make the length of the belt to this gage.

The steel belts run fairly well on smooth cast iron pulleys, but after a time there is a tendency to polish the surface of the pulleys and it has been found desirable to cover them with a thin cork covering which is glued to a piece of canvas which, in turn, is cemented to the pulleys. There is practically no slip whatever on pulleys treated in this way, and the cork covering does not wear away.

Tests undertaken at the Charlottenburg University with these belts indicate that it is the best practice to use an initial tension of 10,000 pounds per square inch of section of belt. The belts were run in these tests at velocities ranging from 3000 feet per minute to 7000 feet per minute, and the percentage of slip varied from 0.036 per cent to 2.2 per cent, the average being about 0.55 per cent.

Although this method of driving by steel belts is too new to have fully established its claims, some thousands of steel belts are already in use, and no doubt the system must be regarded as having an important future. According to figures published by the manufacturers of the steel belts, a steel belt 4 inches in width will transmit the same power as an ordinary leather belt 19 inches wide, or as 6 ropes with 1¾ inch diameter each. The weight of the driving pulleys as compared with those for leather belting is but one-half, and as compared with those for rope drive is hardly more than one-quarter. The total cost of steel belting installed is stated to be 60 per cent less than that for leather belting, and 33 per cent less than that for rope driving, while the loss of power through slippage is almost negligible with steel belting. Steel belts, therefore, appear to have some considerable advantages over those of other materials. They do not stretch, and therefore never have to be taken up. Very high speeds, up to 10,000 feet per minute, may be employed. The belts apparently do not wear, due to the fact that they do not slip. Short drives may be used, and the pull on the bearings and the consequent wear is reduced on account of the decreased weight of pulleys.

On the other hand, the material in the steel belts may not prove as reliable, although this point is speedily being remedied, and it can be added that steel belts have been in continual successful use for over two years. Another consideration is that unless properly guarded these belts would be extremely dangerous if failing when running at a high speed, and the necessity of having to be extremely careful about the exact length may sometimes prove troublesome. The belt must be extremely well applied to insure that the power is evenly distributed over the full width of the steel band, as otherwise excessive stresses would be set up at one edge, and the belt would then be stressed at this point beyond its breaking strength with the result that the whole belt would fail.

* * *

Attention is called in the *Zeitschrift des Vereines deutscher Ingenieure* to the development in the building of motors for airships and aeroplanes. It is stated that the Daimler-Motoren-Gesellschaft, Untertürkheim, Germany, in 1890 built a 5-horse-power motor for an airship, the weight of which was seventy pounds per horse-power. This year the same company has built a 115-horse-power motor for a flying machine in which the weight per horse-power is only 4.8 pounds. It will be remembered in this connection that the weight per horse-power of the Adams-Farwell aeronautic gasoline motor, described in the engineering edition of MACHINERY, July, 1908, is only 2.7 pounds per horse-power.

* * *

The Santos-Dumont new monoplane flying machine, which is fitted with wheels driven by the engine, so that it can run on the road as well as fly, and which weighs complete only 242 pounds, is being built by the French Clement Co., and sells at $1,250 each. This price apparently brings the flying machine into direct competition with the automobile.

WOODEN DRAWINGS

By W. H. SARGENT

The boss patternmaker had put a bit into an upright drill and was boring furiously into a block of wood. "What are you making, chips?" I asked. "No, I'm making a wooden drawing," he replied. "You see, here is the blueprint of a pattern. It needs four views to show the thing up. The back side view is projected n an angle to show a diagonal brace and it is all covered over with dimensions, until no man in the shop can read it. Now I am trying to rough out something which will show the shape so that a man will know just what he is trying to do. It isn't a model, nor a pattern. It is something to work by the same as a paper drawing, so I call it a wooden drawing."

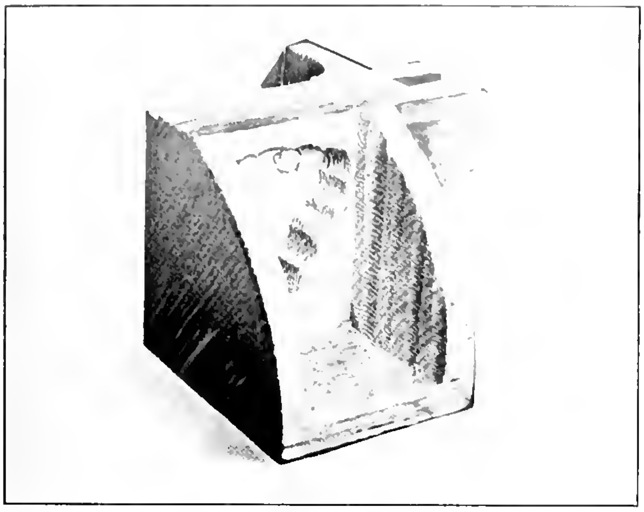


Fig 1. Example of a Wooden Drawing

He handed me the article shown in Fig. 1 which he had grubbed out. The drawing was quarter size and he had made this the same. It was roughly done, being made entirely with a saw and a bit, but it showed what was wanted, and left nothing to the imagination.

Fig. 2 shows a "wooden drawing" of a portion of a 200-ton scale of new design. Rough as this was, it helped astonishingly to give one the sense of proportion. Instead of a number of confusing drawings, more or less incomplete and all on a flat surface, here was in effect the full-sized machine, showing not only the strength and symmetry of the various parts but their weaknesses as well. Careful examinations were made by different men to determine the handiness and accessibility of the various parts and a full discussion was held to consider the general appearance of the design.

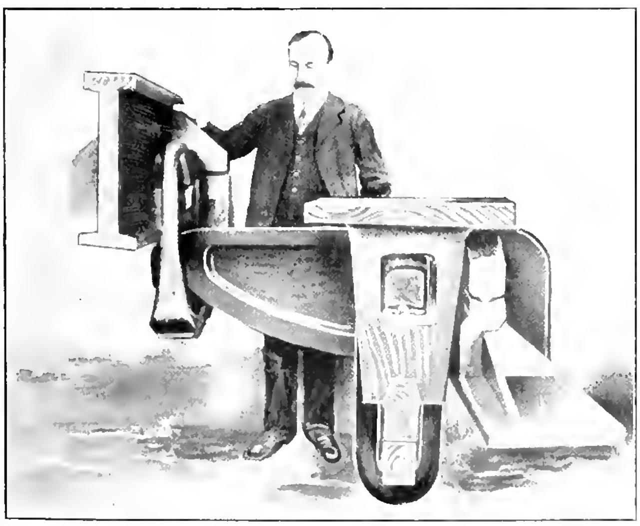


Fig 2. Wooden Drawing of Part of the Mechanism of a 200-ton Scale

No paneling was done. The model was painted a dull lead color and the effect of sunken parts was done with darker paint on a flat surface similar to Fig. 3. Perhaps none of the men concerned in getting up this scale were able to comprehend from the drawings exactly how it was going to look; whether there would be freedom enough between certain parts or whether certain other parts would interfere with each other, yet all these points were satisfactorily decided from the model without the expense of an elaborate set of patterns

Fig. 3 The Wooden Drawings are not panelled, Sunken Effects being obtained by Shading

and core-boxes or the aid of heavy castings with pivots set to a gage. The design was accepted with but very few changes. Fig. 4 shows this part of the scale somewhat modified and as finally completed and erected.

A certain bridge company spent $600 to construct a full sized model of a panel point for the purpose of familiarizing their own men with the details of the work and of impressing

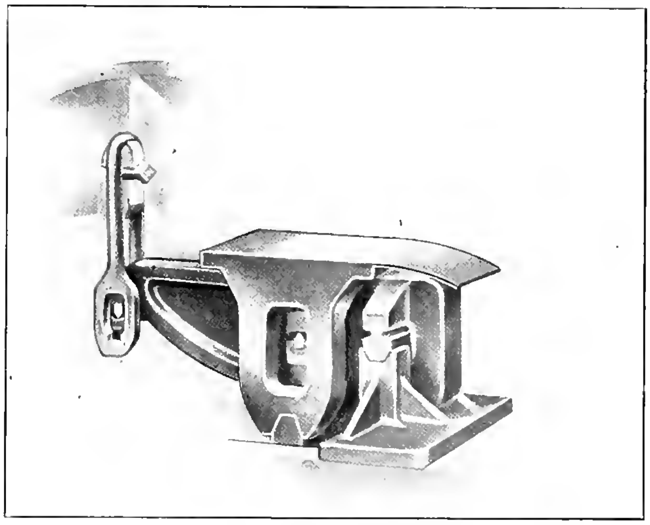


Fig. 4 Completed Design of Part for which Preliminary Wooden Drawing, Fig. 2, was made

others with its importance and magnitude—a large price for something which has no commercial value. The question arises—does it pay to put so much money into something which can neither be sold nor used? Of course it pays; in these days of commercial rivalry anything pays which enables one to find the answer before the other fellow gets his pencil

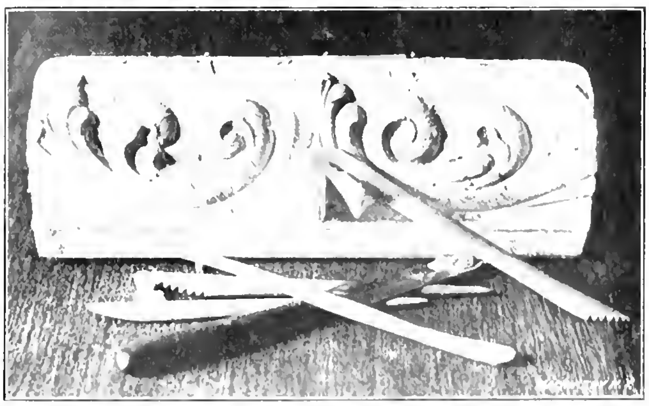


Fig. 5. Clay Model of Scroll Work and Modeling Tools

sharpened. There is no question about the commercial value of good appearances. A "good front" is a distinct financial asset, whether on the salesman or on the goods. No matter

* Address: St. Johnsbury, Vt.

how good the old machines were, the new ones are better if only "just as good," and this isn't as Irish as it may seem, because while some of the old machines may still do good work, yet their misproportions were so disguised with moldings and covered with curling curves and required so much "manicuring" that their total product was materially less than the plain and simple machines of to-day. Ornament has its place but it should not be used to disguise poor construction. "The beautiful is often as useful as the useful" and designers of the beautiful make more frequent use of preliminary models than designers of the useful. In most cases they use modeling clay, building up the design with their fingers and working out the details with the small wooden tools shown in Fig. 5.

While paper drawings are necessary, "wooden drawings" are also helpful in showing which points to emphasize and what to disguise. The Lord didn't make man with the ribs in sight but added flesh to make "the human form divine," so it is up to the draftsman to assemble the mechanical elements—the dried bones, so to speak, and clothe them with a suitable and proper dress.

* * *

BILLINGS & SPENCER CO.'S EMERGENCY HOSPITAL

The Billings & Spencer Co., of Hartford, Conn., has recently added to its plant an emergency hospital for administering "first aid to the injured." Located in a corner of the machine department, it is easily accessible from all other departments of the factory, and all injuries, minor or serious, are ordered to report there for treatment.

For a number of years the company has been doing this work in a crude and rather unsatisfactory manner, using a corner of one of the lavatories for the purpose, and keeping the outfit in a wall cabinet. The results attained have been

Billings and Spencer Co.'s "First Aid to the Injured" Hospital

such that they believed better accommodations would insure even better results; hence the recent establishment of the emergency room. The room, erected for the purpose is 12 feet by 20 feet, and is finished throughout in white enamel, which can be easily cleansed. The outfit consists of an iron enameled bed; sterilizer for both instruments and dressings; cabinet for instruments, solutions and dressings; hot and cold water equipment; stretcher for transportation of serious cases from various departments; and other minor necessities.

An injury sustained by an employe is immediately reported to the foreman of his department, who orders the case to the hospital for treatment, where it is taken care of. If the injury proves too serious, the injured is either ordered home for care by his own physician or to one of the city hospitals. A custom has been established, whereby all secondary dressings are ordered to report at 9 A. M. every day for inspection and advice.

The room is under the immediate supervision of Mr. E. J. Beams, chief clerk of the factory office, whose previous experience in hospital work fits him to have charge.

* * *

According to the *Brass World*, an addition of 2 per cent of metallic sodium to lead hardens it so that it may be used for bearing surfaces. The alloy is so hard that it rings when struck.

THE EXPERIENCES OF A YOUNG TOOLMAKER*

By T. COVEY

"Mr. Anderson," said Jim, "may I eat my lunch beside you this noon, and ask you a few questions?"

"Well, Jim, I've no objection to your company," said Mr. Anderson, "and you may ask as many questions as you like, but whether I answer them or not will depend upon my ability. I would as soon talk as not, though what I say may not amount to much. If that is satisfactory, go ahead."

"I'll take chances on that," said Jim. "I've heard several of the men make remarks about multiplying errors, and I am a little curious on the subject. I should like to know how and why it is done."

"Well, it is usually done to acquire greater accuracy, and

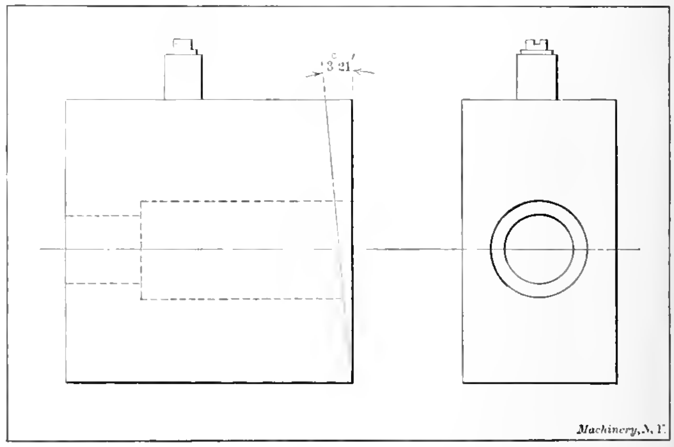


Fig. 1. Small Jig with Button Attached by which Work is set for Boring

there are innumerable ways of doing it; in fact, we have many machines and instruments for that very purpose, such as our micrometers, indicators, graduated dials, etc. However, I do not think that an explanation of them is what you want. What you have in mind is the numerous little methods and kinks obtained by practice and observation whereby we obtain greater accuracy in our work, probably the most common of which is the doubling of an error with the dividers. Suppose that I wished to lay out a radius of say 3 inches as accurate as possible, and the nearest I could be sure of getting, by setting the dividers off a scale, is within 0.0025 inch. To obtain greater accuracy than that I would scribe a straight line on a layout plate, set my dividers as near as I could to 3 inches, place one leg of the dividers on the line and with the other scribe a circle. Then taking a larger pair of dividers, or a set of trams would be better as the legs stand straighter, set one leg on the circle where it crossed the line and the point of the other where the circle crosses the line on the opposite side, using a magnifying glass to see that both points are in the proper position; then try the tram points on a scale and see what the distance between them measures. If the dividers were set right, the distance will be just 6 inches, but suppose that I am able to see that the tram points measure more than 6 inches apart, then I know that the dividers were not set right, and I proceed to readjust them; then selecting a new point on the straight line I repeat the operation. Suppose that this time I am unable to discern an error, or that the diameter of a circle scribed with the dividers is within 0.0025 of 6 inches; then, since any error that exists in the dividers would occur twice in scribing the circle, or be doubled, I know that the dividers are right within half of the least

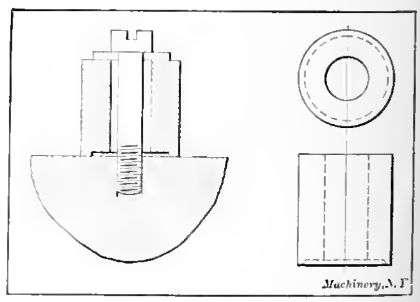


Fig. 2. Steel Bushing or Button used in Precision Work

* Previous installments of this series of articles appeared in the numbers for August and December, 1909, February and April, 1910.

error that I am able to detect, or half of 0.0025 which is 0.00125 inch. This method is practiced extensively by templet makers in laying out their work and can frequently be made use of in other ways as well.

"Here is another instance in this little jig that is lying here. (See Fig. 1.) The man that is making it has got it all squared up and a button set where he wishes to bore a hole. The next thing that he will do is to set it up on the faceplate of a lathe and chuck it true, or approximately so; then, applying an indicator to the button and revolving the lathe, note the amount that the instrument indicates that the button is out of true. This amount is just twice what the actual error is. Suppose that he is able, with the assistance of the indicator, to get the button true within ¼ of one-thousandth; he then removes the button and bores the hole; the center of the hole will not be out more than half of the amount that appeared in the periphery of the button. This can probably be best illustrated by likening it to the pin on a crankshaft which, should the distance from the center of the pin to the center of the shaft be 4 inches, would make the throw of the pin 8 inches. This would, of course, hold good down to the minutest measurements, and in the case of the button we measure the 'throw,' which is just twice the amount that the button is off center."

"I don't just understand why the button is used, Mr. Anderson," said Jim.

"Well, if you had a hole bored in that jig, for convenience say, just one inch in diameter, then if you were to put a one-inch plug in the hole and allow it to project a little it would be an easy matter to measure from the edge of the plug to the edge of the jig and add half the diameter of the plug to the measurement and thus get the distance from the edge of the jig to the center of the hole. Now suppose that instead of inserting a plug in a hole, which we can only do after the hole is bored out and its location fixed, we first lay out the hole approximately, and drill a small hole and tap it out for one of these screws that are used to fasten these buttons on with; then on fastening one of the buttons in place we have the same conditions that exist with a plug sticking out of a hole, with the exception that we can change the location of the button within certain limits, on account of the hole in the button being larger than the screw (see Fig. 2). Now assuming that we want the location of a hole very accurate, we should have the jig squared up accurately so that we can make all of our measurements from the edges of the jig; then length-rods would be made equal in length to the distance from the two edges of the jig to the center of the hole, less half the diameter of the button. Considerable care should be exercised in making these length-rods. Preferably they should be made of round cold-rolled steel, or drill rod, and they should be made like Fig. 4, with the ends faced off square between the centers of a lathe to insure their being parallel to each other. After making the length-rods and measuring them with a micrometer to make sure that they are right, one of the faces of the jig from which we wish to measure is set down on the surface-plate. The button is then adjusted until the proper length-rod can just pass between it and the faceplate. The jig is then turned onto the other surface that is to be measured from and the button is set so that the other length-rod just passes between it and the plate. These operations are repeated until the button is set so that both length-rods touch it alike from their respective sides. This is easier to do if we place a washer of paper under the button and use a fiber washer between the button and its screw head. After the button is set the jig is chucked in a lathe and the button is set to run true; it is then removed and the hole bored.

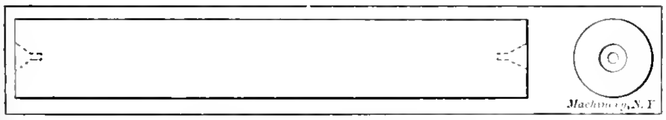


Fig. 4 Length Geges used in Toolmaking

"To return to the subject of multiplying errors, let us suppose that one side of this jig had to be machined to an angle of 3 degrees 21 minutes (see dotted line in Fig. 1). This is an angle that would be difficult to secure accurately with any bevel protractor, but with the assistance of a little trigonometry and a little ingenuity, it is an easy matter. We first take a piece of paper and lay out a triangle as shown in Fig. 3. Then figure out the height of this triangle for a certain length, say 15 inches, which represents the side adjacent to the angle. The side adjacent times the tangent equals the side opposite, or in this case the height of the angle. Looking in a table of natural tangents, we find that the tangent for 3 degrees 21 minutes is 0.05854, which, multiplied by 15, equals 0.8781, which would be the height of the angle.

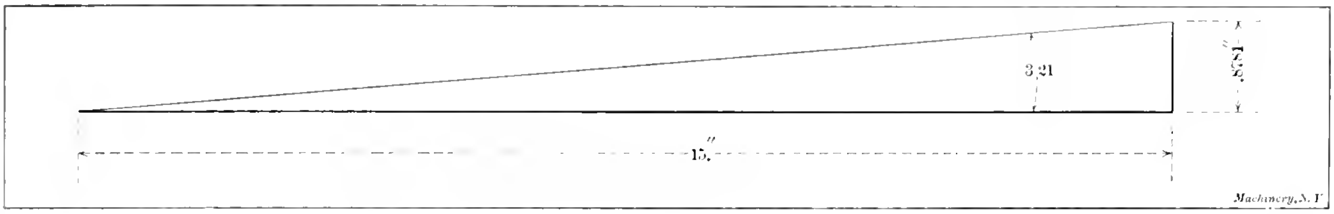


Fig. 3. Preliminary Calculation for Setting Straightedge on Machine Table as shown in Fig. 5.

"Suppose, for convenience, that we do this operation on a milling machine using an end mill. We will select a spot on the table where it will be convenient to clamp the jig securely and set it there temporarily, then get a straightedge about 18 inches long and clamp it at one end to the table so that the squared edge of the jig can be brought against it without changing its position materially (see Fig. 5); then measure from the edge of the table to the straightedge at the clamped end and note the measurement (as at a); lay off a distance of 15 inches from this point toward the opposite end of the straightedge and set the latter so that at this point it measures about 0.8781 inch more from the edge of the table than it does at the first point. (Dimension b would then be 0.8781 inch greater than a.) Now if you have an indicator, fix it securely in the spindle of the machine by means of a suitable fixture (if there is no indicator a stiff rod pointed at the end will do, by using a piece of tissue paper to get the touch with) so that the point can be brought in contact with the straightedge, and after the table is adjusted so that the end of the straightedge nearest the machine is about opposite the spindle, move the saddle in so that the indicator registers some certain amount; then set the dial on the table feed-screw to zero; next move the table toward the opposite end of the straightedge just 15 inches, counting off the proper number of revolutions, and bring the dial to zero; then set the dial on the saddle feed-screw to zero and move the saddle in just

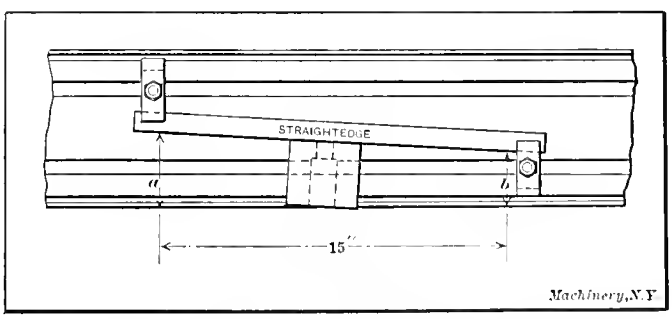


Fig. 5. Method of Accurately Setting Straightedge to a Given Angle by using Test Indicator and Graduated Feed-Screw Dials

0.8781 inch. If the straightedge is properly set, the indicator should register the same as it did at the other end; if it does not, then the position of the straightedge must be altered until it does. Thus you see the lengthwise movement of the table represents the side adjacent to the angle, and the movement of the saddle, the side opposite, or height.

"Now, since we have the straightedge clamped on the table at the proper angle, it is an easy matter to set the jig up

against it and clamp it there, and if a piece of tissue paper is placed between the straightedge and each corner of the jig, and if, when the jig is clamped fast, each piece of paper has about the same tension or 'feel' when pulled, we may be reasonably sure that the jig is properly set. The straightedge can then be removed and the piece machined with the assurance that the angle will be as correct as the straightedge was set. Now suppose that there was an error in setting the straightedge of, say 0.0025 inch, which is a liberal amount on a machine in reasonably good condition, and assuming that we are careful in having the backlash all out of the screws when we take the measurements, then the error existing in the angle on the jig will be in the same proportion to the error in the straightedge as the length of the straightedge is to the length of the jig bearing against it. In this case the length of the jig is three inches, then $15 \div 3 = 5$, and $0.0025 \div 5 = 0.0005$, or an error in the angle on the jig of 0.0005 inch, which is much more accurate than we could ever hope to set a bevel protractor

"As I said before, there are numerous ways of multiplying errors, and a little study of the subject will show many ways to take advantage of them; although there are instances where they act to a disadvantage. I remember once that I had a job of making a jig for drilling twenty-four 1/8-inch holes in a straight line and each a half inch apart. As a half-thousandth of an inch was tolerable for accuracy it was thought to be an easy matter, and that a short jig having three holes in it would do the work. I made up a jig of this kind which was to be used by drilling the first hole and inserting a plug, lining the jig up and drilling a second hole and inserting a plug and drilling the third, after which it was intended to move the jig along and set it by using a plug through the center hole and one in the end hole, the plugs being inserted in the last two holes drilled. On trying the jig out, however, it was found that the two end holes were about six thousandths too far apart, and that the holes were not in a straight line but on a slight curve. This was due to a slight and almost indiscernible error in the jig, but this error was repeated on each hole drilled, and therefore multiplied by the number of holes. Well, that illustrated the impracticability of the method, and the jig was thrown away and one made having thirteen holes in it, the first two and the last two a half inch apart, with the intervening holes one inch apart. In using this jig the two end holes were drilled first and plugs inserted in them; then the intervening holes were drilled, after which the plugs were removed and the jig moved along until the first hole at one end of the jig matched the second hole drilled from that end. A plug was inserted in this hole and also in the second hole from the other end of the jig; the rest of the holes were then drilled. This made a very satisfactory job, and though it was more work to make the jig, much faster drilling could be done."

"Were you blamed for making the jig wrong in the first place?" asked Jim.

"Well, no; in the first place I had made the jig according to instructions, and then it was what might be called a profitable mistake. That is, it showed the fallacy of a design that might be applied to other work of a similar character. It has been well said that we learn more from our mistakes than we do from our successes. When we make a mistake we have a precept, which is more indelibly fixed in our minds than any other training or instruction could be, that instinctively halts us when similar circumstances arise.

"A man that does not make a mistake, generally consumes so much time avoiding them that he rarely accomplishes anything else. There is a difference between mistakes and carelessness, and we should not get the two confused."

"While you were talking about machining that angle on the milling machine," said Jim, "I was reminded of an argument that I overheard between Mr. Corbin and Joe Pitts a few days ago. It seemed Joe had bored a hole in a jig on a milling machine and it did not come out right. Mr. Corbin claimed that the table of the machine was not properly set, while Joe maintained that that made no difference."

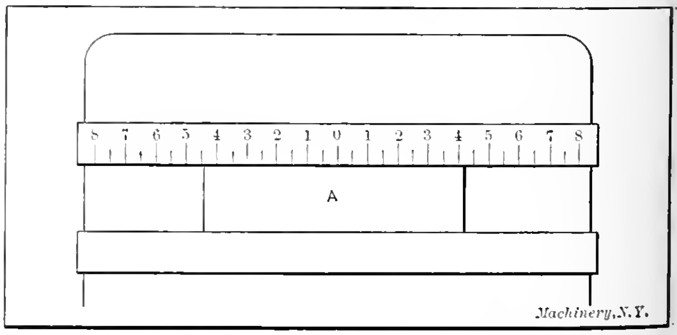
"I remember that," said Anderson. "Joe was wrong. He set his job up using an indicator along the side of the jig that was at right angles with the hole that he was to bore, with the result that while he proved that the jig was set in the proper alignment with the table, he did not prove that the table was set at right angles to the spindle, or to the saddle guides, relying on the graduations of the table base for this. Of course, when the hole was bored, it was no more accurate than the machine. You can readily see that if a piece were placed between the centers of a milling machine table, the table swiveled to one or two degrees, and a hole bored through the piece, the hole would be at an angle the same as that to which the table was set. I have frequently made use of this scheme to give draft to keyways, etc. It is evident that if one desires to bore a hole in a piece set parallel to the table guides, and have that hole at right angles to the side of the piece that was set parallel, one must be sure that the table guides are set at right angles to the saddle guides, or the spindle of the machine. This can be done by setting an indicator in the spindle of the machine so that the registering point will describe a circle of at least six or eight inches when the spindle is revolved; the indicator should then be set at one extreme of its horizontal movement and that portion of the table that has been machined parallel to the table guides brought up against the indicator until it registers some certain amount. Next revolve the spindle half over and note the amount registered; if it registers the same in both places the table is set square to the spindle, and if it does not then the table should be adjusted until it does. The machine will then be set accurate enough for all practical purposes. However, if it is desired to bore a hole of any considerable length, say five inches or more, and there is a surface on the piece that is to be bored that lies parallel to the hole other than the top and bottom, it is much more desirable to disregard the position of the table and set the work parallel to the saddle guides using an indicator along the side of the work that is parallel to the hole, thus dong away with any error in squaring the table of the machine; in fact if the table were set 10 or 15 degrees off square, it would not affect the accuracy of the work. There is a good opportunity for a man to lose sight of the fundamental principles of the thing and get confused as Joe did, but once you thoroughly understand it, it is plain to see that if work is set in line with the table guides, then to bore a hole at right angles, the table must be properly set, but if work is set in line with the saddle guides, the hole will be bored parallel to the guides regardless of whether the table is set properly or not, assuming, of course, that the piece is square and the previous work correctly done. Ah! there is the whistle, and we must get to work."

* * *

SUGGESTION FOR THE MACHINE VISE

By C. F. EMERSON

The sketch submitted herewith very clearly shows a suggestion which I have often thought would be most practical if carried out. By having the steel jaw of a shaper or planer vise graduated somewhat after the manner shown, it would



Plan View of Graduated Machine Vise Jaw

not be necessary to change the position of the stroke of the shaper ram or planer, as is so often the case after the work *A* has been placed in the vise a second time, owing to the fact that the graduations would enable the operator to place the piece in its exact former position. These graduations would also be useful on milling machine vises, as they would do away with the necessity of changing the position of the dogs of the feed-tripping mechanism.

MACHINE SHOP PRACTICE*

LAYING OUT AND MACHINING A PISTON-ROD KEY SLOT

As the laying out and machining of a slot for the keyed connection between an engine piston-rod and its crosshead, is a typical example of the kind of work the all-round machinist is often called upon to do, we shall consider this operation somewhat in detail. A very common method of attaching a piston-rod to a crosshead is shown in Fig. 1. The end of the rod is tapered and it is held in place by a cotter or key *C*, which is inserted in a slot passing through the crosshead and rod. As this key is driven in, the taper side, which bears against the inner end of the rod slot, tends to wedge or draw the rod tightly into place. In order that the key will have this drawing action, the slot in the rod must be off-set as shown, and as keys are usually made to a standard size, evidently this slot must be laid out and machined so that the tapering side of the key, when driven tightly in place, will bear evenly across the slot. It is also desirable that the key

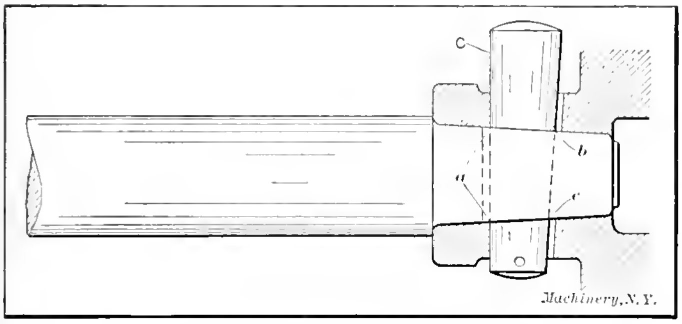


Fig 1. View showing Method of Securing a Piston-rod to its Crosshead by a Key or Cotter

be tight soon after the small end has passed through the crosshead as in Fig. 1.

It will be seen that the most important thing in connection with the laying-out operation, is to locate points corresponding to *b* and *c* on the rod, as this is the side of the slot against which the key bears. To quickly and accurately locate these points, first insert the key in the crosshead, as in Fig. 2, in the position which it will occupy when it is driven through the slotted rod; then with a hook scriber, draw lines l and l_1 across one side of the key to coincide with the inner sides of the crosshead bore. After the key is removed, the rod should be driven in and the outline of the crosshead slot on each side transferred to it by using a sharp pointed scriber. The rod before being removed should be marked in some way so that the scribed line, representing, say, the outer half of the crosshead slot, can be identified. (By outer half is meant the side from which the key is driven.) To locate a line representing the point *b* (Fig. 1) on the rod, the latter is clamped in a vise with the marked or outer side up. The exact width of the key at l (Fig. 2) is then measured and a pair of dividers is used in transferring this measurement to the rod, as illustrated in Fig. 3. The line corresponding to

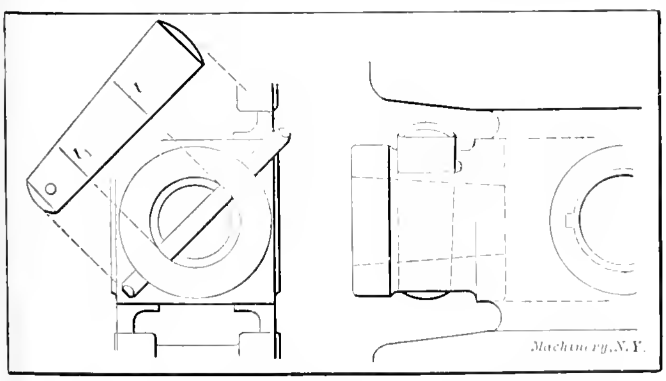


Fig 2. Using Key in Connection with Laying-out Operation

* With Shop Operation Sheet Supplement

point *c* (Fig. 1) is also scribed on the opposite side of the rod with the dividers set to the width of the key at l_1. Circles are now laid out on each side of the rod, as shown by the heavy lines, for drilling. The last circle on the end next to the shoulder should extend 1/8 or 3/16 inch beyond the end line *a* so that the slot will clear the key on this side. The diameter of these circles is, of course, equal to the width of the key, as many are laid out as will come within the length of the slot so that as much metal as possible will be removed by drilling.

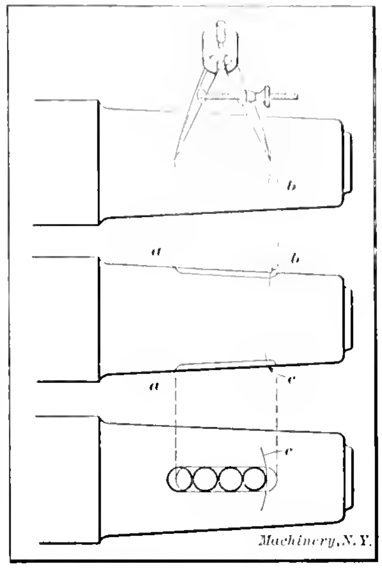
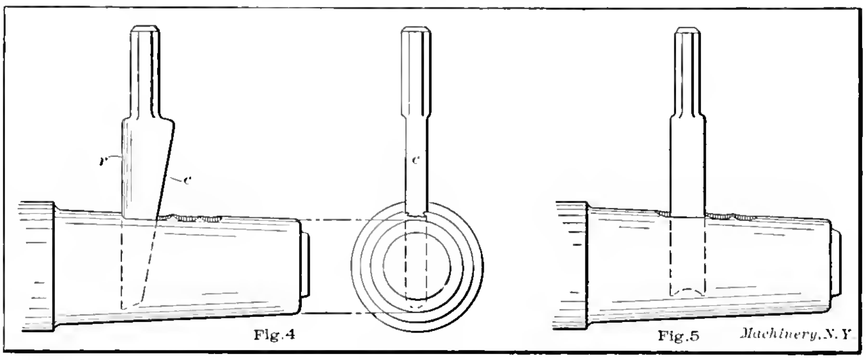


Fig. 3 Laying out the Slot

After all the holes have been drilled half way through from each side, as described in the Shop Operation Sheet accompanying this number, the slot is finished by chipping or broaching, and filing. The ridges on the sides may be removed by the use of an ordinary side chisel, but where slots are frequently cut, the work can be done more quickly by the use of a special chisel such as is shown in Fig. 4, or by a broaching chisel as illustrated in Fig. 5. The first tool is shaped somewhat like a gouge. The side *r* is rounded to fit easily in the drilled holes, and the cutting is done by the corners *c*, which are given a little clearance on the sides. As the tool is driven down through the slot, the tapering cutting edges advance and shear off the ridges on both sides, which have been left between the holes. The width of this tool is slightly less than the required width of the slot so that



Figs. 4 and 5. Tools used for Trimming Slot after Drilling

practically all superfluous metal is removed, and little filing needs to be done. The broaching chisel shown in Fig. 5 can also be employed for this work. The end is ground concave so that it will cut with a shearing action and the tool is given a slight amount of clearance on all sides. The manner of using these tools should be apparent from an inspection of the illustration.

After the chipping or broaching operation is completed, the slot should be finished by filing, a flat file being used for the sides, and a round or "rat-tail" file for the ends. The taper end against which the key is to bear, should be finished to coincide with the lines *b* and *c*, Fig. 3. The accuracy of the work may be tested by inserting the rod into the crosshead (after all the burrs around the slot edges have been removed) and then driving the key in tightly. If, when the latter is removed, there is not a good bearing across the end of the slot, the "high spots" should be filed down until the bearing is uniform.

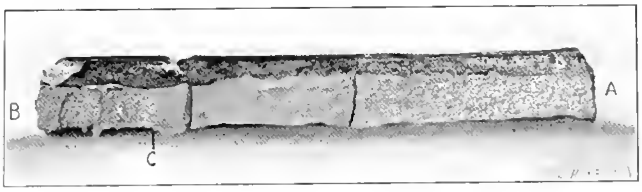
To prevent a key from dropping out of its slot in case it becomes loose, a small split cotter is inserted in the end. In order to have this cotter close up to the crosshead where it will be the most effective, the hole for it should be laid out after the slot is finished and the key is driven to its final position.

HEAT TREATMENT OF CARBON STEEL

By J. H. GILL*

High-speed steel is in fashion nowadays. This fact together with the high degree of skill required to get the best results from carbon has caused carbon steel to be neglected. For some kinds of work, however, carbon steel is superior to any high-speed steel on the market, if it is dressed properly and receives the proper heat treatment.

The carbon in steel may be in one of two forms: Annealed steel has the carbon in the non-hardening or cementite form. Hardened steel has the carbon in the hardening or martensite form. That these are two distinct forms may be seen by taking a small piece of annealed steel and a small piece of hardened steel and dissolving each in hydrochloric acid. The annealed steel will dissolve, leaving a black residne, while the hardened piece dissolves, leaving no residue. This shows that in one case some of the carbon is in the free or graphitic form and does not dissolve in acid while in the other case, the carbon is in the combined form and all dissolves.



Sample of Carbon Steel broken to show Difference in Grain at Different Hardening Heats

Another point that is more important to the steel worker is that the carbon changes form suddenly at the critical temperature. This is shown in the sample reproduced in the accompanying half-tone. This sample was made in the following way: A piece of steel ½ inch x 1 inch was heated and nicked parallel with the axis as seen in the engraving; then this piece was heated till it began to fuse on the end *A* the heat gradually decreasing toward *B*. The end *B* was not hot enough to harden. In this condition the piece was cooled as quickly as possible and then broken along the nick. The characteristic burned grain is seen at *A*. This gets finer as the part that is not so badly burned is reached. Just before the point *C* is reached we find the maximum fineness and the maximum hardness; as soon as the line *C* is crossed, we find the grain of the annealed steel. The sample is soft from *B* to *C*. This shows that there is a sudden change, on the rising heat, at *C*. The best condition for hardening is just after crossing this line.

The determining of the point *C* is a very important matter. The temperature at which this change takes place varies with the different steels. There are several ways of determining this point. One is by heating the steel to a dark red, plunging it into the hardening bath and trying with a file. If not hard, reheat to a little higher temperature and try in the same way. In this way go up step by step till a point is reached at which the steel hardens. This reheating and hardening is a severe treatment and is likely to cause cracks, but if carefully done it will give the lowest heat at which the steel will harden.

There are two other methods which depend on the fact that steel loses its magnetic properties when the hardening point is reached. A piece of steel heated to a dull red and brought into the plane of a magnetic needle will attract the needle. [See MACHINERY, April, 1908.] If heated until the temperature is above the hardening point, there will be no attraction and the needle will not be affected by the presence of the steel. In using this test, care must be taken that the presence of the tongs does not mislead the workman. The comparatively cool tongs may attract the needle even when the steel is above the critical point. An ordinary horse-shoe magnet may be used instead of the magnetic needle. It is less likely to mislead because of the tongs or cooler parts of the steel but is less sensitive. A bar magnet hung on a pivot at the center and provided with a handle can be used very satisfactorily. It can be introdnced into the furnace to test the steel during the process of heating and is more convenient than either of the other methods. It is not necessary to test every piece of steel, but a test should be made whenever the person takes another grade of steel or whenever the light changes. The intensity of the light makes a great difference in the color of a piece of iron or steel at a given temperature.

If steel workers would observe the following in all cases when hardening steel, they would have better results: *Harden carbon steel at the lowest possible heat and always on the rising heat.* The last part of this rule is the one more often overlooked. Steel may be forged at a higher heat than the hardening heat but should in all cases be annealed before being heated for hardening. The grain of the steel corresponds to the highest heat it has received since it was black. If a piece of steel is forged at 1600 degrees F. and allowed to cool down to 1400 degrees F. to harden, it will have a grain corresponding to 1600 degrees. If the piece is forged at 1600 degrees F. then cooled down to the black heat and reheated to 1400 degrees F. and hardened, it will have a grain very much finer and the tool will be very much better.

In making tools that are machined to shape it is always best to rough out the tool, and then anneal it to relieve all internal strains. After annealing, finish to size and it will be much more likely to come from the hardening bath straight and free from cracks. If, in heating for hardening, any part of the tool gets too hot, lay it one side and let it cool slowly to the black heat and then reheat more carefully.

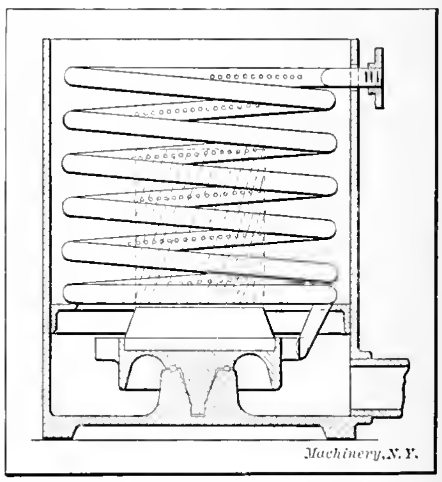
In working steel always have even, thorough heat, all the way through. More steel is injured by uneven heat than by too high a heat.

* Address: University of Illinois, Urbana, Ill.

* * *

APPARATUS FOR HARDENING MILLING CUTTERS

The accompanying illustration from the *Practical Engineer* (London) shows an apparatus for hardening milling cutters, patented by Mr. J. M. Gledhill of Armstrong, Whitworth & Co., Ltd., Manchester, England. As is well known the best results in hardening milling cutters are obtained when only the teeth are hardened and the interior of the cutter left comparatively soft. Instead of plunging the cutter directly into water or other cooling liquid, the exterior of the cutter only is subjected to the action of the cooling liquid in the form of a spray through a series of fine jets at high pressure. The interior is kept soft by previously plugging the hole to protect it from the sudden chilling action. The cutter is made to revolve during the hardening or sprinkling process in order to expose thoroughly every part of the teeth to the spray. The chilling action may be stopped at any desired point by turning off the water, and the cutter is then gradually cooled by immersion in oil or other suitable cooling medium. This method also almost entirely eliminates the cracking of cutters in hardening. The illustration clearly indicates the construction of the apparatus with a coiled pipe surrounding the cutter which is shown in dotted lines. The cutter rests on a carrier mounted on a ball bearing. The carrier is provided with vanes so that it may be caused to revolve by the action of a jet of water from the end of the coil. The water is drained off through an outlet at the bottom of the tank.



Hardening Milling Cutter Teeth by a Spray of Cooling Liquid, leaving the Central Portion Comparatively Soft

* * *

The best mixture for bronze letters used for signs is, according to the *Brass World*, 88 per cent. by weight, of copper, 8 per cent of tin, 2 per cent of lead, and 2 per cent of zinc.

AREAMETER FOR MEASURING HIDES

By FRANK C. PERKINS*

The general construction and method of operation of a novel form of areameter may be seen in the accompanying engravings, Figs. 1 and 2. This instrument is of great value for the accurate measurements of patterns and hides, as well as other areas having irregular outlines. In Fig. 1 the areameter is shown suspended over a table large enough to accommodate a hide of the size usually handled, and as the measurement is obtained by tracing the outer edges of the hide, a table accessible on all sides is preferable.

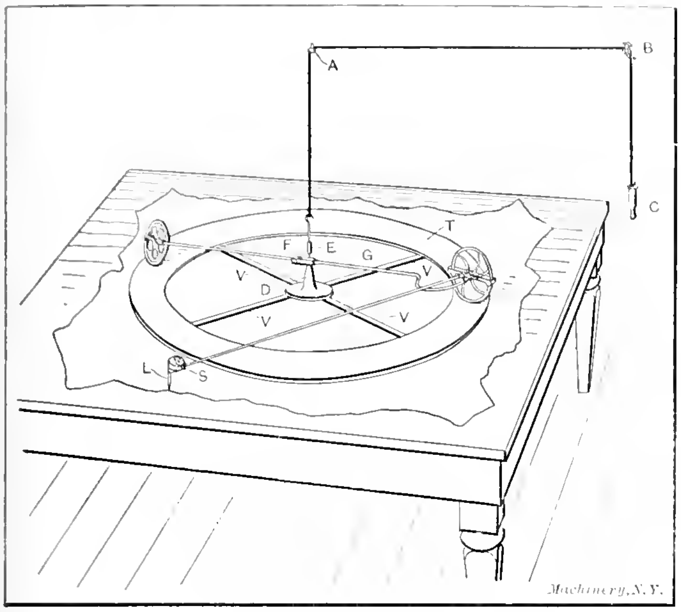


Fig. 1 Areameter used for Measuring Hides

The ordinary pulley *A* is screwed into the ceiling above the center of the table, and the self-locking pulley *B* is placed to one side of pulley *A*, approximately over the edge of the table, where the operator can reach the weight *C* conveniently.

A large wooden disk *T* with center weight *D* and cross-braces *V* is placed on the table, and a center pin screwed firmly into the center weight. The areameter is placed on the disk, being held in position by the center pin *F*, which is inserted through the hole at the middle of the jointed arm. The balanced wheels are fastened to the ends of the arm *G* as shown in Fig. 1. The swivel *E* is then securely fastened to the center pin and the cord which is attached to the lifting weight is passed over the two pulleys. The areameter is then ready to be used.

Fig. 2. Pointer and Dial of Areameter

In measuring hides, the areameter is placed on the leather in such a position that every portion can be reached by the pointer *L*. Small pieces of leather and patterns must be placed outside the wooden disk, unless, of course, they are larger than the disk, in which case the latter should be placed on them in the same manner as on a hide. The pointer is then placed at some designated mark on the outer edge of the hide, both hands on the dial *S* pointing to zero. By lifting the pointer slightly and guiding it with the aid of the thumb or forefinger along the outer edge of the leather, it is made to follow the outline of the hide back to the starting mark. The dial will then show the total of the area measured. The large circle of figures shows the number of square feet from zero to ten, and the small circle of figures shows every five feet, as shown in the engraving of the indicator in Fig. 2.

The operator traces the outer edge of the hide to the right. In case of holes, the complete hide should be measured first, and the pointer then passed around the holes to the *left*; then the exact area with the holes deducted will be indicated directly on the dial. The speed at which leather can be measured varies with the size of the hide, a 50- to 60-foot hide being measured in less than a half minute's time.

* Address: Erie Co. Bank Building, Buffalo, N. Y.

* * *

FORMULAS FOR THE VOLUME OF A PART OF A SPHERICAL SEGMENT

In the March, 1910, issue of MACHINERY a formula by Mr. R. A. Jewett, for finding the volume of a part of a spherical segment, was published. Mr. John B. Sperry, of 583 Benton St., Aurora, Ill., offered a different solution and formula previous to that submitted by Mr. Jewett, but, owing to an oversight, this formula was not published at the time it was submitted, and is, therefore, given below.

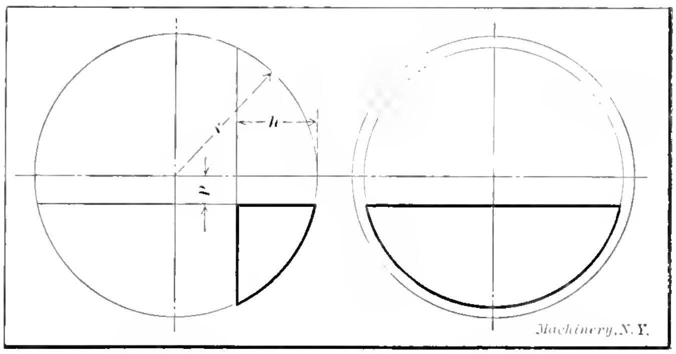
If V equals the volume of a part of a spherical segment, and h, p, and r equal the dimensions indicated in the accompanying engraving, then:

$$V=0.5236\left(3rh^2-h^3-3pr^2+6pr^2\,\frac{\sin^{-1}\dfrac{r-h}{r}}{180}\right)+p(r-h)$$

$$\sqrt{2rh-h^2}$$

This formula is derived by calculus, and owing to the length of the derivation, it is not possible to reproduce it in MACHINERY.

A simplified form of the formula by Mr. Jewett is offered by Mr. W. L. Tryon, 8 Hamburg Ave., Schenectady, N. Y. The symbols in this formula are the same as those used in the



Notation used in Formula for Part of a Spherical Segment

Jewett formula published in the March, 1910, issue, and the simplified formula is as follows:

$$V=\frac{2SP\sqrt{r^2-S^2-P^2}}{3}-\frac{3r^2P-P^3}{3}\tan^{-1}\frac{\sqrt{r^2-S^2-P^2}}{S}-\frac{3r^2S-S^3}{3}\tan^{-1}\frac{\sqrt{r^2-S^2-P^2}}{P}+\frac{2r^3}{3}\tan^{-1}\frac{r\sqrt{r^2-S^2-P^2}}{PS}$$

It will be seen that in the formula above there is but one radical ($\sqrt{r^2-S^2-P^2}$) the square root of which must be extracted, and this makes the formula very much simpler than that in the March issue from which it was derived. The derivation is too lengthy for publication.

* * *

It is stated in the *Iron Age* that, according to computations by the British Commercial Commissioner to Canada, the capital employed by American manufacturers in Canadian branch works amounts to about $125,000,000. The number of firms having branches in Canada amounts to nearly 150. The tendency of American capitalists to manufacture in Canada is, of course, largely caused by the Canadian tariff, which, in turn, is largely due to our own tariff against Canadian products. Here is then a case where the tariff indirectly has caused an exodus of capital from, and a diminished demand for labor in, the United States.

* * *

The English Admiralty specification for phosphor-bronze of great strength is, according to the *Brass World*, as follows: copper, 90 per cent; tin, 9.7 per cent, and phosphorus, 0.3 per cent.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

A POINT IN ROUGH TURNING

In manufacturing the ordinary sizes of machine tools there are many places that have to be machined, belonging to the class indicated in Fig. 1, which have to be reduced an inch or more in diameter and a few inches in length. The particular piece illustrated, which will be taken as an example of this class of work, is a rough-turned pinion for a lathe apron. The stock comes to the lathe cut off and centered, to be rough turned from 2 1/8 inches in diameter to 15/16 inch diameter—a reduction of 1 3/16. As this is merely a question of rapidly removing the stock, no attention need be paid to the smoothness of the cut. Now if one single tool should be used, either

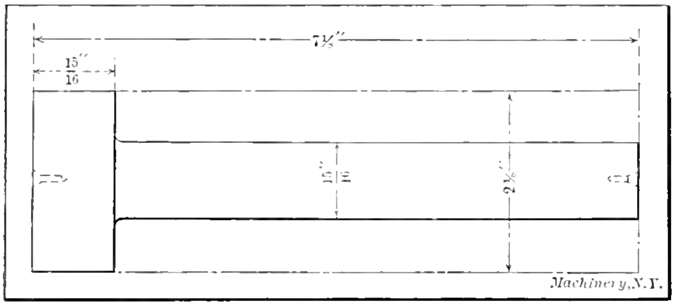


Fig 1. Class of Work on which Two Tools can be advantageously used for Roughing

two separate roughing cuts would have to be taken, or a fine feed used, because of the cutting pressure on the work. Neither the tool nor the machine, however, would be loaded anywhere near its full capacity, as the size of the cut is limited in this case by the strength of the work, and not by the capacity of the machine or tool.

The tool pressure produces, as the cut starts, a large compression of the metal surrounding the rear center, and, if the center is small, it is liable to break out or destroy the tailstock center. Furthermore, the tool pressure causes the work to spring, and when the turned diameter is only 15/16 inch, this bending is very likely to cause trouble. In order to counteract these drawbacks and to insure the possibility of loading the machine to the full capacity, lathes are equipped with two tool-posts and two turning tools, one being used in the front

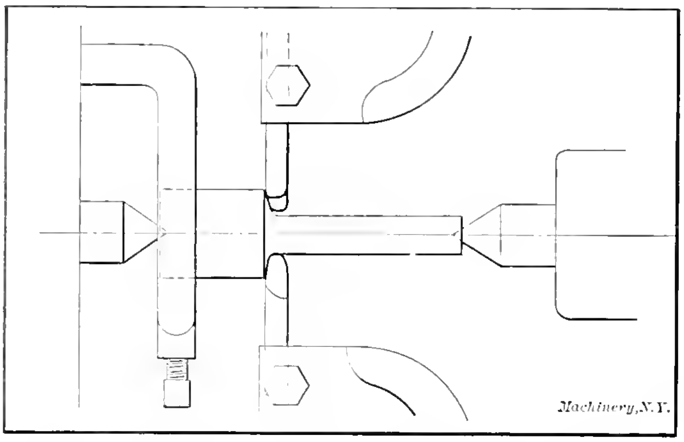


Fig 2. Arrangement of Tools for Taking Heavy Cuts on Small Work

and one in the rear in an inverted position. The arrangement is illustrated in Fig. 2.

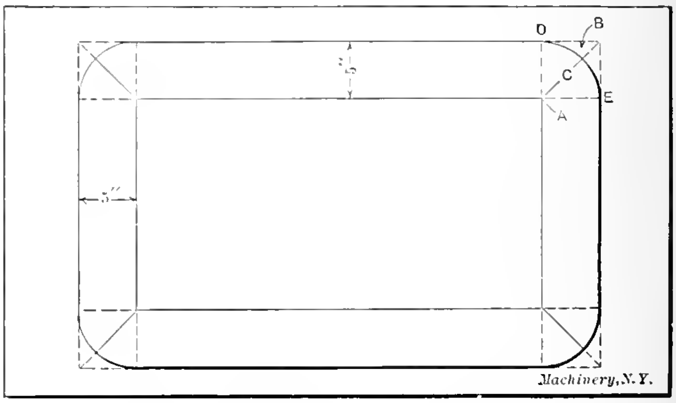
Considering the pressure on the work, the tool pressure on one side is downward and on the other upward, these tending to balance each other as far as bending is concerned. The rear center and the turned part of the work are thus relieved from nearly all the strain. There is a slight strain, however, as the front tool is usually set to take a slightly deeper cut than the back one. By this method the time of rough turning the class of work referred to in the foregoing, can be reduced to less than one-half, because each of the two tools can be made to remove more stock than would a single tool.

Cleveland, Ohio. OSKAR KYLIN

[The principle of two opposed tools to balance heavy lathe cuts is well known and much used in certain classes of manufacture, of course, but it is doubtless not used as generally as it could be with profit.—EDITOR.]

TINNING STEEL PANS

Before steel pans can be tinned all scale must be removed; this can be done in a pickling solution, composed of equal parts of hydrochloric acid (or muriatic acid, as it is often called) and water. Lead tanks are sometimes used for holding the acid, but it is better to obtain an enameled fire-clay bath (such as used for lavatory sinks) or any earthenware vessel that is large enough to cover a quantity of the steel pans at the same time. During the time the pans are in the pickle they should be moved about, so that all parts may be equally exposed to the action of the acid. The length of time for pickling will depend upon the temperature and strength of the acid and on the condition of the pan surfaces. If the acid is fresh, then the pickling may be done in about ten minutes, but if the acid is partly spent thirty or forty-five minutes will be required. The acid must not be heated to increase the speed of working, as the pan surface produced will not be so good as when pickled by cool acid. Any increase of temperature over and above that of the atmosphere required for the effective working of the pickle, is soon obtained by the



Method of Making Tank for Steel Tinning

heat generated through the chemical action. If the pickling solution is too hot, the action upon the pans will not be uniform, and the surfaces will be somewhat rough. To obtain a good-looking surface after tinning, the operator should be careful not to over pickle, as this will cause the pans to look "dead" and "dry." When properly cleaned, the pans should instantly be plunged into a water tank for washing; they are then ready for the flux.

The tank used for tinning can easily be made from 1/16-inch sheet steel. To form the sides, lay out a line 5 inches in from the edge all around, as shown in the accompanying engraving, and then with the intersecting points *A* as centers, scribe arcs for rounding the corners; the portion *B* is then cut away. In working up the corners care should be taken to get them true; the way this is done is as follows: Press the corners over the tip of a sharp stake and bend on the line *C*; this will start the corners and slightly turn up the sides, which can then be bent on a sharp stake assisted by a large wood mallet. When the sides are bent up sufficiently, the corners should be knocked together to make the points *D* and *E* meet, and then bent around on the ends of the pan against which they should be closely flattened. This completes the tank.

When preparing the bath of molten tin, sufficient metal should be obtained to cover the steel pans. The tin can readily be melted over an ordinary forge fire, but care must be taken not to overheat it; the temperature should be about 400 or 450 degrees F.

The flux into which the pans are dipped previous to tinning them is composed of a solution of chloride of zinc, that is

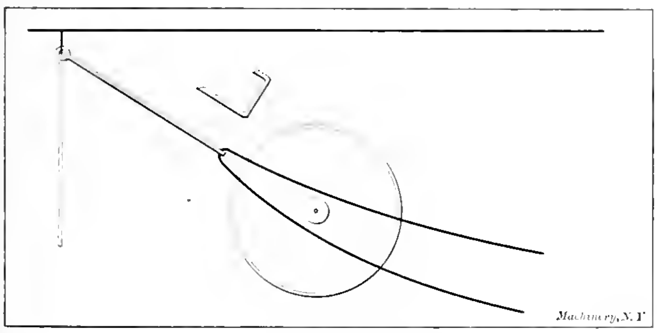
made by dissolving zinc in hydrochloric acid to the saturation point. The steel pans should be heated slightly before putting them into the molten metal. Care should also be taken when immersing the pans to place them in gently, as the molten tin coming in contact with the damp surface of the work boils and "spits." The pan should be moved briskly in the molten metal by means of a pair of smith's tongs, and then removed quickly and shaken over the bath. When the tin has drained to the lower edge, it should be wiped off with a pad of tow or wadding. If the coating of tin is not satisfactory after the first attempt, the work should again be dipped in a solution of zinc chloride and then in the tin, as previously described. A second dip generally improves the appearance of the surface. The work should finally be washed with plenty of water and then dried with clean sawdust. This completes the tinning operation and if the proper method has been followed and care exercised, the pan should have a smooth coating, uniform in depth and color.

FOREMAN TINNER

BELT KINKS

In a small shop where I worked they take very good care of their belts, and here are some points as to how they do it.

Near each pulley on the line-shaft where a belt drives a machine that is liable to stand idle for some time, a staple is driven into the ceiling and a hook of 5/16 or 3/8 inch round iron is hung from the staple. The hook is long enough to reach almost to the rim of the pulley but a little to one side of it. When a belt is run off its pulley, it is hooked up by the belt stick on this hook, the slack of the belt allowing it to be caught on the hook, and when the belt sags, the hook swings so as to make the belt clear the side of the



Method of Suspending an Idle Belt

pulley and also the shaft, as shown in the illustration. This avoids the trouble of tieing belts to beams, hangers, etc: and it is so little trouble to hook the belt up, that it is done when it might not be tied up. Care must be used, of course, in placing each hook, so that the belt, when off the pulley, will reach the hook.

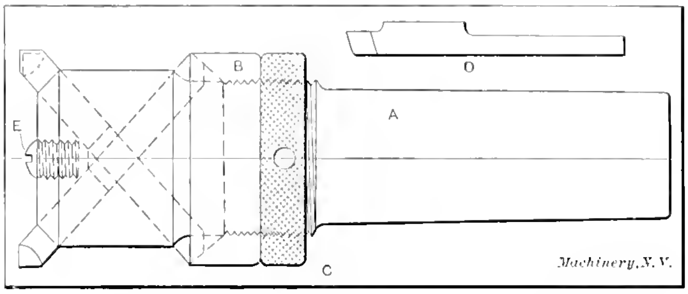
Here is another important point in the treatment of belts: At inventory time or other "shut-down," the belts are examined and the greasy or dirty ones are first scraped to remove the surface dirt, and are then washed with warm soap and water, care being taken that the water is not hot enough to be uncomfortable to the hands. After drying, they are given a light, even coating of castor oil on the working side, and if very dry, on both sides. In fact, those belts running in hot or dusty places are oiled rather frequently. This improves the driving power greatly and can be done without taking the belts down, but simply running them off their pulleys.

For belt joints, they have given up all hooks and lacings for permanent joints. When a new belt is put on, it is laced as tight as it will run, and after the stretch is pretty well out, the ends are beveled, the belt is drawn up with clamps, and a lap-joint is made, the slack due to the stretch of the new belt furnishing all the lap that is needed. This is usually not over three inches and frequently not more than one and a half or two inches for short belts, but long experience shows that it is enough. This treatment has been applied to high-speed and low-speed belts of the widths usual for the average machines and tools—or say up to four inches—and for several years it has been a success. It also enables all the short pieces of belting to be used without the usual trouble due to several laced joints in one belt, and it is surprising to see how much good belting will be found in a lot of old belts that have been well cleaned and oiled.

TAD

EXPANDING BORING TOOL

An expanding boring tool, intended for use in a turret lathe, is shown in the accompanying illustration. This tool can also be employed in a common lathe or drill press, but it is especially adapted for boring cored holes, brass bushings, etc. The shank *A*, which is made from mild steel, is turned to fit the turret and is threaded 14 threads per inch for the knurled nut *C*. The collar *B* is a sliding fit over the threads and is casehardened. The holes for the cutters are 3/8



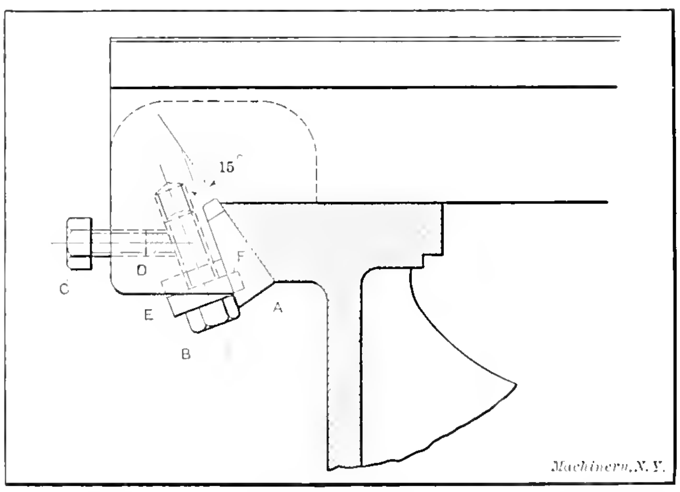
Expanding Boring Tool for Cored Holes, Brass Bushings, etc.

inch in diameter and cross each other. The cutters are made from 3/8-inch round steel and are cut down for part of their length to the center line as shown at *D* so that they will cross each other when in position. After the cutters are made and hardened, they are put in place and adjusted to a trifle over the desired size, and locked with screw *E*. They are then ground to size in a grinding machine and backed off.

Harrison, N. J. A. L. MORE

IMPROVED ADJUSTING STRIP FOR SLIDES

It seems to be a universally accepted fact that the taper strip for taking up the wear in the slides of machines is a big improvement over the older types in which all the pressure was taken by the adjusting screws. The metal-to-metal contact of the former is practically equal to a solid slide; but at the same time it is rather an awkward job to plane, as the taper necessitates an extra setting of the slide; in addition to which the planing and fitting of the strip are much more difficult than with the older designs. To overcome this constructional difficulty, I designed the adjusting strip shown in the



Adjusting Strip for Slides which is moved Crosswise for taking up Wear

accompanying sketch, and I think it will be admitted that where it can be used, and especially where the pressure tending to lift the slide is small compared with the side pressure, it is just as effective as the other kind and much easier to machine and fit.

The illustration shows the application of this strip to a lathe saddle, it being at the rear for convenience of adjustment. The strip *A* instead of tapering lengthwise, tapers 15 degrees in cross section. It is adjusted by screw *B* (of which there are two or more) which has a collar sunk into the strip

at F; E is a counterbored hole to receive the collar of the screw when the latter is screwed up.

At D there is a brass block which is tapped in position to fit the threads of screw B; C is a lock-screw which clamps the brass block onto screw B, thus effectively locking it.

Of course there are, no doubt, many places where the usual end adjustment is the only one that is possible, but the strip described in the foregoing, where it can be used, has a few advantages from a manufacturing point of view. RACQUET

DIE-MAKERS' CLAMP

There are many forms of die-makers' clamps in use, and many have been described and illustrated in the mechanical publications, but the one illustrated herewith has the good points of several combined in one. First, the range of adjustment in the ordinary clamp is too limited, especially where there are punches with round shanks to mark off, as they add at least two inches to the height; and those with three arms are only useful for round jobs. This clamp is adjustable for

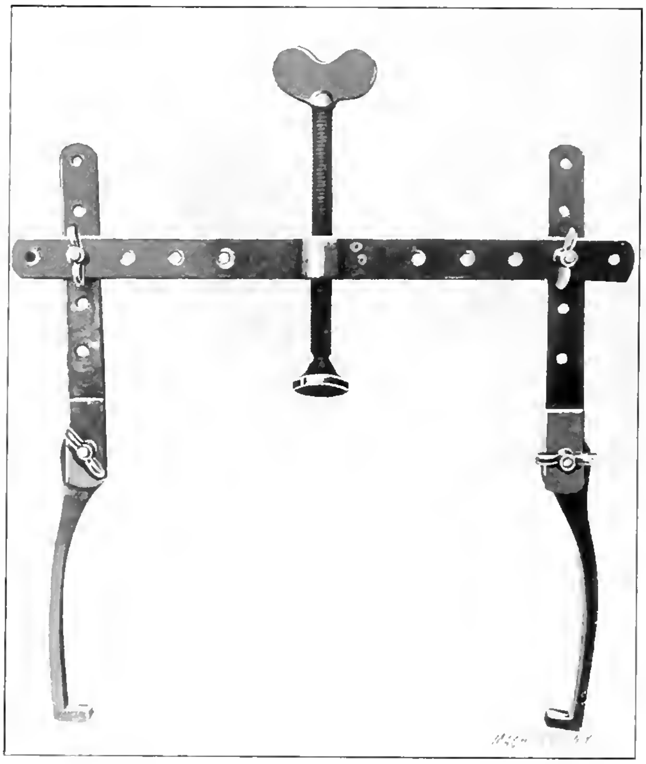


Fig 1. Die-makers' Clamp with Wide Range of Adjustment

width and height, by spaces of one inch. It will take in, extreme adjustment, 11 by 11 inches, and it can be contracted to 1 inch in width and to zero in height. The adjustment is quickly changed by four ¼-inch thumb-screws. The clamp-screw, which is ½ inch diameter, has a 5-inch length of thread, with a ball tip and button shoe, that adjusts itself to any angle. Fig. 2 shows the arms or tongs uncoupled from the extension arms and coupled direct to the cross beam, thus giving the clamp a quick adjustment for small work.

The clamp can be easily made as it is built up of riveted strips of standard stock, the only forged parts being the tongs.

N. S. Pittsburg, Pa. WILLIAM A. PAINTER

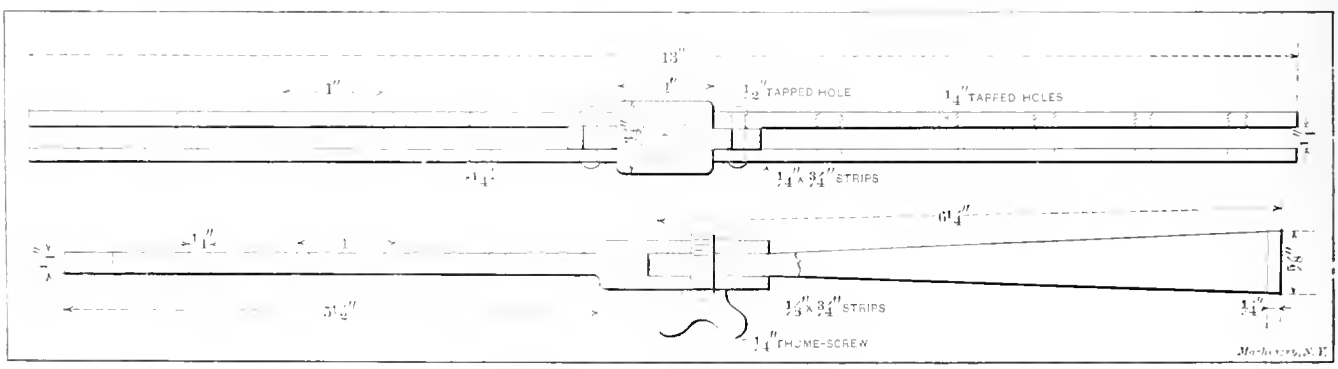


Fig. 3. Details of Die-makers' Clamp

SUGGESTION BOX IN THE FACTORY

A system for rewarding meritorious suggestions on economical methods in the shop was first introduced in our factory about two years ago, the plan being similar to that adopted by the National Cash Register Co. of Dayton, Ohio.

The adoption of this idea in our shop can be traced directly to an incident in which I was directly concerned, and which had to do with a dispute that arose as to whether I or the

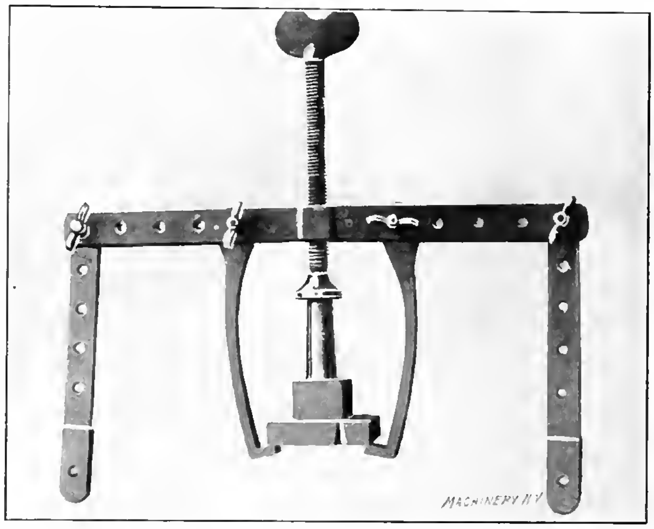


Fig. 2. Tongs of the Clamp attached direct to the Cross Beam for Small Work

superintendent of the factory was the original discoverer of a means whereby, with the adoption of follow dies, the separate operations on a blank could be reduced from three to two, with a consequent saving in time and cost of tools.

While endeavoring to improve the manufacturing methods on a certain part of the typewriter which we manufacture, I called the superintendent to my board to consider the advisability of making certain changes in the construction of the press tools used on this piece, with the idea of reducing the number of operations necessary to finish it. He, after having carefully gone over my suggestion, pronounced it impractical, and let the matter drop. A few days after he came to me, and reminding me of the job on which I had been working, proceeded calmly to unfold to me as a good idea of his own conception the very suggestion which I had made to him a few days previous. As the general manager of the company was present at the time, and as the superintendent was taking the credit to himself for my idea, I produced my sketch book, showing in black and white that he was either mistaken in his claims or had deliberately stolen my thunder.

So impressed was the general manager with this incident that a system of reward for suggestions on improvements in the shop and office systems, followed in a few weeks time. The plan provides that all suggestions shall be written out fully and clearly, accompanied by necessary sketches, and be considered by a committee from the factory composed of the foremen of the most important departments, together with the superintendent. If the suggestion offered is adopted, a nominal reward of two dollars is paid the man who offered it, and his name is included in a list made up at the end of every month, containing the names of those who have had their suggestions adopted.

This plan has been of undoubted value in securing suggestions from some who would otherwise be reticent about offering their ideas for the good of the service, owing to the fact that the foreman is so often given the credit, or because the plan is often rejected without proper consideration if coming from some one not in authority, as it is thought unworthy of serious thought and attention. Nothing is so galling to a man in the shop, perhaps, as to see someone else praised for something which was his own idea.

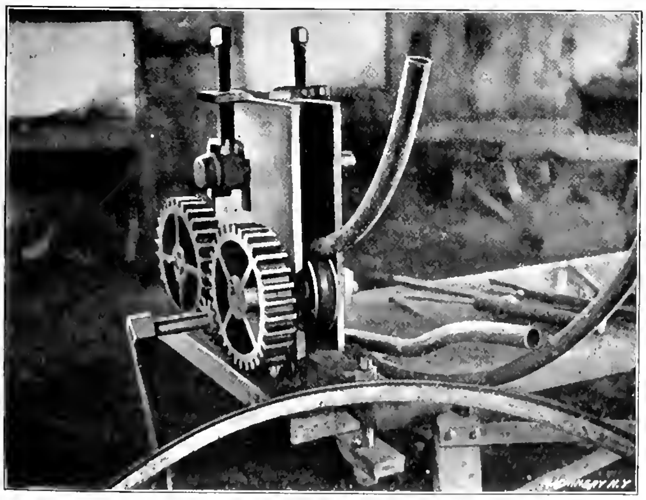
The main benefit to the man rewarded, is not so much in the two dollars which is given him to cover the time spent in preparing his suggestion, which work must usually be done at home or at the noon hour, as in the knowledge that his efforts are appreciated, and that his name is before those in authority. He also realizes that the next time promotions are made he stands a better chance of consideration through what he has accomplished.

The management of our company is highly pleased with the results accomplished after having this system in operation for a year and a half. The money spent in this way is many times repaid by the economies made possible, and besides that consideration, the men in the shop are imbued with a more loyal and liberal spirit toward those in authority.

DESIGNER

MACHINE FOR BENDING PIPE AND ANGLE IRON

A machine which is adapted for bending either pipe or angle iron, is illustrated herewith. The machine as shown in the illustration, is set up for bending pipes. It has three concave rolls (when used for bending pipe) which are located so that the centers of the rolls form a triangle. The pipe is given the desired curvature by screwing down the upper central roller by the two screws shown. The particular pipes bent in this machine are 3/32 inch thick, and this tubing after being bent is about 1/32 inch out of round. When the machine is used for bending angle iron, the concave rolls are replaced by three rolls which are grooved to receive one leg of the angle; in addition there are four side-bearing rolls which are to prevent the angle iron from bending to one side. This machine is cheaply constructed, but very substantial. The side-plates or frame are made from ⅞-inch boiler plate. The shafting is of cold-rolled steel. The pipe rolls are of cast iron, while those for bending the angle iron are of steel. Elongated holes through which the shaft of the upper roller passes, permit the necessary



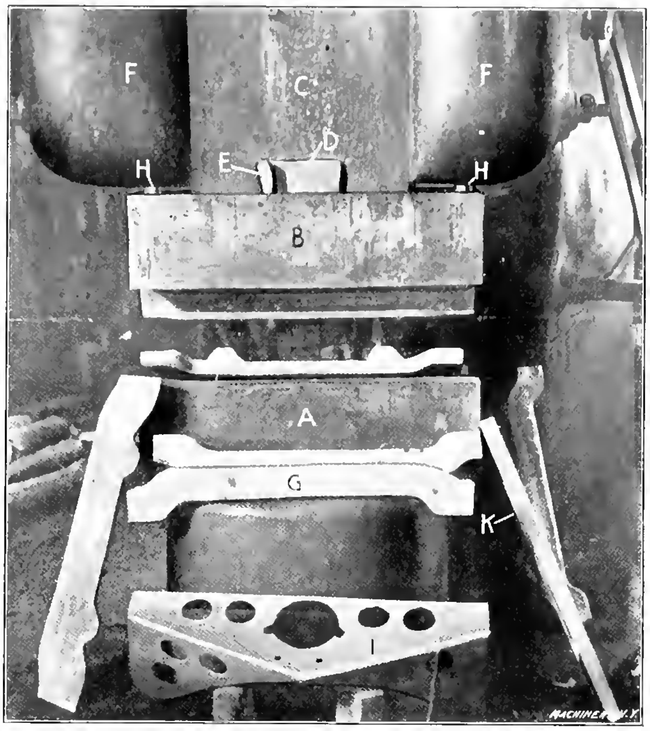
Machine for Bending Pipe and Angle Iron

vertical adjustment. This machine rolled fifty-six angle irons to a circular shape 71¾ inches in diameter in four hours, the work being done by three laborers. None of these angle iron hoops which were subsequently used in connection with a well-casing, were out of round more than one-half inch.

Jackson, Tenn. T. O. MARTIN

MAKING PRESSED STEEL PARTS UNDER THE STEAM-HAMMER

A steam-hammer that is equipped with dies and used as a press for forming pressed steel parts, is illustrated herewith. This hammer does the work very accurately, and much more rapidly than is possible with the hydraulic press. There are three sets of dies used for forming the three differently-shaped cross-members, *G*, *I*, and *K* for automobile frames. Either of these sets of dies, which are made from a good quality of cast iron, may be quickly attached to the hammer. The dies used for pressing the parts *G* and *K*, were cast in chills, it being an easy matter to forge the chills so that very little was left to machine. The dies for pressing the member *I*, were cast from a pattern, and have given excellent service. Each set of dies is equipped with positive knock-outs for removing the pressed part on the upward stroke of the ram. These knock-outs, which are indicated at *H*, consist of round-headed bolts which are set into counterbored holes in the upper die *B*. Beneath the head of each knock-out pin, and



Steam-hammer equipped with Dies for Forming Steel Parts

in the counterbored part of the hole, there are small springs which support the knock-out pins. When the die *B* approaches the end of its upward stroke, the knock-outs are forced down by the frame *F*, thus removing the pressed part. The two knock-out pins are then returned to their original position by the spring as the ram descends.

The dovetailed piece *D* by which the die *B* is keyed to the ram, is detachable, being attached to the die by means of cap-screws which fit in counterbored holes and pass through the dovetailed piece into the die. This same dovetail is used on all the dies; this is done in order to lessen the cost and complication in the die making. When a new set of dies is to be attached to the hammer, the holes in the piece *D* are transferred to the punch as follows: After putting the bottom die in place and keying it securely in the anvil block, the upper die or punch is placed in position. Two center punches which have been machined to fit the holes in the dovetailed piece *D*, and which are about 1/16 inch longer than *D*, are placed in the holes, after which *D* is fastened in place by driving in the key *E*. The ram is then let down with the result that the projecting centers of the punches mark the top of the die *B* at points concentric with the holes. These centers are then used to lay off holes in the upper die, which are drilled and tapped for the bolts.

The efficiency of the steam-hammer for doing pressed steel work, is shown by the following figures: The three frame members *G*, *I*, and *K* were pressed at a cost of 9 cents per set. Three laborers can press five hundred of the pieces *I* in ten hours, one man running the hammer, one keeping the pressed parts out of the way, and one placing the work in position. This same hammer is also used for doing some heavy and difficult pressed steel work for boilers. T. O. MARTIN

Jackson, Tenn.

EFFECTIVE METHOD FOR HOLDING RACK ON PLANER

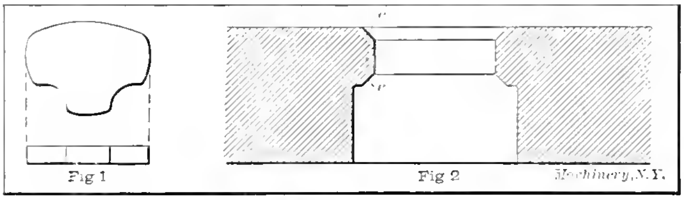
Some readers of MACHINERY may recognize in the following an experience similar to one of their own. I was running a planer which had a rack built in two pieces, and as usual, it was held by screws counterbored in the middle slot of the table. The normal condition of these screws was about half a turn loose and although securely tightened, they persisted in working back to normal, in which state they had worn elliptical holes so that a comfortable little "chug chug" was emitted at the end of each stroke. This continued until one day when the screw sheared off, the table stopped and the rack slid off on the floor. Now at last the machine had to be repaired, but instead of drilling out the holes and setting new screws, I decided to put in new ones of the same size and let the driving thrust be taken by keys. This was accomplished by cutting two half-inch keyways in each section of the rack and corresponding ones in the table. After putting in the new screws, the keys were carefully fitted and the planer was again ready for business.

On the face of it this planer construction, which is so common, seems to be in defiance of theory—relying on bolts under tension to resist the lateral stress which would be caused by the thrust of the cut. Yet in the majority of cases this manner of holding the rack has been effective. Possibly it has no parallel in machine tool design.

Middletown, N. Y. DONALD A. HAMPSON

LAPPING A SIZING AND SWAGING DIE

A die was required for swaging and burnishing pieces of mild steel which had been punched to the shape shown in Fig. 1. These pieces measured about one inch long, across the wide part, ¾ inch the other way and they were about 5/32 inch thick. As they were rough after being blanked out in the press, a die was needed for sizing and burnishing the irregularly-shaped edges. A sectional view of this die is shown in Fig. 2. The hole through it was made perfectly straight for about ⅝ inch from the top, the remainder of the hole being relieved or enlarged as shown. The two edges *e* were then beveled sufficiently to leave about 5/16 inch of the hole straight and smooth. This die was made as hard as possible around the hole, after which it was heated just enough to ease any internal strains which may have existed. As the hole shrank quite a little it was necessary to lap it to size.



Figs. 1 and 2. Punching to be swaged and Section of Die

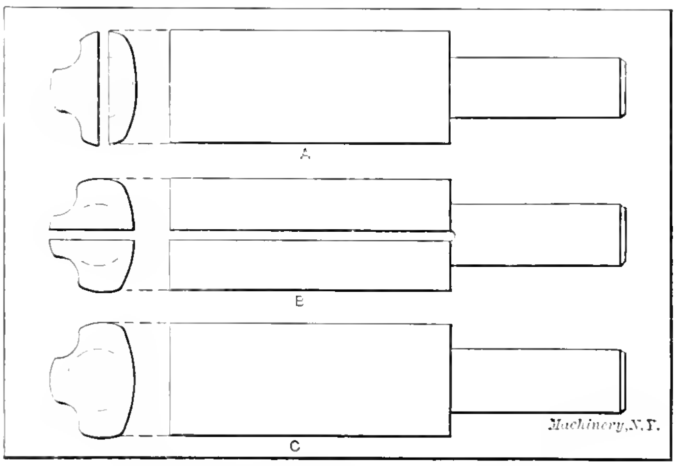


Fig. 3. The Three Laps used for the Die shown in Fig. 2

Three cast-iron laps of the shape and size the hole was to be, were made for this operation. These laps, which are shown in Fig. 3, were two inches long and were provided with a ¾-inch round shank about one inch in length. Two of the laps, *A* and *B*, were slotted, one across the wide part and one across the narrow way as shown. The third lap *C* for finishing, was left solid.

A small Dwight-Slate drill press which was in the shop was used for the lapping operation. One of the split laps was first caught in the drill chuck and the lapping done by working the spindle lever by hand. This method, however, proved too slow so it was decided to rig up the drill press so that the reciprocating movement necessary could be obtained by power from the machine. The way the required motion was transmitted from the driving pulley shaft to the spindle of the machine is shown in Fig. 4. A crank *A* was attached to the shaft and this was connected to the arm *C* by rod *B*. As the pulley shaft only projected ½ inch beyond its bearing, it was necessary to drill and tap it, for a ⅝-inch stud on which to mount the crank. Lever *C* was attached to the screw or stud in the spring-case *D*.

After the parts were connected, the die was placed on two parallel strips on the drill press table. The lap was held in the drill chuck as before, and the lapping done by using carborundum flour and oil as an abrasive. It will be seen that with the driving pulley connected to the drill spindle as shown, the latter is given a vertical movement up and down. The slotted laps *A* and *B*, Fig. 3, which were expanded by the use of wooden wedges, were used first. By changing the split laps and using first one and then the other, the hole was soon lapped practically to size. The solid lap was then used to finish the hole, which completed the die.

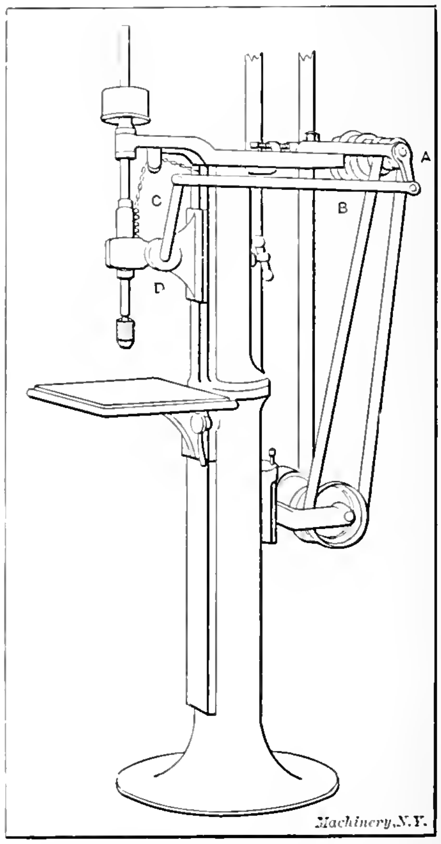


Fig. 4. Drill Press arranged to give Reciprocating Movement to Spindle for Lapping

Those who have not had experience in die work might be interested in knowing how these laps were made. First the approximate center of a sample punching was found, and a ⅜-inch hole drilled through it. Then an end was turned on the rough cast-iron laps to fit the hole and long enough to go through the punching. A smaller hole ⅛ inch in diameter was then drilled and into this a pin was inserted to hold the punching in place. The lap was then inserted between the centers of the milling machine and milled approximately to the required shape, the sample being used as a guide. In this way the laps were roughed out so close to the required shape that little filing was needed. A. S. GUN

GRAPHITE CUTTING COMPOUND

Although there are so many new things on the market, all said to do some particular work better than anything else has ever done it, and though there are so many of those so-called panaceas that one has not time to even read about them, much less try them, we think it will be interesting to readers of MACHINERY to know of some remarkable performances which have been obtained from the use of a new and unique product. We refer to the graphite lubricant, "Aquadag," used as a cutting compound.

Some weeks ago we were cutting off in the lathe a large

number of cold rolled steel rods averaging about 1 inch diameter. Records showed that the average number of cuts made by the cutting-off tool with one sharpening was 60 when using an ordinary soap cutting compound. Having had a sample of deflocculated graphite [see MACHINERY, July, 1907] presented to us we mixed a small amount of it with our cutting compound, and were as much astonished as gratified to find that the tool did not blunt anything like as rapidly as before. In fact the cutting-off tool actually made 980 cuts with only one sharpening. Fig. 1 shows 60 cuts made, representing the maximum that could be done with the plain compound, and Fig. 3 shows the 980 cuts made by the same tool in the same machine, the only difference in conditions being the addition of the graphite to the cutting compound. One also notes that not only did the tool in the second case do about 16 times as much work as in the first, but also that the ends were very much smoother, that is, the work was done much better.

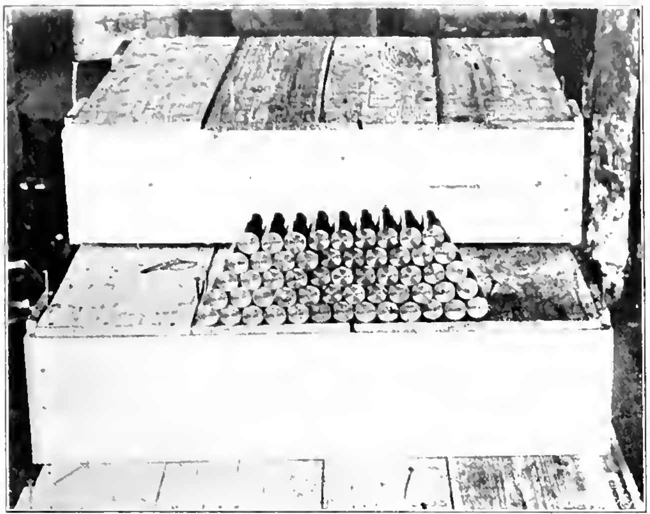


Fig. 1. Sixty 1-inch Cuts made with Plain Compound

We have also used "Aquadag" for many other machine tool operations with the same good results. For instance, in boring and reaming a large number of holes in bronze bushings we find that with our ordinary cutting compound the hole is always about 0.0002 inch smaller than the reamer used, but, through the addition of Aquadag to the compound, we find that we can cut a hole practically the full size of the reamer, this again being a conclusive argument that graphite greatly increases the cutting possibilities of the tool. We have also been enabled to effect considerable reduction in power consumed. We have in our factory a machine for a certain operation in which it was necessary to run with the back gears when using an ordinary cooling compound. However, by the above mentioned addition of graphite to the compound we ran with open belt. One sees here not only a reduction of power consumed by the cutting tool but also that an increase of speed is made possible.

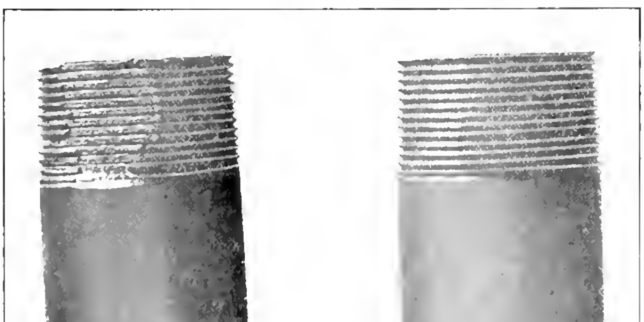


Fig. 2. Left-hand Pipe Thread cut with Lard Oil and Right-hand Thread with "Aquadag" using same Die

As yet, our experience with this product has been somewhat limited; in fact, it was only a few weeks ago that we commenced to use it, but so far, the results show a very much better operation, whether it be in the lathe, for turning or cutting off, or whether it be for milling or thread cutting, than could be obtained without it. Personally we are quite interested in this idea of using deflocculated graphite for a machine-tool lubricant and we shall be glad to hear of the experiences of other readers who may experiment with the same. We should mention that "Aquadag" is a mixture of pure graphite and water, made by the International Acheson Graphite Co., Niagara Falls, N. Y., the graphite contained being so extremely fine that it will feed through a fountain pen and will remain permanently suspended in water.

Niagara Falls, N. Y. NIAGARA MACHINE CO.

A SPLINE MILLING FIXTURE

The description and illustrations of the jig for slot milling long, slender work, published in the March number of MACHINERY by Mr. O. R. Barrett, reminds me of a somewhat similar device designed some time ago for spline milling steel shafts. This fixture contains several improvements over that described by Mr. Barrett, which is open to the following criticism:

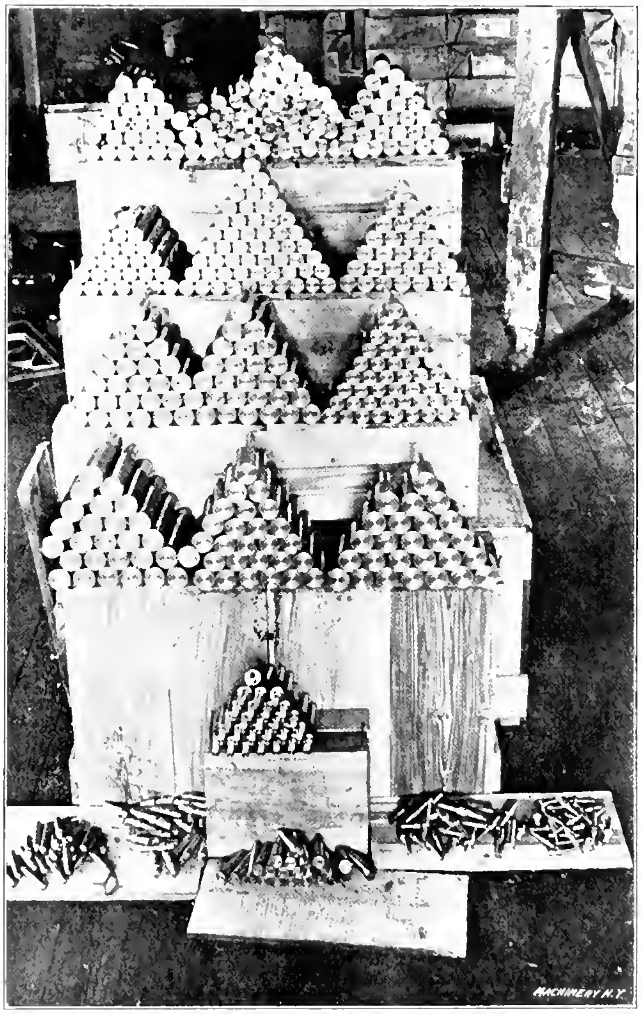
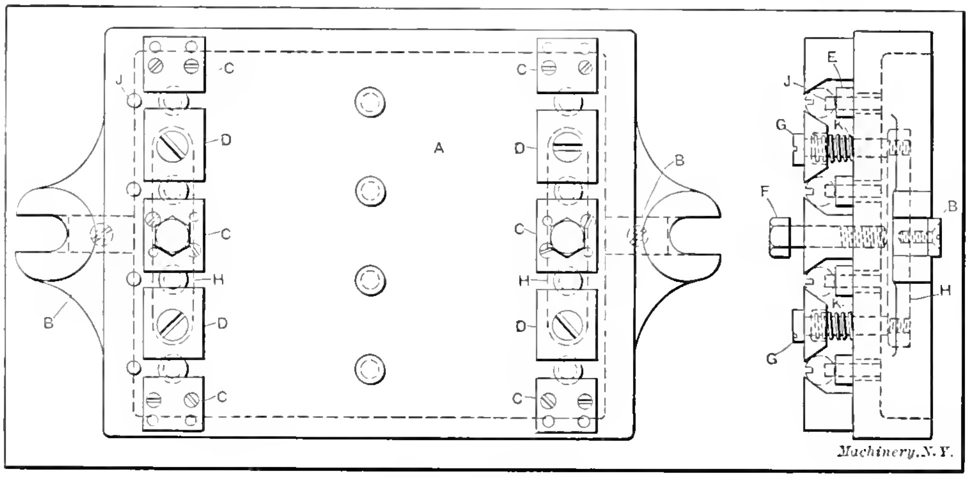


Fig. 3. Nine-hundred eighty Cuts made with "Aquadag" as the Lubricant

In the first place, the pins upon which the work rests between the clamps, are "blind driven" into the base casting, rendering it extremely difficult to remove them when it becomes necessary to renew them on account of wear. Besides, pins of this character taking the thrust from a clamp, should be made with a substantial shoulder, as it is much easier to get them all to the same height above the base surface.

Another weak point in this device is that four nuts must be turned, in order to clamp the four castings, while a little additional thought on the subject would have shown that this could have been accomplished by means of two bolts and a pair of equalizer bars, as will be described later when considering the spline milling fixture.

I also notice that the various blocks, against which the clamping action takes place, are not doweled in position, and while this may be an oversight in the drawing, and was undoubtedly taken care of by the toolmaker, it should not be forgotten that dowel pins are what really hold a block in accurate location and that the screws merely serve to clamp the block against the base and to resist any upward or tilting thrust which may exist; consequently, the two screws which hold the outer blocks should be placed side by side, close to the inner or clamping edge of the block, and the dowel pins should be placed behind the screws, as shown in the accompanying illustration.



Fixture for Spline Milling Shafts

The fixture referred to for spline milling steel shafts consists of a cast iron fixture base, which is provided with steel tongues B, to engage the groove of the milling machine platen. Hardened tool-steel blocks C, mounted on the base casting by means of fillister-head screws, and dowel pins, serve as blocks against which the work is clamped, and it should be noticed that the surfaces of these blocks, as well as the surfaces of the clamps D are straight, in order that the work being clamped will not be mutilated by the pressure being concentrated at one point of contact. [The advantage of having clamps with a single point contact for holding long, slender and rough work, is that there is less danger of springing it. This point was carefully explained by Mr. Barrett.—EDITOR.]

The clamps D are of machine steel, carbonized and hardened, and are counterbored from the under side to receive the helical springs K, which serve to release the clamp by their upward pressure. These clamps are actuated by the casehardened steel screws F, which are threaded through the base casting and bear against the middle portion of the equalizer bars H. These bars are of machine steel, carbonized and hardened, and carry at their extremities screws G, which pass through the clamp blocks D and serve to pull them against the work when the operating bolt F is turned.

The work rests upon hardened tool-steel pins E, which are driven into the base against a shoulder, and the end thrust of the cutter is absorbed by the steel stop-pins J. A socket wrench is used to operate the clamp bolts F.

It will be noticed that this fixture is much more rapid in its operation than Mr. Barrett's yet it accommodates the same quantity of work, and costs practically the same to build.

C. NOSRAC

SETTING A BENCH LATHE SLIDE-REST FOR STRAIGHT GRINDING

To set the slide-rest of a bench lathe to grind parallel, a cylindrical test piece having centers in each end and a collar on one end, may be used and accurate results obtained. The collar is first ground true, after which the position of the test piece is reversed. When the emery wheel is moved up to the other end, its position with relation to the collar as indicated by the sparks, will make it possible to set the slide-rest very accurately, though it may be necessary to repeat this cut-and-try method once or twice.

For inside setting when finishing holes by grinding, particularly when the work is hardened and is to be lapped, it is especially desirable to get the hole as nearly parallel as possible. This may be done by feeding the emery wheel through the hole and making it cut first on one side and then on the other. By noting the sparking of the wheel, the slide can be set so that the hole can be ground parallel, to an extreme degree of accuracy. If the hole is very deep or small in diameter so that the sparks cannot be seen, a "listener" is used which consists of a piece of a small drill rod with a handle on one end. The end of the rod is applied to some part of the grinder and the handle is held close to the left ear. By the sound emitted when the wheel is in contact with the work, it is easy to tell if the cut is the same throughout the length of the hole on both sides. If this "listener" is not sensitive enough, the bottom of a tin can (having one end open) may be applied to some part of the grinder or to the top of the tool-post screw. The contact of the emery wheel with the work can then be easily heard by listening at the open end of the can, even though the wheel is not taking a cut deep enough to make a visible mark in the hole.

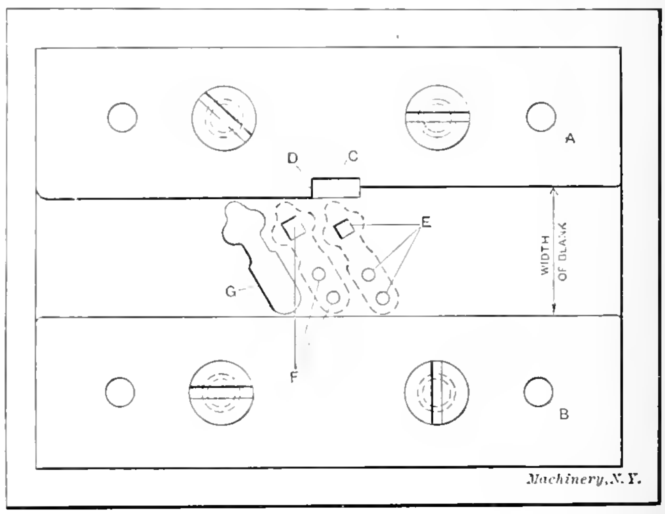
These methods are not only better, but far quicker than the old way of calipering for parallelism.

A. L. MONRAD

East Hartford, Conn.

FEEDING DEVICE FOR PUNCH PRESSES

Seeing an article on feeding devices for punch presses in the April issue of MACHINERY brought to my mind a feeding device which I have used to good advantage when the feeding space was not more than one inch long. The accompanying sketch shows clearly the method used. A and B are the two guide strips which are fastened to the die blank as shown. The stock is cut the required width to slide in between the guide strips. The punch which is inserted in hole C in the die shaves off one side of the strip, allowing it to be located at the point D. Holes E are used for piercing the piece and holes F are made large enough to clear the pierced holes which are embossed and not clean cut. The blank is then punched at G. After feeding the stock in to the die, from right to left, until the end projects past the opposite end of the die, the stock can be grasped by the hand and drawn through the die, the point D acting as a stop. One advantage of this feeding device is that no pilots are required on the punches for spacing accurately. It should be mentioned that it is not advisable to use this device for blanks requiring a feed of more than 1 inch.



Feeding Device for Small Blanks

CHARLES PABESHUTZ

Milwaukee, Wis.

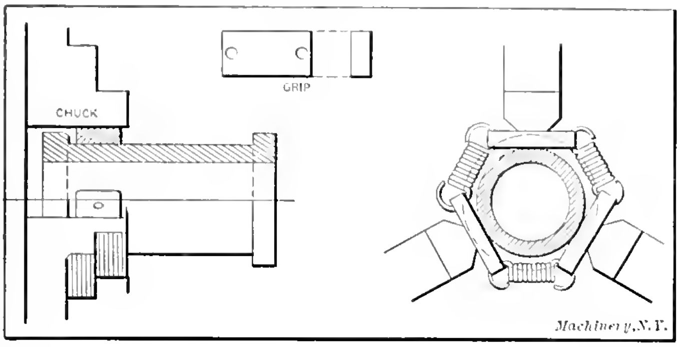
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

CHUCK GRIPS FOR FLANGED WORK

Three or four strips of bar stock, drilled at each end, and hooked together with coil springs, as illustrated in the accompanying engraving, make handy grips for holding

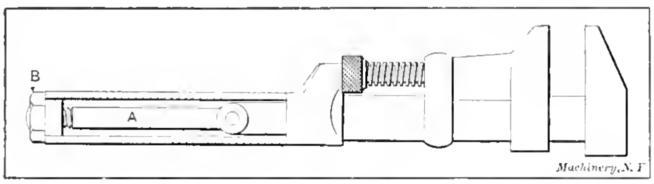


flanged bushings, etc., in a chuck. The number of grips required will, of course, depend upon the type of chuck used. Grips 5-16-inch thick, 5/8-inch wide, and 1 1/4-inch long are a handy size. Charles E. Burns

Beverly, Mass.

HANDLE FOR MONKEY-WRENCH

The way the broken handle of a 12-inch monkey-wrench was replaced with a strong iron one, is shown in the accompanying illustration. The only material required was one



piece of pipe 1 inch by 4 1/2 inches long, and one 3/8-inch steel bolt *A* with a slot cut in the end to fit the tongue-piece of the wrench. This bolt was fastened by a pin as shown, and the nut *B* served to hold the handle in place. W. F. Oliver

Plainfield, N. J.

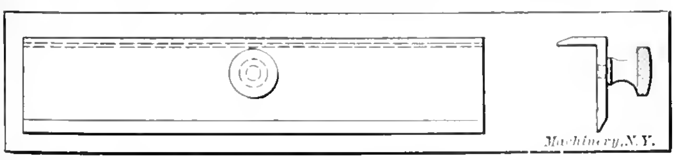
STARTING A DRILL

In the "Experiences of a Young Toolmaker" in the December number of Machinery "George" tells "Jim" that he does not need a centering tool. George is right about the centering or spotting tool, but if he and Jim will use the drill with the lips vertical instead of horizontal, they will find it will not have so much tendency to travel up and down and will take its central position more readily. J. R. Rand

Springfield, Mass.

BOX-SQUARE WITH HOLDER

Probably every machinist has had trouble, at times, in holding a box-square securely on the piece of work to be marked. I have found it so troublesome to hold while using, that I decided to have some sort of a handle attached to it, so I drilled a hole in the center of the broad side and tapped it out for an ordinary thumb-screw which happened to be at hand. After filing the end of the screw even with the inside, the holder was finished. The illustration indicates so plainly the advantage of this little screw that further explanation is unnecessary.



New York City. Arthur Blofield

HOW TO PUT A TAP IN STRAIGHT

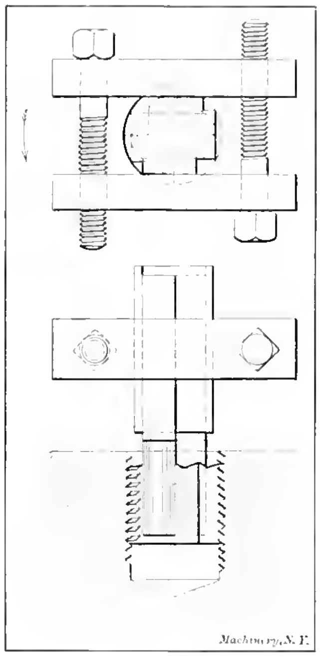
Recently the apprentices at our shop were asked at an examination, how they could tell whether a tap is going in straight or not, if the hole being tapped passed through the center of a sphere. The answer was, by securing a faced nut over the tap and down against the work. If it touched evenly all around this would indicate that the tap was going in straight. Canadian Pacific Railway Apprentice.

MAKING SMALL EMERY WHEELS FROM BROKEN PARTS

If an emery wheel breaks, small wheels may be made from the pieces by drilling a hole in the center of each piece for the arbor and trimming the part to a true circular shape. The center of the broken part should first be found and then a circle drawn equal in diameter to the size of the wheel. The hole should then be drilled for the arbor and the piece ground to shape on an emery wheel. When it is nearly round, it can be finished by mounting it on the arbor of a small wheel-stand, and dressing the periphery with a diamond tool. When drilling the hole, the drill press can easily be driven by hand; it should run slowly, say from 10 to 20 revolutions per minute, and water should be used on the drill. In this way a perfect hole is drilled and the drill itself is uninjured. John C. Monrad

Buffalo, N. Y.

A TAP EXTRACTOR

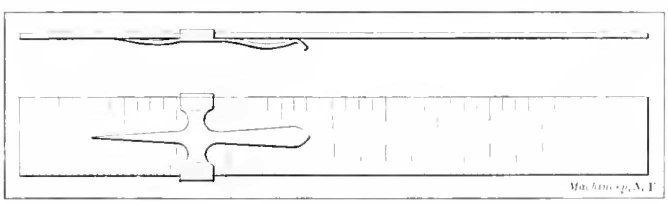


The illustration shows a device for extracting a broken piece of tap from its hole. Take a couple of steel strips, either square or rectangular, and file them part of the way, up to a curved shape, as seen dotted in the plan. Prepare a piece of steel with slight ledges on opposite sides, and bind the strips to this by means of a lathe dog or clamp, as shown. The thin, wedge-shaped ends will pass down the opposite flutes of the tap, and catch against the lands when the rig is turned to the left, thus unscrewing the bit of tap. Fred Horner

Bath, England.

COMBINATION SCALE AND SCRIBER

The accompanying illustration shows a 6-inch scale to which is attached a scriber that is made of tool steel. This scriber



also acts as a pocket clip; in fact, that is the purpose for which it was originally designed. As a scriber is mostly used with the scale, the upper part of the clip was extended so as to form a scriber point, thus combining two tools in one.

Cleveland, Ohio. A. Nielsen

PUMPING HOT WATER

Hot water, even up to 180 degrees F., may be lifted about ten feet if the following piping is run: At the point where the vertical riser from the well meets the horizontal suction pipe to the pump, instead of an elbow use a tee, and on the run of the tee extend the vertical pipe for about four feet and cap it over. If the lift is not too great, this will operate satisfactorily. R. E. Bradley

Winchester, Mass.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

INFLUENCE OF BELT THICKNESS ON PULLEY SPEED

R. D.—Should the thickness of the belt be taken into consideration when calculating pulley speeds?

A.—When the diameters of the pulleys are small and the belt is relatively thick the thickness of the belt should be taken into consideration in pulley speed calculations, more particularly so when the difference of the two pulley diameters is great. In ordinary pulley calculations, however, where the pulleys are, say, twelve inches in diameter or more, it is not customary to consider the thickness of the belt. In the case of a feed belt of an engine lathe, the thickness of the belt makes an appreciable difference in the ratio of the pulley speeds. If the driving pulley is, say, 6 inches in diameter and the driven pulley is 2 inches in diameter, then the ratio of the driving and driven diameters, not considering the belt, would be as 6 to 2, or as 3 to 1. Considering the thickness of the belt, however, to be $\frac{1}{4}$ inch and taking this thickness into consideration, the ratio would be as $6\frac{1}{4}$ to $2\frac{1}{4}$ or as 2.77 to 1. It will therefore be seen that the thickness of the belt makes a difference of about 8 per cent in the speed of the driven pulley.

CRUCIBLE FURNACE CONSTRUCTION FOR GAS FUEL

W. R.—I enclose a sketch of a crucible furnace, see Fig. 1, with which we are having no end of trouble on account of the rapid burning out of the cast-iron gas burners. The furnace is used for casehardening small steel parts. Gas is burned under moderate air blast from the shop line. We would appreciate some solution of the difficulty.

Answered by E. W. Beardsley, Waterbury, Conn

A.—In Fig. 2 at *A* I have reproduced your sketch of the furnace and crucible, adding a cover, a vent at the top, and a

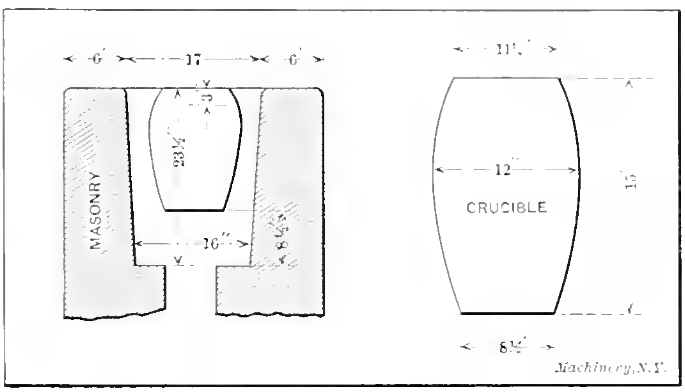


Fig. 1. Furnace Construction which gives Trouble with Burners

burner at the bottom, as illustrative of the probable present construction. The burning out of the cast-iron burner is probably due either to the large surface exposed to radiation from the furnace chamber, or to combustion taking place inside of the burner, on account of faulty design or operation.

At *B* is shown a much better application of burners, which, in a furnace of this size, should probably be not less than two in number. At *C* is a sectional plan of furnace *B*, showing more clearly the tangent relation of the burners to the circular chamber. With this arrangement the flame will probably travel several times around the crucible instead of taking as nearly as possible a straight line from the burner to the vent, as at present.

At *D* is shown a section of a burner which can be made up from standard pipe fittings. If the tip burns out, as it probably will in time, the flange joint enables easy removal and the burned parts can be cheaply and easily replaced. Use a gasket of asbestos paper or similar material between the flanges. Fittings for $1\frac{1}{2}$-inch wrought-iron pipe will probably be large enough for your furnace with two burners, and a 2-inch pipe will be sufficient to bring the gas and air from the mixer to the tee supplying the burners.

If the "shop line" from which the air is taken carries compressed air at a pressure of 40 pounds per square inch or more, the air should be used in a jet blower, for economy. The one shown in Fig. 3 is a combined jet blower and mixer which can be easily constructed from pipe and fittings. These fittings should be not smaller than 2-inch pipe size for the cross, $1\frac{1}{2}$-inch pipe for the gas, and $\frac{1}{8}$-inch or possibly $\frac{1}{4}$-inch for the compressed air. The pressure beyond the mixer need not be more than 2 pounds per square inch, and probably 1 pound will be sufficient.

The changes recommended would probably result in a saving of not less than 10 per cent and very likely 25 per cent of the

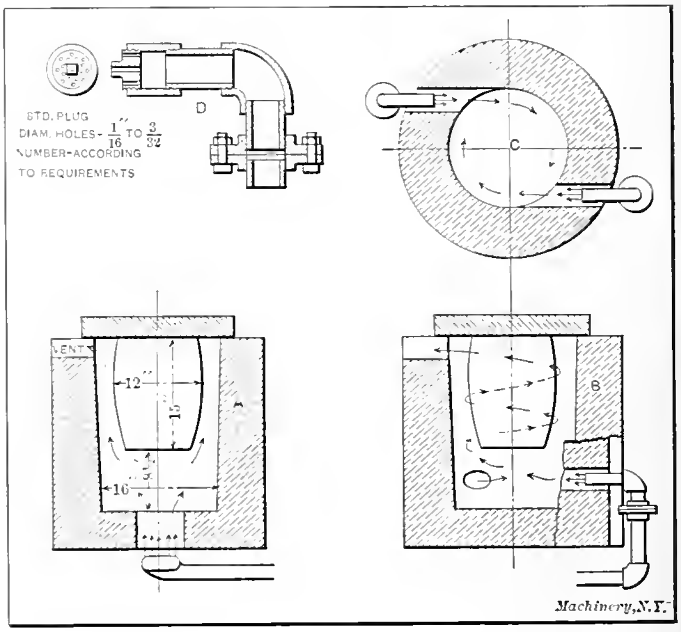


Fig. 2. Suggested Improvements over Furnace A are shown at B, C and D

gas you are now using. With a suitable furnace using fuel oil or coal instead of illuminating gas, you could probably save not less than 60 per cent of the present fuel cost. If in a coal or oil furnace you would use a cast-iron box in place of the crucible which is the usual practice, the saving would probably be 80 per cent or even 90 per cent.

Suitable furnaces for casehardening with any of these fuels can be bought from various manufacturers whose advertise-

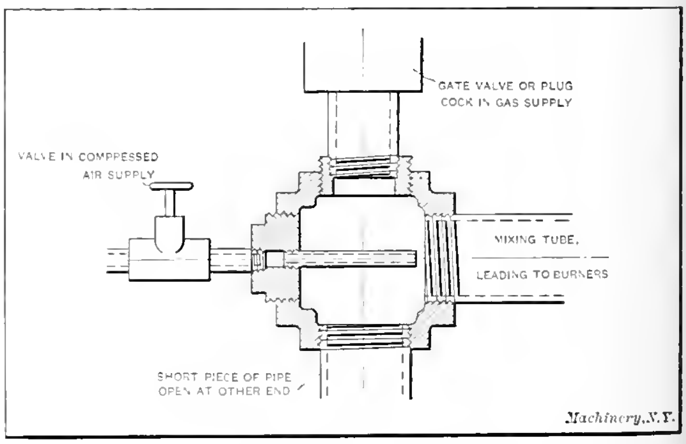


Fig. 3. Combined Jet Blower and Mixer Operated from Shop Compressed-air Service

ments you will find in this paper, at a lower cost than you can make one yourself. You can probably also buy suitable gas burners alone, from the gas furnace manufacturers.

* * *

Some concerns in certain lines of manufacture requiring many comparatively simple and cheap special machines, make a practice of purchasing second-hand machine tools. The headstocks and slides are worked over at small cost so as to adapt them to the desired purpose. Many special machines are in use in a certain factory, built up from regular machine tools at very low cost, the functions of which are quite different from those for which the machines were originally designed.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

MORTON TRAVELING-HEAD CYLINDER PLANER

The traveling-head cylinder planer illustrated herewith, which is built by the Morton Mfg. Co., Muskegon Heights, Mich., is a machine that is particularly adapted to that class of work which, when finished with standard tools, requires, in some instances, more time for adjustment than in the actual machining operations. As this machine, besides being an efficient planer, is also capable of performing boring and milling operations, parts can often be finished at one setting, thus effecting a considerable saving in time.

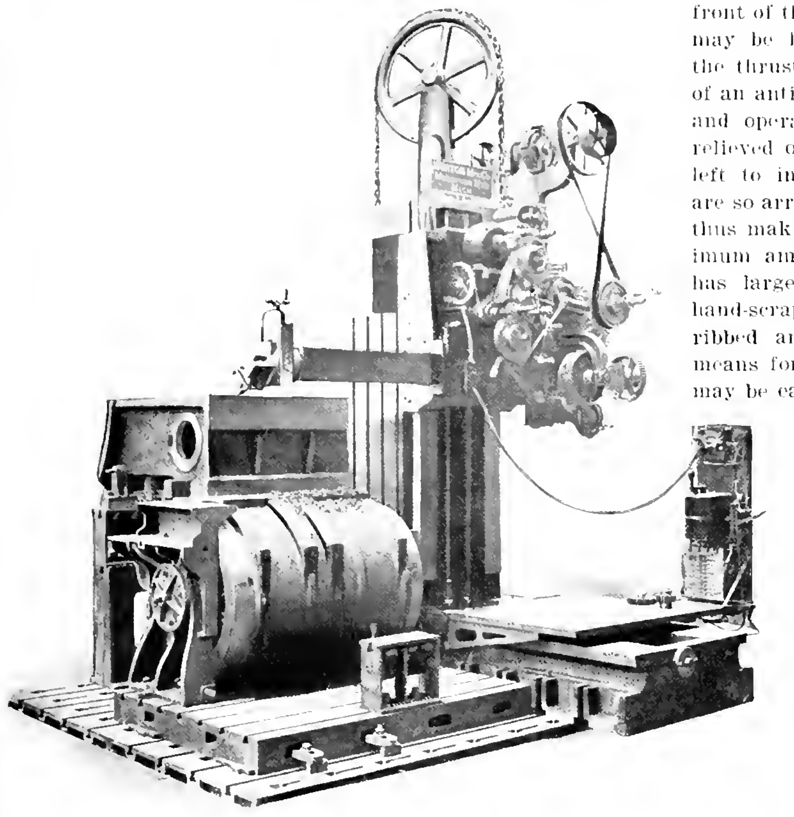


Fig. 1 Morton Traveling-head Planer with Locomotive Cylinder in Position for Planing

This planer is electrically driven by a 10-horsepower variable speed motor, which is attached directly to the base of the column. The power is transmitted through gears to a vertical shaft which is connected with the directly-attached countershaft. From this shaft connection is made by open and cross belts to friction clutch pulleys, which control the reciprocating motion of the ram, and are so arranged that reversals are made without shock or jar. By means of a clutch, the countershaft may be stopped and started independently of the motor and it can be reversed for back-facing, boring, etc., when necessary.

The vertically moving apron which is closely fitted to the column and provided with means for compensating for wear, carries the feeding and other working mechanism of the machine. This slide is provided with taper gibs and is so constructed that it is unnecessary to employ binder clamps back of the bearing rails. The saddle casting is extended in such a manner that in connecting with the taper gibs, it forms a bearing which insures rigidity. The counterbalance for the apron and its mechanism consists of an air cylinder placed on the rear side of the column, in which a given pressure is automatically maintained. A compressor, which is driven direct from the motor, makes the machine independent of any outside connection.

The column and its saddle are made in one piece and are heavily constructed throughout. The T-slotted plate on the front of the column presents a surface against which a bearing may be bolted for supporting high work, thereby bringing the thrust of the cut directly against the column. By means of an anti-friction carriage which is placed beneath the column and operates on a steel track, the bearings on the bed are relieved of a certain portion of the weight, just enough being left to insure the machines working steadily. Coil springs are so arranged that the tension can be increased or diminished, thus making it possible to adjust to the point where the minimum amount of power is required for operation. The bed has large bearing surfaces and square bearings which are hand-scraped and fitted. It is very rigidly constructed, being ribbed and cross-ribbed. Open slots on each side provide means for screwing the bed to the floor-plate by bolts; these may be easily removed, making the machine portable.

The cast-steel ram is made hollow and square and it has a bearing on all four sides which extends through the entire length of the apron. Provision is made for taking up wear by wedge gibs above and by the adjustment of a ram cap on the side. Power is applied to the ram by a rack and pinion movement. The main driving pinion and bevel gears are made of steel and are so arranged that they are entirely enclosed and run in oil, thus insuring practically noiseless operation and great durability. The gearing is all cut from the solid. The stroke of the ram may be quickly adjusted by tappets on a circular disk. The minimum stroke is 3 inches and the

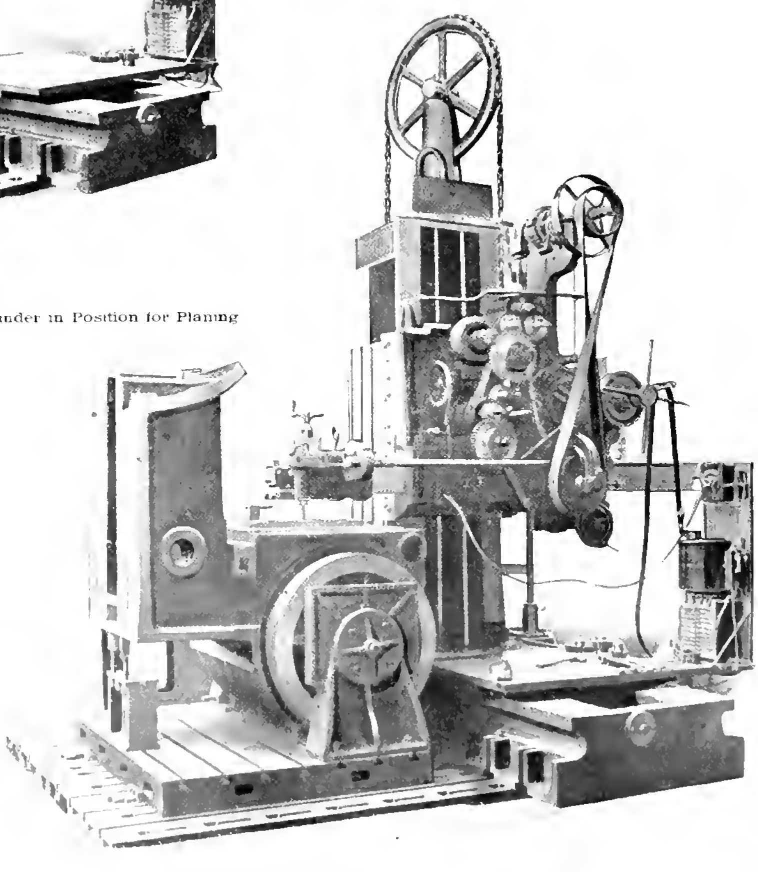


Fig. 2 Morton Cylinder Planer equipped with Port Milling Attachment

maximum 48 inches. The head of the ram is made entirely of steel, and is provided with special steel clamps. It is graduated for planing to angles, and the clapper-box is arranged to relieve the tool on the return stroke.

The feed is a new design of the compound disk friction type, the disks of which are lined on each side with vulcanized fiber. It is of the automatic relieving type and is provided with an instantaneous quick change by adjusting tappets on a circular disk containing holes so that the tappets may be securely locked in position. The feed is reversible so that it may be made to occur at either end of the stroke. When the full feed is required, the tappets may be so arranged as to cause it to operate at both reversals. The feeding mechanism for milling and boring consists of a special feed box secured to the vertically moving saddle, which gives ten changes, covering a range suitable for either boring or milling. Provision is made for reversing so that the saddle may be fed vertically in either direction and the column horizontally in either direction. The ram may also be fed in and out and the arrangement is such that all boring and milling feeds are stopped and started with one lever. The feed screws are of large diameter and the feed nuts are all of bronze and of the revolving type. They have long bearings on the screws and are provided with ball bearing thrust collars with hardened steel plates.

This machine is provided with an auxiliary table 30 inches high, 36 inches wide and 8 feet long, which may be bolted to the floor-plate. By means of parallel strips which may be placed between the bed and the lower edge of the table, the latter can be set in perfect alignment with the bed. It can be used for holding parts being planed or, as illustrated in Fig. 3, in connection with rotary planing.

The milling and boring attachment is provided with a hollow steel arbor which passes through the ram and is journalled in bronze bearings. The front bearing is tapered and adjustable for wear. A special steel yoke which is attached to the back end of the ram, carries a powerful train

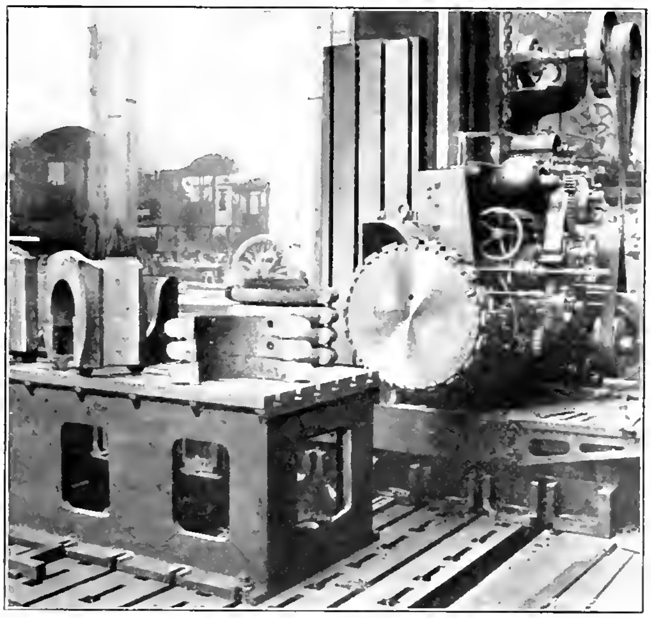


Fig. 3. Cylinder Planer Arranged for Rotary Planing

of gearing for driving. This yoke is so designed that it may be quickly removed with the gearing when necessary. The arbor is bored for receiving taper shank milling cutters, boring-bars, etc., and a retaining or drawing-in bolt which passes through the arbor makes it possible to quickly engage or disengage the tools. The rotary planing equipment consists of a steel milling head about 25 inches in diameter provided with an internal gear, the teeth of which are cut from the solid. The cutters are inserted in the periphery as shown in Fig. 3, and securely clamped.

The port milling attachment, which is shown in use in Fig. 2, may be quickly attached to the squared section of the ram without removing the shaper head. It is provided with a vertical arbor and a train of gearing giving ample power. The spindle is bored to receive a No. 4 Morse taper. This is an efficient attachment for milling cylinder ports, and the operation may be performed when the work is in position for planing the valve seat.

The cylinder chucks, the use and advantage of which will be apparent by referring to Figs. 1 and 2, are attached to movable brackets which are tongued and fitted to one of the slots in the auxiliary base-plate. One of these brackets may be adjusted by a rack and pinion for cylinders of different lengths. These brackets are made to given dimensions so that their surfaces may be used in laying out lines. The chucks are of the three-jawed universal type and make it possible to quickly set a cylinder in alignment, as the jaws

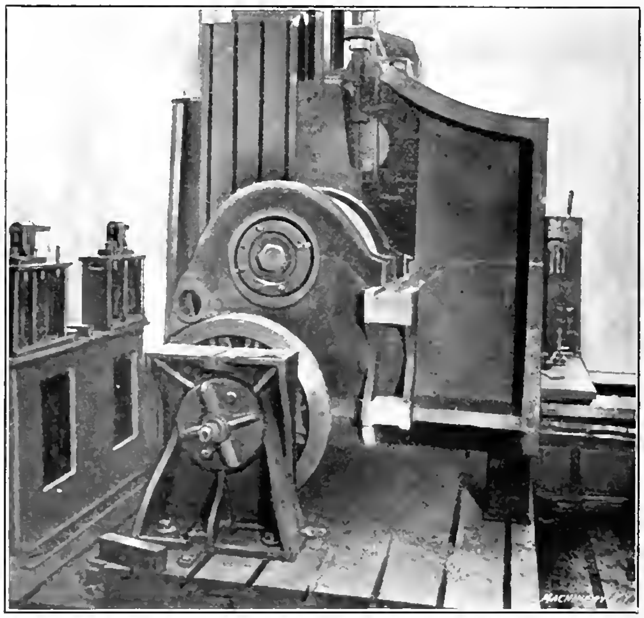


Fig. 4. Boring Attachment of the Cylinder Planer in Use

engage with the finished counterbore. A bolt passing through the cylinder from one bracket to another more firmly aligns and holds in position the work. Parallel blocks are included for supporting a cylinder in various positions and when the work is once chucked, it is not removed until the planing is finished and the bars milled.

This machine has a longitudinal feed of 9 feet and a vertical feed of 60 inches. The extreme height of the machine is approximately 15 feet, the floor space required 14 by 16 feet, and the weight 48,000 pounds.

NEWTON BOLT THREADING MACHINE

The Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., has brought out an interesting type of bolt threading machine which we illustrate herewith. This machine, which is built with the duplex die-head shown in Fig. 1, or with a single die-head, has been designed to handle the diversified class of work that the bolt-cutter is usually called upon to do.

The compact design of adjustable die-head with which this bolt-cutter is equipped, constitutes one of the most interesting features in its construction. These die-heads are fitted with four different sets of chasers, as shown in Fig. 2, so that a single head is always ready to cut any one of four bolt sizes. The chasers are of a standard form and are accurate and interchangeable. The four chaser blocks in which the chasers are fitted, are operated universally when adjusting the die, and each is independently locked in its position by a special arrangement which prohibits any movement whatsoever.

To index the chaser blocks when setting the die to a different size, it is simply necessary to throw the lever controlling the head back far enough to completely disengage the locking mechanism; a pin is then inserted in any one of the chaser blocks, which, together with the others, is revolved to the desired position. The head is then closed by means of a lever, and a hand-wheel is adjusted until a pointer is in line with the zero mark on the scale covering the particular size required. By means of separate index scales for each posi-

tion of the chaser blocks, the dies may be set so accurately that it is not necessary to cut trial bolts except when a chaser is first put into operation or when it has been re-hobbed. After the chasers are once set, the head can be indexed as frequently as desired and it can always be brought to the correct position by the pointer and scale referred to. Chasers of the "hobbed" type will be furnished unless otherwise specified, owing to the fact that many desire to re-hob and make their own chasers. These chasers are made of carbon steel ordinarily, but will be made of high-speed steel if preferred.

The general construction of the die-head is simple, there

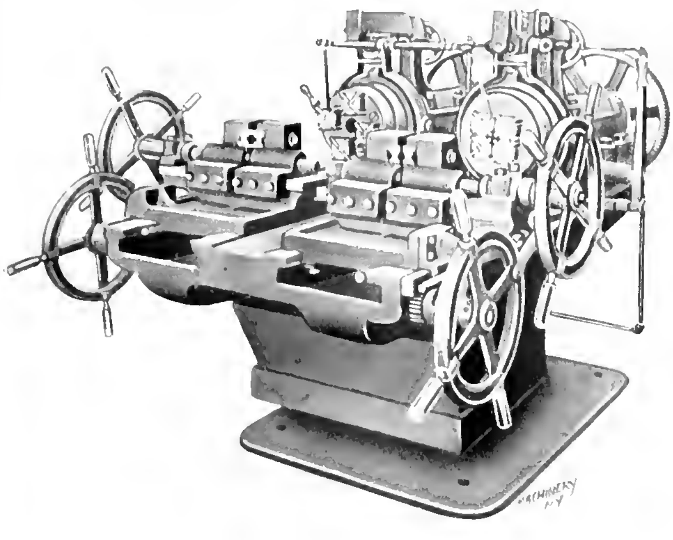


Fig. 1. Newton Duplex Bolt Threading Machine, with Multiple Automatic Die-heads

being few operating parts, all of which are of high-grade material. The head is arranged for automatic opening and closing, or it can be operated by hand. The construction is such that when the opening is done automatically, no fin or burr is left on the thread. The makers claim that this head is as rigid as a solid die, owing to the fact that the in-and-out motion is controlled by a cam and eccentric which give a solid metal-to-metal contact, so that the die is absolutely dependable in maintaining the size of bolt when it is once set. The die-holders are of 50-point carbon steel and the chasers are fitted into slots milled from the solid and have bearings on two sides and the end. The chasers are held in place by a single screw, as shown, and are interchangeable.

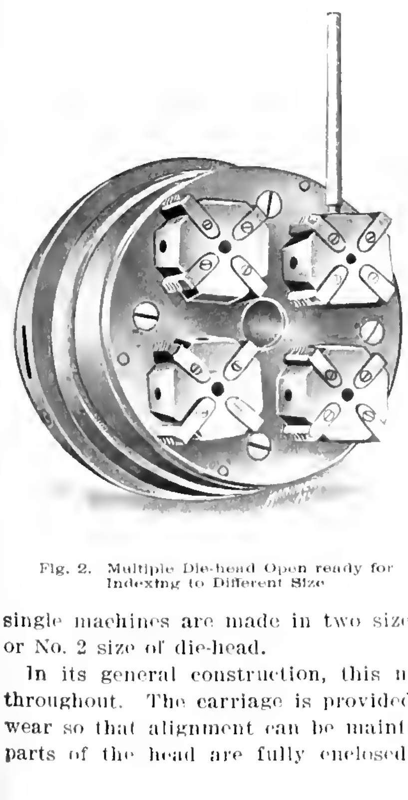


Fig. 2. Multiple Die-head Open ready for Indexing to Different Size

The die-heads are made in two sizes designated as Nos. 1 and 2. The first size will cut $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1-inch bolts, and the No. 2 size, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ and 2-inch bolts. As the spindle of the machine is hollow, any length of thread may be cut. The duplex machines are made in one size only, and are fitted with heads of each size, thus giving them a capacity for cutting bolts of eight different diameters ranging from $\frac{5}{8}$ inch to 2 inches. The single machines are made in two sizes with either the No. 1 or No. 2 size of die-head.

In its general construction, this machine is heavily built throughout. The carriage is provided with compensation for wear so that alignment can be maintained, and all operating parts of the head are fully enclosed so that all dirt is excluded. The clamping jaws of the vise are reversible and interchangeable, and the machine is fitted with a pump, chip box and drip pan.

NEWCYCLE GAS AND OIL ENGINE

An interesting type of internal combustion engine has recently been placed on the market by the Newcycle Motor Co., 39-41 Cortlandt Street, New York City. The main purpose in the development of this new engine, one design of which is illustrated herewith, has been to secure the advantage of an explosion at each revolution, as with the ordinary two-cycle type. It is also designed to give perfect scavenging without waste of fuel and a full charge of explosive mixture for each revolution.

In the operation of this engine, air only is taken into the crank-case on the up stroke of the piston, through a check valve screwed into the opening *N*, Fig. 2. It will be noted that the piston has two diameters, the smaller end working in the power cylinder and the larger diameter acting as a pump piston, which serves to draw air into the crank-case *C* and also to compress the charge, which is done in the annular space *B* above the enlarged piston end. In the case of an oil engine, space *B* holds air only, which is compressed and used for

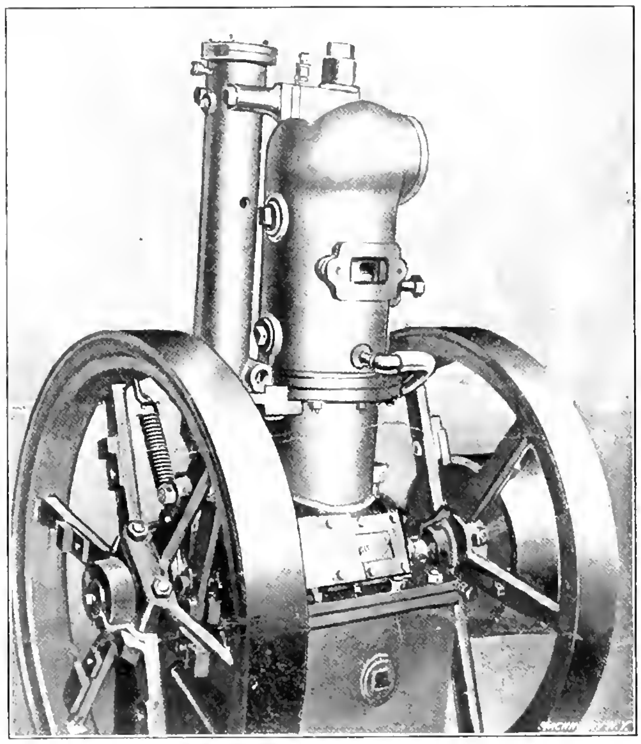


Fig. 1. Newcycle Gas and Oil Engine

injecting the fuel in a blast or spray, while for a gas engine the gas or a rich mixture of gas and air is compressed in this space. When compressed, the charge of air (or gas) enters the valve chest *D* which also acts as a receiver. The admission of air to the annular space *B* is governed by the slide valve *E*, which admits air through the inside port, while the discharge is around the lower edge of valve *E* and up through this valve into the receiver *D*. When the piston is near the end of its downward stroke, it uncovers exhaust port *S* and directly afterward the port *P*, thus releasing the air which has been compressed in the crank-case by the downward motion of the piston. As this air enters, it strikes a baffle-plate *T* on the piston and is deflected upward so that the burned gases are forced downward and out of the exhaust. The volume of the crank-case has been made sufficiently greater than the piston displacement, so that, after allowing for volumetric losses, a charge of air great enough to insure perfect scavenging is injected into the cylinder at the end of each working stroke. The passage of air through the exhaust at this point in the cycle is, of course, immaterial, as the fuel is not as yet mixed with it. Soon after the piston starts on its upward stroke, the valve *F*, which with *E* is actuated by an eccentric, uncovers the port *M* and suddenly releases the air in valve

chest D, which then passes through port M and the check valve H. This is at the time when the exhaust gases have practically all left the cylinder, and when the greater part of the air from the crank-case has passed in through port P. The compression begins, of course, as soon as the ports in the side of the cylinder are closed, and the valve H automatically seats as soon as the pressure is equalized.

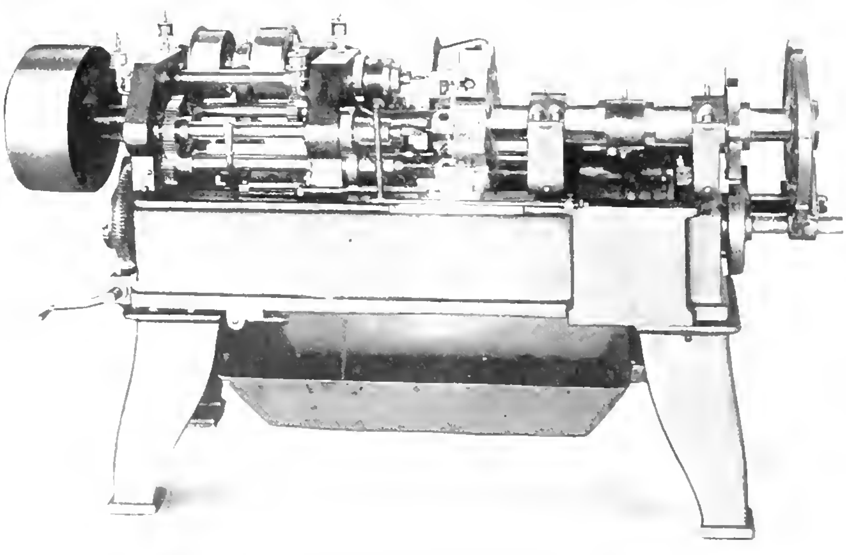
In the case of a liquid fuel engine, the fuel is injected into the passage M by a small pump such as is commonly used on kerosene engines. This pump is under the control of a flywheel governor which regulates its stroke and, therefore, the quantity of oil supplied, according to the load on the engine. As the air in chamber D is under pressure, its sudden discharge at high velocity through port M causes the fuel, which is partly atomized mechanically, to be thoroughly carburetted.

It should be mentioned that the exact construction illustrated is not necessarily to be followed in detail, as modifications will doubtless be necessary to meet different conditions, but the views presented herewith serve to show the cycle of events and the principles involved.

An engine of this type having a 5- by 6-inch cylinder, developed, during a recent test at Cornell University, $6\frac{1}{4}$ horsepower, running at 360 revolutions per minute, and over 7 horsepower during a short period of the time.

PRENTICE FIVE-SPINDLE AUTOMATIC WITH TWO TAPPING SPINDLES

The multiple-spindle automatic turret machine illustrated herewith is a modification of the standard five-spindle automatic built by George G. Prentice & Co., Inc., New Haven, Conn. This machine is arranged especially for the drilling, tapping, etc., of solid castings, forgings and similar work requiring two taps—one under-size for roughing out and the other for finishing. By this method two light cuts are taken, and the breakage of taps of, say, $\frac{3}{8}$ inch or smaller, due to the clogging of chips when using one tap, is overcome.



Prentice Five-spindle Automatic Turret Machine with Two Tapping Spindles

The tapping mechanism consists of a pair of friction pulleys —one for the forward and one for the reverse drive—which are automatically tripped after tapping the required number of threads. The tapping is done by the fourth and fifth spindles, both of which are yoked and geared together and driven by one set of friction pulleys. When starting a new job, the roughing tap is first run through the hole; then the finishing tap is started a few threads by hand into the hole to get the lead. When the collets are tightened, both taps will maintain the same lead.

The machine illustrated has a six-section chuck or work-holder. Five pieces are operated upon simultaneously in this machine while the operator is removing and inserting work at the sixth section of the chuck. The five spindles may be equipped with any arrangement of tooling, including drills, reamers, counterbores, facers, box tools, taps, etc. The machine as shown is equipped with tools and work-holders for drilling, counterboring, and tapping the binder screw holes in automobile clutch-shifter fork forgings.

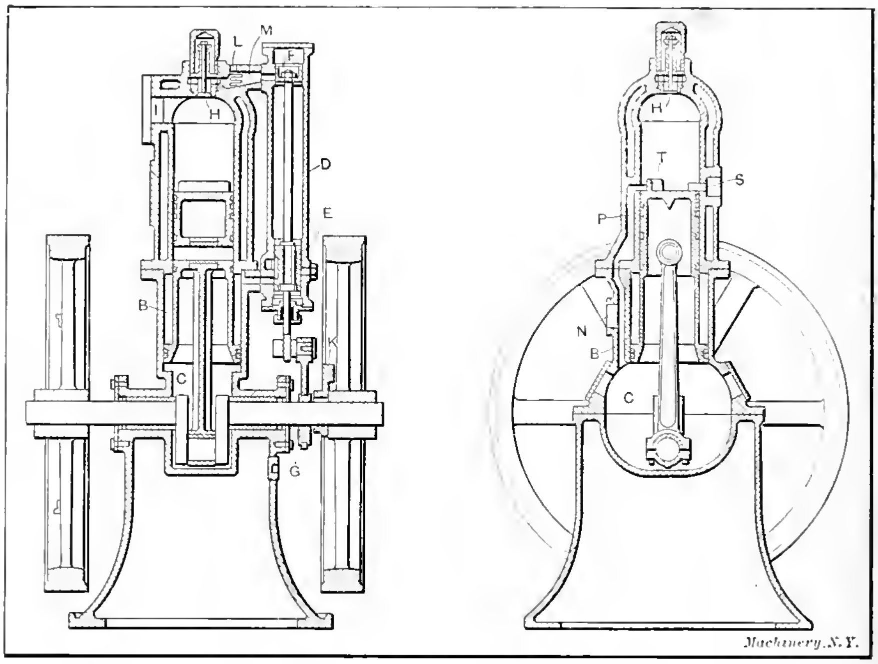


Fig. 2. Sectional Views of the Newcycle Engine

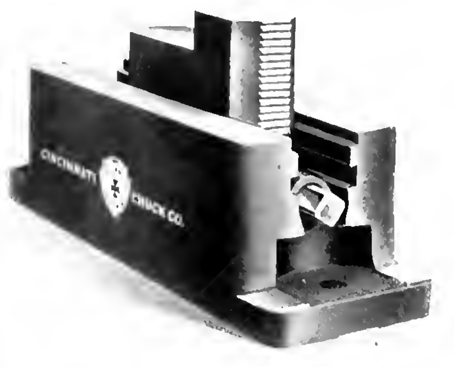
The principle of this machine is the same as in other Prentice single-head automatics. The chuck is automatically advanced towards the revolving spindles by means of a cam on a large drum inside of the bed. There is also a return cam to draw the chuck away from the tools at the completion of the operations. The camming is timed so that the chuck is automatically indexed to the succeeding operation as soon as the longest operation has been completed. A new feature being applied to Prentice automatics, is a differential feed mechanism for speeding up the indexing time of the chuck. By this means the production is increased about 30 per cent.

As all the operations on any piece of work done in this machine are finished complete within the cutting time of the longest operation only, a great saving in time is effected. A further reduction is made on that class of work which requires the drilling of long holes, by drilling one-half the length in one spindle and the remainder in the succeeding spindle. Thus a hole of 2-inch depth could be drilled the entire length, reamed, faced, tapped, etc., in the time that would ordinarily be consumed in drilling a hole one-half that depth. This machine has ample power to drill and tap up to $\frac{5}{8}$ inch in diameter, although the class of work requiring the double tapping arrangement is generally $\frac{3}{8}$ inch and smaller. The net weight of this machine, with countershaft, is about 3000 pounds.

CINCINNATI FACEPLATE JAW

The Cincinnati Chuck Co., Cincinnati, O., is now manufacturing a new faceplate jaw, which we illustrate herewith. The chief feature of this jaw lies in the method of mounting the screws in hardened steel bushings which provide a full bearing for the trunnions of the screws and receive the end thrust on their hardened circular faces, thus minimizing

wear and resultant end play. In the ordinary faceplate jaw, the screws are mounted in semi-circular bearings and receive the end-thrust on semi-circular shoulders formed in the cast iron shell of the jaw, which results in excessive wear that is difficult to overcome. The patented bushings with which these new jaws are equipped will, of course, prove more durable, and when end paly does develop, the construction is such that the bushing can be taken out and replaced by any machinist in a very short time, making the jaw, in this respect, just as good as new. These bushings also serve to hold the screws in absolute alignment with the jaw, thus preventing any tilting of the screw and consequent cutting of the thread. These features are of considerable importance, and overcome most of the jaw troubles commonly experienced.

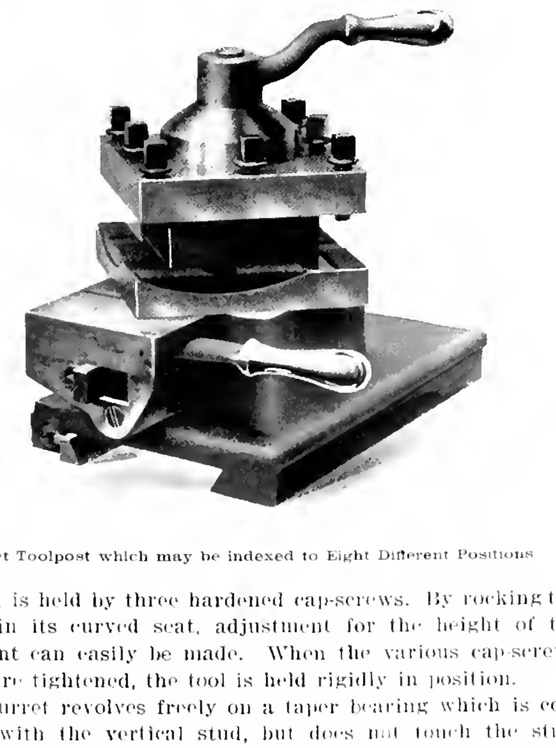


Faceplate Jaw made by the Cincinnati Chuck Co

TURRET TOOLPOST FOR LODGE & SHIPLEY LATHES

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently designed a new turret toolpost which may be applied to any size of lathe manufactured by this company. With this new design, the turret can be indexed to eight different positions so that the tools may be set diagonally, as well as at right angles to or in alignment with the cross-slide. Each tool is clamped well forward of the center so as to give a firm support, and the clamping of the binder lever does not appreciably change the position of the turret.

The lower block of this attachment is interchangeable with the compound rest slide and is fitted to the carriage dovetail by a taper gib. A vertical stud is secured in this base and passes up through the turret to carry the binder lever at its top. The toolpost is of steel. Each one of the four tools rests upon a serrated and hardened bolster or rocker, against


Turret Toolpost which may be indexed to Eight Different Positions

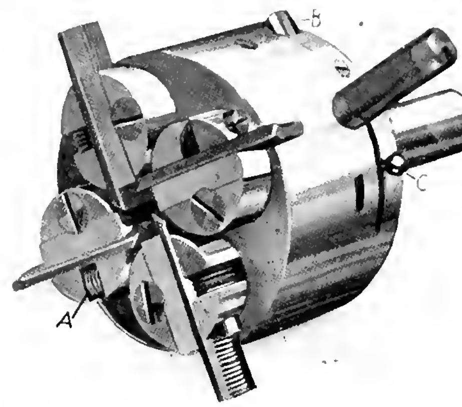
which it is held by three hardened cap-screws. By rocking the bolster in its curved seat, adjustment for the height of the tool point can easily be made. When the various cap-screws shown are tightened, the tool is held rigidly in position.

The turret revolves freely on a taper bearing which is concentric with the vertical stud, but does not touch the stud. A bushing, which is tapered to fit the bearing of the turret, is slipped over the stud. An adjusting nut is threaded to the stud and bears against the upper end of the taper bushing, so that by tightening this nut, the bushing can be pushed down to eliminate play in the bearing. The large collar between the binding lever and the turret, covers the end of the taper bushing and its adjusting nut, so that no chips can get into the bearing. As the large diameter of the taper bearing is at the top, the turret is at all times held against the horizontal bearing of the lower block so that when the binder is clamped, the position of the turret and tools remains unchanged.

The turret is exactly located in any one of the eight positions by a locking bolt which engages notches in an index ring. This locking bolt is withdrawn by the handle seen at the front of the lower block. Compensation for wear in the bearing of the locking bolt is provided for by a taper gib. A coil spring holds the locking bolt against the index ring so that it will at once drop into the notch when the proper point is reached. The screw shown in the illustration just beneath the end of the locking bolt provides adjustment for the tension of this coil spring.

BICKFORD AND WASHBURN TAP THREADING DIE

The die shown in the accompanying illustration, which is manufactured by Bickford & Washburn, Inc., Greenfield, Mass., is intended for the threading of small taps. In this die the well-known milled thread chasers have been used. The advantages of these chasers over the hobbed cutter are in the longer life of the chaser and the shearing cut, which produces a smooth thread when cutting tool steel.



Die for Threading Commercial Taps

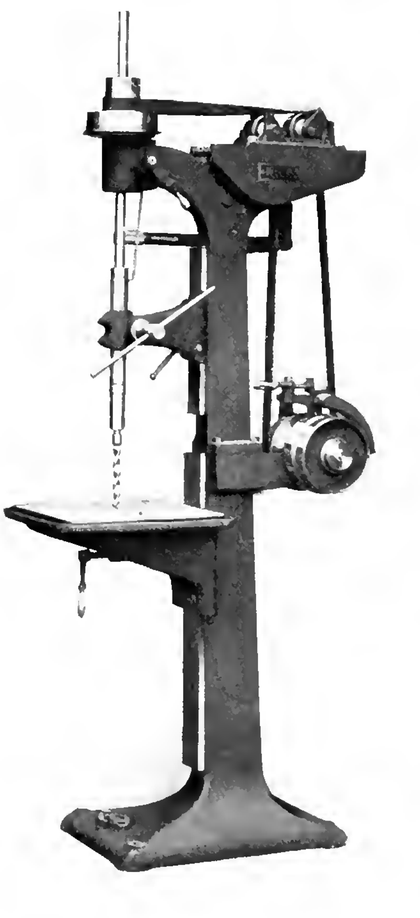
This die, which is designed to be used in a hand screw machine having a lead-screw attachment, has a body 4 inches in diameter, $2\frac{3}{4}$ inches long, and a shank 1 inch in diameter. The shank is hollow and is tapped for a pipe connection so that when the die is in use, a strong flow of oil from the rear keeps the chips well away from the work. The main body is a solid piece of steel accurately bored to receive the cylinders or chaser holders. It is also recessed at the back to make space for short arms which are let in flush at the back end of the cylinders and project across, thus making a bearing to prevent the forward movement of the cylinders. Any backward movement is prevented by the cam plate which comes up directly against the back of the main body and also against the arms referred to. These arms carry pins which are operated by slots in the cam plate, thus opening and closing the die. A collar of the same outside diameter as the main body, is placed just back of the cam plate, and has in its front side a circular recess, into one end of which projects screw *B* which stops the rotation of the cam plate by means of a stud projecting from the plate back into the recess referred to. By turning screw *B* the closed size of the die is determined. The stud in the cam plate is covered by an eccentric sleeve which is operated by the small knob *C*, thus allowing a thick or thin part to come against the end of the screw *B*, so that, by taking a first cut with the knob *C* in the position shown, a very light finishing cut may be taken.

This is a feature in the construction, which will be appreciated by tap makers, as it enables roughing and finishing cuts to be taken. By turning pin *C* to the proper notch for the first cut, it is possible to vary the amount of the finishing

cut as desired. The chasers are held in position by taper gibs which are tightened by the binding screws shown. The necessary adjustment is obtained by means of short worms *A*, inserted in the holders and engaging with the backs of the chasers which are hobbed to receive them. It is possible with this die-head to thread any size of tap within its capacity with the same set of chasers, the proper cutting size being obtained by means of the graduated adjusting screw *B*, as explained.

KERN HIGH-SPEED SENSITIVE DRILL

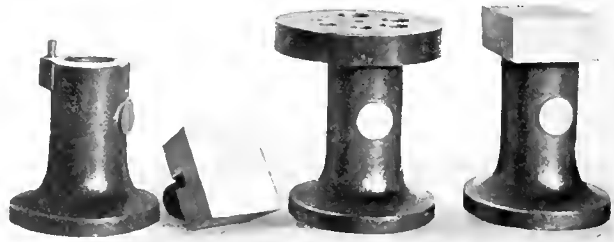
A high-speed, ball-bearing, sensitive drill that is heavily constructed throughout and intended for hard and continuous service, is shown in the accompanying illustration. This machine which is the product of the Kern Machine Tool Co., Cincinnati, O., is exceedingly simple in its design and contains a number of exclusive features. Ball bearings are used throughout, and all cones and ball races are made of steel and are hardened and accurately ground on special machines. The lever at the left of the column near the top controls the idler carriage which is free to move longitudinally. A slight downward pull on this lever loosens the belt and allows speed changes to be instantly made, while an upward movement of the lever tightens the belt to any required tension and automatically locks the idler carriage. The spindle cone, which has two steps, is mounted on a sleeve that is journaled in the column, thus relieving the spindle of any belt pull. This sleeve also serves to raise and lower the cone by means of a rack and pinion operated by the small lever shown on the right side of the column at the top. This vertical adjustment of the spindle cone permits the small or large step to be brought in alignment with the idlers at the rear. Four spindle speeds are available, two being obtained through the two-step cone and the like number by a two-step cone on the countershaft. It will be uoted that the belt-shifting lever is conveniently located and also that the idler pulley is somewhat smaller in diameter than the driving pulley in order to relieve the tension on the belt when the machine is not in use. The upper and lower sections of the column are tongued and grooved to prevent any disturbance of the alignment. The spindle is double-splined and the spindle sleeve is graduated and fitted with an adjustable stop collar. The spindle has a traverse of 15 inches and is bored to a No. 2 Morse taper. The distance from the spindle to the face of the column is 8 inches, and the maximum distance to the table is 32 inches. With a countershaft speed of 800 revolutions per minute, spindle speeds ranging from 600 to 1800 revolutions per minute can be obtained. The table of this machine has a traverse of 21 inches and the head 9 inches. This type of drill can be furnished with any number of spindles up to and including six. The net weight of a single spindle machine is 485 pounds.



High-speed Sensitive, Ball-bearing Drill

CASCADE COMBINATION BENCH ANVIL

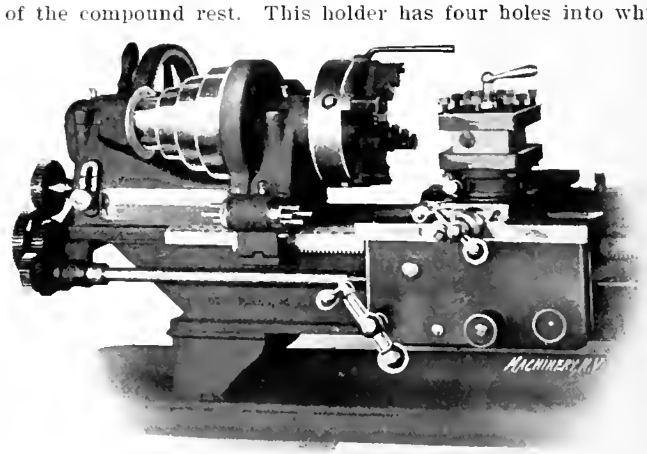
A combination bench anvil that is the product of the Cascade Tool Co., Cohoes, N. Y., is shown in the accompanying engraving. As this illustration is largely self-explanatory, the usefulness of the tool will be at once apparent to the mechanic. The combination consists of a tubular base or stand and an interchangeable anvil and disk, the latter having a series of holes ranging from 1/4 to 1 inch in diameter. The disk has a center hole which engages a pin on the base so that when it is revolved, the holes of various sizes are brought in alignment with the bore of the base for driving arbors, pins, etc. This disk is ground on both sides so that it may be used either side up, and, if desired, one side may be used for rough and the other for finished work. When the disk is not required, it may be lifted off and replaced by the square anvil shown, thus making an excellent bench block for hammering, riveting and similar work. The anvil is also ground on the top and sides, and the supporting base is faced true on the top and bottom. This combination anvil, or a tool of similar construction, could undoubtedly be used to advantage in every shop. In many instances much time is needlessly wasted because of the lack of such inexpensive, but nevertheless, useful tools. The price of this anvil complete with interchangeable anvil and disk is $2.50.



Combination Bench Anvil with Block and Arbor Disk

ATTACHMENTS FOR "STAR" LATHES

In the accompanying engraving two new attachments are illustrated which are intended for use on the well-known 9- and 11-inch "Star" lathes, manufactured by the Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y. One of these attachments consists of a combination carriage turret and toolpost, which is mounted on the cross-slide of the lathe in place of the compound rest. This holder has four holes into which round-shank tools may be insertea. Binding screws are also provided for holding four regular turning tools. Of course, the tools may be fed either by power, cross or longitudinal feeds, or by hand if desired.



"Star" Lathe equipped with Combination Turret and Toolpost, and Carriage Stop

There is shown clamped to the bed in the illustration another attachment which is used to locate the carriage for shoulder distances, etc., when turning duplicate pieces. This stop, which may be attached to the bed at any desired position, has a revolving cylinder containing four adjustable stop-rods which positively locate the carriage. This cylinder may be re-

volved by hand and is held in position by a detent spring and ball.

These two attachments may, of course, be used singly or together. The advantages of the turret are obvious, and the carriage stop will prove valuable for interchangeable work, as it will eliminate measuring each piece, and insure uniform dimensions.

MORTON SPECIAL DRAW-CUT RAILROAD SHAPER

A shaper of the draw-cut type that has been specially constructed to meet the requirements of railway work, is shown in Fig. 1. This machine, which is the product of the Morton Mfg. Co., Muskegon Heights, Mich., is an improved design in which a number of changes have been incorporated to increase

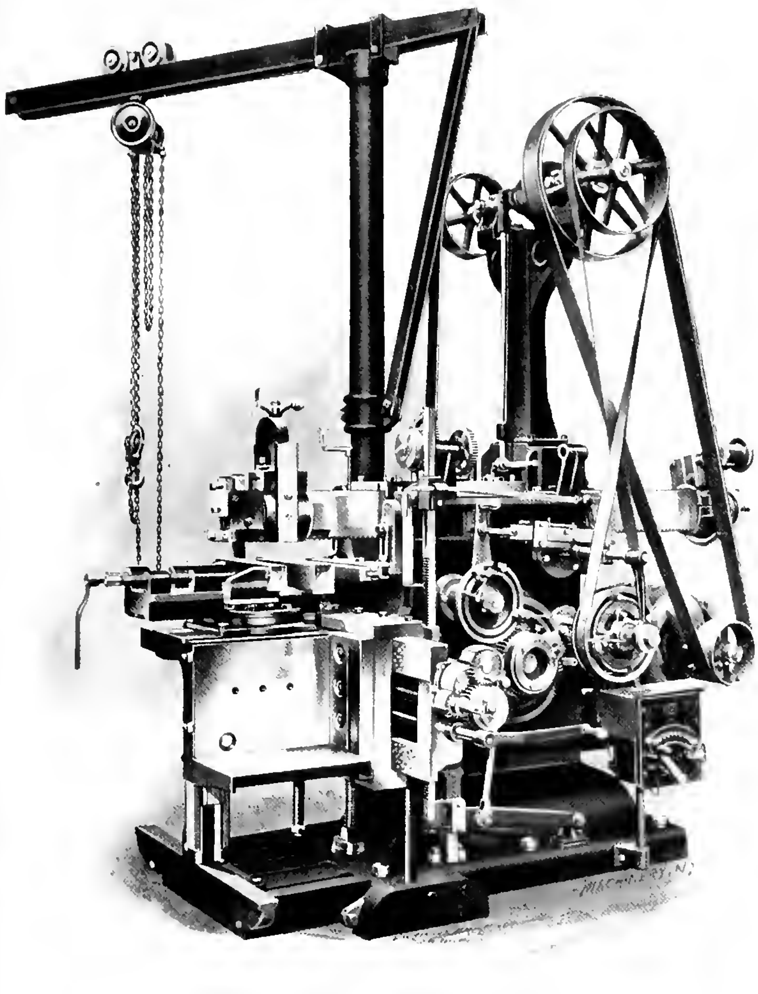


Fig. 1. Morton Special Draw-cut Railroad Shaper

its durability, general efficiency and range of usefulness.

The particular machine illustrated is electrically-driven with a belt transmission which is the form of drive recommended by the makers. As the illustration shows, the motor is mounted on a sliding base at the rear of the column so that the driving belt to the countershaft may be made endless and adjusted for the proper tension. This countershaft has a special friction clutch which may be operated by a conveniently located lever so that the machine may be started or stopped instantly without interfering with the motor. This feature places the machine under complete control of the operator as it enables him to move the ram 1/16 inch at a time, if desired, whenever adjusting or setting the tool. As shown, the drive to the reciprocating clutches is by belts which absorb shocks and tend to protect the motor. The variable speed type of motor with a two or one variation is ordinarily used, but as the cutting speed of this machine is uniform irrespective of the length of the stroke, a constant speed motor may also be used.

The friction clutches, through which, by means of the open and cross belts, the reciprocating motion is given to the ram, are of an entirely new design. The friction surface is made flat, with a revolving disk, which is covered on both sides by vulcanized fiber. The compression is formed by a sliding collar and compression levers provided with set-screws which give ample compensation for wear. The flat disks may be relined at small expense, and being lined with fiber, they never injure the metallic surfaces of the clutches. The reversing mechanism for operating the clutches is also of new design.

The stroke of the ram is adjusted by tappets mounted on a circular disk. Adjustments can be made while the machine is in motion, and the movement of the ram can be reversed by a lever at the will of the operator. The ram has a quick return of $2\frac{1}{2}$ to 1, at a uniform speed.

The friction feed of this machine is of the automatic relieving type, and gives any feed ranging from 1/32 to 5/8 inch, horizontally, and 1/32 to 5/16 inch, vertically. Variations are obtained by moving tappets on a circular disk, which is graduated with suitable index stops.

A power traverse for raising and lowering the cross-rail and moving the apron sideways is supplied. These movements are controlled by a lever which when shifted in different directions moves the apron either to the right or left. As only thirty seconds is required to move the apron the full width of the cross-rail, and forty seconds, for raising or lowering the cross-rail, this feature effects a considerable saving in time when making adjustments.

The ram of this shaper is provided with a rotating arbor, which may be fed automatically in either direction for planing curved surfaces. The rotary-feed motion is transmitted to this arbor from the regular friction, through a gear and ratchet working in conjunction with a vertical bar, connected to a splined shaft, which, in turn, transmits the movement to the arbor. The mechanism is clearly shown in the engraving.

The column of this shaper is of the box type and heavily constructed. All shaft journals, which are mounted in the column, are run in bearings which are fitted in accurately bored holes, thus insuring perfect alignment and rigidity. The knee is of a special design, of the angular bracket

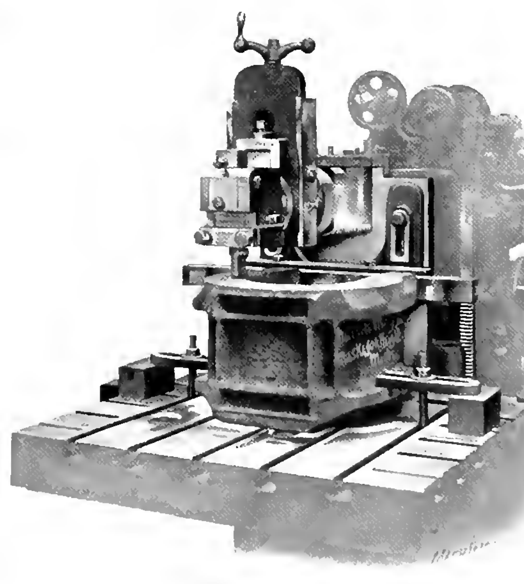


Fig. 2. Planing the Sides of a Driving Box

type that is adjustable vertically on the saddle, so that the distance between the ram and the table may be increased. The table is held in position by a tongue which fits a slot in the knee, and by four bolts, so that it may be quickly removed or placed in position. The vise is of the swivel type and is graduated in degrees. An adjustable back-bearing forms a stop against which work may be placed while being held in the vise or otherwise. This bearing transfers the thrust of the cut directly against the column so that it is not necessary to clamp the part being machined so firmly.

As in previous designs, a crane and hoist is directly attached to the machine, which greatly facilitates the handling of heavy parts. Ordinarily a two-speed hoist of one ton capacity is furnished, that is so arranged that when lifting one-third load, it operates directly and with twice the speed. If desired, the makers are prepared to furnish an air hoist in place of the chain type. This crane will cover a floor space 12 feet in diameter, and the maximum distance from the floor to the hoist is 7 feet.

In order to illustrate the adaptability of this tool to railway work, a number of illustrations showing the machine set up for planing a locomotive driving box and its brass are given. Fig. 2 shows the way the sides of a driving box are planed. As the work is placed against the back-bearing previously referred to, the thrust of the cut is taken directly against the column so that the two small clamps shown are sufficient to hold it in position. For planing the crown brass seat, a double chuck, such

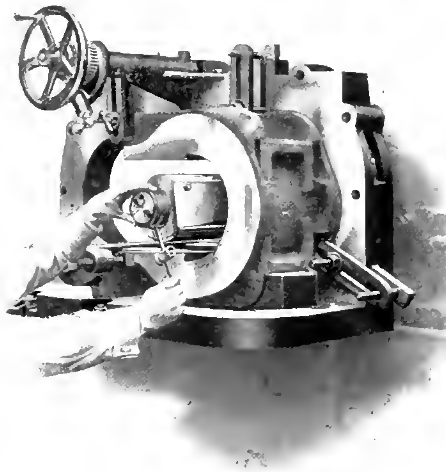


Fig. 3. Gage used in Conjunction with the Ram for Setting Boxes

as is shown in Fig. 3 is used, which has a capacity for two boxes. This chuck is secured to the knee or bracket table of the shaper and it is provided with a back-bearing which transfers the cutting strains to the column. A bracketed bearing is attached at the top which extends forward, thus bringing the operating handwheel in a convenient position. The handwheel is connected to the arbor-rotating mechanism by a universal shaft so that the rotating head may be turned by hand in either direction. Fig. 3 also shows a gage that is used for set-

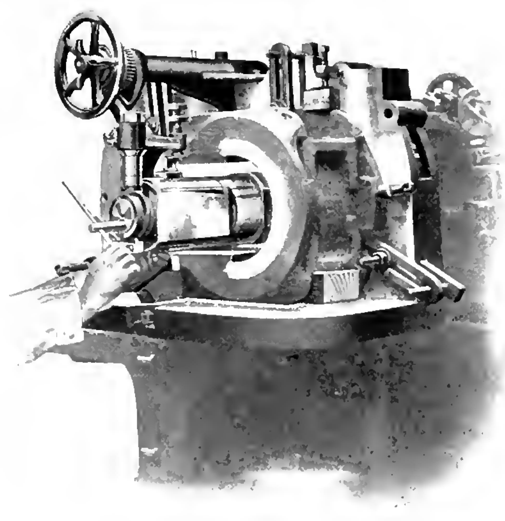


Fig. 4. Setting the Tool by Special Micrometer Gage

ting the box prior to planing. This gage, to which may be attached the scriber of an ordinary surface gage, is accurately fitted to an extension on the rotating head; the extension is also used for holding the micrometer attachment illustrated in Fig. 4, which is used for setting the tool to a given radius. This attachment consists of an arm long enough to meet all requirements, on which there is a scale that enables a sliding bracket to be quickly set to the desired radius. By means of a micrometer screw against which the point of the tool is set, as shown, allowance may be made for the roughing and finishing cuts. After the tool is placed in the proper holder and inserted in its slot from the top, the micrometer

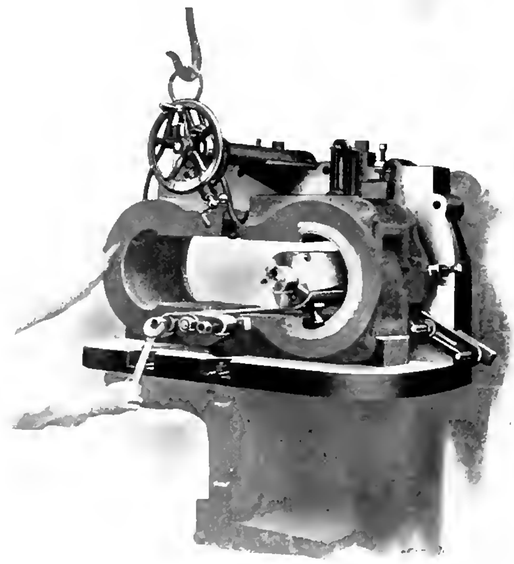


Fig. 5. Placing a Second Box in Position while Planing the First

attachment is placed in position and the tool is raised up to the adjusting screw which has been set inward for the roughing cut. When the tool is being set for a finishing cut, the micrometer screw must be up to the shoulder stop.

The advantage of the double-chuck arrangement is shown in Fig. 5, which illustrates a second box being placed in position while the first is being machined. Obviously the oil cellar fittings may be machined at this same setting of the work if

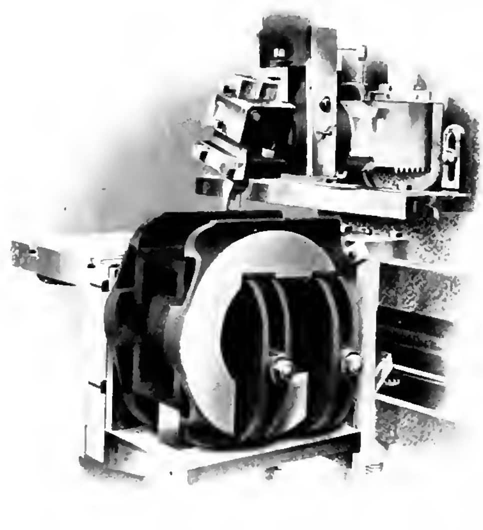


Fig. 6. Method of Holding the Box while Planing Shoe and Wedge Fits

desired. After the crown brass has been forced into the box, it can also be planed for the journal fitting. In Fig. 6, the box is shown in position for planing the shoe or wedge fittings. In cases where single boxes are being finished or when they are being replaned, this machine would undoubtedly handle the work in a very satisfactory manner.

An interesting set of transfer gages for use when fitting the crown brass is shown in Fig. 7. The inner gage, shown applied to the box at the right of the illustration, is so designed that by one or two simple adjustments, the shoes on either side are set to the undercut angles and a central point is brought to bear against the crown so that there are three points for measuring which project beyond the box face. The outer or crescent-shaped gage is next set by these projecting points and then applied to the brass as shown, after the latter is planed on the outside. By means of a scriber, lines are drawn on the end of the brass, thus enabling it to be accurately fitted

to the box. These lines may be quickly and easily set in a vertical position for planing, by means of a special gage.

The attachment for planing the brasses is shown in Fig. 8. This attachment has a tongue fitting a slot in the table so that it is self-aligning. The head is provided with adjusting screws, as shown, which bear against the machine column. The chuck for holding the brass is so constructed that the work may be gripped in any desired position by means of one bolt,

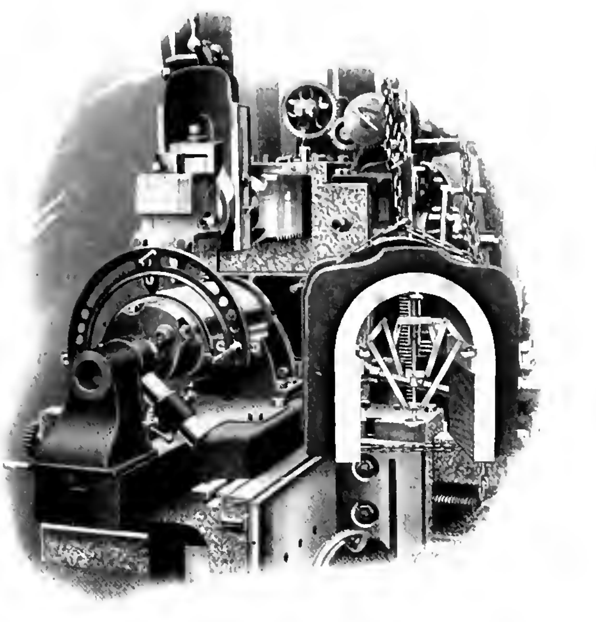


Fig. 7. Inside and Outside Transfer Gages for Crown Brass Work

and as the front head is adjustable, various lengths may be held. The rotary feed is obtained through a worm-gear and flexible shaft which is connected with the regular feed mechanism so that when the ram reciprocates, the chuck is made to revolve intermittently. Fig. 8 also illustrates the use of the micrometer attachment, which is used to scribe a line on the brass at the desired radius. Obviously this line is not broken out by the tool, as the latter begins its cut at this end; this enables the workman to split the line and to produce accurate

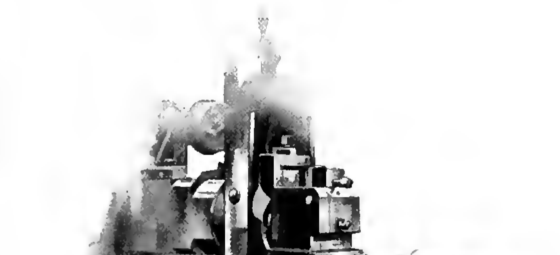


Fig. 8. Use of Micrometer Gage for Sizing Crown Brass

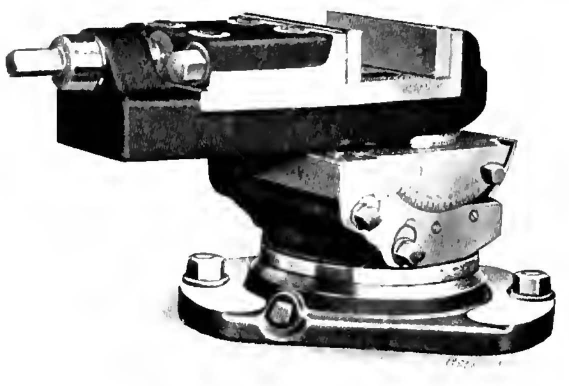
results. The draw-cut also throws the chips away from the operator rather than toward him.

This shaper has a working stroke of 32 inches, a horizontal table feed of 36 inches, and a vertical table feed of 18 inches. The approximate net weight is 10,000 pounds to which 2500 pounds are added when the machine is equipped with a motor drive.

AETNA THREE-WAY VISE

An interesting and useful tool of universal application on the milling machine is illustrated in the accompanying halftone illustration. This device, known as the Aetna three-way vise, is built by the Becker Milling Machine Co., Hyde Park, Mass., and while especially adapted for use with the Becker milling machine, it can be employed, of course, to advantage on milling machines of any type. The vise is provided with adjustments in three planes, so that it can be set practically to any position imaginable within the range of its size. Each of the three adjustments is entirely independent of the others and the respective angles are read in degrees directly from engine-divided dials.

The first adjustment is in a horizontal plane about a vertical axis. This adjustment permits of rotating the work around a full circle, or through 360 degrees. The second movement is at right angles to the plane of the first, and permits of adjustment from the horizontal to the vertical plane through an arc of 90 degrees. The third adjustment, again, is at right angles to the plane of the second, whatever that may be in any one case. The ultimate position of the adjustment of the third swivel which holds the vise proper, depends upon the adjustment of the two previously mentioned. The work can be rotated by this adjustment through an arc of 360 degrees. Although in this manner three joints are introduced from the base to the vise in order to make the device universally adjustable, the tool is so designed as to insure a rigid construction, and is firmly secured to the milling machine table by two bolts. The work to be milled can be clamped in any position



Aetna Three-way Vise for Milling Machines

without disturbing these bolts. The jaws of the vise proper are steel faced.

The capacity of the vise illustrated is as follows: The jaws will open to a maximum width of 3½ inches; the depth of the jaws is 1½ inch, and the width of the vise jaw surface is 5 inches.

WILEY AND RUSSELL THREADING, TAPPING AND CUTTING-OFF MACHINE

A combined bolt cutter, nut tapper, pipe threader, and cutting-off machine, that is especially adapted for railway shops, is shown in Figs. 1 and 2. The headstock of this machine is fitted with a three-step cone pulley and back-gears, through which a special design of work-holding chuck is driven. This chuck has interlocking and interchangeable jaws and is so constructed that it will hold either round or square stock. As the jaws are interchangeable, new ones can be supplied, thus making it unnecessary to secure an entirely new chuck. The spindle is hollow, so that any length of pipe or bolt can be handled. On the carriage, which is operated by means of a rack and pilot wheel, frames for the die-heads are mounted. These frames are connected by a double-threaded shaft so that the dies may be easily opened or closed by means of a handwheel in the front of the machine. Each die-head is accurately fitted in its support and it is held in place by a set-screw that bears against a V-shaped slot, so that the tightening of the screw draws the head against the carrier face. A spring-pin that drops into an opening, prevents the die-heads from turning when the dies are in their proper position. By loosening the set-screw and pulling back the spring-pin, the heads can be

revolved so that any size die within their capacity can be quickly brought into working position. The heads are marked at the top with the size die which is in position for cutting. Each pair of dies has independent stop pins which control its cut. These pins, which are plainly shown in the illustration, can be shortened or lengthened as desired to give the proper diameter of thread. They are made of the very best steel, and are carefully fitted into the circular die-heads. The dies are made in pairs, each of which is properly marked, so that it is a very simple matter to replace them.

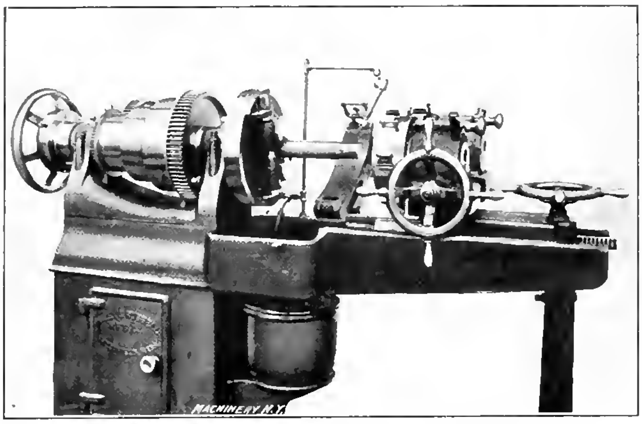


Fig. 1. Combined Bolt Cutter, Nut Tapper, Pipe Threader and Cutting-off Machine

When using this machine for nut tapping, it is only necessary to clamp the tap in the chuck and place the nut in the jaws provided between the carriers that support the die-heads, as shown in Fig. 2. The carriage is then brought up the same as when threading a bolt. It is not necessary to remove the die-heads in order to tap nuts.

A cutting-off attachment, which is plainly shown in Fig. 1, is applied so that it can be swung back out of the way when not in use. This attachment consists of a small carriage with a toolpost and a hand-operated cross-feed. The machine is also provided with a centrifugal oil pump. The lubricant is drained through a screen into a tank below the bed from which it is again pumped to the cutters.

The following figures which relate to the performance of the No. 1 machine, which we illustrate herewith, will serve to

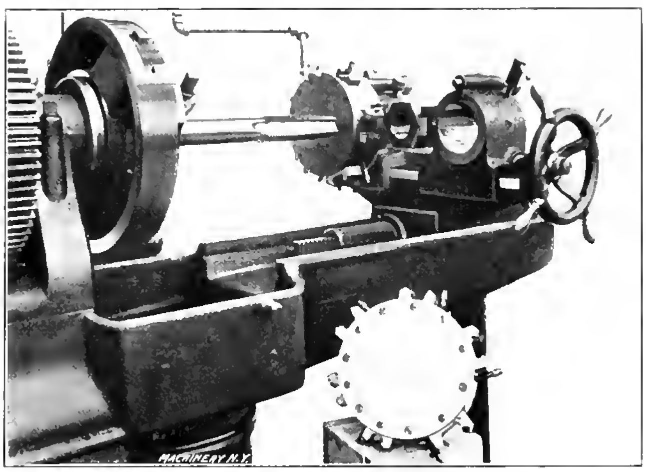


Fig. 2. Machine as used for Nut Tapping

show the possibilities of this type of tool as to output. The threading of ten bolts of the following sizes, $\frac{1}{4}$; 5/16, $\frac{3}{8}$, 7/16, $\frac{1}{2}$, 9/16, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 inch, was accomplished in ten minutes. The same machine also cut a thread $6\frac{1}{2}$ inches long on a 1-inch bolt in one minute from the time the workman picked up the stock until the finished bolt was removed from the machine. Ten one-inch bolts were threaded for a distance of $1\frac{7}{8}$ inch, in six minutes, thirty seconds, and threads were cut on eight steel pipes ranging in size from $\frac{1}{4}$ to 2 inches, in fifteen minutes, a little over a minute being required to replace the bolt-cutting die-heads with those for pipe threading.

For roundhouse work this machine offers many advantages. It is also well adapted to the work of the erecting shop, where it is often necessary to quickly thread bolts or to chase a thread that has been damaged. With three sets of die-heads, the machine is equipped for threading practically all sizes of bolts from $\frac{1}{4}$ to 2 inches, as well as piping between the same dimensions. This machine is rigid in its design and wherever miscellaneous threading is to be done, it will undoubtedly prove very efficient. It is the product of the Wiley & Russell Mfg. Co., Greenfield, Mass.

HAUCK KEROSENE BLOW TORCH

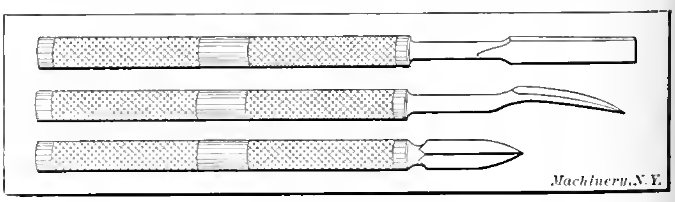
A blow torch in which kerosene is used as a fuel instead of gasoline is shown in the accompanying illustration, being used for brazing cup joints. This torch is said to give better results with kerosene than can be obtained with gasoline. It is adaptable for various heating operations, such as light brazing, tinning, etc. The flame produced is intense and clear, and the construction is such that the tank will remain perfectly cool while the burner is being operated. Only one-pound air pressure is required on the torch, which is obtained by a hand-pump in the usual manner. The flame of this torch will melt a piece of copper $\frac{1}{2}$ by $\frac{1}{4}$ inch, in three minutes and a 1-inch brass rod in two minutes. The particular torch il-

Kerosene Blow Torch being used for Brazing

lustrated has a capacity of $\frac{1}{2}$ gallon, and the consumption per hour is $2\frac{1}{2}$ pints. Larger sizes, however, may be obtained, if desired. The cheapness of kerosene and its comparative safety is, of course, a commendable feature. These torches are simple in design and strongly built to withstand rough usage. They are made by the Hauck Mfg. Co., 140 Cedar Street, New York City.

TOOLMAKERS' SCRAPERS

The scrapers shown in the accompanying engraving are intended for the use of toolmakers or other mechanics who desire something neater and better than a three-cornered or half-round file for scraping. These tools will be found useful in connection with vise work, metal patternmaking, and for similar work. The handles are made of steel tubing and the cutting points of the finest grade of tool steel, which is prop-



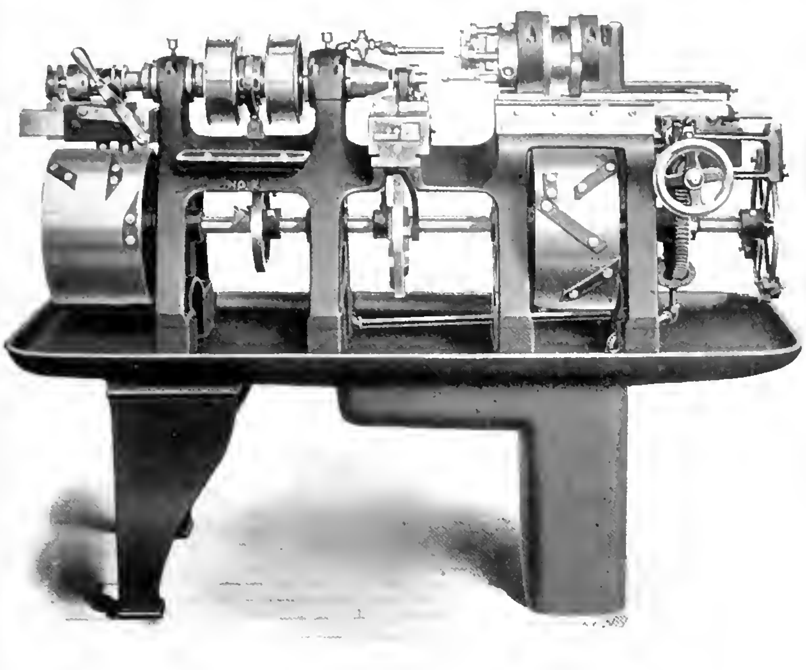
J. E. Poorman Co.'s Scrapers

erly tempered, ground and polished. These scrapers are made in a number of styles, only three of which are shown in the engraving. The upper tool is a small, flat scraper which may be obtained in different widths; the second is of the half-

round, curved type for use in small bearings, etc., while the lower one has a triangular blade which is hollow ground on the sides. These tools are the product of the J. E. Poorman Co., Inc., Bradbury Building, Philadelphia, Pa.

NATIONAL SEWING MACHINE CO.'S AUTOMATIC SCREW MACHINE

The single-spindle automatic screw machine which we illustrate herewith, has been placed on the market by the National Sewing Machine Co., Belvidere, Ill. The distinctive features claimed for the general construction of this machine are: convenience of operation, simplicity in the changing of cams, ease with which adjustments may be made for various classes of work, and low maintenance expense.



National Sewing Machine Co.'s Automatic Screw Machine

The spindle of the machine is driven by a quick-acting friction clutch which is positive and instantaneous in its reverse motion, permitting uniform lengths of thread to be cut when threading. This clutch is operated by a small disk-cam mounted beneath the pulleys on the drum-cam shaft. The stock is fed through the spindle, and the chuck is operated by the drum-cam at the left end of the shaft. Provision is also made for operating the chuck by hand in case this is necessary when setting up the machine.

The turret, it will be noticed, is in a horizontal position, rotation being about a horizontal axis. The location of the locking bolt, which is quick and positive in its action, is such that it engages the turret on a larger radius than that occupied by the tools, which tends to maintain the latter in alignment with the spindle, thus insuring accuracy of the output. The turret is fed to and from the work by a drum-cam.

An accelerated movement for the drum-cam shaft and turret-slide, is obtained through a positive clutch when the tools are not in use, so that they recede from and advance to the work at comparatively high speeds. When the tools are in action, the slower feed then required is obtained through a differential planetary gear system, which reduces the movement between the driving pulley and worm-shaft in the ratio of 18 to 1. The spider disk on the right end of the cam-shaft, controls, by means of dogs on its periphery, the engagement and disengagement of the clutch and consequently the rate of feed. These changes are made instantaneously.

The cross-slide is operated independently to a stop which gives uniform sizes in forming operations. The movement of this slide is controlled by the disk-cam shown beneath it, which engages with the feeding levers shown. These machines are built in two styles, either having a turret or being made plain. The construction of the turret machines is such as to permit the use of taper attachments for turning taper pins and similar work. They are also adapted for thread rolling, knurling, side drilling, slotting and second operation magazine work. The chuck capacity of the No. 2 machine, which is shown in the illustration, is 5/8 inch. The milling length is 3 3/4 inches and the length of feed is 7 1/4 inches. The spindle pulleys are 7 inches in diameter with 1 1/2-inch width of face. The floor space required for this machine is 3 feet by 4 feet 9 inches.

ELECTRIC HOIST FOR MONO-RAIL SYSTEM

An electric hoist, equipped with two hook-blocks that operate together and are driven by the same motor, is illustrated herewith. This type of hoist is undoubtedly superior to the single hook-block hoist for handling a great variety of work, as the two hooks make it possible to carry a lengthy part straight and level and without the swaying incident to the use of a single hook. This feature permits the making of the runway supports narrow and a wide operating space is not required in the storage room or shop. In handling heavy or bulky material, either one or both hooks can be used and either hook has a lifting capacity equal to that of the hoist.

This hoist is furnished with a seat, as shown, or with a cage if desired. When a seat is used, the operator attaches the work, thus making a helper unnecessary. This hoist is very rigidly constructed throughout. The truck wheel frames, which are made of steel castings, are interlocked with the main frame and made to swivel when rounding a curve. By means of handled ropes which hang near the operator's seat, all movements are controlled. The hoist is provided with an automatic load or mechanical brake for lowering, that is entirely enclosed and operates in a bath of oil; there is also an

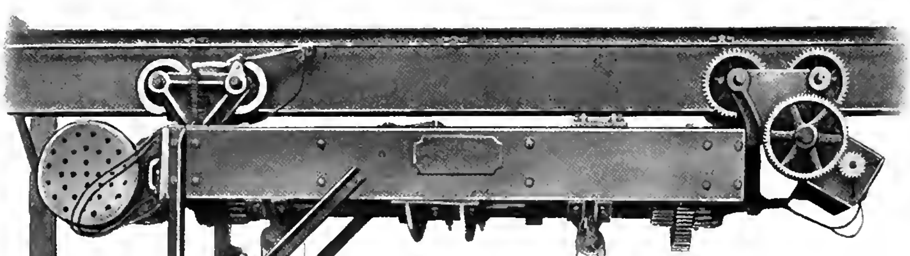


Fig. 1. Electric Hoist with Two Hook-blocks which operate simultaneously

electric brake on the motor. The motor is of the enclosed type, commonly used for crane service. Electric connection to the motor is made by a trolley which is in contact with a conductor attached to one side of the rail as shown. The winding drums have a diameter equal to thirty times that of

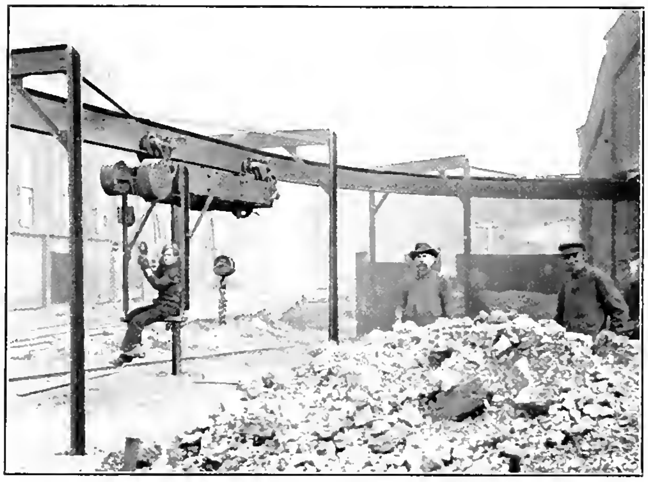
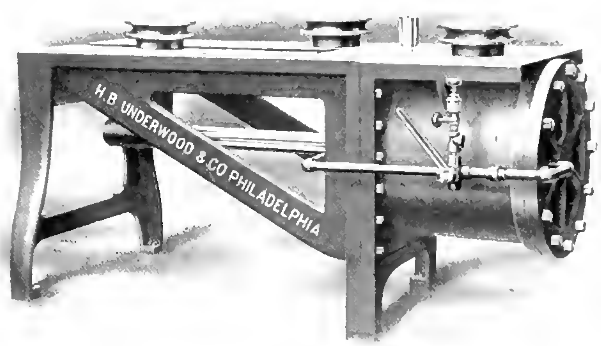


Fig. 2. View showing the Electric Hoist and Runway

the rope. The gearing used is of cast steel and the teeth are all cut. All the bearings are bushed with bronze. These hoists are made by the Johnston & Jennings Co., Cleveland, O., in two-, four-, and six-ton capacities.

UNDERWOOD PIPE BENDER

The pipe bender shown in the accompanying illustration, besides being efficient for the bending of pipes, may also be used as a power bender and bulldozer. This tool has a stroke



Machine for Power Bending built by H B Underwood & Co

of 15 inches, and the control is very flexible. The work-table is rectangular and is provided with numerous holes for the convenient location of dies or pins. As the top of the table is perfectly flat, it offers no obstruction that will in any way interfere with the work. Innumerable shapes can be bent without the necessity of having a large number of dies, by simply changing the position of the resistance studs. The ram, which is beneath the table, slides in a strongly constructed guide and has projecting above the table a stud on which a roller of suitable size may be placed. Either steam or compressed air may be used to operate the machine. For the former a metallic packing is used on the piston rod and for the latter a leather packing. The use of compressed air is recommended, when available, as it offers many advantages over steam. The cylinder is 20 inches in diameter, and the power of the machine is limited only by the pressure applied to the piston. This piston has air on both sides of it at all times, connection from one side to the other being made by the pipe shown, which connects with the operating valve. This valve is so constructed that only the amount of air required for the actual bending escapes. The air is transferred from one side of the piston to the other, depending on the direction of movement desired. Owing to the unequal areas on the two sides of the piston by reason of the space occupied by the piston rods, the piston is given a sensitive control and it may be moved when necessary only a fraction of an inch. The ram may also be held perfectly stationary to allow measuring or the placing of templets on the work. Such nicety of control is, of course, very desirable, and is particularly useful for straightening work. This machine is manufactured by H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa.

WILLIAMSON PORTABLE GRINDER

A self-contained, motor-driven grinder, which is portable and can be used for grinding inserted-tooth face milling cutters on either a horizontal or vertical milling machine without removing the cutter from the spindle, is illustrated herewith. Mr. H. C. Williamson of the H. C. Williamson Engineering Co., Industrial Building, Indianapolis, Ind., has perfected and applied for a patent on this device.

The machine is shown in Fig. 1 in the position in which it would be used for grinding an inserted tooth cutter on a horizontal spindle. The motor, which is specially designed and

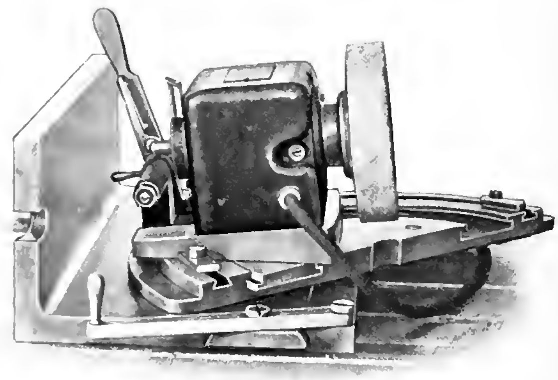


Fig. 1. Williamson Electrically-driven Portable Grinder

may be driven from an electric lighting circuit, is provided with adjustable bearings. It drives a 6-inch cup-wheel and is mounted on a plate having a fixed angle of 5 or 7 degrees, as may be desired, which gives the teeth the proper clearance. This plate is attached to a slide which travels in the circular T-slot of the base shown. The distance of the travel is governed by two stops, which are inserted in an outer dovetailed

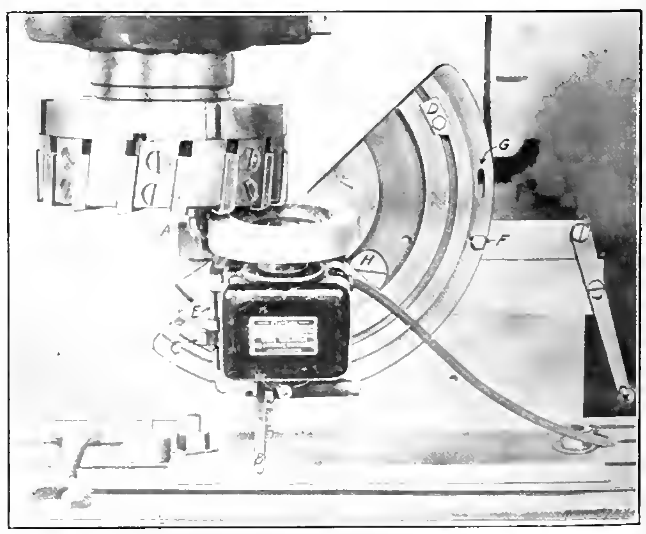


Fig. 2. Wheel in Position for Grinding Ends of Teeth

slot. This circular base is fastened to a slide which can be moved forward or back in the angle plate by the lever shown attached to it. Movements in the opposite directions are obtained by the lever shown pivoted near the back end of the wheel spindle. This lever is used for feeding the wheel up to a tooth for grinding, and its movement is controlled by a positive stop so that each tooth may be ground absolutely the same.

Fig. 2 shows the grinder set up in position for grinding a

10-inch cutter on a vertical milling machine. When the tooth is indexed against finger *A*, the wheel is brought up in contact by lever *B*. By means of the adjusting screw *E*, which comes against a stop, as shown, and controls the movement of the wheel, an equal amount is ground from all the teeth. The stop *C* controls the angular position of the wheel in one direction when grinding the bottom of the cutter. By swinging the motor and wheel around until contact is made with stop *D* (as shown in Fig. 3) the complete cutting edge of the tooth is ground at one sweep. The adjusting screw *E* can be set up so as to give any desired radius for the corners of the

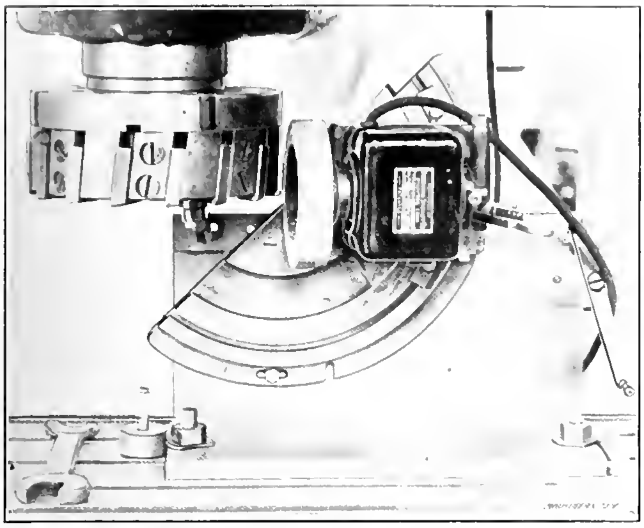


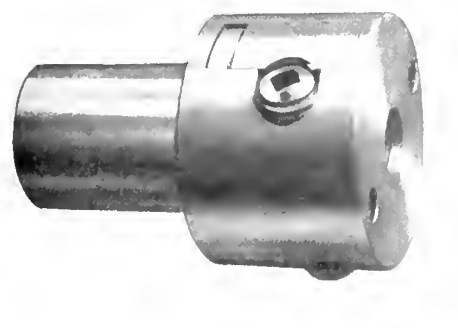
Fig. 3. Wheel swung around for Grinding Sides of Teeth

teeth, from practically a sharp corner to $\frac{1}{2}$ inch radius or larger. The semi-circular base on which the motor and wheel are mounted, swivels on the stud *H* so that its position may be changed for grinding right- or left-hand cutters. This base is secured to the angle-plate by bolts inserted in the slots *F* or *G*, one set being for right-hand and the other for left-hand cutters.

As the illustrations indicate, it is an easy matter for a workman to set up this machine for either horizontal or vertical grinding, and when a cutter is ground while in place, every tooth will run true and do its share of the cutting. This same device can be used in connection with a stand or column so that cutters may be removed and sharpened if desired, and there is no limit to the diameter of the cutter which may be ground.

PRATT TURRET LATHE CHUCK

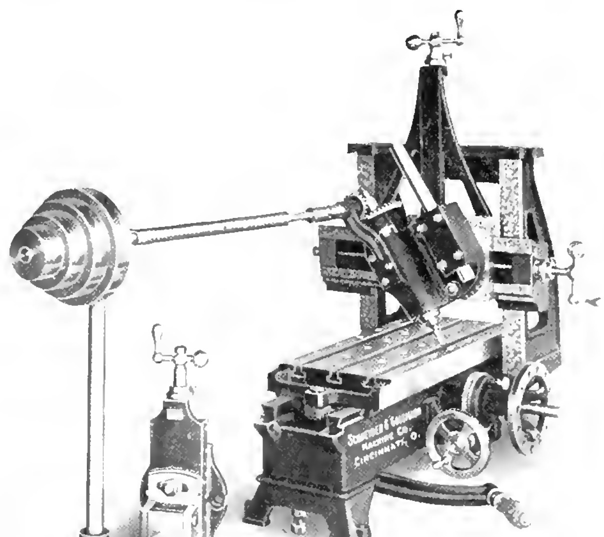
A chuck that has been designed especially for use in turret lathes, turret heads of screw machines, etc., for holding such tools as reamers, drills, outside finishing tools, etc., is now being manufactured by the Pratt Chuck Co., Frankfort, N. Y. This chuck is equipped with the company's patented equalizing driver, which gives a positive rotation to the tool, independently of the chuck jaws. This positive driver is self-adjusting, permitting the jaws to center and align the tool shank accurately in the chuck, so that it is true and at the same time positively held. On finishing cuts, the jaws of the chuck can be partially tightened, thus permitting the tool to float, as the equalizing driver will prevent it from turning and allow it to assume a position in line with the spindle of the machine, thus insuring uniformity of product. These chucks are made in sizes ranging from $2\frac{1}{4}$ to $6\frac{3}{4}$ inches in diameter and with drill capacities from $\frac{1}{2}$ to 2 inches.



Turret Lathe Chuck with Positive Equalizing Driver

SCHNEIDER & GOOSMANN HAND PLANER MILLING ATTACHMENT

The Schneider & Goosmann Machine Co., 20 E. 9th St., Cincinnati, Ohio, has designed a power-driven milling attachment that is intended to be used in conjunction with a small hand bench planer which the company manufactures. This attachment is particularly adapted for handling the numerous small milling jobs that come up in the toolroom and in experimental die, jig and similar work. It is attached to the planer saddle in place of the regular tool-slide, and is driven by a cone pulley mounted on an independent stand fastened to the bench as shown. This cone pulley is connected to the spindle of the attachment by a universally jointed shaft and bevel gears. These gears give a 2 to 1 reduction in order that the spindle will be driven with ample power, though gears with a 1 to 1 ratio can be furnished for high speed or light milling operations. The spindle has a taper bearing, and is provided with compensating collars to take up wear. There is a No. 7 Brown & Sharpe taper hole in the spindle, and a draw-in rod for tightening the cutter arbor. The table feed for milling is through a worm and worm-gearing, allowing micrometer adjustment. Micrometer dials are also provided on the cross and vertical feeds. The worm or feed box can be easily attached to the side of the planer bed with very little fitting. Once attached it can remain there, and may be engaged or disengaged by the in or out movement of a pin which fits in any one of a series of holes in the side of the worm-wheel, thus making it possible to quickly traverse the table in either direction. This milling head is very quickly applied to the planer, and it has a wide range of usefulness in addition to ordinary horizontal and vertical milling operations, as the



Schneider & Goosmann 10-inch Hand Bench Planer with Power-driven Milling Attachment

swiveling head allows the cutter to be set to any angle.

The planer itself, which was described in the department of New Machinery and Tools of December, 1909, has a width of 10 inches between the housings and a maximum distance under the cross-rail of $8\frac{1}{2}$ inches. The table is reciprocated, when the machine is being used for planing, by a small handwheel which is mounted directly on the driving shaft which, in turn, is connected with the table rack by a steel pinion. This handwheel, as the illustration shows, has a series of holes drilled in its rim to receive a pin located in the arm of the driving crank. This feature allows the crank to be used in whatever position is most convenient to the operator.

MODERN 20-INCH DRILL PRESS

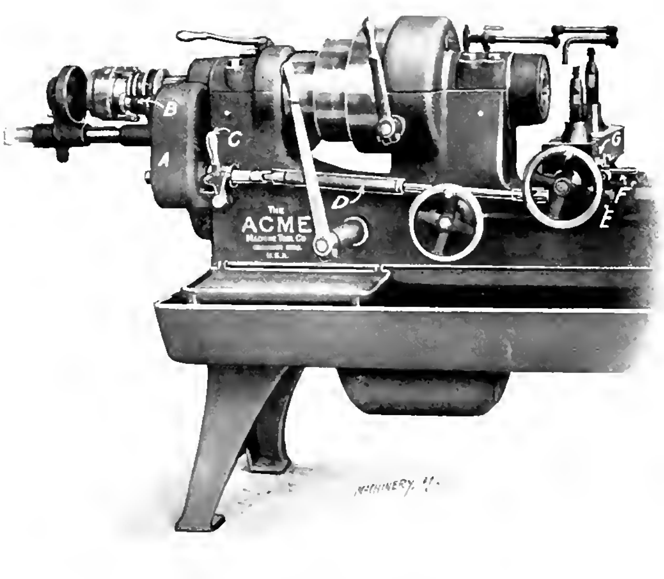
The 20-inch drill press which we illustrate herewith, is built by the Frontier Iron Works, Letchworth and Grant Sts., Buffalo, N. Y., and is designed along the same general lines as the 21-inch machine of the tilting-table type built by this company. The frame of the drill is heavily constructed and the bearings are lined with a special alloy to withstand hard usage

under all conditions. The spindle is of high-grade steel, and it is bored for a No. 3 Morse taper. The teeth of the bevel gears are cut by the generating process, and the gears are practically noiseless in operation. A steel elevating screw is provided for the knee that is operated by a handle connected to it with bevel gears. The machine as illustrated, is equipped with a lever feed and ratchet mechanism which permits the lever to be shifted to the most convenient position. There is also a quick return for the rapid adjustment of the spindle. If desired, a wheel feed can also be furnished at slight additional cost. A treadle form of belt shifter is attached to the base and provides convenient means for starting and stopping the machine. The height of this drill is 62 inches, and the floor space required, 42 by 15 inches. The table has a traverse of 13¾ inches and the spindle, 7½ inches. The diameter of the table is 15¼ inches and the diameter of the column 5 inches. The shipping weight is 650 pounds, to which 100 additional pounds are added when the machine is boxed.

Twenty-inch Drill Press built by the Frontier Iron Works

CROSS-SLIDE POWER FEED OF THE ACME SCREW MACHINE

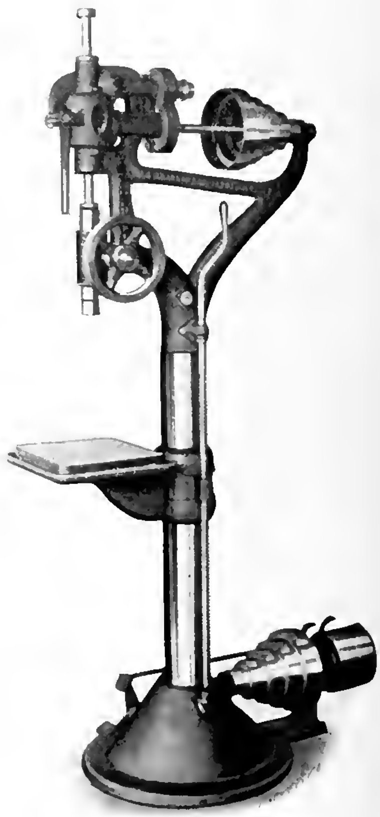
The power feeding mechanism for the cross-slide of the turret lathe or screw machine manufactured by the Acme Machine Tool Co., Cincinnati, Ohio, is illustrated herewith. The feed changing mechanism, which is of the slip key type, is located in the bracket *A*, which is bolted to the end of the head, suitable holes being provided in all machines for this purpose. Three rates of feed may be obtained by the movement of lever *C*, which has attached to it an index showing plainly the rate of feed being used. The motion is transmitted from the feed-change box to the carriage by a universal shaft which drives a worm located in worm-box *E*. This worm engages with a worm-wheel on the cross-slide screw. The feed is thrown in or out by the lever *F* which may be operated by hand or automatically by dogs *G*, the latter being set to trip the feed as required. This power feed is found very useful for facing large castings, forgings, etc., and work of a similar nature, and it is also used in connection with the cutting-off tool. When so ordered, it can be made with a very fine feed, which is suitable for forming operations and similar work.



View showing Power Feed Mechanism for Cross-slide on Acme Screw Machine

BARNES 15-INCH DRILL

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., has brought out a new drill, intended for light and medium work and particularly adapted for tapping operations. The lever, by which the tapping attachment is controlled, is located just in front of the spindle in a position that enables the operator to reverse the tap without releasing his hand from the feeding wheel, thus making the control as convenient as possible. This lever also serves to start and stop the spindle instantly while the machine is in motion, without shock or jar. The reversals are obtained through a clutch, mounted on the spindle between two bevel gears, which revolve in opposite directions. When the clutch is shifted and engaged with the upper of these gears, the reverse movement is obtained. The tapping attachment may be disengaged by the movement of a lever, so that the gearing of the attachment is only running while it is in use, thus reducing the wear. The wheel for the hand-feed is provided with holes in its periphery, so that the operator has a choice between a lever or wheel feed. This machine is equipped with extra long bearings, solid steel forged gearing for both the bevel and spur gears and hardened steel clutches, all of which insure strength and endurance. The particular drill illustrated has a 15-inch swing, but the geared tapping attachment can be furnished on the 22, 22½, 25, 26, 28, 34, 42 and 50-inch drills manufactured by this firm. The height of this machine is 65 inches and the distance from the spindle to the base 47 inches. The spindle has a travel of 7 inches and is bored for a No. 2 Morse taper. The maximum distance from the spindle to the table is 31 inches, and the table has a working surface of 10 by 12 inches. The floor space required for this tool is 20 by 31 inches and the weight is 290 pounds.



Barnes Fifteen-inch Drill with Geared Tapping Attachment

BAIRD DOUBLE OBLIQUE TILTING TUMBLER

In the May number of MACHINERY, in the department of New Machinery and Tools, we illustrated and described a large tilting tumbler which is a product of the Baird Machine Co., Oakville, Conn. This firm has now brought out a new tumbler of the duplex type which we illustrate herewith. This machine, which with others of its class, is used largely for the polishing and grinding of various articles, has been designed particularly for concerns which have considerable work of this kind, and which have heretofore found it necessary to employ

a number of single and independently driven units. This tumbler, as is evident from the illustration, takes up less room than two single machines, and it has the additional advantage of being driven by a single belt. The movements of the barrels, however, are entirely independent, so that one can be emptied and refilled while the other is in motion.

The driving pulley is located between the two barrels, and the drive is direct through bevel pinions, which are mounted on each end of the shaft and which mesh with corresponding gears on the barrels. As the engraving shows, these barrels may be tilted either for dumping the contents, inspecting the work, or to an angle which will give the best results. These angular adjustments may be made while the machine is in motion through a crank and gear mechanism which is easily operated. The tumbler is shown with one barrel in the dumping position and the other in the operating position. These barrels are interchangeable and they can be made of wood, cast iron, steel, sheet or cast brass. The main bearings in which the barrel shafts rotate are fitted with ring oilers affording good lubrication, and bushing bearings which may be removed when worn and replaced by new ones. The end-thrusts of the barrels are taken by adjusting screws and washers, thus relieving the gears of any unnecessary strain. Obviously, cutting down or burnishing compounds, or water

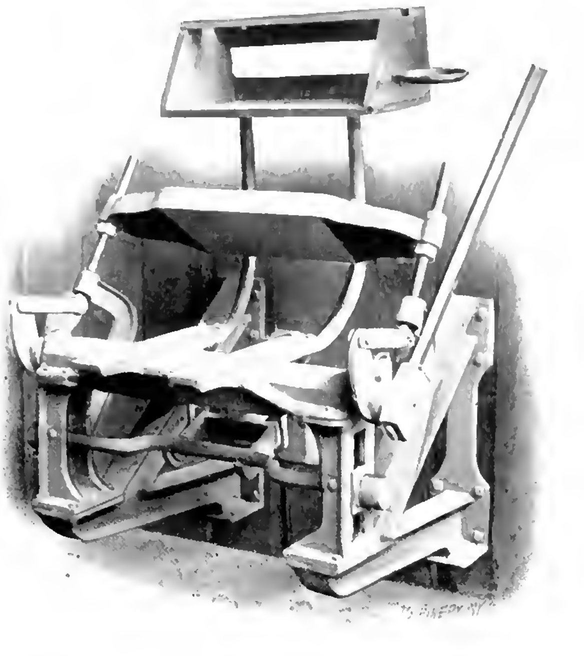
Baird Tilting Tumbler of the Duplex Type

for the purpose of cleaning the work, can be introduced into the tumblers while they are in motion.

These machines are built in two sizes, designated as Numbers 1 and 2. The first machine takes barrels ranging from 16 to 22 inches in diameter at the base, and the No. 2 machine, barrels from 22 to 36 inches in diameter. The smaller size, with 22-inch barrels, occupies a floor space of 45 by 64 inches, while the No. 2 machine with 28-inch barrels, requires a floor space of 66 by 81 inches. The respective weights of the two sizes without the barrels, are approximately 500 and 1000 pounds.

FARWELL SQUEEZER TYPE MOLDING MACHINE WITH WALL BRACKET

In the May number of MACHINERY, in the department of New Machinery and Tools, we illustrated and described some of the new molding machines recently brought out by the Adams Co., 842 White St., Dubuque, Iowa. This company has now added another type of Farwell squeezer to its line, that is designed to be attached to the wall instead of being mounted upon legs. The principal advantage of this type is that it occupies very little space, and where the floors are crowded, makes it possible to put up one or two more rows of molds. This machine would, of course, be unsuitable on long floors where considerable space is covered with molds and where a day's work is poured off at one time. It is adapted, however, for malleable foundries and other foundries in which heats are taken several times a day and where pouring is continuous. When pouring is done once a day, the molds accumulate to such an extent, that the portable type of machine is the most desirable. In fact, the ordinary portable type of squeezer is better adapted to the work of most foundries, for, by moving it several times a day, a great deal of the work of carrying molds and moving the sand is eliminated. When floors are very narrow, the broad-gage type of portable machine which

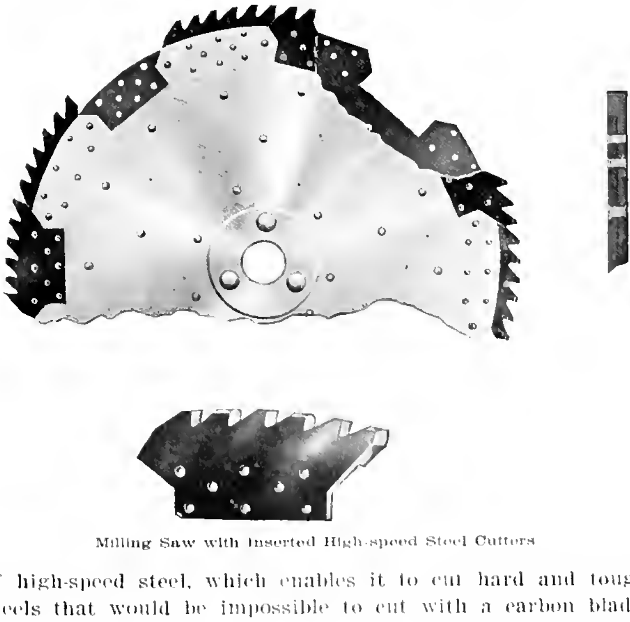


Farwell Squeezer-type Molding Machine with Wall Bracket

straddles the sand heap may be used, but such a machine must be moved quite frequently and necessitates a constant cleaning of the floor so that it is not recommended by the manufacturers where the regular portable machine can be used. The accompanying illustration shows a 30-inch machine, this dimension being the distance between the side rods, but this bracket type of squeezer will also be built in 24-, 34- and 38-inch sizes. The addition of these four sizes of bracket squeezers brings the number of molding machines manufactured by this company up to seventy-two, of various styles and sizes. It should be understood that this new machine is not intended to take the place of the stationary Farwell squeezers, or any of the other types, as it is a special design that is adapted to certain conditions.

HUTHER BROS. INSERTED TOOTH MILLING SAW

The inserted tooth milling saw shown in the accompanying engraving, is equipped with teeth made from the best grade



Milling Saw with Inserted High-speed Steel Cutters

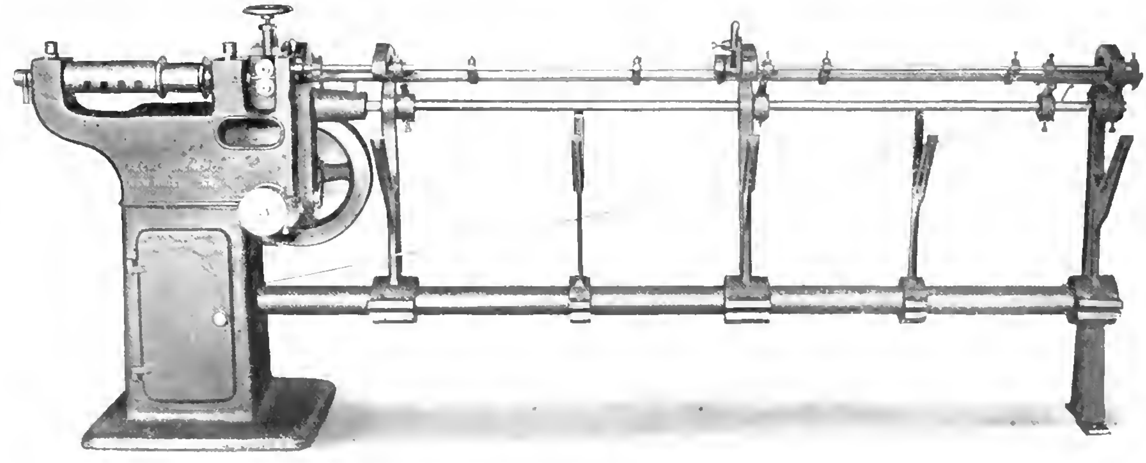
of high-speed steel, which enables it to cut hard and tough steels that would be impossible to cut with a carbon blade. The body of this saw is constructed of two crucible steel plates

which are firmly riveted together as shown. The pockets into which the teeth are inserted are cut into the plates alternately and the teeth are inserted in these pockets and securely riveted to the plates from alternate sides. The location and shape of these pockets is plainly shown in the engraving, the dotted lines indicating these in the back-plate. This method of attaching the teeth permits them to be replaced when worn, and the thickness of the saw is comparatively small which is very important, as a thin blade will cut with less strain and require less power than a thicker one. It is claimed that this saw will not fracture, as the plates are made of the best crucible steel and are given a very tough temper. Saws of this type, 32 inches in diameter and 5/16 inch thick, also 24 inches in diameter and 1/4 inch thick, are being used in steel mills with satisfactory results. This construction insures a tough and rigid blade, and these saws are recommended by the manufacturers to any firm requiring high-speed steel saws, ranging from 20 to 36 inches in diameter.

GREINER AUTOMATIC WIRE STRAIGHTENING AND CUTTING MACHINE

The automatic wire straightening and cutting machine shown in the accompanying engraving, is one of a line of various sizes manufactured by the Charles Greiner Co., New Haven, Conn. The particular machine illustrated, which is one of the smaller sizes built by this company, is capable of cutting wire of 1/8 inch diameter or less, directly from the bundle into lengths up to and including 6 feet. The wire first passes through straightening rolls which are located above the column at the left of the machine. It is then fed by a roller feed past the cutting-off tool which is automatically operated by the engagement of a clutch controlled by a gage that may be adjusted for obtaining various lengths.

The operation of this machine is as follows: A shaft, which is about as long as the machine's capacity for cutting, is attached to the fulcrum of the cutting-off lever and rotates simultaneously with this lever. A guide-bar that is situated above and in front of this shaft is connected both with the shaft and the cutting-off lever. This guide-bar has a groove running its entire length in which is located the adjustable gage, which is connected at its outer end by a wire with a clutch on the camshaft. The wire to be cut is drawn through the rotary straightening device by feed rolls until its end strikes against this gage. The clutch, which operates the cutting-off lever, is then automatically engaged and the wire is severed. At the same time, the rotary action of the shaft throws a cover off the groove in the guide-bar by means of arms on it, and the cut wire drops into forked holders which are mounted on a piece of wrought-iron pipe. This pipe is fastened into the base of the machine at one end and it is supported at the other by a floor stand as shown in the illustration. Some of the holders extend upward and support the shaft, guide-bar and other necessary parts, thus giving strength and rigidity to the cutting-off extension. These machines are made to cut wire to almost any length in the following sizes: 1/16, 1/8, 3/16, 1/4, 3/8, 1/2, 5/8, and 3/4 inch.

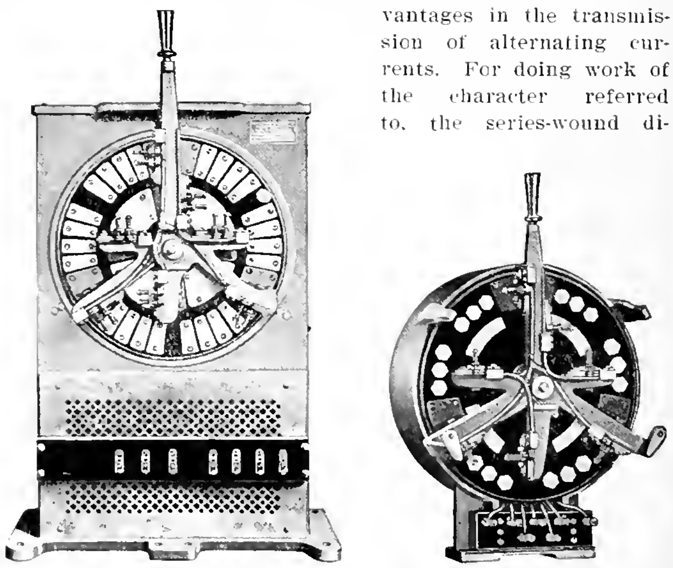


Automatic Wire Straightening and Cutting Machine

Each machine is capable of handling smaller diameters of wire than that indicated as its size, by equipping it with the necessary feeding and cutting-off tools. This line of tools is rigidly constructed and is designed to withstand long and continuous service. They may be used on all kinds and qualities of brass or copper, and also on tinned, black and galvanized iron, or steel wire, and for plated and highly finished wire, with satisfactory results.

ELECTRIC CONTROLLER AND MFG. CO.'S ALTERNATING CURRENT CONTROLLERS

Direct current motors, which formerly were used almost exclusively for operating electrically-driven cranes, mill machinery, etc., have been replaced in many instances, by motors of the alternating current type because of the well-known advantages in the transmission of alternating currents. For doing work of the character referred to, the series-wound direct current motor has the very desirable characteristic of a high starting torque. In alternating current motors, this feature is more often found in the slip-ring type than in the squirrel-cage type; therefore, for the operation of cranes and similar work, the development of the alternating current motor has been toward the slip-ring type.



Controllers for the Slip-ring Type of Alternating Current Motors

The speed and torque control of this motor is obtained by inserting and varying the resistance of the secondary winding by means of controllers. A complete line of manually-operated controllers of this type, ranging in capacity from 1 to 100 horsepower, has been developed by the Electric Controller & Mfg. Co., Cleveland, Ohio. These controllers, two sizes of which are illustrated herewith, follow, as closely as possible, the design and construction of the direct current controllers made by this company, and they may be used in connection with reversing slip-ring motors, operating on either the two- or three-phase system. The resistance is entirely self-contained, and it is necessary to connect only seven leads to the controller. Where heavy currents are to be handled, cast

grids resistance is employed, and unusual precautions have been taken to insure insulation which will be permanent. All the contacts, which are of heavy copper and reversible, are mounted on a vertical slate face so that dust cannot settle between the segments and cause short circuits. The use of screws or bolts with special threads has been avoided, and so far as possible, the wearing parts have been designed so they can be replaced by the user. The operation of these controllers is by a lever motion, which the manufacturers consider advantageous for crane and mill service.

AMERICAN SPEED VARIATOR FOR PLANERS

A planer speed variator of the cone-pulley type, which is now being applied to the planers of the American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, is shown in Figs. 1 and 2. This device gives four speed changes, which are obtained through a pair of opposed four-step cone pulleys that are mounted upon a substantial platform on top of the housings. These pulleys are connected by an endless belt which is shifted from one step to another by a pair of belt forks that are moved alternately along guide rods by means of two cylindrical cams; these cams are revolved alternately by intermittent gears, operated by the handwheel shown at the rear. One revolution of this wheel shifts the belt from one step to another, and a stop pin indicates the complete revolution. The cam rolls have spiral slots milled in their peripheries and the belt forks are moved along the guide rods through the medium of a roller operating in the spiral slots. The relation between

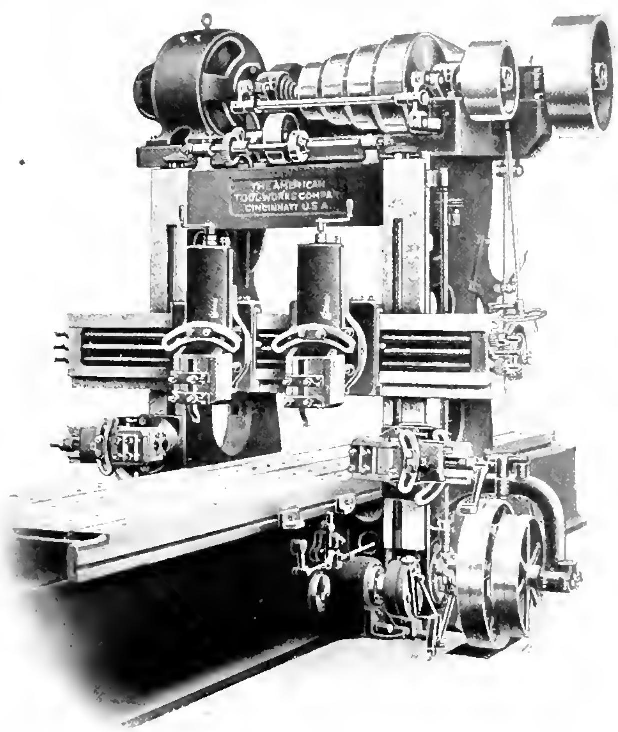


Fig 1. Planer equipped with Speed Variator

the cams and forks is such as to shift the belt off the high step of one cone before placing it on the high step of the opposing cone. The tension of the belt is controlled by the vertical lever shown at the rear, which operates a pair of bell cranks through link connections. These cranks serve to slide the driven cone towards the driver, thus slackening the belt. This feature, together with the mechanical belt-shifting device and the fact that the steps of the pulleys are beveled on the edges so as to offer no resistance to the passage of the belt, permits the making of speed changes rapidly.

After the belt is located for the desired speed, it is tightened by moving the hand lever to a point where the tension is sufficient for the work, after which the lever is securely clamped by a binder handle. As the driven cone is moved toward the driver, which carries the planer driving belts, the tension of the vertical driving belts is not disturbed when making speed changes. The speed changes can be made with this variator without stopping; in fact, it is easier to make the changes while the machine is in motion.

The driving pulleys have flywheel rims, the momentum of which reduces to a minimum all shocks to the driving mechanism due to intermittent cutting and reversing. They also insure a steady, even drive during the cut, and as they are perfectly balanced, the vibration is eliminated even on high speeds.

All the shafts of this variator are of large diameter, accurately ground and run in massive phosphor-bronze journals which are lubricated by the ring or "dynamo" system of oiling. The journals are supplied with liberal oil wells and return ducts, thereby preventing the oil from escaping and coming in

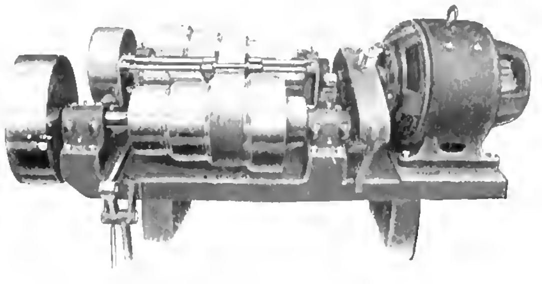


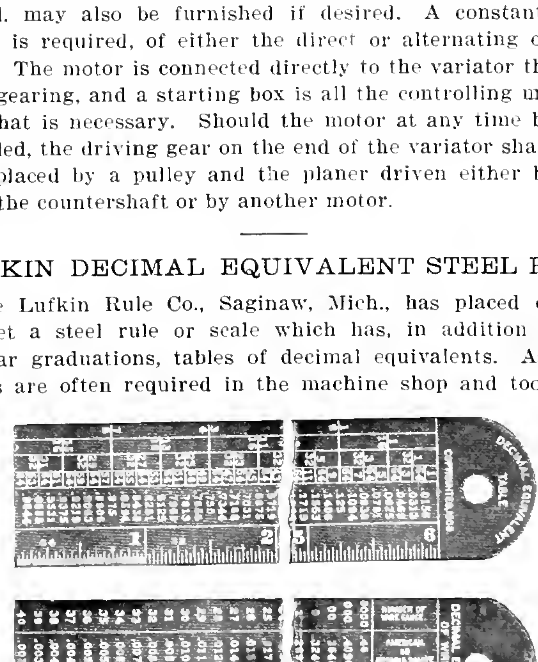
Fig. 2. View of Speed Variator from above

contact with the belts. The bearings are of the ball-and-socket type, thus insuring perfect alignment at all times.

The cutting speeds can be arranged to suit individual requirements, but, as regularly furnished, the variator gives speeds of 20, 30, 40 and 50 feet, with a constant return speed of about 80 feet. A belt drive is regularly furnished with this variator, the tight and loose pulleys being applied to the rear of the countershaft. The drive can be obtained direct from a lineshaft, provided it has sufficient speed, but slow shafts making about 150 revolutions per minute require an intermediate or jackshaft. The construction is such that it is a simple matter to convert the belt drive into a motor drive at any time after the machine is installed. The electric drive, as illustrated, may also be furnished if desired. A constant-speed motor is required, of either the direct or alternating current type. The motor is connected directly to the variator through spur gearing, and a starting box is all the controlling mechanism that is necessary. Should the motor at any time become disabled, the driving gear on the end of the variator shaft may be replaced by a pulley and the planer driven either by belt from the countershaft or by another motor.

LUFKIN DECIMAL EQUIVALENT STEEL RULE

The Lufkin Rule Co., Saginaw, Mich., has placed on the market a steel rule or scale which has, in addition to the regular graduations, tables of decimal equivalents. As such tables are often required in the machine shop and toolroom,



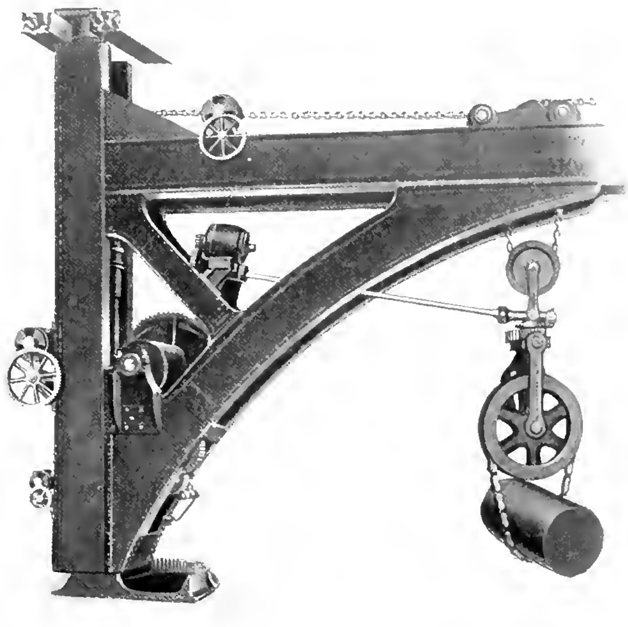
Steel Rule with the Decimal Equivalents of Fractions and Wire Gages

this rule will doubtless be appreciated by machinists and toolmakers. Both sides of the rule are shown in the accompanying illustration. One side has, in addition to a 6-inch scale with one inch graduated in 64ths and the remainder in 32nds, the decimal equivalents of all the fractional parts of an inch

by 64ths. The other side is marked with the decimal equivalents of wire gages and also a 6-inch scale graduated in 16ths. These rules are made of tempered steel and are machine divided. The surfaces are polished, and the figures and graduations are black so that they are distinct and easily read.

JOHNSTON & JENNINGS CRANE BILLET ROTATOR

The Johnston & Jennings Co., of Cleveland, Ohio, has recently designed a device for forge shop cranes, that is used for rotating billets or ingots under the hammer. The rotating mechanism of this device is power-driven, so that its use decreases the number of helpers required on the hammer crew, as it is only necessary to steady the end of the billet by balancing tongs. The drive between the motor and rotating mechanism is so arranged that it does not prevent obtaining any movement that is available with the ordinary crane, it being possible to operate the hook-block and sling chain close to the hammer or in any position on the boom. The billet and sling chain can be swiveled entirely around, as all joints in the hook-block are universal. A sprocket wheel is used for the sling chain so as to obtain a positive drive. By removing a



Crane equipped with Electrically-driven Billet Rotating Mechanism

small pin, the chain wheel can be disconnected and used without power when desired. The mechanism is very rigid and compact and is heavily designed to absorb the shocks without damage. The motor does not receive any shocks due to hammering, nor can it be injured by the billet being fast or refusing to rotate. All parts are made of either steel castings or steel forgings, and the gears are provided with cut teeth. All the bearings are bushed with bronze bushings which are self-lubricating. The lubricant is such as to withstand the heat of the billet without burning. This mechanism can be operated by the crane-man at the base of the crane, or, if desired, the crane and rotator controllers can be located near the hammer-man's position. The particular crane illustrated, which has a capacity of 25 tons, is equipped with an electric drive, but steam may be used if desired. This rotating mechanism is made for cranes of any capacity, and for either the jib or traveling type. It is effective for handling eccentric shafts, such as crankshafts, etc., as well as for round forgings, and its use would undoubtedly result in a greater output because of the increased speed of rotating and handling the work. This device enables the heaviest billets to be turned through a complete revolution in from 2 to 5 seconds.

CORRECTION

The weight of the Gardner Machine Co.'s pattern-shop disk grinder, a description of which appeared in the May number of MACHINERY, was erroneously given as 12,000 pounds. The correct weight of this grinder, complete with countershaft, is about 1200 pounds.

NEW MACHINERY AND TOOLS NOTES

Lathe Tool-holder: Lowe Tool & Machine Co., Ansonia, Conn. This is a holder of the inserted-blade type with which seven high-speed steel cutters ground to shape are furnished. These cutters are so held in the holder that they may be clamped in any one of four positions, thus adapting them to various purposes. They are made from stock sizes and may readily be obtained in the bar.

Thread Snap Gage: K. L. Herrmann, Detroit, Mich. This device consists of two hardened and lapped jaws provided with threads fastened to a C-frame. It is intended for the rapid inspection of threaded work, especially for work of large diameter and a great number of threads per inch, such as is commonly found in automobile work. The gage indicates inaccuracy in pitch, diameter and angle of thread.

"Star" Grinding Wheel Dresser: C. H. Stephan Specialty Co., Dayton, O. This tool, for truing grinding wheels, consists of a tapered tube which is filled with an abrasive. The abrasive instead of being baked in position is first made as a vitrified stick, which is afterward united to the taper tube by a metallic substance which holds it firmly. A wooden handle is inserted in the end of the tube and the dresser is used in the usual manner.

Toolmaker's Pin Vise: A. S. Koch & Sons, 143 Nevin St., Lancaster, Pa. This device is so arranged that it can be opened by one hand, while the other hand holds the work in place between the jaws. The handle consists of a sliding sleeve with a tapered end which engages the back ends of one jaw and clamps the jaw lightly against the work. A short lever which actuates an eccentric is then operated and the jaws closed firmly on the work.

Micrometer Plug Gage: Nash Engineering Co., 248 Gates Ave., Brooklyn, N. Y. This tool is intended for measuring small holes or slots with great precision. The barrel is graduated to read by thousandths and by means of subdivisions to ten-thousandths of an inch or less. This tool is nearly as rigid as a solid plug and has the advantage that intermediate sizes can be measured with accuracy, each instrument having a range of about 1/32 inch above and below its nominal size.

Hinge-joint Belt Fastener: Webb Hinge Belt Hook Co., Boonton, N. J. These fasteners are of the hinge-joint type and consist of a series of wire hooks which are inserted in the belt from both sides and clinched. The hinged connection is made by inserting a pin through eyelets or turns in the hooks which come between the belt ends. Made-up fasteners are furnished in sizes from 1 to 4 inches in width and for any thickness of belt. For wide belts a number of sets may be used.

Drill Socket: Sager Drill Socket Co., West Albany, N. Y. This drill socket is designed for holding shanks with broken tangs by the tapered part of the shank without the necessity of cutting a keyway or a flat, or using any other driving means. The socket is split and a taper sleeve screws onto the lower end of the socket. By means of this sleeve the drill shank can be firmly tightened or clamped in place. The sockets are made in several sizes for drills from ¼ to 3 inches diameter.

Measuring Device: C. J. Root Co., Bristol, Conn. This device has been designed for measuring the linear lengths of various materials during the process of manufacture. A measuring wheel mounted in a bracket rests upon the material to be measured, while a flexible shaft extends from the wheel to the counting register. The device is applied to machines through which the material passes while in the manufacturing processes. Wheels for measuring units of 12, 20 and 36 inches are furnished.

Swaging Machine: Coulter & McKenzie Machine Co., Bridgeport, Conn. This machine embodies certain improvements recently patented by Andrew Berg and is especially intended for making file tangs. The operation of forming file tangs can be accomplished in about four seconds. All the operator has to do is to place the heated stock between the dies, close the chuck mechanism and press a foot treadle. After the swaging of one tang, the swaging dies automatically open to receive another blank.

Variety Saw for Pattern Shop: B. M. Root Co., York, Pa. The countershaft by which this saw is driven, is mounted at the rear on an extension of the base. An endless belt may be used for transmitting motion to the saw arbor, as the latter with the table is adjustable horizontally. Instead of vertical adjustment for the table, the saw itself is raised or lowered by a handwheel conveniently located. The table tilts to an angle a little greater than 45 degrees and is provided with suitable graduations. This machine can be fitted with a foot-operated boring attachment if desired.

Double Back-geared Lathe: Prentice Bros. Co., Worcester, Mass. The quick-change gear mechanism of this lathe gives 36 changes of lead for screw cutting from 1 to 16 threads per inch. The lead-screw, which is large and of coarse pitch, is rotated when screw cutting only. The spindle of this machine has a $2\frac{1}{2}$-inch hole through it and runs in bearings of hard bronze. The tailstock is of the offset type, permitting the compound rest to be set parallel with the bed. The feed

is automatically thrown out at any point by a stop which disengages a clutch on the feed rod. A taper attachment can be furnished, if desired, at extra cost.

Worm-gear Hobbing Attachment: Garvin Machine Co., Spring and Varick Sts., New York City. This attachment, which may be placed on the maker's milling machine tables, will permit of the cutting of two worm-gears at a time. While two gears are being cut, two previously finished gears can be taken off and new gear blanks put in place, the device having provision for the simultaneous holding of four gears. When the worm-gears are being cut, they are positively rotated; they are driven from the spindle of the machine by worm gearing to a positive clutch. The hobs are driven from the spindle by being held in an ordinary collet chuck.

Gearless Reversing Countershaft: Carl M. Wheaton, 9 Calendar St., Providence, R. I. This is a countershaft of the reversible type that is driven by a single belt and is without gears. The reverse movement is obtained by a short endless rope belt which, by passing over idlers, connects the belt pulley with the one giving the reverse motion. The desired direction of rotation is obtained by means of a clutch which connects the shaft direct to the belt pulley or indirectly through the rope drive. All parts are self-oiling and the same general constructional features employed for the regular two-pulley countershafts manufactured by the builder, are retained.

Relieving Attachment: Lodge & Shipley Machine Tool Co., Cincinnati, O. This attachment, which may be applied to this company's patent head lathe, can be used for relieving either straight or taper work, having any number of flutes ranging from 3 to 16 inclusive. A special relieving rest is furnished, which is reciprocated by a single-throw cam that is actuated from the headstock by longitudinal and cross-shafts connected by bevel gears. Multiple cams are not required as the indexing to relieve different numbers of flutes is accomplished by change gears. Three cams are furnished to give variations in the depth of relief of 1/32, 1/16 or 1/8 inch. Cams giving other throws may, of course, be easily made by the purchaser if desired.

Friction-driven Sensitive Drill Press: Barry & Zecher Co., Lancaster, Pa. This machine may be driven direct from the countershaft, as the necessary speed variations are obtained through a friction disk drive. By means of a treadle at the base, the drill is started or stopped by disengaging the friction disk, while a second treadle controls the position of the driver on the friction disk and consequently the speed of the spindle. Speed changes can be made while the machine is in motion and the available speed variations for the spindle range from 250 to 1800 revolutions per minute. The drill has a capacity for holes up to 9/16 inch in diameter. The maximum distance from the spindle to the table is 36 inches, and from the center of the spindle to the column, 13 inches.

Drawing and Broaching Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This is a press for drawing tubes in brass, gold, silver, platinum and copper, or for redrawing and broaching cups and tubes of heavy metal. The machine is designed to give a uniform pressure on the work and to draw stock evenly. It has a maximum stroke of 24 inches which may be varied to suit the work being done. The speed of the press may also be varied either by means of the lineshaft or through change gears located on top. By the use of roller thrust bearings which take the thrust of the screw and ram on both the upward and downward strokes, a considerable saving in the power required to operate the machine is said to be effected. The floor space required for this press is 3 feet, 2 inches by 7 feet, 6 inches and the extreme height is 9 feet.

Vertical Boring and Turning Mill: Betts Machine Co., Wilmington, Del. This company has brought out a new line of vertical boring mills, ranging in size from 5- to 20-foot swing. Both the vertical and horizontal movements of the heads of these machines are controlled by levers located on the heads so that the latter may be started or stopped without the operator's leaving them. The feeds may also be controlled from the heads or, if more convenient, from either side of the machine. These machines can be arranged to be driven either by motor or by belt. The cross-rail is raised and lowered and the heads rapidly traversed by a constant-speed motor mounted on the distance piece between the uprights. Each tool is independently counterbalanced by weights which do not need to be changed for any position of the cross-rail or head. On the 7-foot mill, eight feeds are provided ranging from 0.023 inch to 1 inch per revolution, which are obtained through positive clutches. All sliding surfaces are of rectangular section, the bearings are bushed with bronze, and no gears are used having less than 11 teeth.

Steam and Air Flow Meter: General Electric Co., Schenectady, N. Y. This company has developed a recording steam flow meter, two types of indicating steam flow meters, and an indicating air flow meter, each of which will accurately measure the rate of flow of steam, air or other gases under any conditions of pressure and temperature met in commercial practice. The principle governing the action is a modification of that of the Pitot tube. A brass nozzle is screwed into the pipe at the point where measurements are to be taken, having two sets of openings so arranged in relation to the direction of flow that the impingement of steam against one set results in a pressure equal to the static pressure plus the pressure due to the velocity head, while the second set is acted on by the static pressure less that due to the velocity. The difference in these values is a measure of velocity, and for constant temperature and pressure, gives the rate of flow. The pressures existing in the two sets of openings are transmitted through separate longitudinal tubes, to the outer end of the plug and from there by pipes to the meter.

Heavy-Duty Radial Drill: Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. In the design of this drill, particular attention has been given to the matter of strength and convenience of operation. The arm is rigidly constructed with cross-ribs and a large strut to prevent deflection, and it is carried on the saddle by ball thrust and roller bearings. The saddle has a vertical power traverse and a long bearing on the column. The drive is from a variable speed motor by belt to a shaft at the top of the column. Speed variations, with and without the back-gears, are obtained through a drum type controller, which is mounted on the column. When particularly slow speeds are required, they may be obtained through special gearing. Positive tooth clutches are provided in the head for reversing the drive and for engaging the back-gears, which are operated by levers located on the head. Six changes of feed are provided, ranging from 0.0051 to 0.04 inch per revolution. The spindle-reversing clutch on the horizontal shaft permits tapping without the use of an extra attachment. These drills are made in two sizes having 5- and 6-foot arms. A 20-horsepower motor is supplied with each machine, and the respective weights are 17,000 and 18,000 pounds.

Sprue Press: Standard Machinery Co., 7 Beverly St., Providence, R. I. This is a press that has been designed to meet the needs of brass founders and other manufacturers for a machine to cut the sprues or gates from soft metal castings. It is a modification of the company's style D power press. Both a treadle and hand lever are furnished for controlling the clutch mechanism, so that when necessary the operator can have both hands free to hold and guide the work, the machine stopping automatically at the upward end of the stroke. The cutters are made of open-hearth tool steel, and are two inches square in section, so that they may be made from plain bar stock. Provision is made for adjusting these cutters so that they may be accurately set to just cut off a gate without touching each other, thus preserving the cutting edges. When it is found more convenient to present the work from the side of the machine, the cutters may be turned at right angles to the normal position. The patented instantaneous clutch with which this press is fitted is so designed that the machine can be run continuously or stopped instantaneously after each revolution. This clutch, which is of the Horton type, illustrated in an article on "Clutches for Power Presses," in the November, 1908, number of MACHINERY, operates so quickly that there is less than 1/32 inch travel on the periphery of the flywheel, after the clutch mechanism is engaged or disengaged, thus insuring efficient operation.

Turn-table Lathe: Pratt & Whitney Co., Hartford, Conn. The tool-carrying cross-slide of this machine is provided with a plain rotary table of hexagon shape onto which the tools are clamped. The machine derives its name from this rotary table. It is intended for the machining of bar stock, castings and forgings, and it has a capacity for bar stock up to $2\frac{1}{2}$ inches diameter and turns a maximum length of 26 inches. The swing over the bed is 20 inches and the swing over the forming slide is 11 inches. The machine is provided with a geared head and single-pulley drive, the gearing in the head giving eight speed changes for the spindle, the speed ranging from 10 to 251 revolutions per minute. An automatic chuck and rod feed mechanism of the same design as that provided on the Pratt & Whitney open turret lathe described in MACHINERY July, 1907, is also applied to this machine. A feed gear box is placed beneath the head in front of the machine. This gear box provides for six feed changes. The stops for the cross-slide are arranged in a similar manner as on the maker's regular turret lathes, six regular and three supplementary stops being provided. Power and hand feed are provided for the cross-slide in both directions. The turn-table or top of the cross-slide is indexed either automatically when the carriage is run back or directly by hand. The machine can be either belt- or motor-driven, the motor being $7\frac{1}{2}$ horsepower.

Universal Triple-Geared Radial Drill: American Tool Works Co., 300-350 Culvert St., Cincinnati, O. This is a powerful triple-geared radial drill of the universal type, designed to meet the demand for a tool having a wide range of usefulness and at the same time the required power, rigidity and durability to withstand the heavy duty imposed by the use of high-speed steels. One of the striking features is the design of the arm, which has been made exceptionally rigid to resist the combined strains of torsion and deflection. This arm is made in the form of upper and lower tube sections which are bound together in the back by a double wall of metal and further reinforced by heavy transverse ribbing. By means of a worm-

wheel, which engages with teeth cut in the flange of the arm, the latter may be rotated in a complete circle. This movement in connection with the angular adjustment of the head makes it possible to drill and tap to any angle radiating from the center of a sphere. The head of this machine is very compact in its design and is equipped with powerful steel triple gears. The spindle is provided with 24 speed changes ranging from 19 to 314 revolutions per minute in geometrical progression. The tapping mechanism is interposed between the triple gears and the speed box, being mounted in the column end of the arm. By placing the tapping mechanism in this position, it receives the benefit of the triple gear ratio, thus making possible unusually heavy tapping without undue strains and at the same time permits the backing out of taps at an accelerated speed. The lever for operating it is placed on the front of the saddle and controls the starting, stopping and reversing of the spindle. The speed box is of the cone-and-tumbler type and provides eight changes of speed, any one of which is instantly available by shifting the tumbler gear lever to the proper position. By means of an auxiliary train of gearing placed between the pulley and cone shafts, the cone gears are automatically rotated when speed changes are being made, so that undue shocks to the gears are avoided. The driving mechanism is further protected by a flexible coupling or cushion interposed in the line of drive for the purpose of absorbing shocks.

* * *

NATIONAL ASSOCIATION OF MANUFACTURERS' CONVENTION

The fifteenth annual meeting of the National Association of Manufacturers was held in New York, May 16, 17, and 18, the Waldorf-Astoria being the headquarters. The registered attendance, including members and visitors, was 321. The proceedings of this association are largely of a semi-political character, questions of governmental policy, foreign relations, the tariff, patents, immigration, internal commerce, waterways, merchant marine, conservation of resources, etc., being subjects of committee reports. Industrial accidents, means of prevention, and liability insurance, which are of direct and vital importance to every manufacturer, were very practical matters that received attention, however. The program included the following, bearing on them:

An illustrated lecture by Prof. Frederick R. Hutton, "The Prevention of Industrial Accidents";

Address by Henry L. Rosenfeld, "Cooperation and Compensation vs. Compulsion and Compromise in Employers' Liability";

Address by Miles M. Dawson, "True Economy in Compensation for Industrial Accidents," etc.

The report of the committee on industrial indemnity insurance comprising insurance against accidents, sickness and old age; home acquirements, safety appliances and prevention of accidents, etc., probably is one of the most thoroughgoing documents on the subject ever presented. It is authoritative, and represents a large amount of labor in the collecting of the information from manufacturers, government statistics, reports, and other sources. The workings of the present liability insurance system were denounced, and an employers' mutual indemnity insurance system, providing for accidents, sickness and old age was recommended. Liability insurance is a wasteful system of protecting the manufacturer. The defense of damage suits clogs the courts; it is said that from one-third to one-half the time of the state and federal courts is taken up with accident damage suits, and that less than 30 per cent of the premiums paid by employers reach the injured or the dependents of the killed. The report recommended that annual prizes of $10,000 be offered for the safest plants and the best means of accident prevention.

Honor was paid to the late James W. Van Cleave, former president of the association, by a memorial service at 4 o'clock May 17, when the funeral was being held in St. Louis. Glowing tributes were paid to his courage and aggressive qualities.

John Kirby, Jr., president, and F. H. Stillman, treasurer, were both re-elected.

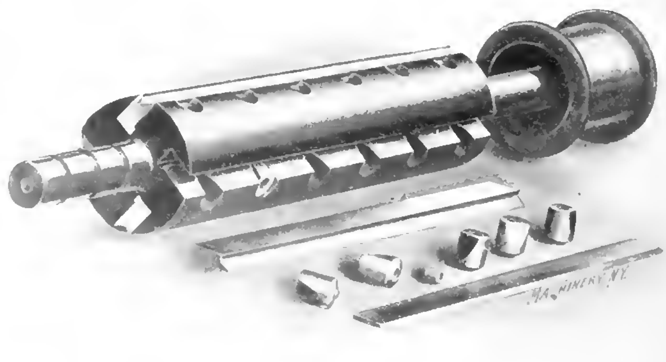
Nearly 400 attended the banquet at the Waldorf-Astoria Wednesday evening at which Speaker Joseph G. Cannon, of the House of Representatives, was the principal speaker.

* * *

Flaming arc lamps are used for interior lighting with great success by the H. H. Franklin Mfg. Company, Syracuse, N. Y.

SAFETY HEAD FOR WOODWORKING MACHINE

A simple method of safeguarding workmen from the knives or cutters of a jointer, has been developed by the Crescent Machine Co., Leetonia, Ohio. This company has applied to machines of this type, a cylindrical cutter head, such as is shown in the accompanying illustration, which, by reason of its shape, is much safer than the square type commonly used. In case the hand gets in contact with the knives of this new safety head, as it has been appropriately called, a flesh wound



Cylindrical Cutter Head for Jointer, designed to minimize Injuries

would be about the limit of the injury, whereas with the square type of head, there is great danger of the hand being drawn in, resulting in the loss of fingers or in a more serious injury. The reason for the comparative safety of this new head is plainly indicated by the illustration. In conjunction with this head, there is also used a protective shield or guard, which is intended to cover the unused portion of the cutters. The safety head affords protection, however, even though the workman neglects to use the guard, as it minimizes the extent of the injury.

* * *

BORING AND MILLING OPERATIONS ON ALUMINUM CRANK-CASE

An interesting machining operation that is performed on the crank-case of the "Cino" motor in the shops of Haberer & Co., Cincinnati, Ohio, is illustrated herewith. The casting is of aluminum and all the operations of boring and milling are done on the horizontal machine shown. The first operation is that of milling the top face. The piece is then put in a jig where all the holes are drilled, after which it is returned to the horizontal boring machine where the crank-shaft holes and

Milling Aluminum Crank-case on Horizontal Boring and Milling Machine

cam-shaft holes are bored by means of a double boring-bar. The next operation is that of facing the ends of the crank-shaft holes, which is accomplished in the manner illustrated. Six straddle mills are mounted on a bar with adjustable spacing collars between them. Each mill takes a cut ¼ inch wide, with a feed of 0.0155 inch per revolution of the spindle, on each of the six faces at the same time. The spindle runs at 30 revolutions per minute, which gives a peripheral speed to the cutters of about 85 feet per minute. This particular operation on the crank-case takes only fifteen minutes, which includes the time of setting up and taking down. The machine on which this work is dene is built by The Fosdick Machine Tool Co., Cincinnati, Ohio.

HERRICK BALANCED ROTARY ENGINE

A new type of rotary engine that promises to be of commercial value in connection with marine work, if not in other fields, was formally exhibited at the Waldorf Astoria, Saturday evening, May 21, before a large gathering of engineers. This new engine, which is the invention of Mr. Gerardus P. Herrick, differs from the countless designs which have preceded it, principally in an ingenious method employed for counterbalancing the radial load on the bearings, which in other rotaries has resulted in serious loss of power through

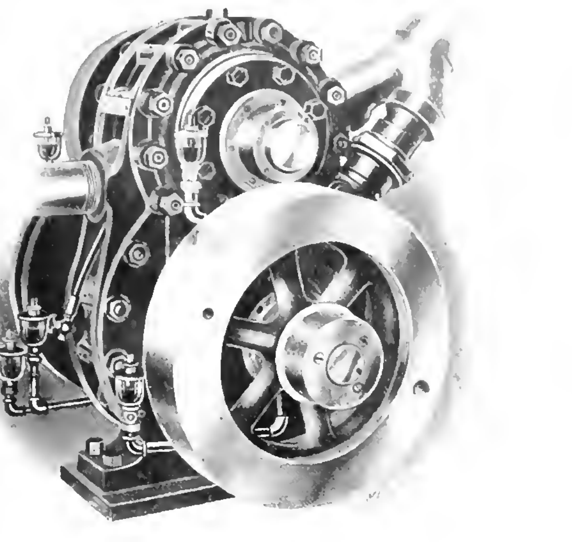


Fig. 1. The Herrick Rotary Engine

excessive friction. The way in which this counterbalancing effect is obtained, as well as the operation of the engine itself, will be explained in connection with the accompanying illustrations, Figs. 1 and 2, which show, respectively, general and sectional views of the experimental motor.

This engine has two rotating cylindrical members A and B,

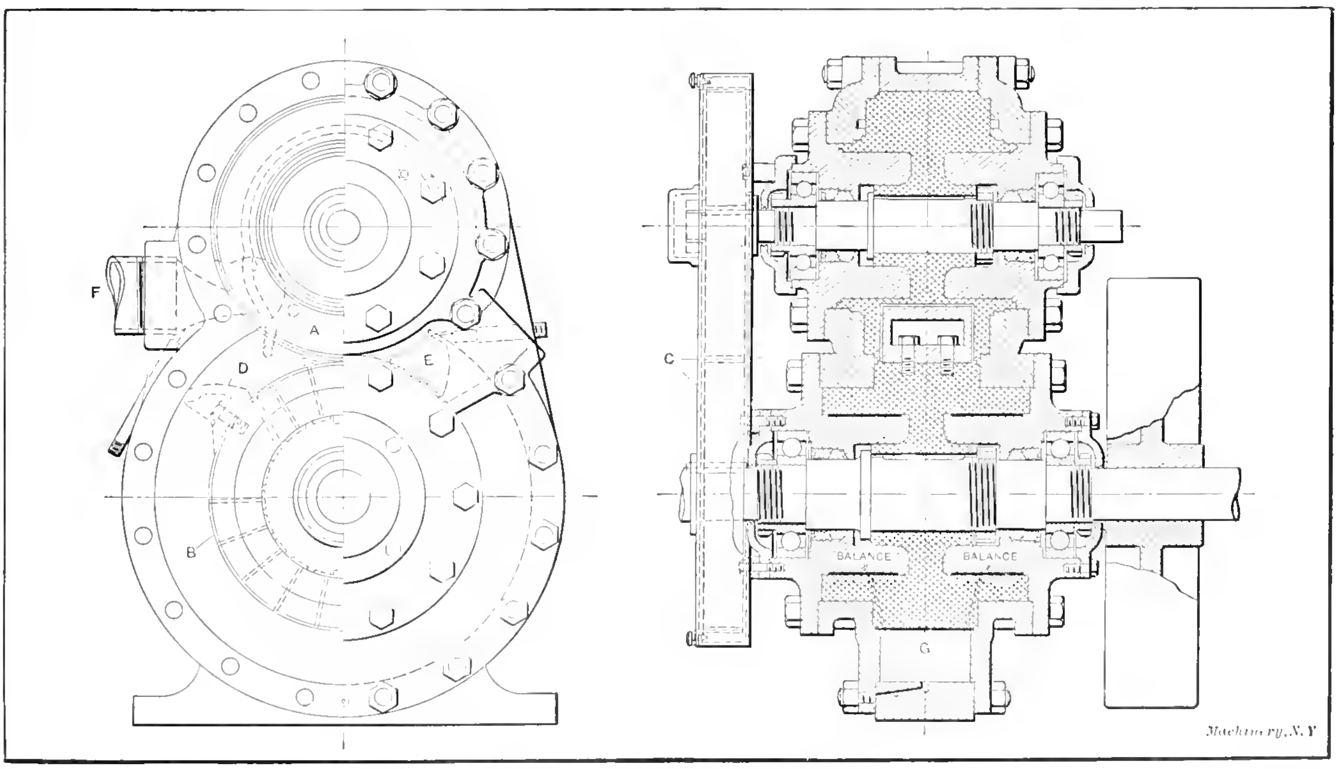


Fig. 2. Elevation and Section of the Herrick Rotary Engine

which are mounted in bearings placed just far enough apart to obtain a rolling contact between the peripheries. The lower part B is the rotor to which is attached a single impeller blade against which the steam acts. The upper part A is, in reality, a valve which controls the admission of steam. This valve also serves, by its contact with the rotor, to separate the steam and exhaust spaces of the cylinder. The rotor and valve are connected by herringbone gears C of the same size which give these two parts synchronous movements. A circular recess is cut in the periphery of the valve, as indicated by the dotted lines in the elevation, which meets the impeller blade D at each revolution and allows it to pass without contact. When this recess moves around to the point where it connects with the steam port which communicates with the pipe F, steam is admitted to the space between the blade D and the contact point between the rotor and valve. When the valve moves to the position shown in Fig. 2, the steam is cut off and used expansively throughout the remainder of the revolution. As soon as the impeller blade passes port E, the exhaust takes place. The recess in the valve has then moved around to allow the blade to pass, which completes the cycle.

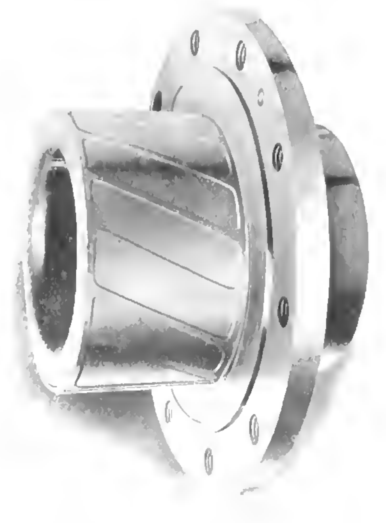


Fig. 3. Enlarged View of Balancing Plug showing Balancing Chambers

The casing which forms the cylinder, has side plates bolted to it, to which are attached, concentric with the valve and rotor shafts, what are known as "balancing plugs." These plugs fit closely into annular spaces on each side of the central webs of both the valve and rotor, and contain the packing and bearings. They are also provided with shallow chambers on their peripheries, as shown in the enlarged view, Fig. 3. The way these plugs are utilized in balancing is as follows: As the steam enters the cylinder, a small amount passes through holes located just back of the impeller blade (these are indicated at G in Fig. 2) to a chamber of the balancing plug, and then to successive chambers as the rotor revolves, thus introducing into each chamber a film of steam, the pressure of which gradually decreases as the steam expands. As these balancing plugs are lengthened sufficiently to compensate for their small diameter, theoretically the radial thrust from the pressure on part of the exterior surface of the rotor, is counter-

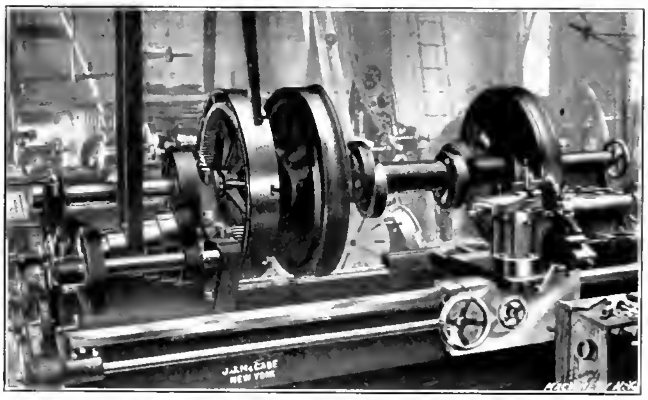
balanced by this inner steam film which rests against the inner wall of the rotor. It will be seen that as the pressure area on the outside of the rotor increases, the balancing area between the plugs and the inside of the rotor also increases.

Mr. Luther D. Lovekin, Chief Engineer of the New York Shipbuilding Co., has suggested that this engine could be advantageously used in connection with turbines for ship propulsion. The plan is to use a three-shaft installation, the two wings or outer shafts being driven by turbines and the central shaft by a rotary engine interposed between the boilers and turbines. By this arrangement, high-pressure superheated steam, which cannot be used economically in turbines without greatly increasing their weight and size, could first be utilized in the rotary, from which it would be exhausted at the most suitable pressure for economy in the turbine. This plan has been indorsed by Captain A. B. Willis, U. S. N., who further recommends that three separate rotaries (not compounded) with impeller blades located 120 degrees apart, be used in order to obtain a better balance and a steadier steam flow to the turbines. The construction of this new rotary is such that the rotating surfaces do not come into actual contact within the steam space, which, while it reduces the friction, results, of course, in some leakage. Such leakage, however, with the roto-turbo combination will pass out through the exhaust and be utilized in turbines. Mr. Lovekin estimates that by this arrangement a water rate of ten pounds per brake horsepower per hour, can be obtained.

* * *

TURNING LOCOMOTIVE DRIVING WHEELS IN A McCABE DOUBLE-SPINDLE LATHE

An excellent example of the adaptability of the double-spindle lathe, particularly for shops handling a large variety of work with a more or less limited tool equipment, is shown by the accompanying engraving. The particular work illustrated, is that of re-turning the tires of a pair of locomotive driving wheels in the Empire Machine Works of Brooklyn, N. Y., on one of the J. J. McCabe double-spindle lathes. These



Turning the Tires of a 48-inch Driving Wheel in a McCabe Double-spindle Lathe

wheels are 48 inches in diameter, the width of the tire is 6 inches, and the approximate weight is 7000 pounds. As they had been in constant service both night and day for two years, they were not only badly worn, but extremely hard, owing to the chilled spots due to the braking action and the slippage between the wheels and the rails. By doing this job in the machine referred to, it was unnecessary to send the wheels to Philadelphia to be turned ou a regular wheel lathe as formerly. By the use of an auxiliary tool-stand that may be attached to one side of the saddle, two tools were used simultaneously to cut down the ridges on either side, which reduced the time required for the turning operation.

* * *

LAUNCHING OF THE FLORIDA

The U. S. S. *Florida*, which, when completed, will be the largest battleship in the United States Navy, was launched at the Brooklyn Navy Yard on Thursday, May 12. The *Florida* will have a normal displacement of 21,825 tons, which exceeds the displacement of the *Connecticut* by 5825 tons, and that of the *Oregon* by 11,537 tons. Her length over-all is 521 feet, and her width of beam, 85 feet. The armament consists of ten 12-inch rifles in the main batteries, and sixteen 5-inch rapid-fire guns, four 3-pounders, two 1-pounders, and a number of machine guns in the secondary batteries. There are also two 21-inch submerged tubes for torpedoes. The broadside fire will be 20 per cent greater than any battleship in commission in our navy. The engines are of the turbine type and are designed to develop 28,000 horsepower, which will give an estimated speed of approximately 22 knots. Propulsion is obtained through four propellers, being arranged in tandem on each side of the twin shafts. When launched, the *Florida* weighed approximately 8700 tons, and she was 65 per cent completed. Her estimated cost at completion is $6,000,000.

* * *

THE NEW CINCINNATI PLANER PLANT

Five of the largest concerns connected with the Cincinnati machine tool industry have formed an industrial colony at Oakley, Ohio, which is only a few miles out of Cincinnati. These concerns are the Cincinnati Planer Co., Cincinnati Milling Machine Co., Cincinnati Bickford Machine Tool Co., Triumph Electric and Ice Machine Co. and the Modern Foundry Co., and they all own a power plant in common, the stock ownership of which is proportioned to the amount of power used. This power plant furnishes power, light, service water, sprinkler water, compressed air, steam line and hot water for heating plants. As noted elsewhere, the Triumph plant is already in complete operation; so too are the Modern Foundry Co. and the Cincinnati Planer Co., the latter having entirely vacated its old plant in Cincinnati.

Fig. 1. Colony Power Plant and Modern Foundry Co.'s Plant, Oakley, Ohio

Pictures of the Modern Foundry's Co.'s plant and the common or colony power plants are shown in Fig. 1 and in Fig 2 is the Cincinnati Planer plant. A general view of the shop interior of the latter place is given in Fig. 3 and shows the magnificent lighting, and the crane system; in the lower left-hand corner are shown the tops of freight cars which are run into the shop on depressed tracks, capable of holding two 40-foot cars, which bring the floor of the cars on a level with the shop floor.

Fig. 2. Cincinnati Planer Co.'s Plant, Oakley, Ohio

Each department is driven by individual motors, the line-shaft being in sections. Hyatt roller bearings are used on all shafts and the method of mounting the motors is somewhat

unusual. In the first place the shop floor is composed of about eight inches of cinders, eight inches of concrete, then creosoted sleepers imbedded in concrete, next $1\frac{5}{8}$ inch of oak and lastly a layer of easily renewable $\frac{7}{8}$-inch oak flooring. The motor foundations are built up like a big concrete box, directly from the eight-inch concrete foundation. These hollow motor foundations average about three feet in height and are filled with cinders, on top of which is placed four inches of oak as shown at *A*, Fig. 4. The motors are bolted down solidly by bolts imbedded in the concrete. The construction of the motor foundations in this way does away with the vibration present when

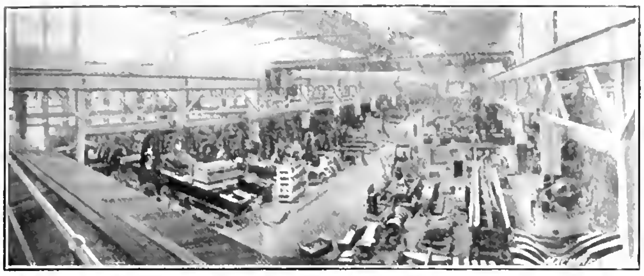


Fig. 3. Interior View of Cincinnati Planer Co.'s Shop

they are placed on platforms in the usual way, and it also provides means of oiling and inspecting without using a ladder. This engraving also shows one of the short shafts at *B* used for testing planers in position before shipping.

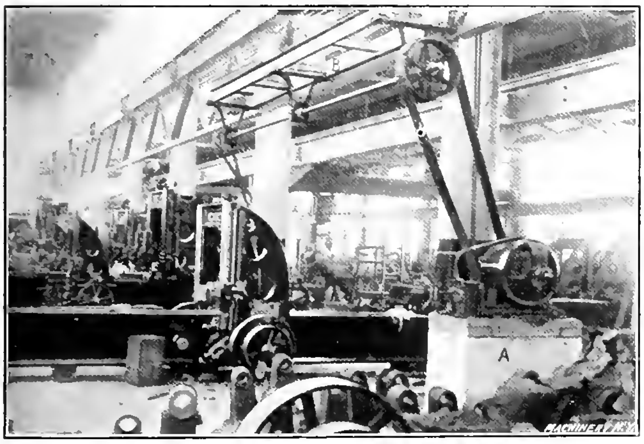


Fig. 4. Motor Foundation and Test Shaft in Shop

Fig. 5 shows a small section of the individual locker and wash-bowl system, which is only one of the many features of the plant designed to provide for the comfort of the employes.

* * *

Cement will resist a temperature of 500 degrees F. for an indefinite period, but a continuous temperature of over 700 degrees F. is disastrous. The heat-resisting power of cement is due to the amount of moisture chemically combined, being from twenty to twenty-five per cent of its weight. At a high temperature this chemically-combined water is driven

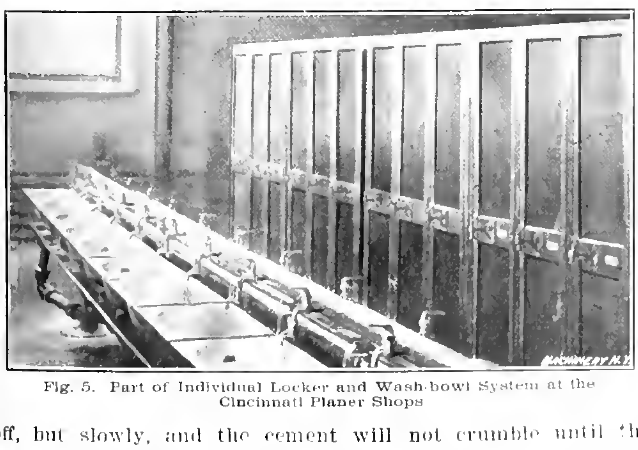


Fig. 5. Part of Individual Locker and Wash-bowl System at the Cincinnati Planer Shops

off, but slowly, and the cement will not crumble until the water has been evaporated. The slowness of evaporation is probably the cause of the ability of concrete to resist high temperatures for a short period, while a much lower temperature, long continued, will ultimately disintegrate it.

OPENING OF NEW PLANT OF TRIUMPH ELECTRIC CO. AND TRIUMPH ICE MACHINE CO.

A special B. & O. railway train carried 350 visitors from Cincinnati to Oakley, Ohio, to the opening of the Triumph Electric, and Triumph Ice Machine Co.'s new plant, Saturday, April 30. In addition to these about 150 more made the trip in

New Machine Shop of Triumph Electric Co. and Triumph Ice Machine Co., Cincinnati, Ohio, 300 feet long, 140 feet wide, Center Bay 60 feet

automobiles and street cars. Buffet lunch was served, after which John L. Shuff, acting as chairman, introduced W. N. Hobart, the venerable head of the concern, who made a short speech. He was followed by James J. Heekin, president of the Chamber of Commerce; A. J. Conroy, president of the Business Men's Club; President Egan of the Industrial Bureau; W. F. Robertson of the Manufacturers' Club, and R. K. LeBlond of the Metal Trades Association. After the close of the speeches, all of which were brief and to the point, the guests were divided into groups with a guide at the head and shown over the plant.

An interesting feature of the plant is the position of the various store-rooms which are situated in the middle gallery either directly above, or directly below, the department which they are to serve, thus reducing the trouble of getting stock promptly, to a minimum. The view reproduced herewith shows the main machine shop, which is 300 feet long and 140 feet wide. The center bay is 60 feet wide.

* * *

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The program of technical papers for the American Society of Mechanical Engineers' convention, which will be held in Atlantic City, N. J., May 31 to June 3, is as follows:

"The Shockless Jarring Machine," by Wilfred Lewis.

"A Comparison of Lathe Headstock Characteristics," by Prof. Walter Rautenstrauch.

"The Strength of Punch and Riveter Frames Made of Cast Iron," by Prof. A. L. Jenkins.

"The Mechanical Engineer and the Textile Industry," by H. L. Gantt.

"The Elastic Limit of Manganese and other Bronzes," by J. A. Capp.

"The Hydrostatic Chord," by R. D. Johnson.

"The Resistance of Freight Trains," by Prof. Edw. C. Schmidt.

"A Regenerator Cycle for Gas Engines Using Sub-adiabatic Expansion," by Prof. A. J. Frith.

"Gas Engines for Driving Alternating Current Generators," by H. G. Reist.

"Two Proposed Units of Power," by Prof. William T. Magruder.

"Some Operating Experiences with a Blast Furnace Gas Power Plant," by H. J. Freyn.

"Improvements in Lineshaft Hangers and Bearings," by Henry Hess.

"Experimental Analysis of a Friction Clutch-Coupling," by Prof. William T. Magruder.

"An Improved Absorption Dynamometer," by Prof. C. M. Garland.

"Critical Speed Calculation," by S. H. Weaver.

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The semi-annual convention of the National Machine Tool Builders' Association at Rochester, N. Y., May 24 and 25, was the most successful spring meeting ever held, the attendance breaking the record for a semi-annual convention. Twenty-one new members joined—the largest number of accessions at any meeting.

F. A. Geier, president of the association, called the meeting to order and in a few well-chosen remarks congratulated the members on the progress made and the mutual good feeling engendered. He contrasted the members' relations with the conditions existing abroad, especially in Germany, where practically no cooperation whatever exists, and where almost every machine tool builder regards his competitors with suspicion and distrust. Great regret was expressed for the illness of W. P. Davis, president of the W. P. Davis Machine Tool Co. of Rochester, through whose efforts, largely, the meeting was held in Rochester.

After the transaction of the routine business came the reports of committees, the first being that of the committee on standardization of motors, of which Paul A. Montanus, of the Springfield Machine Tool Co., Springfield, Ohio, was chairman. The report gave the substance of the conference of the committee with a similar committee appointed by the American Association of Electric Motor Manufacturers. Fifteen principal points of discussion were presented, of which eight had been agreed on, the remainder having been left for further discussion. The results of the committee work will be published when it has been completed.

The Committee on Uniform Costs, of which E. J. Kearney, of Kearney & Trecker Co., Milwaukee, Wis., was chairman, was represented by S. H. Reck of the Rockford Drilling Machine Co., Rockford, Ill., in the absence of Mr. Kearney. A communication from the latter expressed satisfaction with the uniform costs system installed in the Kearney & Trecker plant.

The Apprenticeship Committee, of which E. P. Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn., was chairman, was represented by F. L. Eberhardt, who read a paper giving an outline of the apprenticeship system in operation in the plant of Gould & Eberhardt, Newark, N. J.

The Tariff Committee, of which J. B. Doan, of the American Tool Works Co., Cincinnati, Ohio, was chairman, rendered a report which briefly reviewed the work and gave some statistics of the present tariff, including the minimum and maximum features.

The cancellation of machine tool orders was ably discussed by C. Wood Walter, C. A. Johnson, Murray Shipley and William B. Reid, the first three taking the manufacturer's side. It was practically agreed that present trade practice is unsound, too much looseness existing in the character of orders and in permitting cancellations without adequate cause. Parallel conditions exist in no other industry. The privilege of cancellation is abused. Customers and dealers place orders on chance. If the business materializes the machines are accepted, but if not, the orders are countermanded without thought of the hardship inflicted on the machine tool builder. The injurious effects of this system of doing business are so obvious that no great argument was necessary to prove them. Mr. Reid, representing the dealers, conceded much that had been said. He stated, however, that 80 per cent of the machine tool trade is done through dealers and that grave practical difficulties prevent any radical change in a system that has become strongly established by custom. If the builders were unwilling to practically carry stock in the dealers' warerooms in good times, through permitting cancellations at will, they should not in justice ask the dealers to order stock in dull times.

Prof. F. B. Dyer, superintendent of Cincinnati public schools, described the work of the Cincinnati continuation school and illustrated the character of instruction with stereopticon views. (See MACHINERY, May, 1910, for abstract of similar paper.) His talk evoked hearty applause and many members evinced great interest in the school work, which undoubtedly is a forerunner of one of the most important educational works that has been undertaken in America along industrial lines.

Robert Pierpont, works manager of the Olds Motor Works, Detroit, Mich., read a paper on the future of the automobile business with reference to machine tools, in which he set forth some very practical ideas developed from experience in the management of one of the large automobile factories. He advocated special machinery and simpler standard tools. In his opinion individual motor drive is best adapted to special machines in which the power consumption is practically a fixed quantity. On standard tools, where the power requirements vary widely, the motor equipment is necessarily greater in power than the total required for a group of the same machines when driven by a motor direct connected to the lineshaft. He advocated cone drive in preference to gear drive as the latter is likely to be noisy and inefficient. Suggestions were made regarding milling machines, lathes, grinders, drilling machines, screw machines, gear cutters, and special machinery.

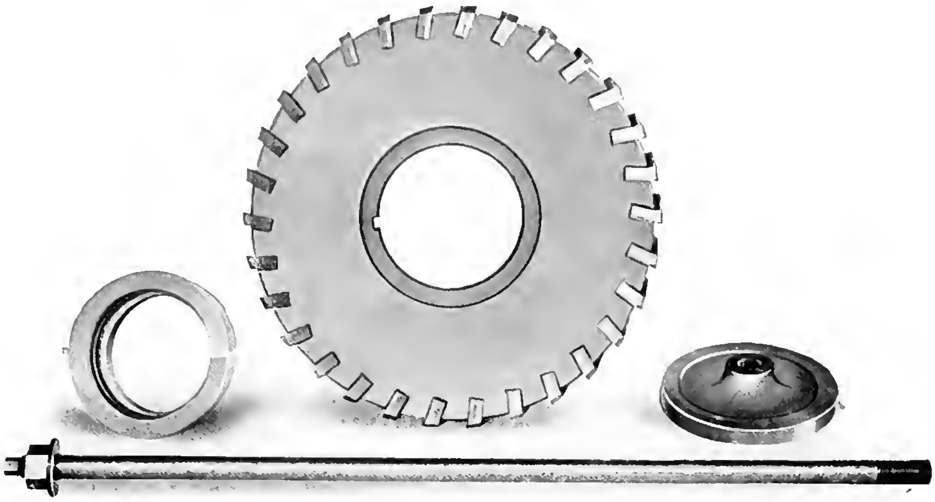
R. K. LeBlond of the R. K. LeBlond Machine Tool Co. and William Lodge of the Lodge & Shipley Machine Tool Co., discussed the relative merits of cone drive and gear drive, the former advocating the cone drive and the latter the gear drive. Mr. LeBlond claimed that all the advantages that can possibly be secured with the gear head can be better obtained with a variable speed motor and comparatively few mechanical changes, because the changes can be obtained with small friction loss. In his opinion the great difficulties of all gear-driven machines are lack of efficiency, expensive maintenance and increased first cost. It was pointed out that the single-pulley gear-drive 16-inch lathe required a one-horsepower motor to turn it over, and fully one-half horsepower is absorbed in friction loss under actual working conditions. With the cone pulley drive on direct speeds an efficiency as high as 85 per cent is obtained and in the extreme cases of transmitting power through the back gears the efficiency is seldom lower than 75 per cent.

Mr. Lodge conceded that for light work the cone pulley drive can be used to advantage, but advocated the gear drive when taking heavy cuts at high rates of speeds, the power consumption then being increased from two to five times the ordinary ratings.

William R. Wood of Cincinnati, Ohio, read a paper advocating a court of patent appeals. He referred to the importance of patents in the machine-tool manufacturing business and the hopeless discrepancies between the means provided for securing patents and for protecting the patent when secured. The Patent Office represents one piece of the patent machinery and the United States courts the other. The application for a patent receives the most careful scrutiny, and thorough examination is made into the state of the art before the patent is granted. The time required for securing a patent may vary from six months to six years and when granted it is supposed to give the inventor a monopoly for a period of seventeen years. After all the elaborate precautions have been taken by the examiners, we have the glaring inconsistencies of the courts in passing on the validity of the patents so cautiously obtained. The United States courts have exclusive jurisdiction in patent suits and, with all due respect to the attainments of the learned judges comprising the court, it must be conceded that they have not the experience that qualifies them to pass on many questions of purely mechanical merit. The American Bar Association, the Washington Bar Association and many members of the patent bar, are in favor of creating a patent court of appeals composed of five judges selected from the thirty regular circuit judges with special view of their fitness, to whom all patent suits shall be taken. A bill has been introduced to the Senate, known as Senate Bill No. 4982, and a similar bill has been brought before the House of Representatives, known as House Bill No. 14,622.

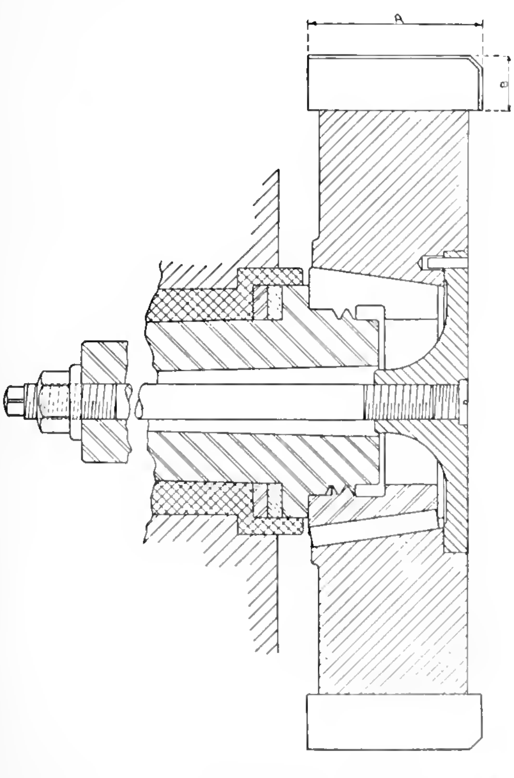
A new and original feature, and one of the most interesting in the proceedings to the newspaper men, was the discussion of the value of what was called "Direct Advertising," represented by A. H. Hitchcock of *Hitchcock's List*, and "Trade Paper Advertising," by John A. Hill of the *American Machinist*. A raised platform for the participants, equipped with buckets of water, boxing gloves and sponges created great merriment as the members assembled in the hall. The speakers were placed in chairs. Charles G. Allen of Barre, Mass., seconded

Why do you keep a large number of face milling cutters on hand when you can use one on several sizes of machines?



B. & S. Inserted Tooth Face Milling Cutters

can be used interchangeably on machines of different sized spindles and so greatly reduce the number of cutters necessary to keep on hand.



The cutters are made to fit over a split sleeve which screws on to the nose of the spindle. When it is desired to use one cutter on different sized spindles, the internal diameter of the sleeves varies to fit the different spindles but the external diameter of the sleeves is the same.

Another advantage of the cutters is the fact that the sleeves are made with a taper that will allow for ready release when it is desired to remove the cutter.

The theory of the cutter allows for taking the heaviest cuts, as all danger of jamming the cutter on the nose of the spindle is eliminated. Thus the capacity of the cutter is limited only by the full power of the belt.

Send for our new Cutter List.

BROWN & SHARPE MFG. CO., Providence, R. I., U.S.A.

Mr. Hill and A. E. Newton of Worcester, Mass., Mr. Hitchcock. Edward Rivett of Brighton, Mass., acted as referee. Our limited space prevents an extended report of the papers, but those who are acquainted with the speakers will agree with us that both sides were ably presented, the discussion being declared a drawn battle by the referee.

One function of the trade journal, and an important one, which is sometimes lost sight of by advertisers who consider direct results only, is the educational and informative work the best trade journals perform in their respective fields, and which indirectly brings more and better results to manufacturers than their advertising. We need only point to the progress of the machinery trade in this country, which is coincident with the development of the trade journals in this field, to prove the necessity for their existence, even if they brought no returns whatever to an advertiser.

The social event of the meeting, long to be remembered with pleasure by those participating, was the reception, Tuesday evening, given by Miss Kate Gleason and brother, William Gleason, of the Gleason Works, Rochester, at their "Spanish castle" home "Clonos" on East Ave., Pittsford, a suburb of the city. About 180 machine tool builders, friends, guests and ladies were taken there by automobile. The unique architectural features of "Clonos" inspired the liveliest interest, and the entertainment left nothing to be desired.

There are now 116 members in the association including the new members added at this convention, the names of which are as follows:

Adams Co.	Dubuque, Iowa.
Baker Bros.	Toledo, Ohio.
Becker Milling Machine Co.	Hyde Park, Mass.
Bridgeford Machine Tool Works	Rochester, N. Y.
Betts Machine Co.	Wilmington, Del.
Bryant Chucking Grinder Co.	Springfield, Vt.
Foster Machine Co.	Elkhart, Ind.
Edwin Harrington Son & Co., Inc.	Philadelphia, Pa.
Landis Tool Co.	Waynesboro, Pa
Leland, W. H. & Co.	Worcester, Mass.
Moline Tool Co.	Moline, Ill.
Morton Mfg. Co.	Muskegon Heights, Mich.
New Haven Mfg. Co.	New Haven, Conn.
Oesterlein Machine Co.	Cincinnati, Ohio.
Pratt & Whitney Co.	Hartford, Conn.
Rochester Boring Machine Co.	Rochester, N. Y.
William Sellers & Co., Inc.	Philadelphia, Pa.
Taylor & Fenn Co.	Hartford, Conn.
Universal Boring Machine Co.	Hudson, Mass.
Walker Grinder Co.	Worcester, Mass.
Waltham Watch Tool Co.	Springfield, Mass.

The officers and committees are to be congratulated on the results of the work, which has greatly strengthened the association, and which undoubtedly has contributed materially to general information on technical and practical matters of great moment to the members. The fall meeting will be held in New York City.

* * *

PERSONALS

E. A. Murray, general foreman of the C. & O. R. R. shops at Covington, Kentucky, has been promoted to the position of master mechanic of the Lexington shops.

J. H. Nash, master mechanic of the Illinois Central Ry. shops at Paducah, Kentucky, has just been given the position of superintendent of the Burnside shops of the same road.

J. E. Parker, formerly connected with the H. Mueller Mfg. Co. of Decatur, Illinois, has taken a position as steel expert and traveling salesman with the Crucible Steel Co. of America, his headquarters being at Philadelphia.

Martin S. O'Connor has been promoted from the position of foreman in the Avis, Pa., shops of the Pennsylvania division, New York Central Lines, to that of general foreman of the Highbridge, N. Y., shops of the Putnam division.

A. F. Cook, general car foreman of the Chicago division of the C. B. & Q. R. R., has taken charge of the car department of the Chicago & Western Indiana R. R. and the Belt Ry. Co. of Chicago, with headquarters in Chicago.

Dr. William H. Tolman, director of the Museum of Safety, New York, sailed for Europe May 12 with a commission from the National Electric Light Association to investigate European methods of protection of life and limb in electric plants.

John R. Back has resigned his position as instructor in the Worcester trade school, Worcester, Mass., and Mr. M. L. Carroll has been elected to the position. Mr. Back, who was for many years superintendent of the F. E. Reed Co., has entered the employ of Prentice Bros. Co., Worcester.

J. B. Comstock, for six years with the Westinghouse Electric & Mfg. Co. at its East Pittsburg Works, and for four years manager of its publication department and printing plant, severed his connection with that company in April to take a similar position with the P. & F. Corbin Co. of New Britain, Conn. Prior to Mr. Comstock's connection with the Westinghouse Co. he filled the position with the Corbin Co. that he has recently been recalled to assume.

S. Noda, president of Roku-Roku Shoten, Inc., machinery merchants, 3 Shinsakancho Kyopashiku, Tokio, Japan, visited a number of American machine tool manufacturers in May, whom he will represent in Japan. He sailed the last of May for Germany with the intention of attending the Brussels Exposition. Mr. Noda has thoroughly equipped himself for handling machine tool business in Japan. He speaks English and German fluently. His brother is spending three years in the machine shops of the United States to obtain a thorough practical knowledge of machinery manufacturing and operation, particularly the latter. It is his intention to cooperate with his brother in selling machine tools. His practical experience will enable him to get the best possible results from American machinery. In many cases, at present, machine tools are being operated in Japan very inefficiently, no one in charge being competent to work them to the best advantage.

OBITUARIES

Thaddeus W. Tyler, the original of Longfellow's "Village Blacksmith," died at Lynn, Mass., in April, aged seventy-six years.

John I. Kinsey, who for forty years was master mechanic of the Lehigh Valley R. R. shops at Easton, Pa., died in Easton, April 28, aged eighty-three years.

Charles W. Gage, an expert draftsman, employed by the George H. Bushnell Press Co., Thompsonville, Conn., died at his home in Thompsonville April 15, aged forty years.

Leonard B. Spence died in New York, April 16, aged seventy-two years. Mr. Spence was a pioneer manufacturer of mowing machines and made, in Worcester, Mass., some of the first machines for cutting grass produced in New England. He had been connected with the New York Aquarium for fifteen years as a scientist.

James W. Van Cleave, president of the Bucks Stove & Range Co., St. Louis, Mo., and former president of the National Association of Manufacturers, died at his home in St. Louis, of heart disease, May 15, in his sixty-first year. A memorial service was held by the association, which was in convention at the Waldorf-Astoria hotel in New York, at four o'clock, May 17, just at the time the burial was taking place in St. Louis. Van Cleave will be remembered as one of the great fighters of unions and union labor. His labor troubles undoubtedly shortened his life.

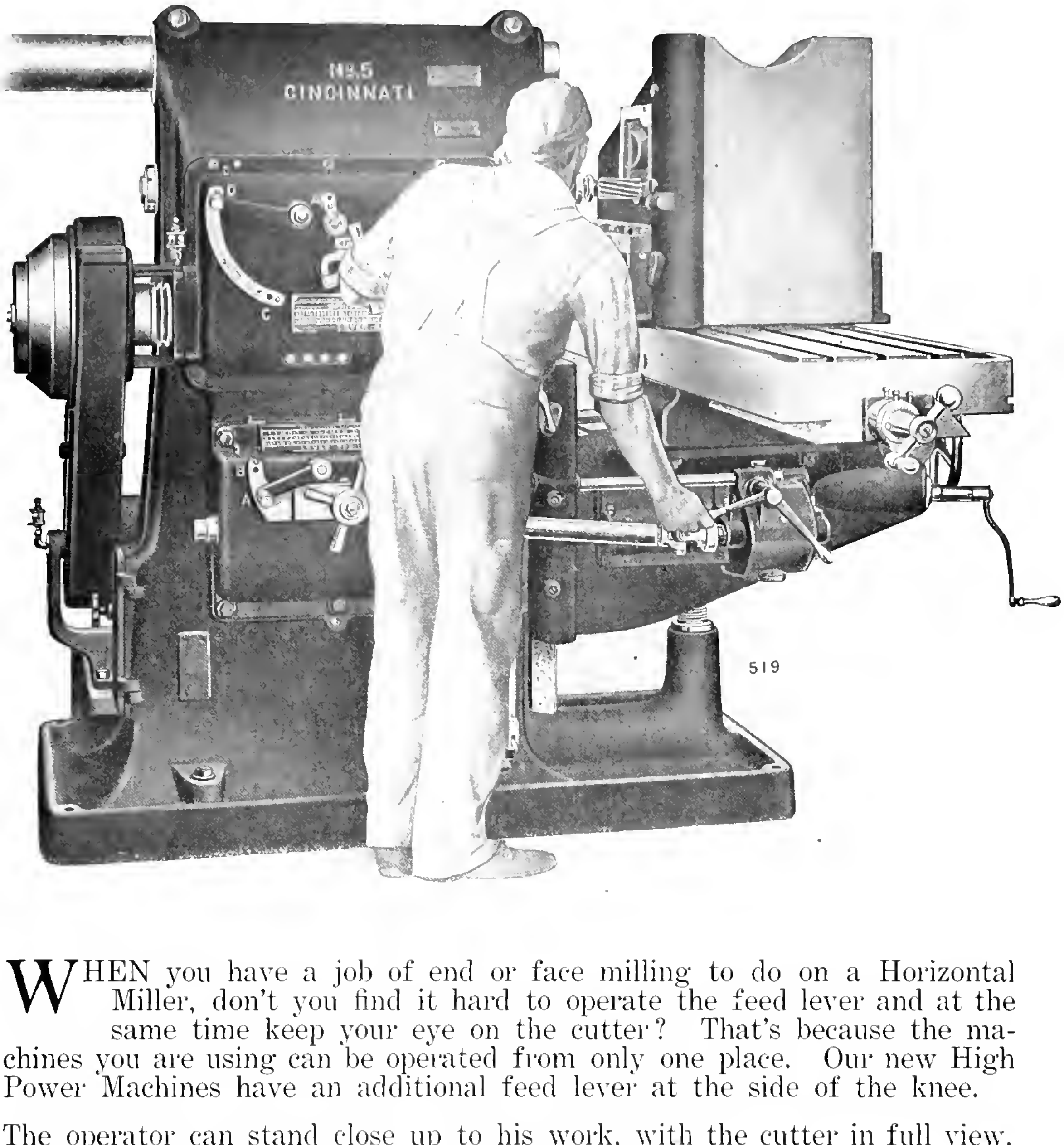
John Wilson Wheeler, president of the New Home Sewing Machine Co., Orange, Mass., died at his home in that town May 2, aged seventy-seven years. Mr. Wheeler left the mercantile business in 1867 to engage in the manufacture of sewing machines in Orange, Mass. Mr. Thomas White, of the White Sewing Machine Co., Cleveland, Ohio, is the only survivor of the company. These pioneers began the business in a very small way, making small hand sewing machines. The business in Orange grew from this small beginning to the present capacity of 600 machines a day and the employment of over 800 people. Mr. Wheeler worked unceasingly to build up the business, first as secretary and treasurer, and then as president for the past ten years.

John H. Converse, president of Burnham, Williams & Co., Philadelphia, Pa., died suddenly of heart disease at his suburban home in Rosemont, May 3, aged sixty-nine years. Mr. Converse was born in Burlington, Vt., and graduated from the University of Vermont in 1861. His first employment was in newspaper work as an editorial writer on the *Burlington Times*, where he stayed for three years. He then went to Chicago, where he engaged in railroad work for two years with the Chicago & Northwestern Ry. Co. In 1866 he went to Altoona, Pa., to work for the Pennsylvania R. R. Co. In 1870 he became a member of M. Baird & Co., Philadelphia, afterwards Burnham, Parry, Williams & Co., and now Burnham, Williams & Co., builders of Baldwin locomotives. The growth of the company during Mr. Converse's regime was enormous, the production increasing from less than one locomotive a day to seven or eight a day in the most prosperous times.

WALTER CRAIG KERR

Walter C. Kerr, president of the Westinghouse Church Kerr & Co., 10 Bridge St., New York, died on May 8 at Rochester, Minn., where he had gone two months previous to undergo an operation for cancer. Mr. Kerr was born at St. Peter, Minn., in 1858. He received his early education in the public schools of his birthplace and took a course in mechanical engineering at Cornell University, graduating in the class of 1879. After his graduation he remained at Sibley College as an instructor and assistant professor until the organization of Westinghouse Church Kerr & Co. was effected in 1884, when, from the first, Mr. Kerr was one of the officers of that

Cincinnati Handiness



WHEN you have a job of end or face milling to do on a Horizontal Miller, don't you find it hard to operate the feed lever and at the same time keep your eye on the cutter? That's because the machines you are using can be operated from only one place. Our new High Power Machines have an additional feed lever at the side of the knee.

The operator can stand close up to his work, with the cutter in full view, and control the machine from this position.

With this one lever he can operate and reverse table, cross or vertical feeds.

The main starting lever is immediately in front of him and the speed and feed changers are at his elbow, so that the entire machine is under complete control from here.

Ask for the Catalog.

The Cincinnati Milling Machine Company

Milling Specialists

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.

AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

Walter Craig Kerr

firm. Much of the credit for the growth and success of this company, of which Mr. Kerr was long president, was due to him.

Mr. Kerr was one-time vice-president of the Westinghouse Machine Co., and at the time of his death was a director of the Electric Properties Co. Since 1890 he had been a trustee of Cornell University. He was a member of the American Society of Mechanical Engineers and of various other engineering societies and clubs. He is survived by a widow, one son and three daughters.

* * *

COMING EVENTS

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-4.—Second annual state convention of Pennsylvania engineers, for the furtherance of the organization of the Engineers Society of Pennsylvania, Hall of Representatives, Harrisburg, Pa. Engineers Society of Pennsylvania, Gilbert Building, Harrisburg, Pa.

June 6-10.—Convention and exhibition of the Foundry and Manufacturers' Supply Association, Detroit, Mich. C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary, American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, Cincinnati, Ohio, secretary.

June 15-17.—Annual convention Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-22.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Old Colony Building, Chicago, Ill.

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

August 16-19—Annual convention of Traveling Engineers' Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

NEW BOOKS AND PAMPHLETS

Cost of Living to Railways. By Edward W. Harden. 8 pages, 6 x 9 inches. Reprinted from the *Outlook*, New York.

National Vitality; Its Wastes and Conservation. By Irving Fisher. Document No. 419 issued from the Government Printing Office, Washington, D. C.

Tests of Washed Grades of Illinois Coal. By C. S. McGovney. Bulletin No. 39. 146 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin presents the results of an elaborate series of boiler tests made in connection with a 210-horsepower brick set water-tube boiler, equipped with chain grate stoker. A description of the method employed and the results of the tests are given in detail.

Study in Heat Transmission. By J. K. Clement and C. M. Garland. Bulletin No. 40. 17 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin describes the method of studying the effect of agitation of a medium in contact with metal walls upon the heat conducted through these walls and to or from the medium. Experiments were made on a one-inch steel tube through which water flowed at different velocities. A record of the amount of heat transmitted was obtained from the weight of the water and rise in temperature while passing through the tube.

Ornamental Concrete Without Molds. By A. A. Houghton. 132 pages, 5 x 5½ inches. 30 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price \$2.

The process of making ornamental concrete without molds has long been held a secret, it is said. It is now given to the public in a practical treatise and is said to be the only work issued which explains simple and practical methods whereby concrete-workers are enabled, by using wooden and metal templets of different designs, to mold or model in concrete any cornice, archivolt, column, pedestal, base, cap, urn or pier in monolithic form. Full directions are given for making templets at very slight cost of time and labor.

Dynamo Building for Amateurs. By A. J. Weed. 83 pages, 5 x 7½ inches. 64 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price \$1 in cloth, and 50 cents in paper.

The book gives a general description of a 50-watt dynamo and describes its building in detail, telling of the tools and material required. Separate chapters are devoted to side-bearing rods, field punchings, bearings, commutator, pulley, brush holders, connection board, armature shaft, armature, armature winding, field winding, connections and starting. The book is one that should enable an amateur to proceed intelligently in the making of a working dynamo capable of lighting six 6-candle lamps. Various operations are made plain by halftone illustrations and drawings.

Self-Taught Mechanical Drawing and Elementary Machine Design. By F. L. Sylvester, with additions by Erik Oberg. 333 pages, 5 x 7½ inches. 218 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price \$2.

This comprehensive and well-prepared work has been published to meet the demand for an elementary treatise on mechanical drawing, including the first principles of machine design. The opening chapters are devoted to mechanical drawing pure and simple, taking up instruments and materials, definitions of terms used in geometrical and mechanical drawing, geometrical problems, projection, and working drawings. The following chapters are on algebraic formulas, elements of trigonometry, elements of mechanics, first principles of strength of materials, cams, sprocket wheels, general principles of gearing, calculating the dimensions of gears, cone pulleys, bolts, studs and screws, couplings and clutches, shafts, belts and pulleys, flywheels for presses, punches, etc., trains of mechanism and quick-return motions. The work should be well-suited to the class for which it is intended. The mathematics are simple and readily understandable. It can be specially recommended to those desirous of improving their mechanical education by home study.

Safeguards for the Prevention of Industrial Accidents. Edited by David Van Schaak. 174 pages, 6¾ x 9¾ inches. 168 illustrations. Published by the Aetna Life Insurance Co., Hartford, Conn. Price 50 cents.

The importance of promoting the movement for the prevention of industrial accidents has been fully realized by the great accident and liability insurance companies and a concerted movement is being made to induce manufacturers to supply guards for gears, belts, moving chains, elevators, set-screws, and other potentially dangerous things. Accidents may be attributed to the following principal causes: Ignorance, carelessness, unsuitable clothing, insufficient lighting, defects of machinery and structures, insufficient room, unclean conditions, and lack of good air. The work treats of these subjects and gives general suggestions for safeguarding all classes of machinery. A large number of illustrations are given, showing methods of guarding gears on slitting machines, rolling mills, slotting machines, gear cutters, lathes, wall-paper printing machines, tumbling barrels, pipe threading machines, boring mills, twisters, baling machines, looms, etc. Chapters are devoted to flywheels, driving belts, set-screws, sprocket wheels, rolls and knives, punch presses, stairways, platforms and runways, elevators, contracting, bake-shops, and miscellaneous. The concluding chapter is on rules and regulations, instructions, warning notices, etc. The book is one that every manufacturer, superintendent and shop foreman should read and study. If the suggestions contained therein were followed, most of the distressing industrial accidents would be avoided.

CATALOGUES AND CIRCULARS

Bristol Co., Waterbury, Conn. Bulletin No. 124 illustrating Bristol's atmospheric recording thermometer.

Terrell's Equipment Co., Grand Rapids, Mich. Folder illustrating steel wardrobes, steel lockers, and steel shelving and bins.

Peter Gerlach Co., Cleveland, Ohio. Catalogue of circular and cylinder saws, stave beading and barrel machinery, and saw and logging tools.

American Blower Co., Detroit, Mich. Catalogue of "Sirocco" electric fan and air purifier for insuring absolute ventilation in offices all the year round.

Northern Engineering Works, Detroit, Mich. Catalogue of the Newten cupola having a differential adjustable tuyere system and an all-steel air chamber.

Wiley & Russell Mfg. Co., Greenfield, Mass. Circular of "Green River" opening die bolt cutter, nut tapper, pipe threader and cutting-off machine No. 55.

Landis Machine Co., Waynesboro, Pa. Catalogue of bolt threading, pipe and nipple threading, bolt pointing and nut tapping machinery, and special threading machines.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 124 superseding No. 112 on exhaust fans. The motors of these fans are built for durability and are practically "fool-proof."

Dodge Mfg. Co., Mishawaka, Ind. Pamphlets entitled "Friction Clutches," "Safe Construction and Speeds for Flywheels," "From Log to Lineshaft," and "Dividends and Drives."

T. R. Almond Mfg. Co., Ashburnham, Mass. Circular of Almond three-jaw geared drill chuck made in two sizes having capacities from 0 to 5/16 inch and 0 to ½ inch respectively.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 119 superseding No. 107 on direct-current lighting and power generators; also Bulletin No. 121 on small engine type direct-current generators.

Joyce-Cridland Co., Dayton, Ohio. Catalogue of lifting jacks, including hydraulic jacks, lever jacks, automatic jacks, geared automatic jacks, screw jacks, traversing jacks, journal jacks, navy jacks, etc.

Bickford & Washburn Inc., Greenfield, Mass. Catalogue of thread milling machines, index centers for fluting taps and reamers, open die for threading small taps, solid adjustable die and upright threader.

Pawling & Harnischfeger Co., Milwaukee, Wis. Folder illustrating line of horizontal drilling and boring machines, recommended for drilling all classes of work. The drill capacities range from ⅜ inch up to 3 inches.

Lucas Machine Tool Co., E. 99th St., and L. S. & M. S. Ry., Cleveland, Ohio. Circular No. E-2 of No. 21 precision boring, drilling and milling machines, illustrating the cone drive, and constant-speed drive and gear box types.

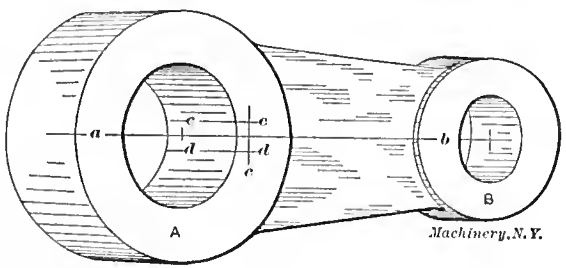
National-Acme Mfg. Co., Cleveland, Ohio. Leaflet illustrating a piece formed complete on the Acme multiple-spindle automatic screw machine on which circular forming, taper forming, drilling and facing operations are performed.

Supplement to MACHINERY, July, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Chipping"

SHOP OPERATION SHEET NO. 139

Oscar E. Perrigo MACHINERY, July, 1910



Laying Out the Keyway in a Crank Hub

NOTE.—It is assumed that the crank shown in the illustration is to have a keyway cut through the bore and that there is no suitable machine available for doing the work, which makes it necessary to cut the keyway by hand. It is first necessary to lay out the keyway in its correct position with relation to the bore.

1. Rub moistened sulphate of copper ("blue stone"), in the bore and at the ends where the keyway is to be laid out, so that the scribed lines will show more distinctly.

2. With a straightedge and scriber, draw a centerline *a—b*, passing through the centers of the shaft bore and crankpin bore. The straightedge may be set central at each end by adjusting it until the distance from its edge to the sides of the two holes, as measured by a scale, is equal to the radius of each respective hole. If the faces *A* and *B* are not in the same plane, the work may be laid on a surface-plate in the position illustrated and a surface gage used to advantage for scribing a center line, after the centers of both holes have been set to the same height from the plate.

3. With the dividers set to one-half the required width of the keyway, set off each side of centerline *a—b*, the location of the side lines, *c* and *d* and scribe these lines parallel with the centerline. If a surface gage has been used for drawing the centerline, it can also be employed for laying off the side lines c and *d*.

4. With the dividers set as explained in Step 3, mark the depth of the keyway on the lines c and *d*, and scribe the depth line *e*.

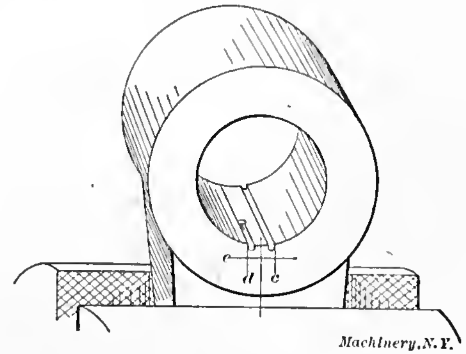
5. Pass the blade of a square through the bore, and holding the stock firmly against the face of the crank, scribe the center and side lines through the bore.

6. As the keyway is to be chipped half way through from each side of the hub, repeat the laying out operation on the opposite side, locating side and depth lines as before. If the key is to be tapered on top, allowance should be made for this when locating the depth lines.

NOTE.—The keyway is here placed in its usual position. If a certain location is prescribed, it will be laid out, of course, with the given point as its center. In the case of a wheel or pulley, it is customary to locate it opposite one of the arms. The keyway is usually located adjacent to the strongest part of the piece.

SHOP OPERATION SHEET NO. 140

Oscar E. Perrigo MACHINERY, July, 1910



Chipping the Keyway in a Crank Hub

NOTE.—The keyway is supposed to have been laid out as described in the previous sheet, its width being indicated by lines through the bore, and its width and depth shown by lines on both faces. On this sheet, the operation of finishing the keyway by chipping and filing will be described.

1. If the keyway is comparatively large as to width and depth, begin by taking a light cut just inside one of the side lines. Use a round-nosed cape chisel, or what is sometimes known as a grooving chisel, and carry the cut back steadily to about the center of the work. Take a similar cut on the opposite side of the keyway, and then with a straight-point cape chisel, continue to take light cuts in each groove until they are nearly down to the depth line. By using a grooving chisel, as described, for cutting the first grooves, the cast iron does not tend to break over the line as it would be likely to do if a straight point were used.

2. With a wider chisel, cut out the central rib between the two channels, taking as many cuts as are necessary to cut down nearly to the depth line. To prevent chipping below the line when in from the face, measure the depth of the keyway at the sides with a small scale.

3. From the opposite face of the crank, repeat the cuts described in Steps 1 and 2, meeting the cuts taken from the first side.

NOTE.—The method of procedure when chipping a keyway, depends somewhat upon its size. A small keyway, for example, would be cut by chipping a single groove with a chisel having a width slightly less than that of the keyway.

4. With a square, coarse cut file, straighten the keyway by filing it on each side, closely to the side lines and down to the depth line.

5. Finish the sides of the keyway with a flat second cut file, so that the key to be used will crowd tightly to the bottom at all points in its entire length. Also file the bottom side straight.

NOTE.—The following requirements should be borne in mind when finishing a keyway in a hub: The sides should be parallel with each other and also with a radial line passing through the center of the keyway; the keyway should be parallel with the axis of the bore, and the correct width, depth, and taper when taper is given.

SHOP OPERATION SHEET NO. 141

Oscar E. Perrigo MACHINERY, July, 1910

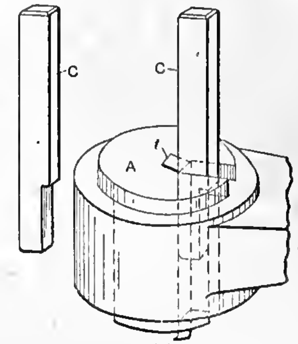


Fig. 1

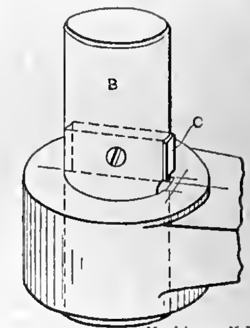


Fig. 2

Broaching the Keyway in a Crank Hub

NOTE.—Two methods of cutting a keyway in a hub by hand will be given in the following, either of which is quicker than the one described in the previous sheet; their use, however, necessitates special tools which are not always available. By the first method, illustrated in Fig. 1, a mandrel *A* is used which fits closely the bore of the hub and which is splined to receive a cutter *C* that is driven through the hub and fed out for each successive cut by placing thin strips of metal back of it. By the second method, illustrated in Fig. 2, a closely fitting mandrel *B* is also used, but the cutter *C*, in this case, is attached to the mandrel and the two are driven through the bore together.

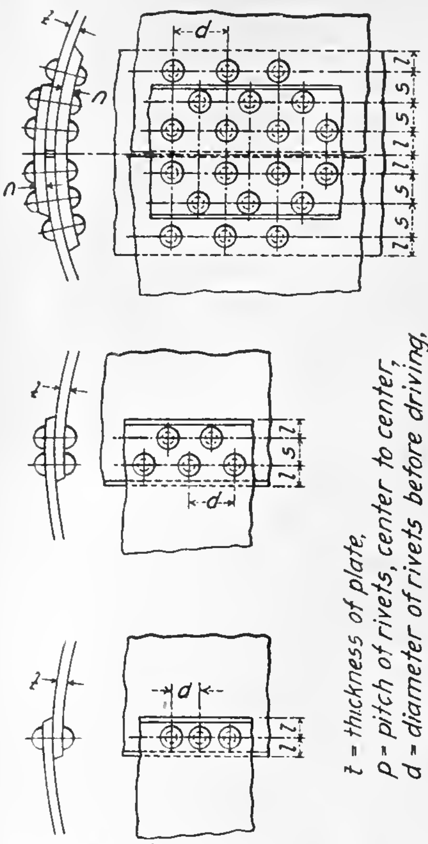
1. Lay out the keyway as described on Sheet No. 139, omitting the lines through the bore and also those on one side.

2. Select a guiding mandrel *A* (Fig. 1) and cutter *C* of the required size, and insert the mandrel in the bore of the hub. Support the work on blocks so that there is plenty of clearance beneath it for the cutter *C* and drive the latter through the bore. Before taking the first cut, care should be taken to turn the mandrel so that the cutter coincides with the lines indicating the position of the keyway.

3. After removing the cutter from below, insert a strip *t* of tin or other thin material, having a length somewhat greater than that of the mandrel, in the spline and again drive the cutter through. It will be seen that by repeating this operation of adding additional liners each time the cutter is driven through, that the latter will gradually be fed to the required depth. After a number of thin liners have been used, it is well to replace them by a thicker one which will be more rigid.

4. By the second method, a closely-fitting mandrel *B* is also essential, and the work must be blocked up so that the mandrel may be removed at the bottom. Set the cutter *C* to take a light cut, turn the mandrel to the correct position and with a soft hammer drive it through the hub. A screw or hydraulic press may also be used for this work if one is available. Return the mandrel to its original position and again drive it through the work after the cutter has been set out for a second cut. Repeat this operation until the depth line is reached.

STANDARD PROPORTIONS OF RIVETED JOINTS FOR PRESSURE TANKS—I



t = thickness of plate,
p = pitch of rivets, center to center,
d = diameter of rivets before driving,
D = diameter of hole,
s = distance between lines of rivets,
l = distance from edge of plate to first line of rivets,
u = thickness of strap,
E = efficiency of joint in per cent.

Thickness of Plate t	Lap Joint Single Riveted					Lap Joint Double Riveted						Double Strap Butt Joint Triple Riveted						
	p	d	D	l	E	p	d	D	s	l	E	p	d	D	s	l	u	E
5/16	2	3/4	13/16	1 1/8	59	3 2/10	3/4	13/16	2	1 1/8	74	6	5/8	11/16	2 3/8 to 3 for all pitches	1 1/8	1/4	88
3/8	2 1/16	13/16	7/8	1 3/16	56	3 2/10	13/16	7/8	2	1 3/16	72	6	3/4	13/16		1 3/16	5/16	86
7/16	2 1/8	7/8	15/16	1 1/4	54	3 2/10	7/8	15/16	2	1 1/4	70	6 3/4	7/8	15/16		1 1/4	3/8	86
1/2	2 1/8	15/16	1	1 1/4	53	3	7/8	15/16	2	1 1/4	67	7	7/8	15/16		1 1/4	7/16	86
9/16	2 3/16	1	1 1/16	1 1/4	51	3 1/16	15/16	1	2	1 1/4	66	7	7/8	15/16		1 1/4	45/100	86
5/8						3 1/8	1	1 1/16	2	1 1/4	66	7	7/8	15/16		1 1/4	1/2	86
11/16						3	1	1 1/16	2	1 1/4	62	7	15/16	1		1 1/4	9/16	85
3/4						2 7/8	1	1 1/16	2	1 1/4	60	7	15/16	1		1 1/4	9/16	85
13/16												7 1/4	1	1 1/16		1 1/4	5/8	85
7/8												7	1	1 1/16		1 3/8	5/8	84
15/16												7 1/4	1 1/8	1 3/16		1 3/8	11/16	83
1												7	1 1/8	1 3/16		1 3/8	3/4	83

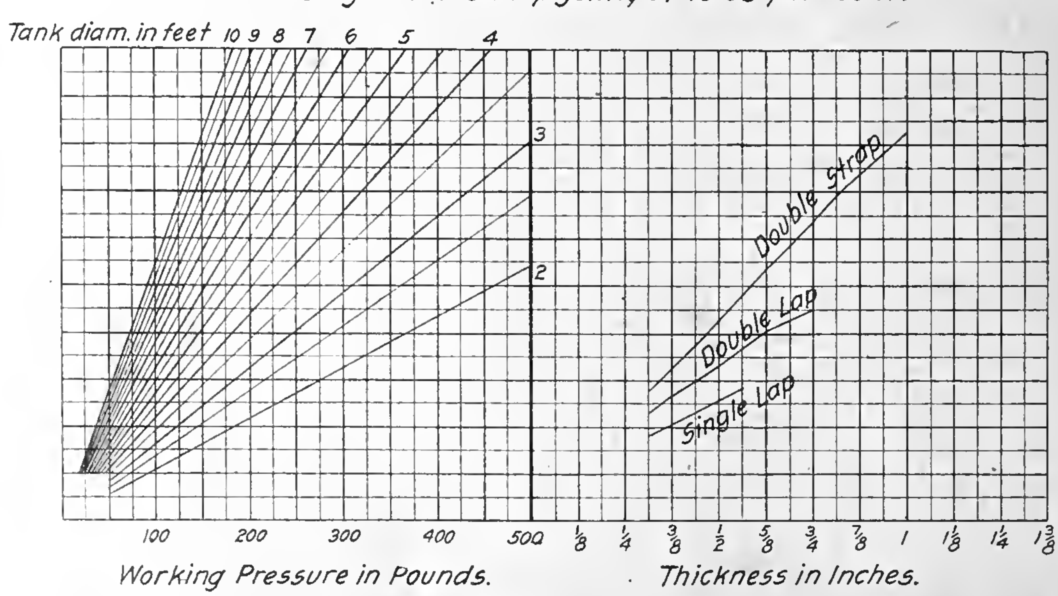
Contributed by C. R. Whittier

PLATE THICKNESS FOR PRESSURE TANKS II

$$\text{Thickness in inches} = \frac{(\text{factor of safety, 5}) \times 100 \times \text{working pressure in pounds} \times \text{diam. in inches}}{2 \times (\text{breaking stress, 55000}) \times \text{efficiency in per cent}}$$

$$= \frac{0.004545 \times \text{working pressure in pounds} \times \text{diam. in inches}}{E}$$

Efficiency E = for double strap, triple riveted butt joint, 83 to 85 per cent,
for double riveted lap joint, 60 to 74 per cent,
for single riveted lap joint, 51 to 59 per cent.



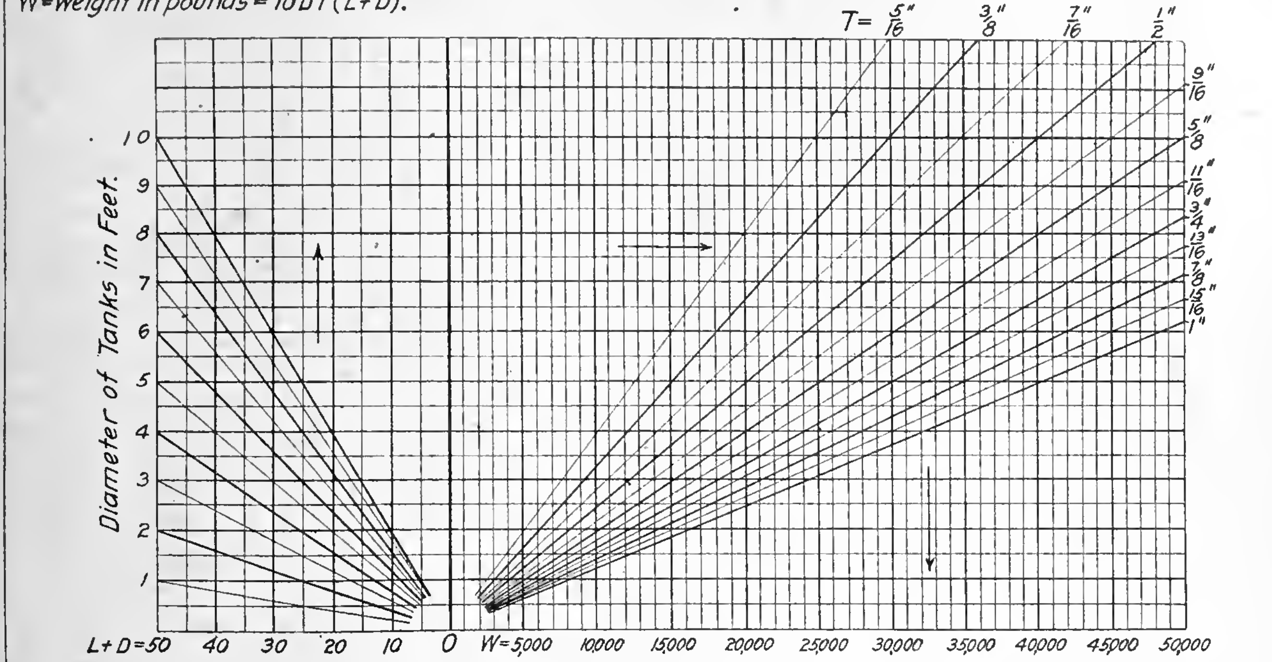
Contributed by C. R. Whittier

WEIGHTS OF CYLINDRICAL PRESSURE TANKS—III

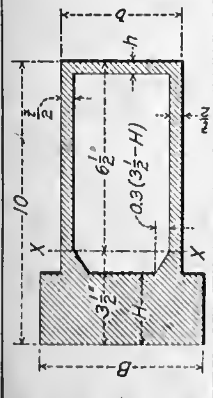
Average shipping weights of cylindrical pressure and discharge tanks with dished heads $\frac{1}{16}$ inch thicker than shell, and with manholes, nozzles and inside pipes, compiled from actual tanks.

L = length in feet,
D = diameter in feet,
T = thickness in 16ths of an inch,
P = pressure per square inch,
W = weight in pounds = $10DT(L+D)$.

For double strap, triple riveted long. seams, $T = 0.01DP$ (min. $= \frac{5}{16}$) $W = P\left(\frac{G}{60} + 0.1D^3\right)$,
For lap joint double riveted long. seams, $T = 0.013DP$ (min. $= \frac{5}{16}$) $W = P\left(\frac{G}{46} + 0.13D^3\right)$,
For lap joint single riveted long. seams, $T = 0.016DP$ (min $= \frac{5}{16}$) $W = P\left(\frac{G}{37} + 0.16D^3\right)$,
G = capacity in gallons $= 6LD^2$



PROPERTIES OF SECTIONS FOR PUNCH AND SHEAR FRAMES—IV



S_c = Section Modulus for Compression,
S_t = Section Modulus for Tension,
A = Area of Section,
I = Moment of Inertia about Gravity Axis X-X

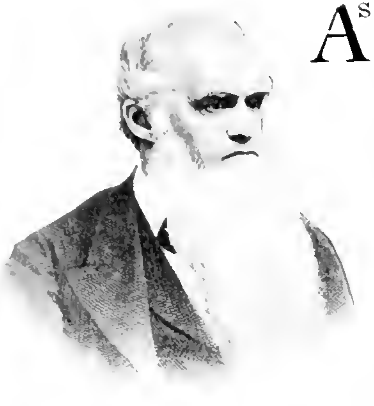
B	b	$h=\frac{t}{2}$	H	A	I	S_c	S_t	B	b	$h=\frac{t}{2}$	H	A	I	S_c	S_t
10	10	¼	0.57	15.36	228.51	35.20	65.40	8	7	⅝	3.00	36.41	377.05	58.0	108.0
"	"	⅜	1.10	23.43	311.78	47.95	89.10	"	6	¼	0.43	12.43	155.80	23.9	44.5
"	"	½	1.80	31.82	397.83	61.20	113.70	"	"	⅜	0.91	18.07	221.14	34.0	63.1
"	9	¼	0.51	14.66	200.77	30.89	57.36	"	"	½	1.50	24.20	283.77	43.5	80.8
"	"	⅜	0.99	21.64	290.32	44.66	82.95	"	"	⅝	2.36	31.79	339.75	52.3	96.9
"	"	½	1.61	29.56	371.95	57.22	106.27	"	5	¼	0.33	11.61	139.76	21.42	39.9
"	"	⅝	2.41	38.69	438.24	67.44	125.21	"	"	⅜	0.75	16.81	204.37	31.41	58.4
"	8	¼	0.44	13.87	180.98	27.80	51.50	"	"	½	1.25	22.27	261.65	40.25	75.2
"	"	⅜	0.88	20.41	272.07	41.90	77.70	"	"	⅝	2.00	29.00	310.74	49.7	88.8
"	"	½	1.38	27.27	345.47	53.20	98.50	"	"	¾	2.75	35.66	350.65	54.0	100.0
"	"	⅝	2.04	35.20	410.37	63.10	117.00	7	7	¼	0.70	13.52	169.40	26.04	48.4
"	"	¾	3.50	49.63	462.98	71.20	132.00	"	"	⅜	1.40	19.99	243.80	37.5	69.6
"	7	¼	0.38	13.15	172.76	26.50	49.30	"	"	½	2.44	27.28	310.80	47.8	88.8
"	"	⅜	0.77	19.21	261.46	40.30	74.60	"	6	¼	0.55	12.55	147.20	22.6	42.1
"	"	½	1.24	25.69	320.52	49.30	91.50	"	"	⅜	1.14	18.27	220.03	33.8	62.8
"	"	⅝	1.74	32.24	378.80	58.30	108.00	"	"	½	2.00	25.17	282.60	43.4	80.8
"	"	¾	2.34	39.42	428.57	65.90	122.60	"	5	¼	0.41	12.28	136.92	20.0	39.1
9	9	¼	0.59	14.66	204.06	31.40	58.30	"	"	⅜	0.95	16.98	203.40	31.0	58.0
"	"	⅜	1.20	21.57	291.47	44.80	83.40	"	"	½	1.65	23.03	258.64	40.0	73.8
"	"	½	2.00	30.68	363.50	55.80	103.60	"	"	⅝	2.55	30.36	302.60	46.5	86.5
"	8	¼	0.50	13.83	185.91	28.60	53.65	"	4	¼	0.31	10.96	124.20	19.12	35.5
"	"	⅜	1.00	20.34	268.15	41.28	76.65	"	"	⅜	0.76	15.71	183.00	28.15	52.3
"	"	½	1.70	28.07	338.66	52.15	96.81	"	"	½	1.31	20.80	232.20	35.7	66.4
"	"	⅝	2.60	37.12	403.27	62.10	115.12	"	"	⅝	1.98	26.30	275.00	42.3	78.6
"	7	¼	0.42	13.00	173.33	26.60	49.80	6	6	¼	0.68	12.56	156.25	24.0	44.6
"	"	⅜	0.89	19.25	250.41	38.40	71.60	"	"	⅜	1.56	18.79	222.10	32.6	60.5
"	"	½	1.42	25.65	317.24	48.80	90.50	"	"	½	3.50	30.00	275.00	42.3	78.6
"	"	⅝	2.11	33.03	375.00	57.70	107.10	"	5	¼	0.53	11.68	180.83	29.0	51.6
"	"	¾	3.06	42.13	420.36	64.60	120.10	"	"	⅜	1.27	17.25	214.79	33.0	61.4
"	6	¼	0.36	12.40	161.70	24.90	46.20	"	"	½	2.35	24.15	253.85	39.0	73.4
"	"	⅜	0.75	17.92	226.20	34.80	64.70	"	4	¼	0.38	10.88	125.59	19.3	35.8
"	"	½	1.23	23.89	290.50	44.70	83.00	"	"	⅜	1.00	15.84	181.36	27.9	51.8
"	"	⅝	1.79	30.22	345.70	53.10	100.60	"	"	½	1.80	20.87	228.96	35.2	65.4
"	"	¾	2.62	38.26	392.00	60.30	112.00	5	5	¼	0.73	11.76	139.73	21.5	40.0
8	8	¼	0.62	14.09	187.46	28.90	53.55	"	"	⅜	1.70	17.28	196.98	30.2	56.2
"	"	⅜	1.20	20.50	268.38	41.30	76.70	"	4	¼	0.55	10.97	125.40	19.3	35.9
"	"	½	2.10	28.79	336.75	51.80	96.20	"	"	⅜	1.45	16.13	181.52	28.0	52.0
"	7	¼	0.55	13.69	172.25	26.50	49.20	"	3	¼	0.84	10.16	110.14	17.25	32.0
"	"	⅜	1.10	19.50	248.56	38.30	71.10	"	"	⅜	1.12	14.90	167.70	25.70	47.6
"	"	½	1.90	27.07	315.01	48.50	90.00	"	"	½	2.10	19.99	198.57	30.50	56.8

MACHINERY

July, 1910

HISTORY OF THE INVENTION OF THE UNIVERSAL GRINDING MACHINE

By LUTHER D. BURLINGAME

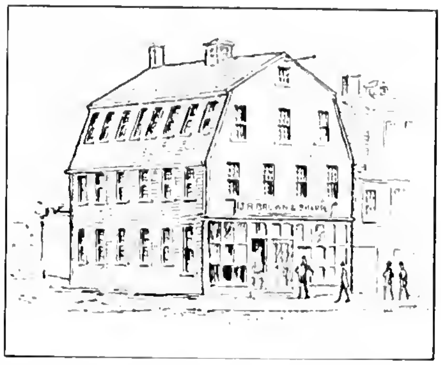


Joseph R. Brown, born January 16, 1810, died July 23, 1876

As far as the writer knows the early history of the universal grinding machine has never been recorded in print. This machine is one which has had such an influence on modern machine methods and has done so much to raise the standard of workmanship and to increase economy of production that it is believed that its history should be recorded while the records still exist and while the memory of living men can be drawn upon for the facts necessary to complete it.

In investigating this matter it has been interesting to trace the progress from the crude grinding lathe of the early 60's, step by step, to a complete universal machine, a progress with which Mr. Joseph R. Brown, senior member of the firm then doing business under the name of J. R. Brown & Sharpe, was intimately connected in all its steps.

The grinding machine as first built at the Brown & Sharpe works was for the accurate and economical manufacture of their own products without thought of putting the machines on the market. In this respect, its origin and development were very much like the origin and development of the universal milling machine and other machine tools which have originated in the works of this company. The first work for which the grinding machines were designed was for grinding needle bars, foot bars, and shafts of the Wilcox and Gibbs sewing machine. This was done by mounting an emery wheel on the carriage of a lathe and traversing it back and forth past the work.



Old Shop in South Main St., Providence, R. I., where the Universal Grinding Machine was invented and first built

In 1864 and 1865 drawings were made and machines built using parts of a 14-inch Putnam lathe, mounting a wheel stand as above mentioned and adding a feeding mechanism including a reverse. One of these early machines is still in use in the Brown & Sharpe works, although the feed mechanism and footstock have been removed. It is now used for grinding the faces of dies. This machine in its present form is shown in Fig. 1. It bears an old brass plate stamped "Grinding Machine by J. R. Brown & Sharpe." The construction of the wheel stand and feed mechanism of this machine is shown in Fig. 2 and Fig. 6 reproduced from the original drawings.

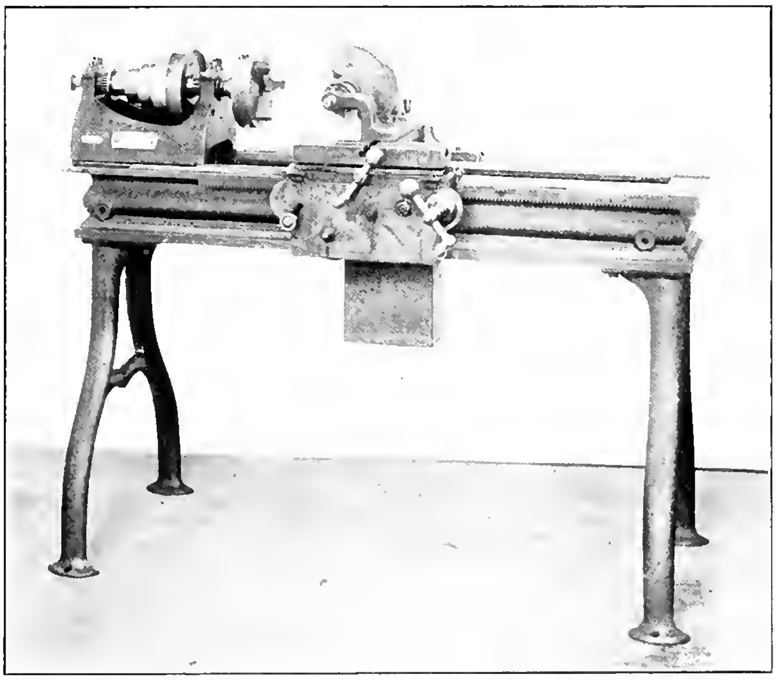


Fig. 1 One of the Original Brown & Sharpe Grinding Machines—a 14-inch Putnam Lathe converted for the Purpose

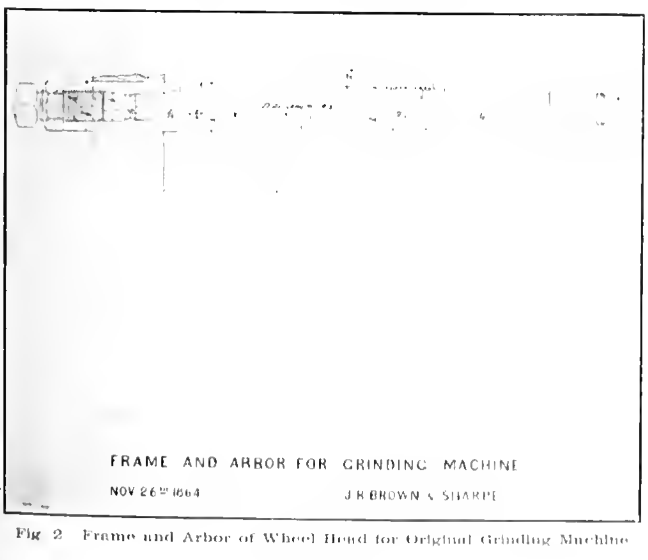
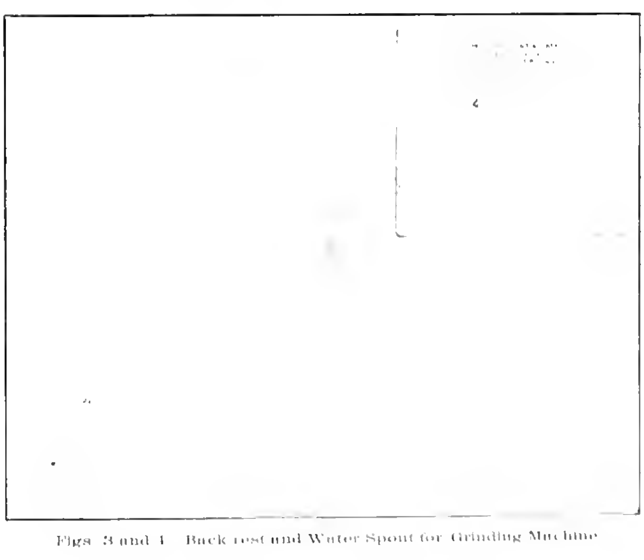


Fig. 2 Frame and Arbor of Wheel Head for Original Grinding Machine



Figs. 3 and 4 Back rest and Water Spout for Grinding Machine

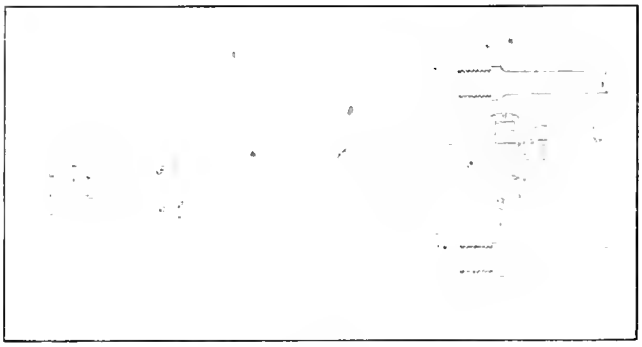


Fig 5. Dead Center Pulley for Grinding Machine

That cylindrical grinding was done in the Brown & Sharpe works at an earlier date than that of these drawings is indicated by the drawing of a back-rest dated September 22, 1862, which contains the essential features of a solid back-rest of to-day. This is shown in Fig. 3. A spring back-rest was also used for finishing and was applied by having a spring rod extending from the footstock, this rod carrying leather washers which pressed against the work. Skill in adjusting this back-rest was required to prevent chattering. A dead center pulley, an important step in the development of the grinding art, is shown in Fig. 5, reproduced from a drawing made in 1864. Wet grinding was done on these early machines by using a wet sponge held by hand against the work. The sparks were quenched in a dish of water placed below the work. Later a supply of water was provided through a nozzle shown in a drawing dated December 22, 1866, Fig. 4.

During the next few years about thirty of these machines were built and sold, the same plan being followed of using Putnam lathes, partly dismantled. These were bought ready to apply the parts which were built and applied at the Brown & Sharpe works. The first machine was sold to the Leavitt Sewing Machine Co. of Boston, Mass., in July, 1865; the second one was sold to Charles Callefaut, Paris, France, and included apparatus for grinding bevel cutters. Several of these machines were in constant use in the shops of J. R. Brown & Sharpe on the sewing machine parts, but work kept piling up ahead of them and could not be hurried as a considerable amount of time and a high degree of skill were required to produce work of a sufficiently high standard on such machines. There were also many kinds of work where finishing by grinding would be an advantage, but which could not be done on this machine. During these years Mr. Brown had constantly in mind the need of building a machine designed from the floor up especially for grinding, and he considered the matter to such good purpose, that in 1868 he had a drawing made of such a machine. This drawing shows a machine containing most of the essential elements of the universal grinding machine of to-day. Un-

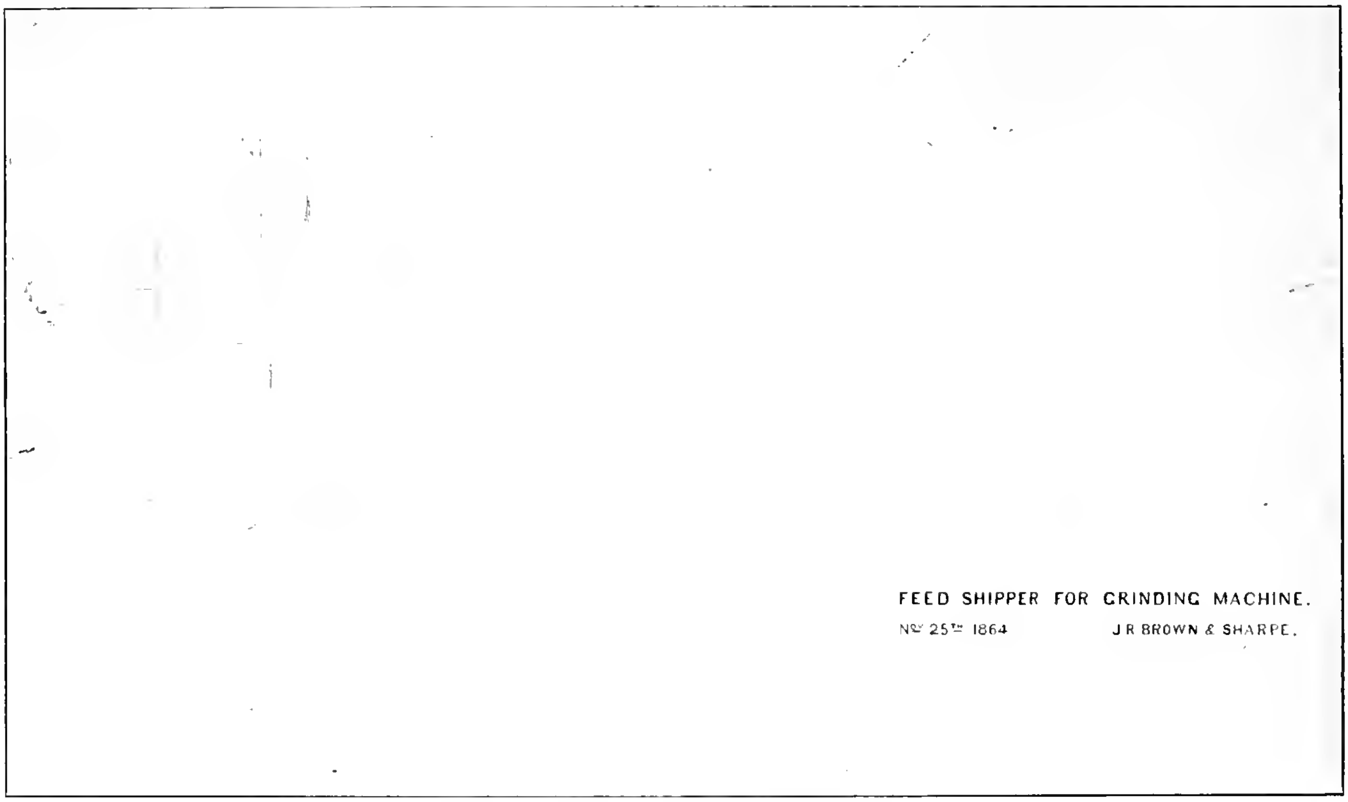


Fig 6 Feed Shipper for Original Grinding Machine

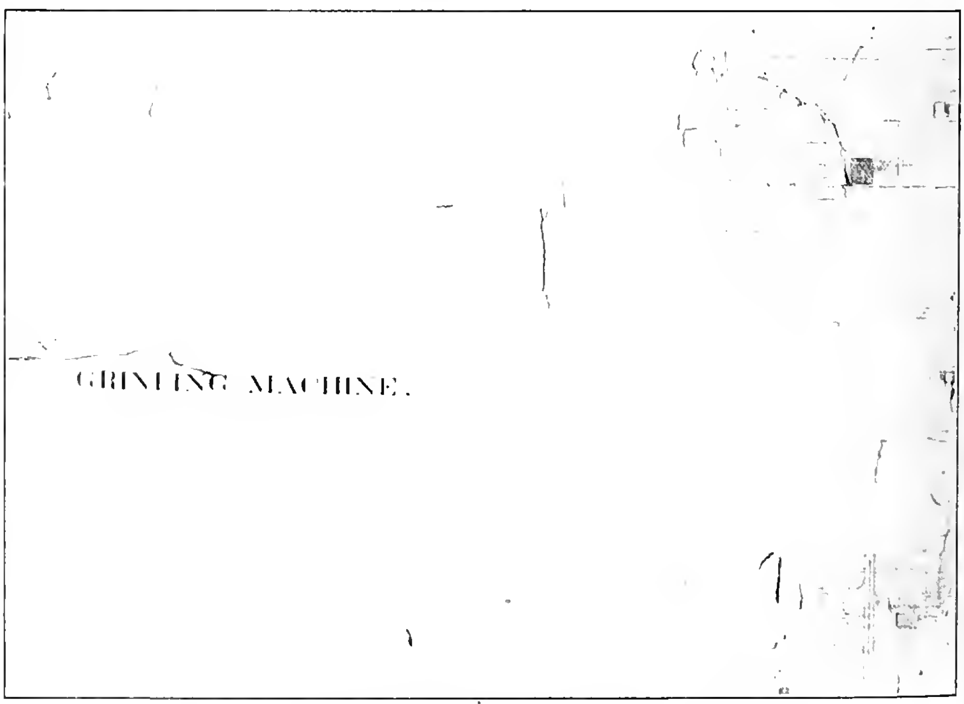


Fig 7 Part of Mutilated Drawing of Grinding Machine made in 1868

fortunately it is made with the fine lines which, in those days, were considered the marks of an expert draftsman, and the drawing is also much the worse for wear. Its historic interest is such, however, that parts of it are here shown in Figs. 7 and 8. This machine has the same wheel stand as that of the earlier grinding lathe shown in Fig. 2, but instead of having the wheel travel, there is a sliding table carrying a swivel table on which are mounted the headstock and footstock, the headstock also being arranged to swivel. This drawing did not, however, show a machine having a swivel wheel stand.

As far as known, none of these machines were built at this time on account of pressure of other matters, but in 1874 working drawings were made for a machine which included a swiveling wheel stand as well as other features of improved construction. One of the drawings of this machine is shown in Fig. 10. This drawing shows stops on the cross-feed handwheel, a feature which had been previously used on the earlier grinding lathe, but of which no record could be found. The machine shown in Fig. 10 also indicates some attempt at providing for carrying off the water used in grinding. An interesting feature of the wheel spindle of this machine shown in Fig. 11 is that its bearings and boxes being of hardened steel and having double tapers would seem to require the use of a universal grinding machine to produce them. It would be an interesting bit of history to know just how the first ones were produced. It is hard for us in these days to appreciate just what our ancestors had to contend with in obtaining results without the machines and tools which we consider essential to-day. One of the machines of this design was sold to E. Cornely, Paris, France, on January 3, 1876. This, however, was not the first machine built, the first machine being reserved to be exhibited at the Centennial Exposition in 1876. It was sold at the close of the exposition to M. M. Heilman-Ducommun & Steinlen, Mulhouse, Alsace, Germany. The first machine sold in America was to the Whitehill Mfg. Co., of New York City, the following year.

The judges at the Centennial Exposition, in commenting on the Brown & Sharpe exhibit, after speaking of the machines in general which they said "are characterized by great neatness of design and excellence of execution," continued: "Their universal grinder is an exceedingly substantial and well studied machine whose working details are exceptionally well managed for facilitating the work it is to perform."

In a history of the Centennial Exposition by Thomas Bentley, published in 1876, is shown a cut of this first universal grinding machine, which is here reproduced in Fig. 12. The comments of the author may be of interest as showing an appreciation of the trend of the times and as something of a prophecy. He says of the Brown & Sharpe exhibit:

"The superior class of tools here represented are of a character fitted to elevate the standard of workmanship in connection with machine shop manipulation. Accurate tools like these produce accurate and interchangeable work, cheapening production and at the same time giving that perfection which is becoming more and more indispensable in the sharp competition attending the manufacture of machinery. The machines themselves illustrate this in their fine workmanship and finish, and in the nice adaptability of their motion and parts to produce the required work."

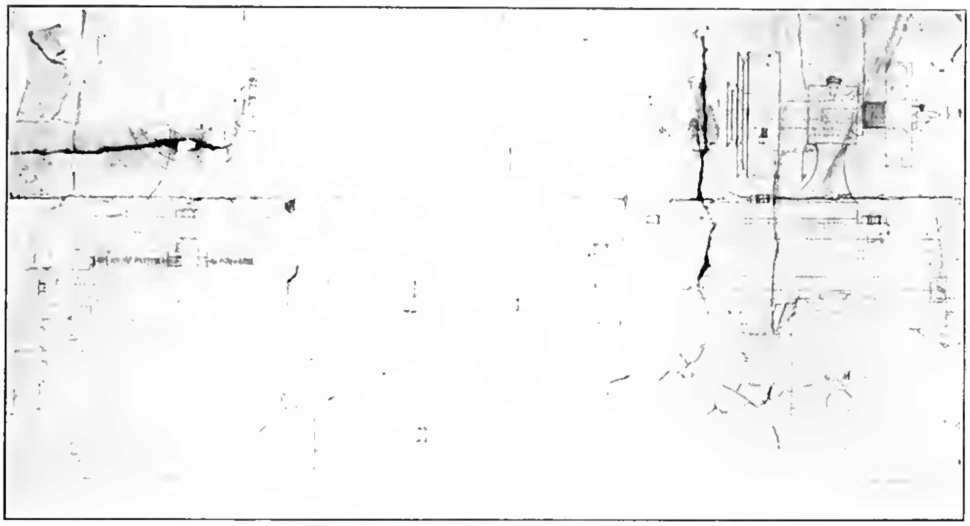


Fig. 8 Another Part of Mutilated Drawing of Grinding Machine made in 1863

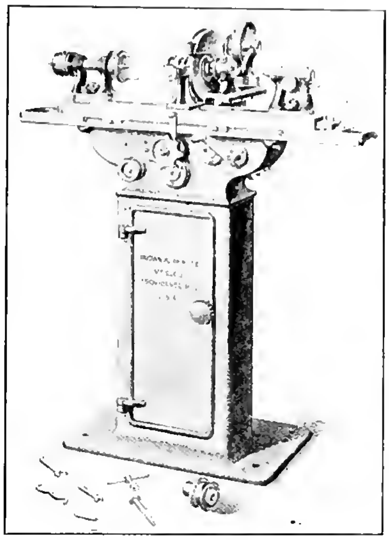


Fig. 9 "The Baby Grinder"

On the death of Mr. Brown in 1876, application was made by his executors for a patent on the universal grinding machine, and it was issued on February 27, 1877. Figs. 1, 3 and 4 of this patent are here reproduced as Figs. 13 and 14, and give a fair idea of the mechanism of the machine as it existed at that date. It will be noticed that these patent office drawings show a machine for form grinding, in addition to the ordinary features of a universal machine. A smaller machine was designed a few years later, which is shown in Fig. 9. This was known for many years in the shop as the "Baby Grinder," a name which still persists among older employes.

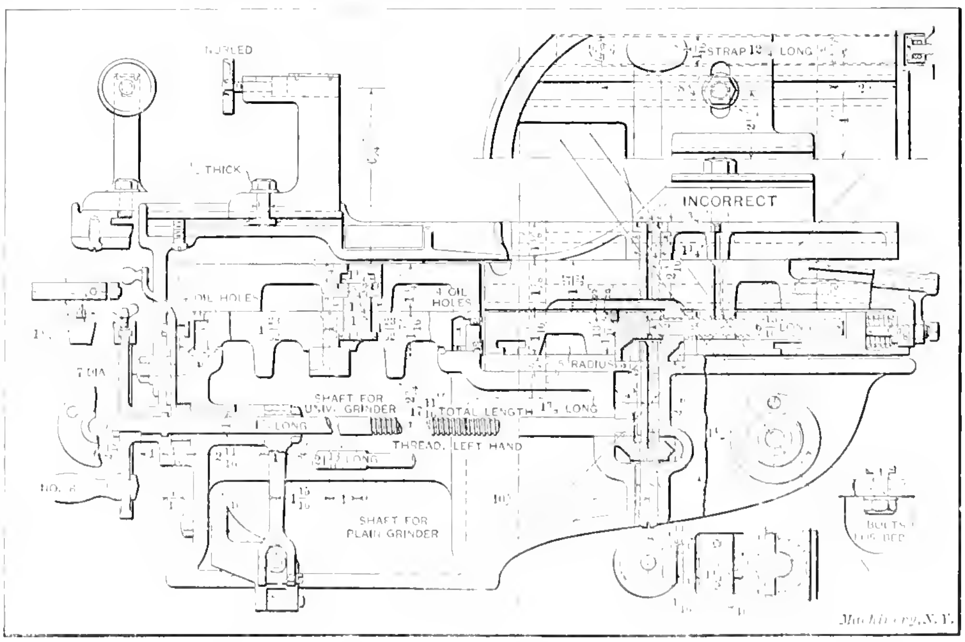


Fig. 10 Part of Drawing made in 1874 of Grinding Machine with Swiveling Wheel Stand

While the development of the grinder art since the Centennial Exposition has brought out many improvements and refinements, the essential principles of the universal grinding machine are found in the machines here described, and are as Mr. Brown left them at the time of his death in 1876.

MACHINE SHOP FLOORS

The question of what kind of floor to put into a new machine shop has become a rather vexing one of late, because the rising cost of lumber has made the wood floor an expensive matter, while the granolithic and other artificial surfaces that have come into use have often proved disappointing in wearing

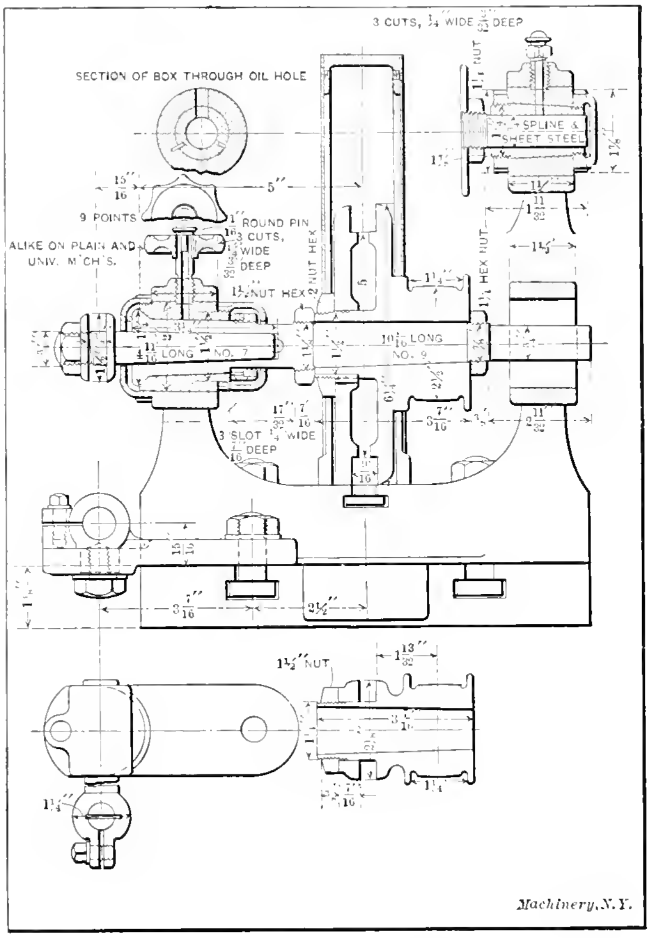


Fig. 11. Details of Wheel Stand of Grinding Machine designed in 1874

qualities, although at the same time they are cheaper than the wood floor. This whole question is thoroughly discussed in a pamphlet called "Wearing Surfaces for Factory Floors," in which the Abertbaw Construction Co., of Boston, reports the results of its investigation into the experience with different

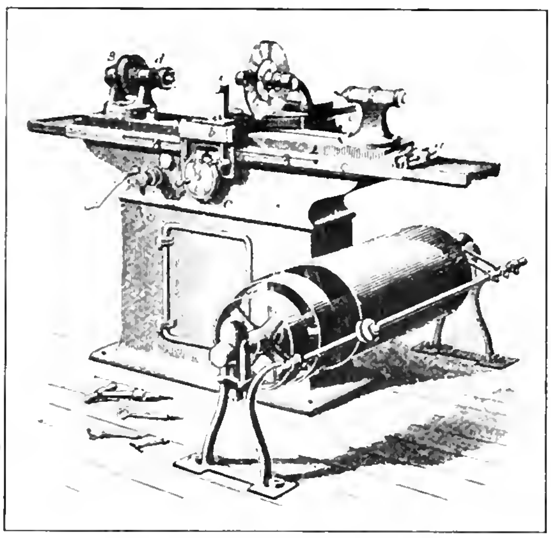


Fig 12 The First Universal Grinding Machine, exhibited at the Centennial Exposition in 1876

floor surfaces of a large number of machine shops and factories.

Discussing the general principles of cost and construction of the two types of floor surface in fireproof buildings, the Aberthaw Co. says that the granolithic finish has the advantage in the points of first cost of the surface itself and in cost of the whole structure. It points out that the wood floor laid on

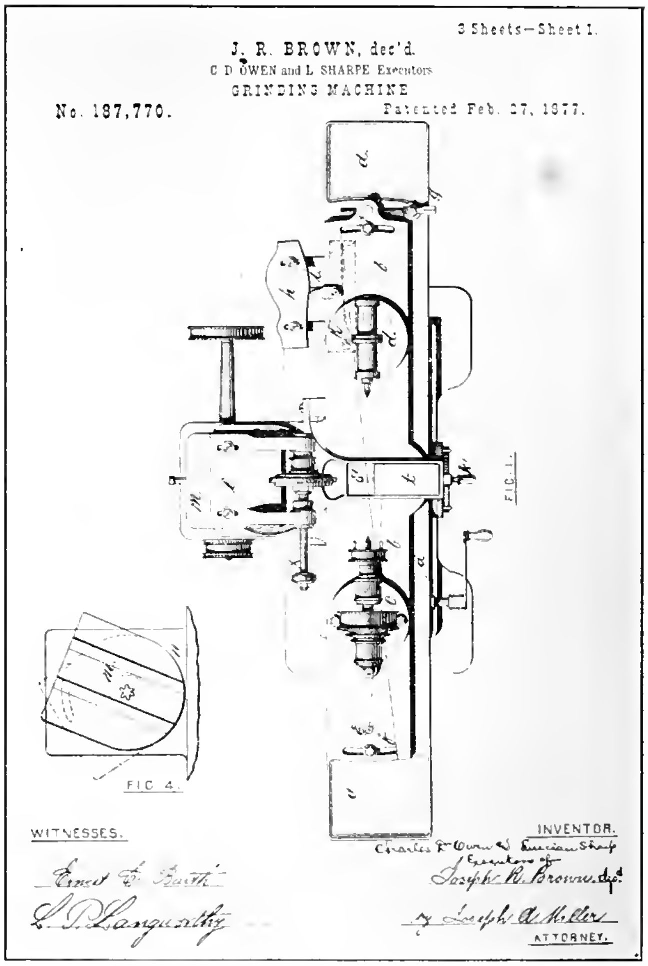


Fig 13. Patent No. 187,770 granted to Estate of J. R. Brown for the Universal Grinding Machine

concrete floor slabs is a dead weight on the supporting structure, and necessitates an increase in thickness of floor slabs,

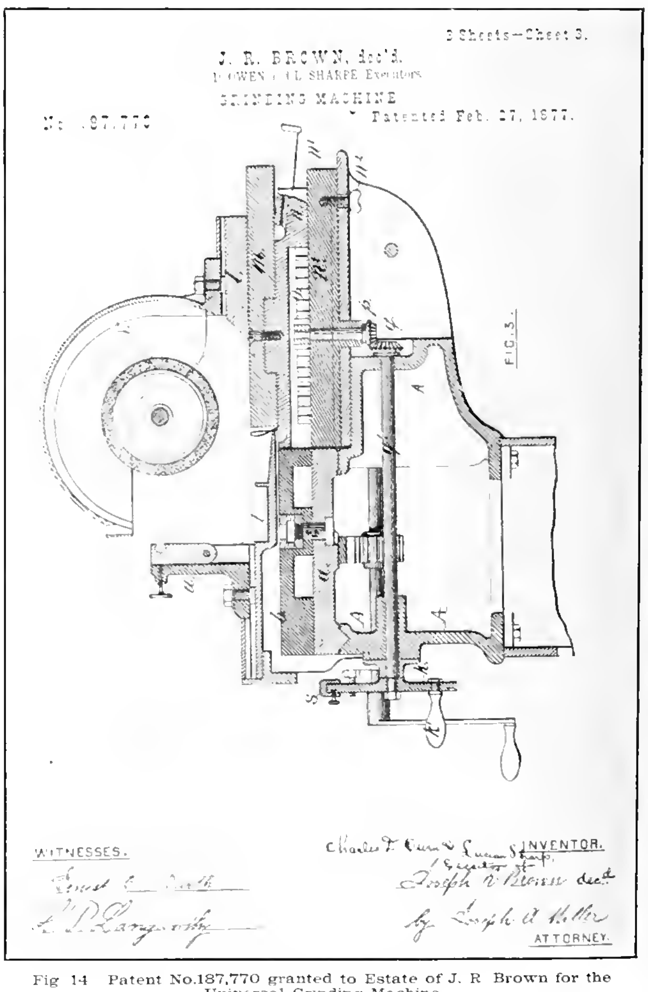


Fig 14 Patent No.187,770 granted to Estate of J. R Brown for the Universal Grinding Machine

size and number of reinforcing members, and also of supporting pillars. In contrast, the granolithic finish, if it is laid as it should be before the concrete of the floor slab has become dry, forms an integral part of the floor slab and takes part of the compression strains. In other words, the granolithic finish laid on the green floor slab is not a dead weight like the wood floor, but is an actual strengthening of the floor slab. This means thinner slabs, lighter supports, and a general lower cost per cubic foot for the whole building.

In making its investigation the company put two questions to a large number of factories of various sorts; machine shops, engineers and architects in the northern and eastern part of the country, these questions being the following:

1. From your experience, do you believe that a granolithic or other masonry surface is actually bad for the operatives, and if so, why?

2. What objections do you know to granolithic finish that would make it advisable to incur greater expense for some other wearing surfaces?

Machine shops returned 68 per cent of the whole number of 118 replies. Of these machine shops, 27 per cent had had no experience with granolithic floors; 25 per cent recommended granolithic floors both in regard to the health of operatives and to the wearing qualities of the surface; 48 per cent offered more or less unfavorable criticism as to the wearing qualities or the effects on operatives from a granolithic surface.

The first question is disposed of in this report by the frank admission that where operatives have to stand still in one place on granolithic floor, they are likely to suffer somewhat from soreness of the feet and lameness of the legs, owing to the fact that concrete is a good conductor of heat and therefore chills the legs of operatives who stand still upon it. The two remedies suggested for this condition are: First, movable gratings of wood or other non-conducting material for workmen who have to stand still, as at a bench or lathe; second, the heating of concrete floors by running through the floor slab hot air ducts or steam pipes so that the floor slab shall be a radiating surface for the warming of the whole building. This system has been tried out with remarkable success in the plant of the Morse Chain Co., at Ithaca, N. Y.

In regard to the wearing qualities of granolithic floors, the company declares that the granolithic surface, if laid according to correct principles and with thoroughgoing, careful workmanship, will be free from dust and will give more and better service for general factory purposes than any other wearing surface. A set of specifications showing its own practice gives the details of what it considers correct theory and good workmanship. The granolithic surface, improperly constructed, the report says, is certain to fail—to be dusty, to crack abundantly, to chip under blows, and to wear away under trucking. A good deal of emphasis is put on the matter of wear by trucking. No masonry surface can long withstand the wear of heavy trucking when trucks are fitted with flat, sharp-edged, iron wheels. For such service a special design of steel plate embedded in the soft concrete, or the use of embedded racks made of small flat bars separated by thick washers and bolted together, are recommended.

The report is not, however, a partisan tract which attempts to give all credit to granolithic surface and none to others. On the contrary, it explicitly states that under many conditions the wood top floor is preferable to granolithic finish. One situation of this sort is that in which the conditions required for the construction of a perfect granolithic surface, cannot be obtained. If the granolithic surface cannot be made properly, it will be unsatisfactory, and it is better to lay a wood floor than to lay a defective granolithic surface. Some special manufacturing conditions also make the wood surface preferable even at higher cost, as for instance, when the manufactured product is very delicate and would be injured or destroyed if dropped upon a masonry surface. Several specifications are given in the report showing the practice of certain prominent engineers in the laying of wood top floors on cement base and on a tar concrete base.

* * *

Don't forget, when working around punch presses, that you need all your fingers, and that they will never grow out again; neither are there any more in stock.

THE DESIGN OF FLAT SPIRAL SPRINGS*

By L. J. BUTZOW†

The calculation and design of helical and elliptic springs has recently been treated in MACHINERY; but little has been published on the design of flat spiral springs. The following is an exposition of the principles entering into the calculation of this class of springs, and the most important equations have been deduced so that the reader who has little time for mathematics can obtain an idea of the subject and the use of these equations merely by studying the sample calculation given in the latter part of the article. The discussion on the energy of flat springs is applicable in particular to large springs which dissipate an appreciable portion of the stored energy through friction between consecutive convolutions.

In the following, let

r = radius of case, Fig. 1,
h = radius of hub, Fig. 1,
a = inside radius of unwound spring, Fig. 2,
b = outside radius of wound spring, Fig. 3,
t = thickness,
L = length,
T_u = number of turns in the unwound spring,
T_w = number of turns in the wound spring,
T = number of turns to wind spring,

The number of turns to wind the spring is equal to the difference between the number of turns in the wound spring and the number of turns in the unwound spring.

$$T = T_w - T_u \tag{1}$$

From the figures it is seen that

$$T_w = \frac{b-h}{t} \quad \text{and} \quad T_u = \frac{r-a}{t}$$

Substituting, we have

$$T = \frac{b-h-(r-a)}{t} \tag{2}$$

From the figures it is also seen that

$$\pi r^2 = \pi a^2 + Lt, \text{ or } a = \sqrt{r^2 - \frac{Lt}{\pi}}$$

Also

$$\pi b^2 = \pi h^2 + Lt, \text{ or } b = \sqrt{h^2 + \frac{Lt}{\pi}}$$

Substituting for a and b in equation (2), we have,

$$T = \frac{1}{t}\left(\sqrt{r^2 - \frac{Lt}{\pi}} + \sqrt{h^2 + \frac{Lt}{\pi}} - r - h\right) \tag{3}$$

which gives the number of turns which may be obtained from a spring of given thickness t and length L when placed in a case of radius r and wound on a hub of radius h.

The principal interest in equation (3) relates to the conditions which will give the maximum number of turns. By means of calculus we can find that T becomes a maximum when

$$\sqrt{r^2 - \frac{Lt}{\pi}} = \sqrt{h^2 + \frac{Lt}{\pi}} \tag{4}$$

This equation, however, is simply $a = b$, and hence, the number of turns is greatest when the inside radius of the unwound spring is equal to the outside radius of the wound spring. The spring, in other words, should fill just half of the area provided.

Solving equation (4) for L, we have,

$$L = \frac{1}{2} \times \frac{\pi}{t}(r^2 - h^2) \tag{5}$$

which gives the relation for best proportions.

Substituting for L in equation (3)

* For additional information relating to the design and calculation of springs, see MACHINERY, January, 1910, engineering edition: "The Design of Automobile Springs," and the articles there referred to. See also MACHINERY'S Reference Series No. 58, "Helical and Elliptic Springs."

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$$T = \frac{1}{t}\left(\sqrt{r^2 - \frac{1}{2}(r^2 - h^2)} + \sqrt{h^2 + \frac{1}{2}(r^2 - h^2)} - (r + h)\right)$$

$$T = \frac{1}{t}\left(\sqrt{2(r^2 + h^2)} - (r + h)\right) \qquad (6)$$

which gives the maximum number of turns available with a given case, hub, and thickness of spring.

The above formula, when correctly applied, gives reasonably accurate results. In the calculations, the thickness of the spring should be assumed to be a little greater than the micrometer measurement, to allow for the small spaces existing between adjacent coils. The radius h should be taken large enough not only for the hub, but also for the spring fastening. The radius r must be taken a little smaller than the radius of the case to make up for the connection of the spring at its outside end.

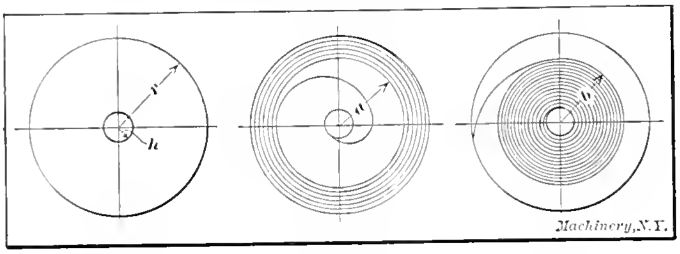


Fig. 1 Fig. 2 Fig. 3

Relation between Torque and Number of Turns

The next step is to obtain the relation between torque and number of turns. A number of springs have been tested by measuring the torque developed at each turn of the hub throughout the process of winding and unwinding the spring. These data were then plotted and a smooth curve drawn through the points. A sample curve is shown in Fig. 4.

Logarithms of the abscissas and ordinates of a number of points were taken from the descending (lower) part of each curve, and plotted out as shown in Fig. 5. Straight lines were then drawn through the points. The inclination or angle of these lines is such that the tangent of the angle with the horizontal base line is 2/3. If this is assumed to be correct, the torque, while unwinding, may be expressed by the product of a constant times the 2/3 power of the number of turns. The lines would probably agree more closely with the points if drawn at a somewhat smaller angle, but the lines as drawn provide for a simple mathematical expression and serve the purpose very well. A greater torque is required when winding the spring, due to the friction. When rapidly unwinding, a spring will not produce as great a torque as indicated by the diagrams, which merely show the torque that might be expected from the spring if it were stopped at any point while unwinding; but the diagrams and the equations in the following are of value for making comparisons.

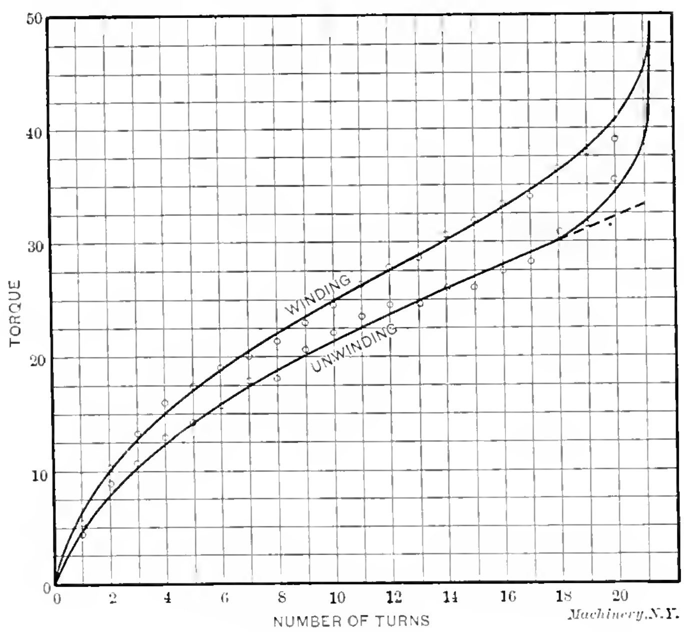


Fig. 4 Diagram showing Plotted Relation of Torque to Number of Turns in a Given Spring

The constant required depends upon the dimensions of the spring and the material and method of treatment. The effect of varying the thickness of the spring is to vary the torque at any given position by approximately the cube of the thickness, and to reduce the number of turns as shown by the formula already given. Varying the diameter of the hub and the length of the spring with small hubs and long springs principally affects the available number of turns. The relation between turns and length for a given hub and case is shown in Fig. 6.

In Merriman's "Mechanics of Materials" the following formula may be found:

$$\frac{S}{C} = \frac{E}{R}$$

where S = maximum fiber stress,
C = distance from neutral axis to remotest fibers,
R = radius of curvature,
E = coefficient of elasticity.

Then, for a spring tempered flat, it is evident that the part next to the hub will be subjected to the greatest stress. The radius of curvature at any given point on the spring very closely approximates its distance d from the center of the hub. Then the above formula may be written

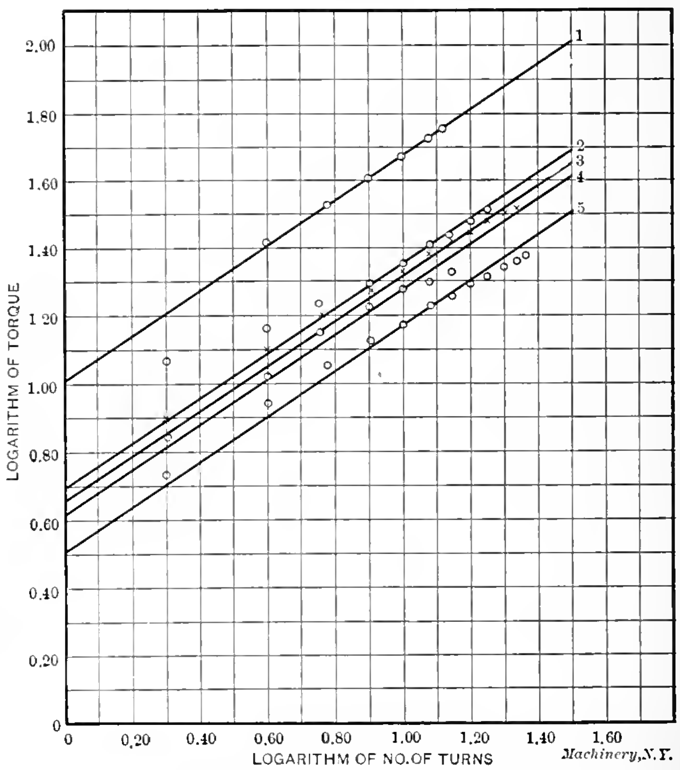


Fig. 5 Diagram showing Method of obtaining Formula giving Relation between Torque and Number of Turns

$$\frac{S}{C} = \frac{E}{d}$$

This gives a method for finding the radius of the hub. This radius should not be so small as to cause the fiber stress to pass beyond the elastic limit except when necessary to meet commercial conditions. In many cases, where the space is limited, it would be advantageous to temper the entire spring, or at least the inside end of it, on a psiral curve, and in that way allow for a small hub and still keep the stress within working limits. If the entire spring is formed to a curve when tempered, it should be so proportioned as to give a constant uniform stress throughout the spring when fully wound. It is evident, however, that this would materially increase the cost of production.

Assume $P = KT^{\frac{2}{3}}$, where P = torque, and K = constant.

Let E = energy in foot-pounds. Then by the methods of calculus

$$E = \frac{6\pi K T^{\frac{5}{3}}}{5}$$

which gives the relation between number of turns and available energy at slow speed for a given spring. This energy is equal to a constant times the cube root of the fifth power of the number of turns.

The amount of energy which may be stored in a given spring is approximately proportional to its weight, and is equal to about 60 foot-pounds per pound of spring. A relatively thick spring of few turns will store no more energy than a thin spring of many turns, provided the weights are equal. On account of this it is also evident that the torque may be increased without changing the number of turns, by merely increasing the width of the spring. If the torque is sufficient, but a greater number of turns is required, the spring should be lengthened. Should it be found that a smaller torque with a given number of turns, or fewer turns with the given torque is sufficient, then material may be saved by reducing the weight of the spring even if the same case is used. When it is found that the capacity of the spring is adequate but that its torque and turns are not correctly proportioned, the difficulty may be adjusted by varying the length and cross-section, keeping the weight constant.

As a practical example suppose that a maximum available torque of 50 pounds is required from a spring having 30 turns. Assume that the spring is tempered flat.

$$\text{Torque} = K T^{\frac{2}{3}}$$

$$50 = K\, 30^{\frac{2}{3}} = K \times \sqrt[3]{30^2} = K \times 9.65$$

$$K = \frac{50}{9.65} = 5.2$$

$$\text{Energy} = \frac{6\pi K T^{\frac{5}{3}}}{5} = \frac{6\pi \times 5.2 \times \sqrt[3]{30^5}}{5} = 5680 \text{ foot-pounds}$$

Assume 60 foot-pounds per pound of spring. Then,

$$\text{Weight} = \frac{5680}{60} = 95 \text{ pounds.}$$

Assume radius of hub $= 3$ inches, maximum stress $= 200{,}000$ pounds, and $E = 30{,}000{,}000$. Then

$$\frac{S}{C} = \frac{E}{R},$$

$$C = \frac{3 \times 200{,}000}{30{,}000{,}000} = 0.02$$

$$t = 0.04$$

Allow 0.042 thickness, for non-uniformity of spring.

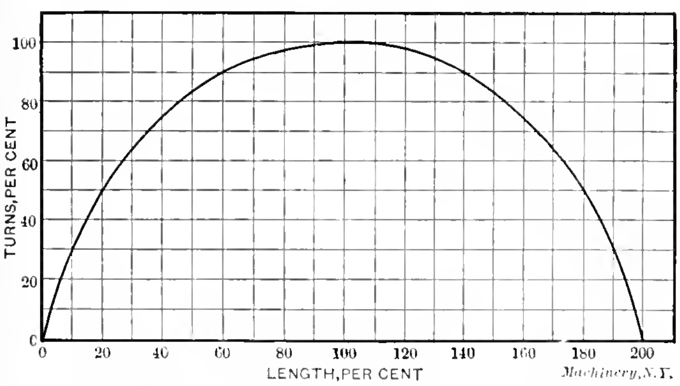


Fig. 6. Diagram of Relation between Number of Turns and Length of Flat Spring

From formula (6) we have, when $T = 30$, and $t = 0.042$:

$$30 = \frac{1}{0.042}\left[\sqrt{2\,(r^2 + 3^2)} - (r + 3)\right]$$

$r = 8.54$ inches, or diameter $= 17.08$, or about $17\frac{1}{8}$ inches.

From formula (5)

$$L = \frac{1}{2} \times \frac{\pi}{0.042}\,(8.54^2 - 3^2) = 2391 \text{ inches, or } 200 \text{ feet,}$$

nearly.

$$\text{Width} = \frac{95}{0.283 \times 2391 \times 0.040} = 3.5 \text{ inches, about.}$$

Hence, size of spring equals 0.04 inch $\times$ $3\frac{1}{2}$ inch $\times$ 200 feet; inside diameter of case inside of spring fastening, $17\frac{1}{8}$ inches; diameter of hub outside of spring fastening, 6 inches.

General Remarks

Springs as large as the one just calculated are used in spring motors. These motors may be built in several ways. When the external diameter is limited, a good method is to make the spring in sections and to place these sections on a shaft so that they may be fastened together. This may be done by providing the inside end of each sectional spring with a clip as shown in Fig. 7, which fits into a notch in the hub of the next case. Then all of the springs may be wound together and all will unwind together. The torque produced equals the torque of one spring, but the number of turns equals the sum of the number of turns of the individual springs. One of the advantages of this method is that if one spring breaks, it can be replaced at a lower cost than could a large spring that took the place of all the individual springs. The calculations previously given may be applied to this construction as well, by assuming that each sectional spring stores its relative portion of the required energy.

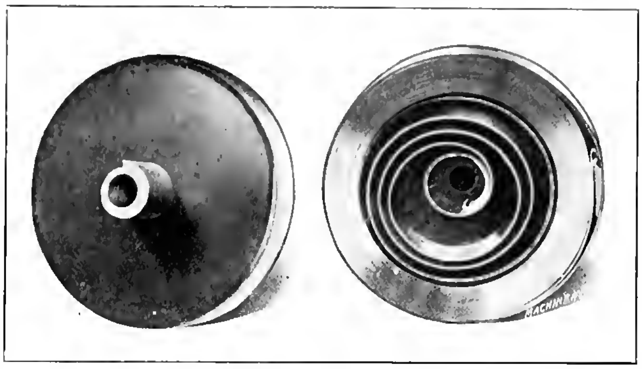


Fig. 7. Method of Arranging Springs "in Series" where the Space is Limited

* * *

SAFETY OF TRAVEL ON THE PENNSYLVANIA SYSTEM

Figures recently compiled by the Pennsylvania Railroad and its subsidiary lines show that in 1908 and 1909 a total of 299,762,658 passengers were carried on its 24,000 miles of track, and only one passenger out of this number was killed as a result of a train wreck. This is an extremely good record, and credit should be given to the management of the railway system to whose efforts in regard to car equipment, signaling systems, discipline and training of employes this result is due. If the same results were duplicated on other American railways there would be only about three passengers (instead of between three and four hundred) killed in train accidents yearly in the whole of the United States. During the same two years 370 passengers were injured in train wrecks. This is also a low figure compared with the total for the railways in the United States. In fact, the number of passengers injured in proportion to the number of passengers carried on the Pennsylvania lines is only about one-eighth of the average number injured on all the railways in the United States. This record of the Pennsylvania Railroad is all the more remarkable as its traffic is heavier than that of any other railroad in the country, which means that it operates more trains than any other railroad and hence would meet with more opportunities for accidents. The number of passenger collisions was two less and the number of freight collisions 15 less in 1909 than in 1908, while the number of freight derailments was 69 less in 1909.

As compared with the records abroad, the Pennsylvania Railroad holds a better record, even, as regards the small number of passengers killed than the German state railroad system, noted for its safety. As regards the number of passengers injured, however, several of the European systems are still ahead of the Pennsylvania Railroad.

SHOP HEATING BY DIRECT RADIATION*

By CHAS. L. HUBBARD†

While it is probably true that a large proportion of the shops and foundries erected at the present time are equipped with hot-blast heating, there are still many cases where for various reasons the older form of heating by direct radiation seems preferable to the owners, and to these a few practical points in regard to the proper methods of installing and operating a system of this kind may be of considerable value. For example, a shop may be heated by a system of direct radiation, which originally gave satisfaction, but which, owing to numerous changes and extensions, fails to operate properly. The owner may feel that it is necessary to install an entirely new system of heating, when perhaps a few changes or additions may make the old one as good as new. Again, an addition to the plant may be in progress and it is

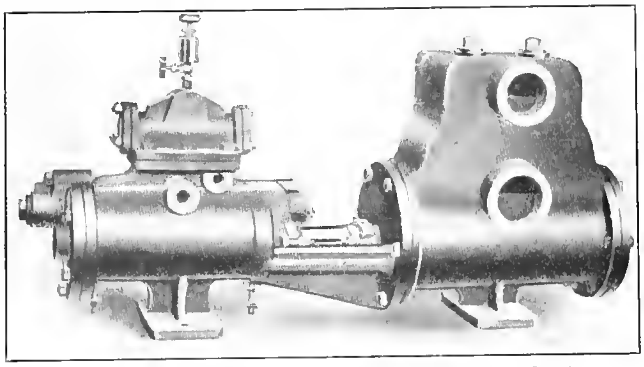


Fig. 1. Special Vacuum Pump for obtaining Necessary Suction in an Overloaded System

desired to extend the present system of direct heating rather than install a hot-blast apparatus in a single building. The object of this article is to give some of the faults of direct heating as commonly found in shops and factories, together with suggestions for overcoming them entirely or in part. Rules to be observed in laying out and installing new work will also be given, as well as a review of correct methods of extending present systems to include new buildings or additions to old ones. Some of the points to be considered in con-

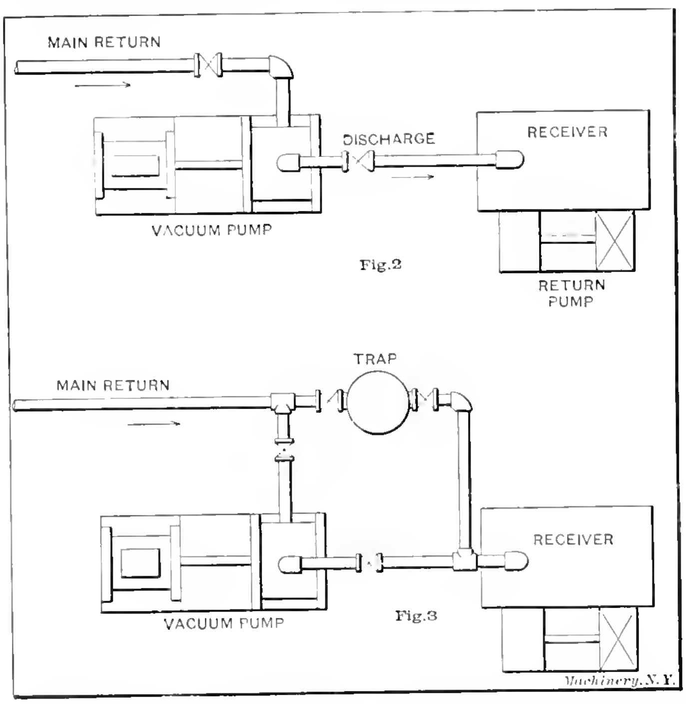


Fig. 2. Method of Connecting Vacuum Pump, used continually, to the Return. Fig. 3. Method of Connecting Vacuum Pump, when used only at intervals, to the Return

necting a heating system with a power plant will also be touched upon.

Faults of Direct Heating Systems

Among the most common causes of trouble in existing plants which have been changed and enlarged from time to time are small pipes, insufficient grading, and air binding. The system may have worked satisfactorily in the beginning, when doing only the work for which it was designed, but numerous additions have so overloaded the supply mains and branches that the pressure is considerably reduced in the

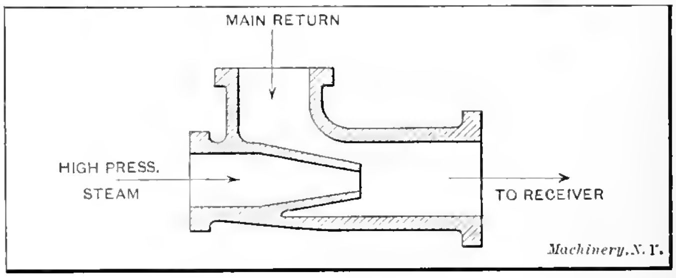


Fig. 4. Steam Ejector used for Cleaning the Pipes and Starting up the Circulation

more remote parts of the system. In addition to this, the returns are flooded by the increased amount of condensation, and the result is poor circulation of steam, cold pipes, and water-hammer.

Matters are made worse from the fact that there are usually no basements in which to carry sealed or wet returns; hence it is necessary to rely on drainage through dry returns, which are much more likely to give trouble than when the mains are sealed. Both supply pipes and overhead returns in extended systems are likely in time to sag and form pockets for the accumulation of condensation. This results in the

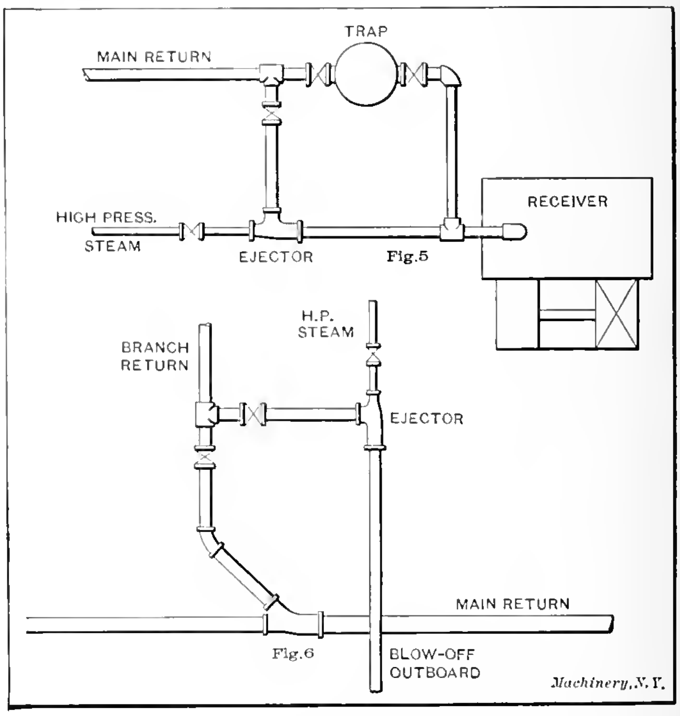


Fig. 5. Method of Connecting the Ejector with the Return Main. Fig. 6. Ejector connected with a Branch having Defective Circulation

holding back of air in certain parts of the piping and coils, and causes poor circulation and water-hammer.

About the only way to deal with a situation of this kind is to first re-grade the piping wherever it is found necessary to give the required pitch in the right direction, and then attach some form of suction to the end of the main return. If the system of piping is quite extensive and in bad condition, it may be best to place the matter in the hands of some engineering concern making a specialty of vacuum systems for the return of condensation. There are many cases, however, where the necessary results can be secured by home-made methods, or by means within the reach of any good steam fitter.

The necessary suction is best obtained by attaching a special vacuum pump to the main return. Pumps for this particular purpose can be obtained from the best manufacturers, and one of well-known make is shown in Fig. 1. The condensation from heating systems of this kind is usually trapped

* For further information on this and kindred subjects, see MACHINERY, November, 1909: "Heating and Ventilating Offices in Shops and Factories," and previous articles there referred to.
† Address: 283 Central St., Auburndale, Mass.

into a vented receiver, from which it is automatically pumped back to the boilers. In attaching a vacuum pump to the return, the connections may be made as shown in Fig. 2, when it is intended to use the pump all the time, or as shown in Fig. 3, when it is desired to retain the trap and use the pump simply for clearing the system of air in the morning when first warming up, or at intervals during the day when the circulation becomes sluggish. There are many cases where the system will work satisfactorily after the pipes and coils are once cleared of air, and steam circulation established. Operating the vacuum pump for a short time in the morning is often all that is necessary.

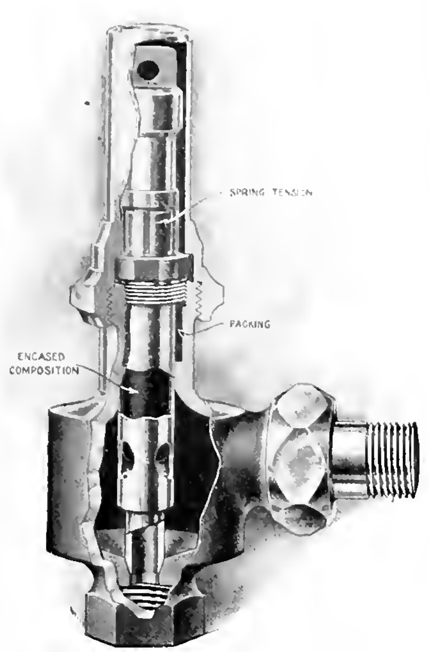


Fig. 7. Thermostatic Valve used in Connection with a Vacuum Pump

Sometimes an ordinary steam ejector connected into the return is all that is necessary to clear the pipes and start up the circulation. Such a device is shown in Fig 4, and the method of connecting it into the return main, in Fig. 5. Sometimes defective circulation may be confined to one particular building or section of the heating plant. In this case all that is necessary may be to connect an ejector into this particular branch, and exhaust the air and water once or twice a day as may be required. If this branch connects with the main return at some distance from the receiving tank, the exhaust may be blown outboard, as it will be operated only for a short time and the waste will be small. Connections for the arrangement above described are shown in Fig. 6. Whenever ejectors are used in this way it is necessary to have steam at a higher pressure for operating them.

The principal feature in the patented vacuum systems is the automatic valve placed at the return end of the coil or radiator which opens only to allow the passage of air and water, and closes in the presence of steam. If the ordinary radiator valve is used and left wide open, there will be short-circuiting through the nearer coils and radiators, while very little, if any, vacuum will be formed in the returns and coils more remote from the pump.

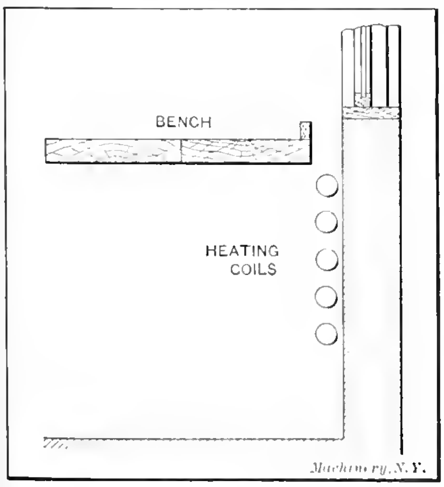


Fig. 8. A Good Method of Placing the Heating Coils

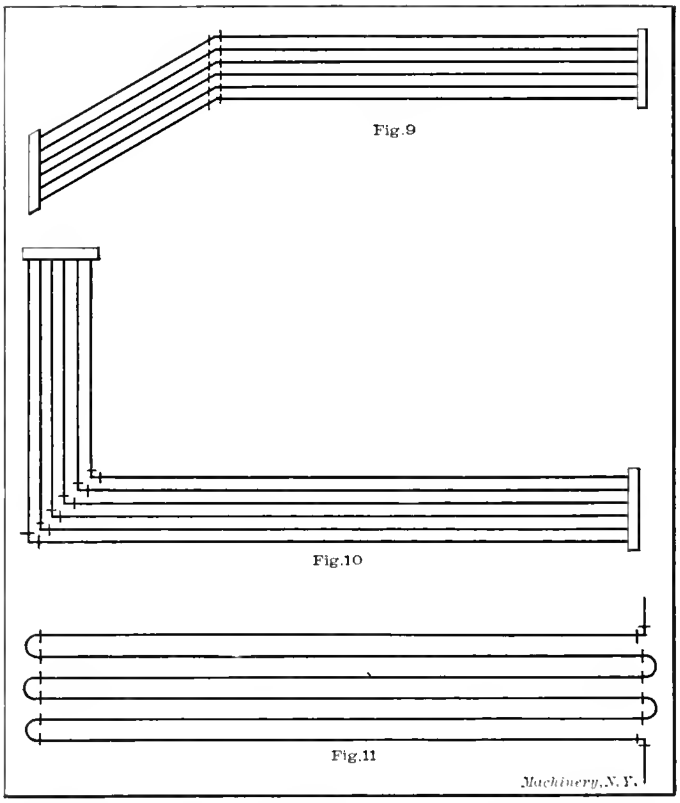
When the plant is not too large very good results may be obtained by throttling the return valves, leaving an opening just sufficient to care for the condensation under the slight vacuum formed in the returns. When this is done, the radiators and coils should be inspected at frequent intervals to make sure that the throttled valves do not become clogged. If this occurs, they should be opened wide and the steam and water allowed to blow through for a short time, which will usually serve to clear them. Sometimes it is not necessary to throttle the valve on each coil and radiator, but they can be grouped together and a throttle valve placed in the branch return from each group. Special thermostatic traps or valves are now on the market which can be used on the return end of the radiators and coils in connection with a vacuum pump if so desired, such a trap being shown in Fig. 7. These open automatically to allow the passage of air and water from the coil.

Throttling and automatic return valves must only be used when the vacuum pump is to be operated continuously, as otherwise the coils would not drain properly when returning by gravity without a vacuum.

There are several types of patented vacuum systems in use, some operating by exhausting the air from the radiators through special air-valves, while the condensation flows to the receiving tank by gravity in the usual manner. In others the vacuum is attached to the return main in a manner similar to the method already described, no air valves being used. The latter arrangement is preferable for the class of buildings under consideration, as it overcomes the effect of improper grading of the return pipes to a considerable extent, and also makes it possible to work with less distance between the heating coils and the return mains.

Design of a New System

Let us next take up some of the points to be considered in the design of a new system. We will assume that it is to



Figs 9, 10 and 11. Branch Coil, Miter Coil and Return Bend or Trombone Coil

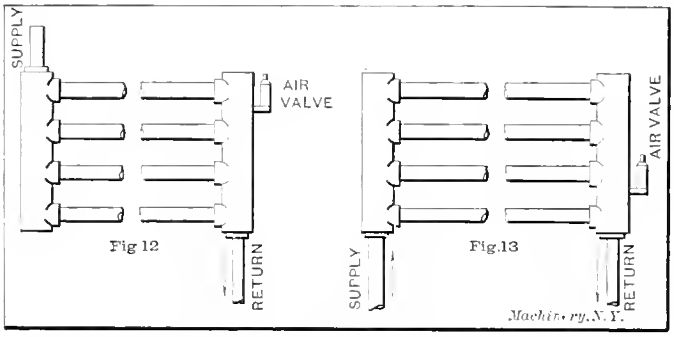
operate by gravity without the use of a vacuum pump, it being a simple matter to add this accessory should the plant outgrow the gravity method for the return of condensation. The first step in the design of a new system is to compute the amount of heating surface. For ordinary conditions, with low-pressure steam, there should be about one square foot of heating surface for each 10 square feet of wall surface, and the same amount for each 4 square feet of glass surface. If the building is in an especially exposed location or not especially well built, use the constants 8 and 3 in place of 10 and 4. For one-story buildings and upper floors having an exposed roof surface without attic space beneath it, count the roof the same as wall. The square feet of heating surface can be reduced to linear feet of pipe by the following:

TABLE I

Square feet of surface multiplied by	Linear feet of
3	1-inch pipe
2.3	1 1/4 inch pipe
2	1 1/2-inch pipe

The next point to be considered is the form and location of the radiating surface. For shops and similar rooms, circulation coils of 1¼-inch pipe are most commonly used. These are best placed along the walls beneath the windows, but if for any reason this cannot be done, they may be suspended on the side at a height of 8 or 9 feet above the floor. This height, again, is governed to some extent by the position of shafting, cranes, etc., and must be located to suit the actual conditions in each particular case. An ideal way to place the coils, from a heating standpoint, is shown in Fig. 8. By setting the bench out about 3 inches from the wall the warm air from the coil rises in front of the windows where it is most needed.

If there is no basement in which to carry the return pipes, there is sometimes difficulty in using this arrangement, for if they are carried above the floor it is likely to bring them too close to the bottom of the coils. If the supply pipes are of good size so as to keep up the pressure, the return may run within 18 inches of the lowest pipe of the coil; but for ordinary conditions 24 inches is better. If the vacuum system is used, the return may be carried much closer to the coil. Sometimes sufficient space may be obtained by carrying the return in a trench. In other cases there may be enough room to carry the returns beneath the floor; but in case this is done, they should be thoroughly protected against freezing.



Figs. 12 and 13. Supply and Return Ends of Branch Coil with Different Methods of Steam Supply, and Corresponding Positions of Air Valve

Common forms of heating coils are shown in Figs. 9, 10, and 11. The coil in Fig. 9, called a branch coil, is shown in perspective and is used wherever there is a chance to carry it around a corner in order to secure flexibility. The miter coil shown in Fig. 10 is used in places where a doorway or other obstruction prevents the use of a branch coil, and where there is space on the wall for carrying up a vertical portion to care for expansion. Overhead coils are usually of the miter form, laid on the side and supported by means of pipe-rolls and hangers. The wall coils are supported on hook-plates made especially for the purpose. Fig. 11 shows a "return bend" or "trombone" coil, which is used where there is no opportunity for breaking the coil around a corner or carrying it up the wall as in Fig. 10.

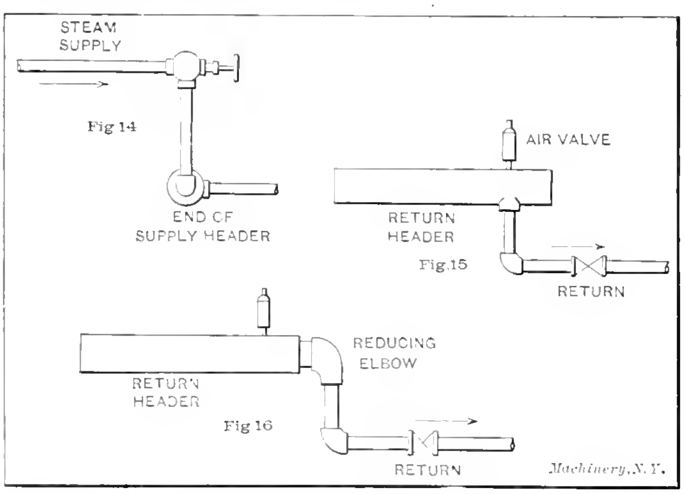


Fig. 14. Method of Making Connection with an Overhead Coil. Fig. 15. Method of Connecting Return Main to Coils. Fig. 16. Using an End Connection between Return Header and Return Main

In making the steam and return connections to coils, care should be taken to arrange them in such a way as to obtain the necessary air venting and drainage. Figs. 12 and 13 show the supply and return ends of a branch coil with different methods of steam supply and the corresponding position of the air valve. Fig. 12 shows the more common way of supplying steam to the top of the header. In this case the steam has a tendency to be driven past the upper pipes of the coil and to flow through the lower ones first. This forces the air to the upper part of the return header, at which point the air valve should be located as indicated in the illustration. Sometimes, on the upper floors, it is more convenient to connect the supply into the bottom of the header as in Fig. 13. In this case the conditions are reversed and the air valve should be placed near the bottom of the return header instead of at the top.

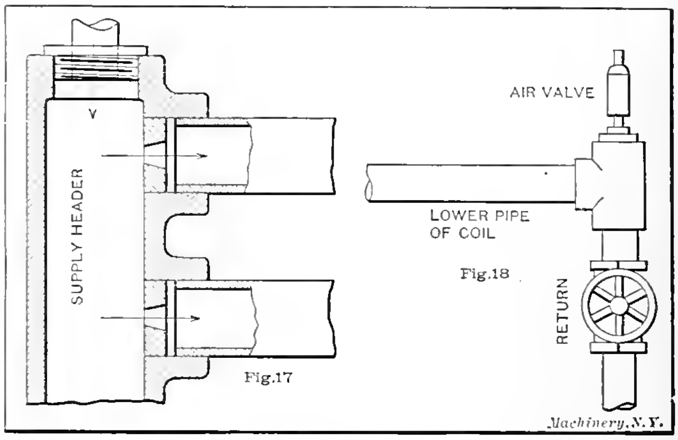


Fig. 17. Method of Equalizing the Flow of Steam from the Header to the Different Pipes in the Coil. Fig. 18. Method of Attaching Air Valve to Trombone Coil

Fig. 14 shows the method of making the connections with an overhead coil. When possible, it is best to use what is known as a "side-outlet" branch-T for the return header, as this, when in position, makes it possible to connect the return pipe into the bottom of the header, thus securing better drainage. The return mains and branches should always be carried at a lower level than the coils, as shown in Fig. 15. Sometimes it is not possible to obtain the side-outlet headers when wanted. In this case an end connection may be used, provided a reducing elbow is employed, taking in the full size of the opening at the end of the header as shown in Fig. 16. The opening in the return header should never be bushed when used in this way. In placing the air valve, it is better to tap into the top of the header, as shown in Fig. 12, rather than to connect it into the plug in the end of the header as is sometimes done. With the former connection there is less liability of its becoming filled with water and dripping.

TABLE II

Square Feet of Radiation	Size of Steam Pipe	Size of Dry Return	Size of Sealed Return
60	1	¾	¾
100	1¼	1	¾
130	1½	1	1
350	2	1¼	1
650	2½	1¼	1
1000	3	1½	1¼
1600	3½	2	1½
2200	4	2½	2
4000	5	3	2
6000	6	3	2½

One difficulty commonly experienced with circulation coils is that the steam, when first turned on, is quite likely to flow through certain pipes first, filling the return header, and then entering the remaining pipes at the return end, thus pocketing a considerable quantity of air in the center of the coil and causing it to remain cold. This condition can be avoided to a considerable extent by inserting a bushing with a small opening, about ¼ inch in diameter, in each pipe opening at the supply end as shown in Fig. 17. This equalizes the

flow of steam to the different pipes and causes the whole coil to fill evenly from the supply end. Fig. 18 shows a good way of attaching the air valve and making the return connection for a trombone coil. In this case the steam flows through each pipe of the coil in series, so there is no danger of air pocketing unless steam enters the return end from some other coil.

The sizes of supply and return pipes may be taken from Table II, which may be used for lengths of run up to 200 or 250 feet; for greater lengths the pipes should be increased a size or more according to conditions.

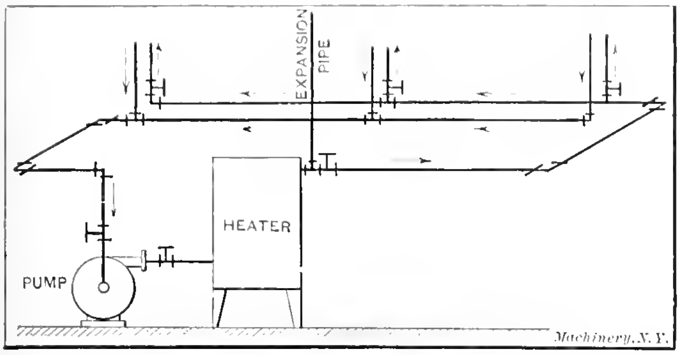


Fig. 19. Two-pipe System for Forced-circulation Hot-water Heating

Thus far only steam heating has been considered. When there is plenty of exhaust from the engines so that the matter of steam economy does not have to be considered, this method of heating is very satisfactory and has its strong points. The principal fault with direct steam is the difficulty in regulating the temperature of the rooms, and this usually results in a considerable waste of heat through open windows in mild weather. It is true that the temperature can be regulated by shutting off and turning on the heating coils, but the chances are that the workmen will resort to the easier method of opening windows. This has its advantage in providing a certain amount of fresh air, but ventilation by means of open windows in cold weather is not always desirable. If a vacuum system is used, a considerable range in temperature can be obtained by using a vacuum reducing valve which allows steam pressures below the atmosphere to be carried in the heating system.

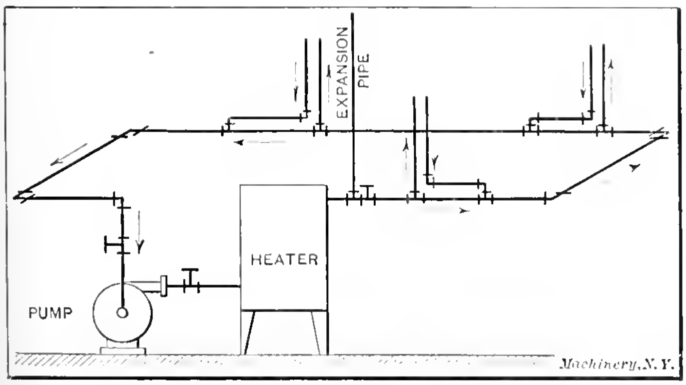


Fig. 20. Single Pipe or Circuit System for Forced-circulation Hot water Heating

When considerable live steam is necessary for heating, and it is desired to economize in its use, very satisfactory results may be obtained by the use of hot water under forced circulation. In this way the entire heating system is under the control of the engineer who can vary the temperature of the water to suit the requirements at all times. Under these conditions of warming very little heat will be lost through open windows. The piping need be no more complicated nor the heating surface more extended than in the case of low-pressure steam heating. By placing the expansion tank at a sufficiently high elevation, and using a small amount of live steam, the temperature of the water may be made to equal that of low-pressure steam in the coldest weather.

The mains for forced circulation are usually carried in one of two ways. In the two-pipe system shown in Fig. 19 the supply and return are carried side by side, the former reducing in size and the latter increasing as the branches are taken off. The flow through the coils is produced by the difference in pressure in the supply and return mains. As this is greatest nearest the pump, it is necessary to place throttle valves in the branches to equalize the flow to the different parts of the system.

The single pipe or circuit system is shown in Fig. 20. In this case a single main is carried entirely around the building, the ends being connected with the suction and discharge of the pump, as shown.

The supply risers are taken from the top of the main and the returns connected into the side, a short distance along the line. Circulation through the risers and coils is due partly to gravity (the hotter water rising from the top of the main to the coil and the cooler return-water falling through the return pipe) and partly to the drop in pressure in the main between the points at which the supply and return pipes are connected. When there is a basement in which the circuit main may be carried, this system of piping is the simpler, but the two-pipe system has the advantage of a decided drop in pressure between the supply and return mains, so there is much greater flexibility in running the pipes, which makes it much better adapted to the conditions found in shop heating. Both supply and return mains may, for example, be carried at the ceiling, or both at the floor, or one at the ceiling and the other at the floor. A good arrangement for a two-story building is to carry both mains at the ceiling of the first story, and connect with the first floor coils by drops and with the second floor by risers. In a one-story building both mains are usually carried overhead, as they are less in the way of machinery and other equipment.

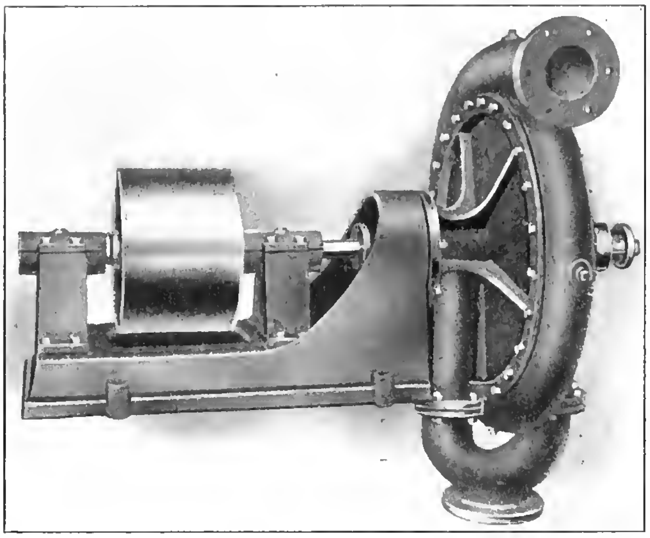


Fig. 21 Belt-driven Centrifugal Pump for Heating Service

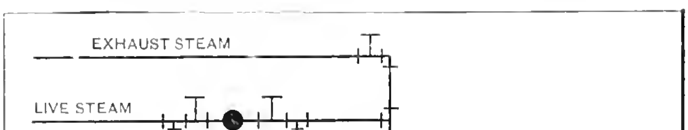


Fig. 22. Diagram of Connections between Pump and Heater when Live and Exhaust Steam are used in the same Heater

In the circuit system it is customary to count on a drop in pressure of about 20 degrees between the pump suction and discharge, and in the two-pipe system to allow a drop of

about 40 degrees. In the circuit system the return water from the radiators flows back into the main, so the supply to the radiators along the line becomes cooler and cooler as the distance from the pump increases. For this reason, a larger volume of water must be circulated at a less drop in temperature, or the size of the heating coils and radiators must be increased along the line to make up for an excessive drop in temperature of the circulating water. Hence, it is a choice between a larger pump and main, or more radiating surface. In the two-pipe system all of the radiation is supplied with water at practically the same temperature, except for the slight cooling which results from radiation from the main

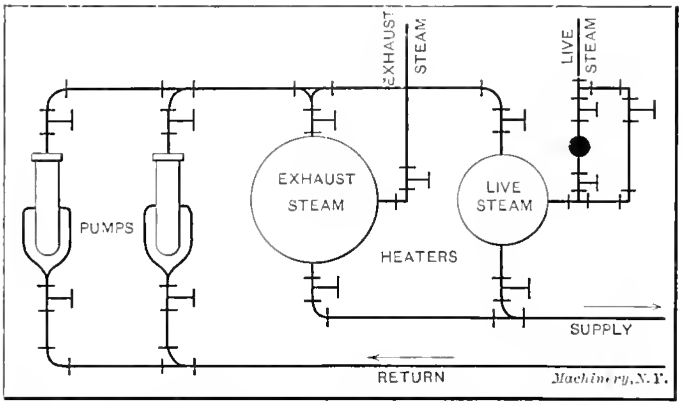
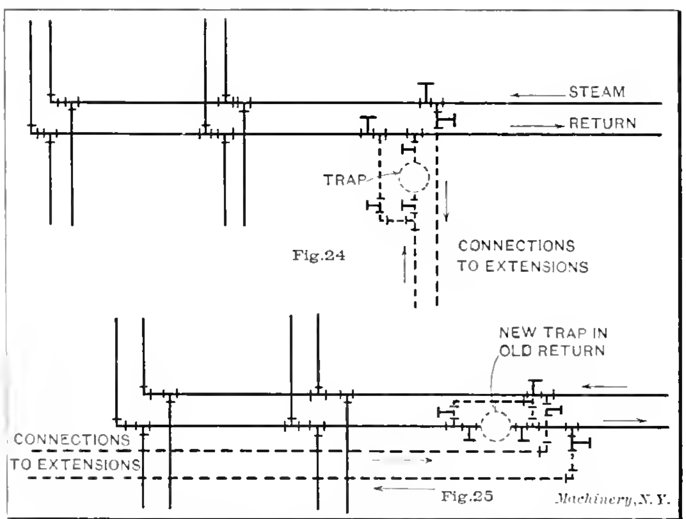


Fig. 23. Diagram of Connections between Pump and Heater when Separate Heaters, in Parallel, are used for Live and Exhaust Steam

itself. The size of mains and capacity of pump depends upon the volume of water circulated, and this, in turn, upon the amount of radiating surface and the drop in temperature of the circulating water.

Example of Calculations

Taking the case of a circuit main, and allowing a drop in temperature of 20 degrees, there will be $8.3 \times 20 = 166$ heat units given up to the heating system by each gallon of water circulated. If the water is pumped into the system at a temperature of 200 degrees and cooled to 180, the heating coils will have an efficiency of about 220 heat units per square foot of surface per hour. Hence there should be $220 \div 166 = 1.33$ gallons of water circulated per hour for each square foot of radiation, or $\frac{1.33 \times 100}{60} = 2.2$ gallons per minute for each 100 square feet of radiation. Assuming approximate velocities of flow of 3.4 feet per second for pipes 3 inches in diam-



Figs 24 and 25. Methods of Making Connections for Additions located near the Boiler-room and at the Extreme End of the Line

eter and under, 5.0 feet for 4-inch pipes, 5.7 feet for 5- and 6-inch pipes, and 8.0 feet for 7- and 8-inch pipes, we have in Table III the pipe sizes for various amounts of radiating surface. These sizes are suitable for mains up to 1500 feet in length, or even 2000 feet in special cases, if necessary.

The mains in the two-pipe system may be made somewhat smaller, owing to the greater drop in temperature allowed. On the other hand, the radiation will be slightly less efficient, owing to the lower average temperature of the water. Proceeding as before, and allowing a drop in temperature from 200 to 160 degrees, we have $8.3 \times 40 = 332$ heat units given up by each gallon of water circulated. Assuming in this case

TABLE III

Size of Circuit Main, Inches	Square feet of Direct Radiation Supplied
3	3,400
4	9,000
5	16,000
6	22,000
7	43,000
8	56,000

TABLE IV

Size of Mains for Two-pipe System, Inches	Square Feet of Direct Radiation Supplied
3	7,000
4	18,000
5	32,000
6	44,000

an efficiency of 210 heat units for the radiation, we have

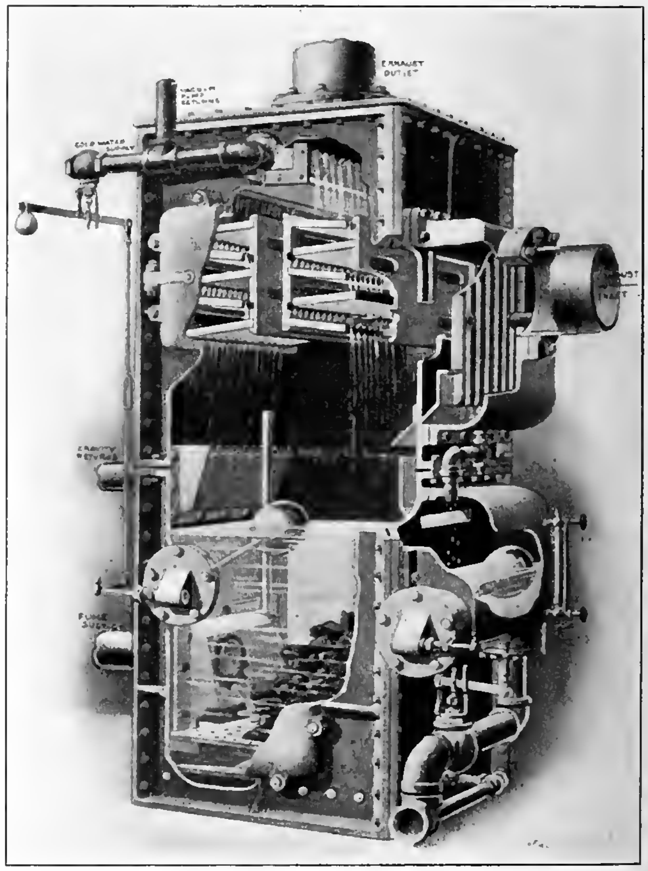


Fig. 26. Open Heater Combining Oil Separator, Feed Water Heater, Purifier, Return Tank and Filter

$210 \div 332 = 0.63$ gallon of water required per hour for each square foot of radiation, or $\frac{0.63 \times 100}{60} = 1.05$ gallon per minute for each 100 square feet of radiation. Using the same velocities as before we have in Table IV the sizes of pipe mains for the two-pipe system. These sizes are also for circuits up to 1500 to 2000 feet in length. Should it be decided to use a drop in temperature of 30 degrees instead of 40, the amount of surface supplied by any given size of pipe would be the mean of the quantities given in Tables III and IV.

The branches and risers to the coils are made considerably larger than the mains in proportion to the volume of water

TABLE V. SIZES OF RISERS AND COIL CONNECTIONS FOR THE SINGLE-MAIN OR CIRCUIT SYSTEM

Size of Pipe, Inches	Square Feet of Radiation
3/4	20
1	40
1 1/4	70
1 1/2	120
2	250
2 1/2	300

TABLE VI. SIZES OF RISERS AND COIL CONNECTIONS FOR THE TWO-PIPE SYSTEM

Size of Pipe, Inches	Square Feet of Radiation
3/4	40
1	80
1 1/4	150
1 1/2	250
2	500
2 1/2	600

which they carry. The pipe sizes in Tables V and VI may be used for the circuit and two-pipe systems, respectively.

Pumps

Pumps of the centrifugal type are best adapted to this class of work on account of their simplicity and the low-pressure heads required. For the sizes of pipe given in Tables III and IV the required pressure head for overcoming the friction in the mains will not exceed 40 feet for straight lengths of pipe up to 1500 feet. Each long-turn L and T adds 4 and 9

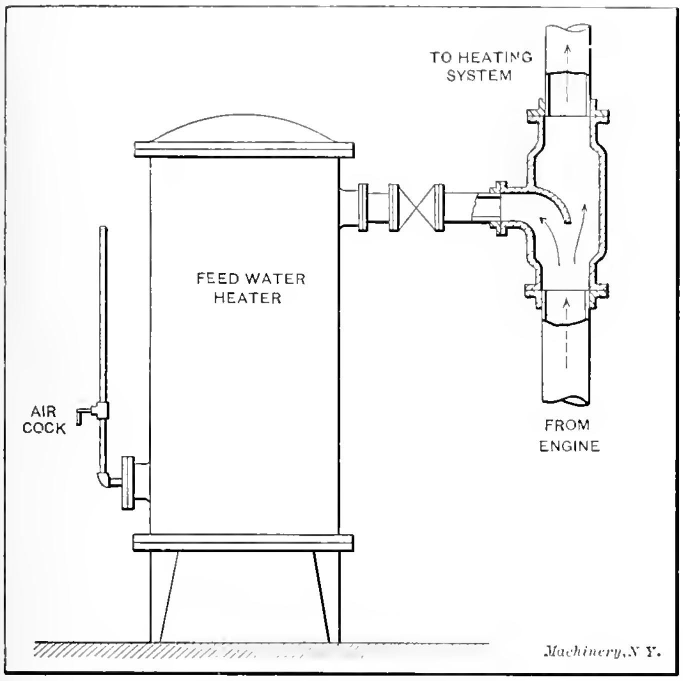


Fig. 27. Induction Method of Connecting the Heater with the Exhaust Main

feet, respectively, to the length of the main. Centrifugal pumps may be driven by direct-connected steam engines, turbines, electric motors, or may be belted to a convenient line of shafting. Fig. 21 shows a belt-driven pump of this type.

The horsepower required for driving a centrifugal pump is given by the equation:

$$\text{H. P.} = \frac{H \times V \times 8.3}{33{,}000 \times E}$$

in which H = friction head in feet,

V = gallons of water moved per minute,

E = efficiency of pump, which may be taken as 0.50 for average conditions.

In heating work the pumps are commonly run under a head

TABLE VII

Size of Delivery, Inches	Rated Capacity in Gallons Per Minute	Revolutions per Minute for Different Pressure Heads				H. P. for each Foot Pressure Head
		20-foot Head	30-foot Head	40-foot Head	50-foot Head	
2	100	780	945	1090	1210	0.063
3	210	710	850	970	1080	0.136
4	430	640	765	870	960	0.217
5	730	530	635	720	800	0.309
6	1050	480	570	650	715	0.446
7	1440	405	485	550	605	0.606
8	1880	355	420	480	530	0.791

of 20 to 50 feet. Table VII gives the capacity and power required for driving medium lift pumps at medium speeds.

Table VII is for the type of pump which would probably be used if belt-driven. If a direct-connected steam engine driven pump were employed, a larger impeller at a lower speed would be used, and for a motor or turbine-driven pump a small impeller at a high speed is required.

Heater

The water is usually heated in a closed feed-water heater with the connections reversed; that is, with the steam on the

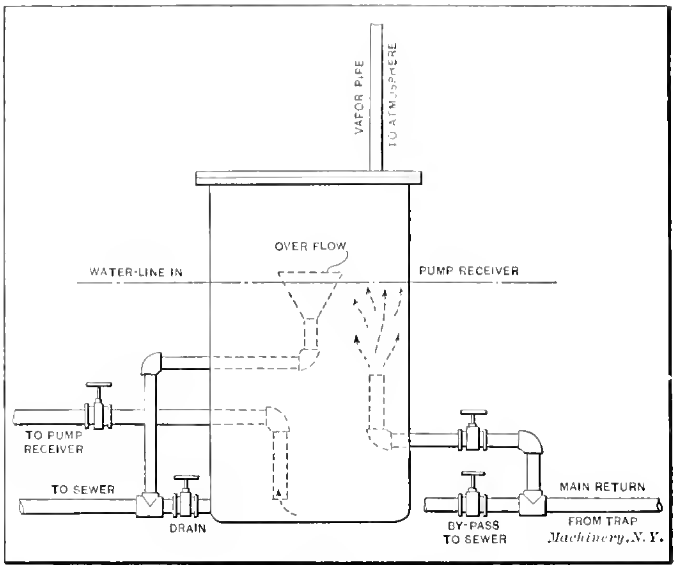


Fig. 28. Arrangement for passing the Return, a Settling Chamber or Tank

inside of the tubes and the water on the outside. Any good form of heater can be used for this purpose by providing it with steam connections of sufficient size. In the ordinary form of heater, the feed water flows through the tubes, and the connections are therefore small, making it necessary to substitute special nozzles of large size when used in the manner described. When computing the required amount of heating surface in the tubes of a heater, it is customary to assume an efficiency of about 200 heat units per square foot of surface per hour per degree difference in temperature between the water and steam.

Taking the case of a two-pipe system where the water is delivered at 200 degrees and returned at 160, the average temperature of the water passing through the heater will be, approximately, 180 degrees. If exhaust steam is supplied to the heater at atmospheric pressure, there will be a difference of 212 − 180 = 32 degrees between the steam and water, thus giving an efficiency of 200 × 32 = 6400 heat units per square foot of heating surface. Hence 6400 : 210 = 30 square feet of direct heating surface that may be supplied from each square foot of tube surface in the heater. Commercial heaters are commonly built on a basis of 1/3 of a square foot of tube surface per horsepower, from which it is seen

that $\dfrac{6400}{3 \times 210} = 10$ square feet of radiating surface supplied by each horsepower of the heater, or in other words, one commercial horsepower of heater is required for each 10 square feet of direct radiation.

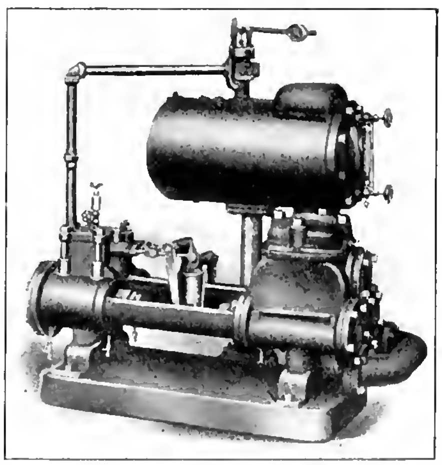


Fig. 29. Combined Pump and Receiver used for returning the Condensation to the Boilers

When there is not sufficient exhaust steam for heating requirements, live steam may be admitted to the heater through a pressure-reducing valve, provided the exhaust is purified of

oil so the condensation may be returned to the boilers. If the exhaust is not purified, and the condensation is allowed to waste, it is better to use a separate heater for the live

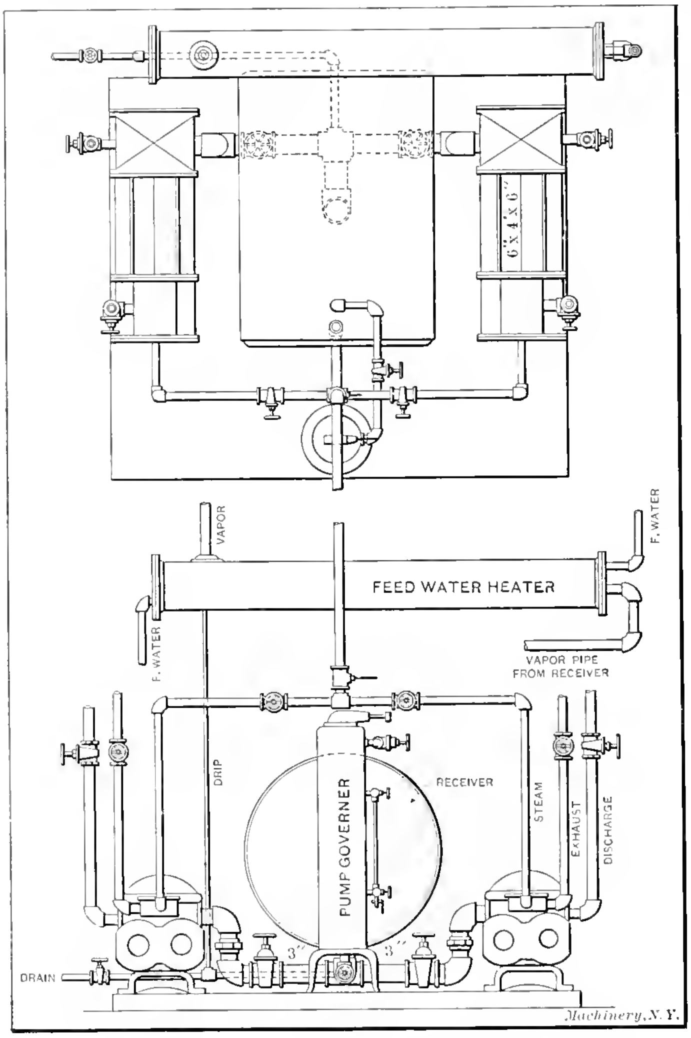


Fig. 30. Arrangement of Duplex Pump and Receiver for Large Plant

steam on the ground of economy. In the Evans-Almiral patented system of hot-water heating, the two heaters are placed in series, with the exhaust heater next to the pumps. Good results may be obtained by placing them in parallel if the water connections are so throttled as to supply the proper proportion of water to each heater. The efficiency of a live steam heater is, of course, greater than one using exhaust, owing to the higher temperature of the steam. The efficiency for any given pressure can be easily determined by the methods already given.

The general methods of making the connections between the pumps and heaters are shown by the diagrams in Figs. 22 and 23. In the first case the live steam is used in the same heater with the exhaust, and in the second, separate heaters are used, connected in parallel. It is best to provide two pumps, each capable of doing the entire work, for if the pump gives out, there is no way of warming the building until it is repaired. In making the connections, the arrangement should be such that any part of the apparatus can be cut out without interfering with the operation of the remainder. All fittings about the pumps and heaters should be of the long-turn pattern, and sweep bends of wrought-iron pipe should be used in the mains for making right-angled turns, when possible.

Extensions to Existing Plants

In making extensions to a plant already in use, the first step is to determine if there is sufficient boiler power in reserve to provide steam for the additional heating surface. If the present boilers are loaded up to their full capacity, new boilers should be installed, allowing one horsepower for each 100 square feet of direct heating surface. Next see if the supply and return mains are large enough to carry the additional radiation, using Table II for this purpose. If not, separate mains should be run from the boilers and receiving tank. Sometimes it is necessary to go back only part way to the boiler room to find a point where the mains are large enough to do the entire work without too great a drop in pressure.

If the addition is of considerable magnitude—a new building, for example—it is usually best to place an independent trap on the return, especially if it is nearer the boilers than the rest of the system. Where several buildings or wings are drained through a single return main it is often of advantage to place a trap in the return from each building and vent the receiving tank to the atmosphere. When the addition is at the extreme end of the line and the main is not of sufficient size to care for the extra load, it is usually much cheaper to run a separate supply and return, parallel to the old lines, than to enlarge them, owing to the work of discon-

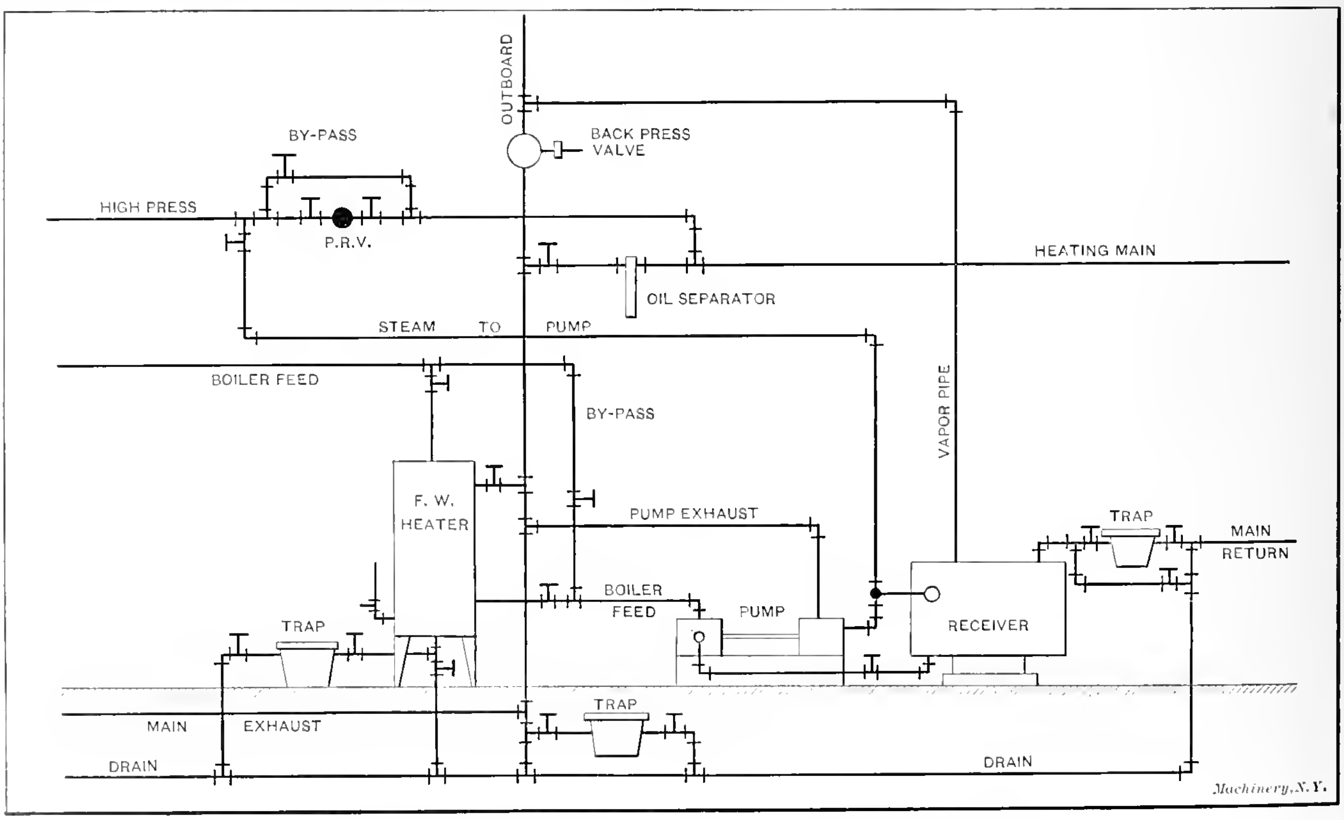


Fig 31. General Method of Making Pipe Connections for Combined Power and Heating Plant

necting and connecting the various branch pipes along the line. Figs. 24 and 25 show methods of making connections for additions located near the boiler-room and also at the extreme end of the line. The full lines represent the old system of piping and the dotted lines the new.

Connecting Heating System to Power Plant

In connecting a heating system with a power plant, it is nearly always advisable to plan for using as much of the exhaust steam as may be necessary for heating the feed water, as this effects a constant saving in summer as well as in winter. With non-condensing engines of average economy, from 1/6 to 1/5 of the exhaust may be used for this purpose. Both open and closed heaters are adapted for use in connection with the heating systems. The former is often made to combine the oil separator, feed-water heater and purifier, return tank, and filter, as shown in Fig. 26. Either type of heater will produce satisfactory results if properly proportioned and connected. The induction method of connecting the heater with the exhaust main makes a good arrangement for a heating system. This is shown in Fig. 27, and when used, the steam for the heating system does not pass through the heater at all. This prevents any possibility of spray from the trays in the open heater being carried over into the heating system, and secures rather dryer steam than in the case of the closed heater with two connections, because the passage of the steam over the cold tubes tends to form a certain amount of moisture in the surplus steam when the whole volume is passed through the heater. The arrangement also makes it easy to cut out the heater in case of repairs.

If the condensation is to be returned to the boilers, the exhaust steam must be passed through an efficient oil separator before entering the heating system, and if there is still any tendency to priming, the return should be passed through some form of filter or settling chamber before entering the boilers. This is provided for in most types of open heaters, but if a closed heater is used, some special device must be used. A good arrangement for this purpose is shown in Fig. 28. This consists of a cast-iron settling tank so arranged that the oil on the surface can be made to overflow into the funnel by closing the valve in the pipe leading to the pump receiver. This can be done at intervals as the oil collects. The best results are generally obtained by venting the receiving tank and trapping the main return into it. If the system is fairly compact a simple trap may be used, placing it near the tank, but if two or more buildings are included, it is best to place a trap in the return from each.

In small plants a combined pump and receiver of the type shown in Fig. 29 is commonly used for returning the condensation to the boilers, but in the case of large and important heating systems it is best to use two pumps, each of sufficient capacity to do the whole work. When two pumps are used they should be run alternately to keep them in good condition. Fig. 30 shows a good arrangement for duplicate pumps and receiver. The pumps are operated automatically by means of a governor or regulator located in front of the tank, as shown. This admits steam to the pumps by means of a float valve when the water in the tank rises above a given point.

The diagram, Fig. 31, shows the general method of making the pipe connections for a combined power and heating plant. This diagram will be found useful in planning the boiler room equipment of a new plant and in remodeling an old one.

* * *

The Navy Department has recently instituted competitive rewards for low fuel and oil consumption records on naval vessels. The economies in power plant operation, which can be secured by proper instruction and encouragement of firemen and attendants, are shown by the fact that according to results thus far obtained, a saving of almost $1,000,000 a year will be effected in fuel and oil alone.

* * *

A monument was unveiled at Spencer, Mass., May 19, erected to the memory of three famous inventors, brothers, namely: Elias Howe, Jr., inventor of the sewing machine; William Howe, inventor of the truss bridge known as the "Howe truss;" and Tyler Howe, inventor of the spring bed.

PUNCH AND DIE FOR ELLIPTIC GEARS

By W. J. McDEVITT*

In the half-tone illustration, Fig. 1, are shown two elliptical gears which are punched out. The method of calculating, laying out and making the punch and die for this work may be of interest to mechanics in general. The known dimensions of the gears to be made were the major axis of the pitch line ellipses which equals the distance between the centers of rotation and the approximate eccentricity. The two gears are, of course, alike. To find the minor axis the number of teeth of a suitable pitch had to be determined. The least allowable eccentricity in this case was 0.437, and the distance between centers was fixed at $1\frac{3}{4}$ inch. According to a formula given in the text-books of the International Correspondence Schools, the perimeter of an ellipse equals

Major axis × 1.82 + minor axis × 1.315.

By assuming 18 pitch for the teeth and $1\frac{1}{2}$ inch for the minor axis, we find that the number of teeth would equal

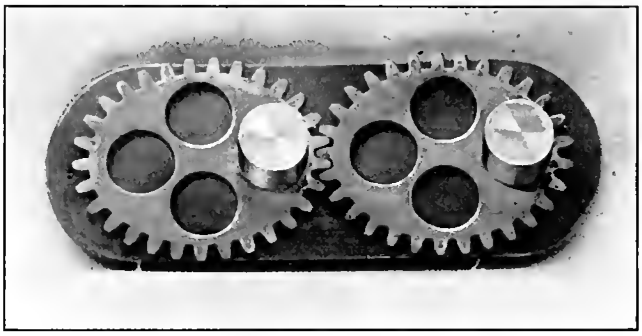


Fig. 1. Elliptic Gears Produced by Punching

29.55. Let us settle upon 29 teeth. It is evident that the number of teeth must be an odd number, inasmuch as when the gears are in the position shown in Fig. 1, the center line passing through the studs on which the gears are mounted must intersect a tooth space in one gear and a tooth in the other at the point where the teeth mesh. In other words, in each of the gears there must be a tooth at one end of the major axis and a tooth space at the other end, and this, of course, necessitates an odd number of teeth. Taking 29 teeth, as mentioned, and 18 pitch, we have

$$\text{Circular pitch} = \frac{3.1416}{18} = 0.1745 \text{ inch, and}$$

Perimeter = 29 × 0.1745 = 5.0605. From the formula

Perimeter = major axis × 1.82 + minor axis × 1.315, we have

$$\text{Minor axis} = \frac{\text{perimeter} - \text{major axis} \times 1.82}{1.315}$$

$$= \frac{5.0605 - 1.75 \times 1.82}{1.315} = 1.426$$

Hence, major pitch diameter = 1.750 inch, and minor pitch diameter = 1.426 inch.

[The formula here given for finding the perimeter of an ellipse is only approximate. More accurate formulas are ordinarily given in the standard hand-books, but these formulas require a table of constants for different eccentricity of the ellipse. The formula above, while less accurate, has the advantage that it requires but two constants which can be retained by memory. For practical work of the character described in this article the accuracy obtained was apparently sufficient.—EDITOR.]

The next step in the making of the tools for these gears was to lay out the ellipse on the drawing board and the construction used was taken from a book on mechanical drawing by Prof. Faunce of the Massachusetts Institute of Technology. This method is as follows:

Having given the axes, to draw a curve of tangential arcs of circles approximate to the ellipse. Referring to Fig. 2 AO

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is the semi-major axis and OB the semi-minor axis. Draw a rectangle with the axes as sides. $AOBC$ is one-quarter of the rectangle. Draw AB. From C draw CMP perpendicular to AB and meeting BO produced at P. Make OE equal to OB. With AE as a diameter draw a semicircle AKE. Produce OB to K. Make $OL = BK$. With center P and radius PL draw the arc LN. Make AD equal to OK, and with center M and radius MD draw the arc DN, meeting LN in N. Draw NMR and PNS. With center M and radius MA draw AR; with center N and radius NR draw RS; with center P and radius PS draw an arc through B from S. Repeat this in each of the quadrants.

By laying out the ellipse as carefully as possible at four

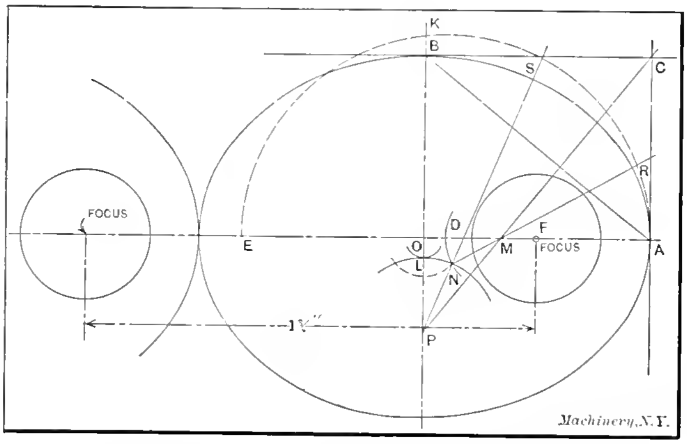

Fig. 2. Method of Laying out an Ellipse by Eight Circular Arcs

times the size and then measuring to the nearest hundredth inch, gives the following distances for pitch line:

$$PS = PB = 4.300 \text{ inch, or } \frac{4.300}{4} = 1.075 \text{ inch.}$$

$$NR = NS = 3.160 \text{ inch, or } \frac{3.160}{4} = 0.790 \text{ inch.}$$

$$MA = MR = 2.320 \text{ inch, or } \frac{2.320}{4} = 5.580 \text{ inch.}$$

As there were nine different centers required on the face of the punch, and it was convenient to lay them out from the center O, the following distances were used:

$$OM = 0.875 - 0.580 = 0.295 \text{ inch.}$$

$$OP = 1.075 - 0.713 = 0.362 \text{ inch.}$$

$$ON = \frac{0.590}{4} = 0.147 \text{ inch.}$$

$$MN = 0.790 - 0.580 = 0.210 \text{ inch.}$$

$$PN = 1.075 - 0.790 = 0.285 \text{ inch.}$$

$$\text{Addendum} = \frac{1}{18} = 0.0555 \text{ inch.}$$

Then major diameter of blank $= 1.75 + 0.111 = 1.861$ inch.
Minor diameter of blank $= 1.426 + 0.111 = 1.537$ inch.
To find distance OF, the center of rotation, we have:

$$OF = \sqrt{OA^2 - OB^2} = \sqrt{0.875^2 - 0.713^2}$$
$$= \sqrt{0.2572} = 0.5072 \text{ inch.}$$

According to the properties of the ellipse, the eccentricity

$$e = \frac{OF}{OA} = \frac{0.5072}{0.875} = 0.579.$$

It will be found that three cutters are required to cut the teeth.

To find the cutters to use for different circles, we have

$1.075 \times 2 = 2.150$, and $2.150 \times 18 = 38.7$ teeth.
$0.790 \times 2 = 1.580$, and $1.580 \times 18 = 28.44$ teeth.
$0.580 \times 2 = 1.160$, and $1.160 \times 18 = 20.88$ teeth.

The center of a tooth or center of a space should be at A. As there were several shifts to be made and changing of cutters the work required considerable care, but the job was done by an exceptionally good workman. After the punch was cut and hardened it was used to broach out the die which was worked out as near as possible. These tools were made at Cummings Machine Works, Boston, Mass.

The punch and die were of the simple push-through style. The hole in the elliptic gear for the shaft as well as the other three holes through it were drilled in a jig. As the gears have an odd number of teeth, they must be placed in the jig in the same position each time, this position being determined by a pilot in the jig which fitted into the tooth space on the line of the major axis. In this way the hole of which the focus is the center would be always either at the tooth end or at the space end of the gear. The original idea was to have a roughing and a shaving punch and die, but only one set was made and the result proved satisfactory.

* * *

CONCISE AND DEFINITE INFORMATION

We sometimes wonder if the readers of MACHINERY fully appreciate the concise and definite information that is spread before them. The substance of long articles is often given in notes of a few lines. As an example of the type of articles which tell little or nothing and use a good many words to tell it, we present the following clipped from a Sunday newspaper:

Urauium and Tellurium Solder

Science has at last discovered a perfectly solid solder for metal joints. Just what this will mean in future decades to railroads and in other metallic features, where a solid jointure is so desirable, only experience and actual wear and tear in active use can disclose. However, the fact that is claimed for the new uranium and tellurium solder mixture will practically compose a solid joint between two metals is of vast interest.

In modern electric street railway systems the absence of a solid joint causes millions to be spent annually in connecting rails by wires. Numerons attempts have been made with other solders to form a continuous rail out of the ordinary steel rail.

All these attempts have proved failures. Now comes the assertion that uranium and tellurium in certain proportions will form an absolutely perfect union from a metallic standpoint when put between two steel rails.

The rarity and costliness of the two metals involved in the new composition robs the discovery of much of its present utility, but it can still be used at many points where, in delicate machinery, a solid joint is highly to be desired. This is especially true as regards delicate apparatus used in the scientific laboratories where the solidarity of the metallic jointure frequently would mean success where at present this is unattainable.

Just what the exact proportions of uranium and tellurium are that must be employed in the new solid metallic jointure is not publicly known. It is the claim fonnded on alleged actual achievement that is most interesting to scientists and to the men actively engaged in the varied branches of commercial chemistry and engineering.

An analysis of the statements in the above discloses first that the solder is suggested for uniting rail joints of electric railways—a most brilliant idea! An uninformed reader might infer that engineers were vainly seeking for some solder or other means of efficiently joining street railway rails. As a matter of fact, we have the electric welded joint, the cast-iron joint, the thermit joint and the fish-plate joint with cast zinc filling, all of which are efficient and satisfactory although more or less expensive. The best copper bonds also are fairly efficient and satisfactory. In the second place, the note proposes an impractical solder—impractical because the materials are rare and costly, so costly that it would be totally out of the question to use them for commercial purposes. Moreover, there is no experience quoted indicating that the solder would work efficiently in the situation suggested. Thirdly, the precise constituents of the solder are unknown! The analysis, therefore, discloses that the entire proposition is tenuous and without substantial foundation for commercial purposes. Granted that the fact of a uranium and tellurium solder having been discovered is of some popular interest, the substance of the foregoing lengthy and misleading statement could have been expressed about as follows:

"A new solder composed of uranium and tellurium has been discovered, the exact proportions of which have not been made public. It is believed that this solder will be of considerable value for uniting parts of scientific instruments where it is essential that a perfect union be secured and the cost is not prohibitive. The rarity and high cost of the components probably will limit the use of the new solder to experimental and special purposes."

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—4

THE CINCINNATI SHAPER CO.

By ETHAN VIALL*

The special and original devices and shop kinks in use in the shop of the Cincinnati Shaper Co., are almost unlimited and only a small number of them can be noticed in this article. Of course a good many of them are applicable only to shaper construction, though they may contain, in themselves, a suggestion or idea which may be used on other work. In fact, the principal value of a description or illustration of a "shop kink" to the average toolmaker or designer, is its suggestiveness; that is, it may contain just the idea for which the reader has been searching, and thereby assist him to overcome a difficulty in a line which is, perhaps, radically different from the one in which the "kink" was originally used. It is for this reason that a pictorial panorama of the interesting shop devices in use not only in Cincinnati, but in other cities, is run in these pages each month.

Tool Turret for a Shaper

Toolpost turrets of various shapes and sizes are in common use on lathes, but one seldom sees a revolving tool-holder on a shaper, though it is extremely useful wherever several tools are to be used on a number of pieces of the same kind. Such a tool-holder with four tools in place, is illustrated in Fig. 1.

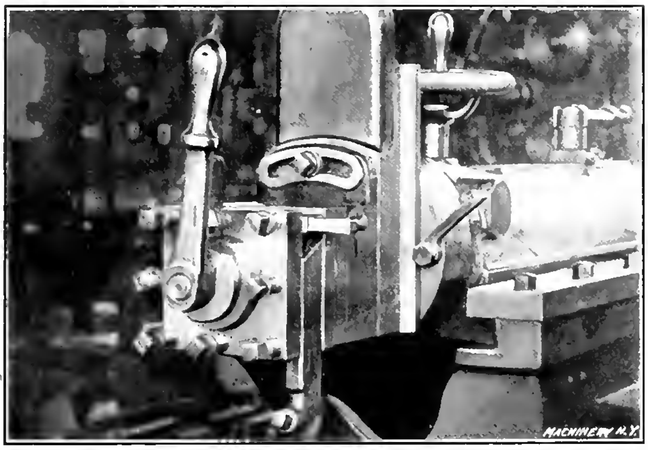

Fig. 1. Shaper with Turret Toolpost

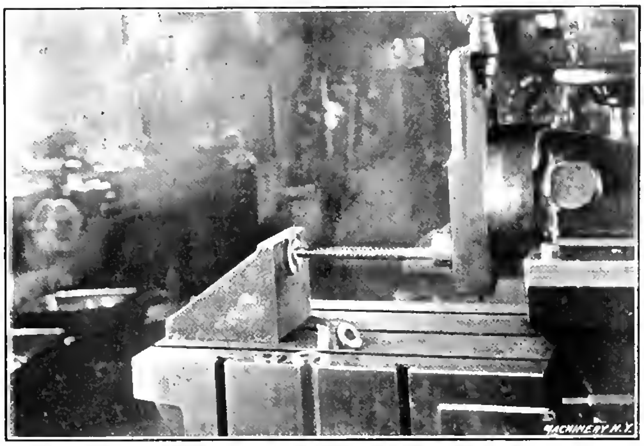

Fig. 2. Broaching D-Washers in the Shaper

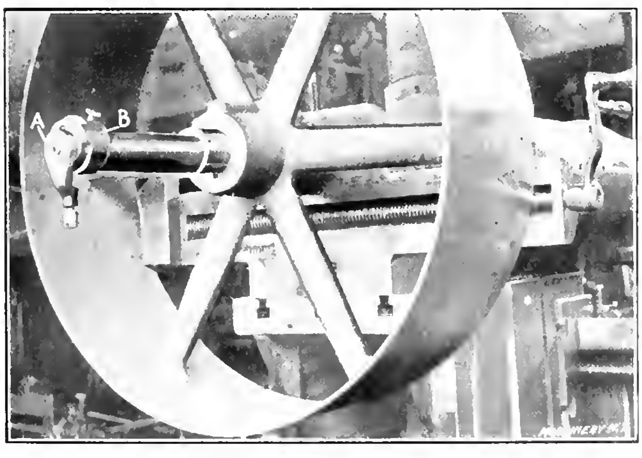

Fig. 3. Keyseating a Large Pulley—Front View

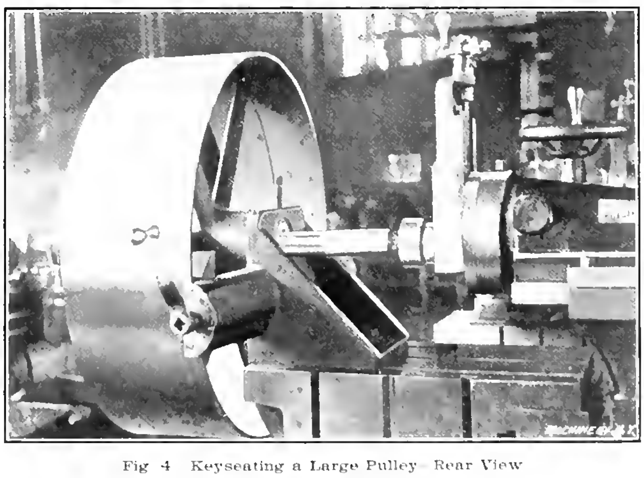

Fig. 4. Keyseating a Large Pulley—Rear View

Broaching D-Washers—Keyseating on a Shaper

Many small parts such as D-washers may be broached out to advantage in a shaper, as shown in Fig. 2. For this work, the clapper-block is, of course, either removed or locked, and the shank of the broach is held, preferably, in a split block or socket, so as to be easily removed. In the example shown, the drilled washer is placed in a U-shaped socket in the face of a foot-plate, which allows the operator to put a washer in place at every stroke of the ram, only stopping the machine when the shank of the broach is full.

Cutting keyways in pulleys is a job often done on a shaper, but in the shop under discussion, a regular keyseating attachment is made which practically makes a keyseating machine out of an ordinary shaper. A front view of this attachment at work on a big pulley, is shown in Fig. 3. The feeding of the keyway cutter is done by turning the handle *A*. Fig. 4 shows a rear view of the same job, while Fig. 7 shows the construction of the attachment in detail. The ball-and-socket connection of the cutter bar to the shaper head, is to be noted in this illustration, as well as the method of feeding the cutting tool. The adjustable stop-ring and set-screw *B*, Fig. 3, show plainly the way the depth of the cut is gaged. Fig. 5 shows a large cone pulley being keyseated. This last illustration is included because it shows the vise jaws set on the outside of the pulley, while the large single pulley was chucked from the inside of the rim. The vise jaws, however, do but little more than to center and steady the pulley. As the tool cuts only on the return stroke of the ram, the entire pull is against the angle-plate body of the vise.

Miscellaneous Shaper Appliances

Bushings with solid keys are cut in an automatic feeding fixture, Fig. 6, in which the feed worm is worked by the rod *A*, which is attached to the head of the shaper ram. The bushings, a finished one of which is shown at *B*, are placed on a shouldered mandrel and held between the centers of the fixture. The tail of the dog is held between the drivers *D* and *E*, in such a way as to avoid any unnecessary play. If, in setting, it is required to revolve the mandrel, it may be done by turning the small crank *F*. The worm-wheel is also an indexing disk and may be set or locked, at various points, by using the arm and pin *G*, which makes the fixture suitable for other work not requiring the automatic feeding device.

Figs. 8 and 9 show two shaper jigs for holding special parts, which need no explanation, and in Fig. 10 is shown a special motor-driven mill used to machine the surface of the shaper base on which the bottom of the table support rests. As this milling device travels on the horizontal table ways, the surface milled must necessarily be parallel to them, which is what is required in order that the support may properly do its duty.

*Associate Editor of MACHINERY.

The semi-circular spots on clamp-bolts are accurately reamed to the correct radius by using the special left-hand spiral reamer *A*, Fig. 11. *B* and *C* are guide bushings, fitting the hole in the casting *D*; *E* is the clamping bolt, and *F* is a size-testing bar. By using reamer *A* to finish the recess in the bolt, a

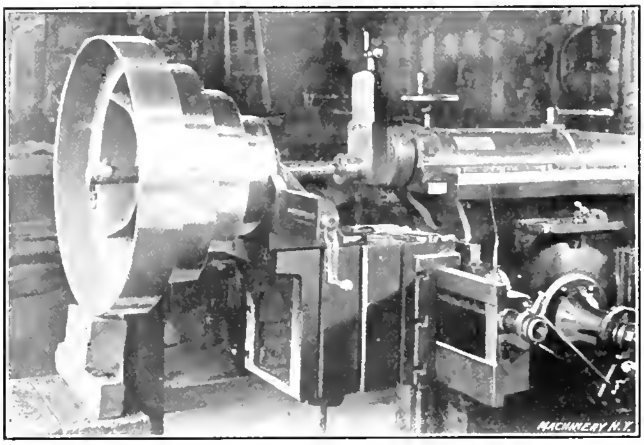

Fig. 5 Keyseating a Large Cone Pulley

perfect fit is obtained and, in consequence, only a slight tension is needed to lock the parts securely.

Graduating and Numbering Swivel Heads—Testing Vise Jaws

Shaper swiveling heads are graduated on a machine built along lines similar to several other Cincinnati graduating machines, though it differs in several points from them. Fig. 12 is a front view of the device. It may be run either by hand or by means of the motor attached. This motor is an old fan motor and the method of belting, as shown in this illustration and in Fig. 13, is interesting. These two engravings show the cam motion for obtaining the one long and the four short graduating strokes, as well as the various adjustments, so plainly that no explanation is needed. After graduating the swiveling heads, the degree numbers are rolled in on the machine shown in Fig. 14, an enlarged view of which is shown in Fig. 15. An inspection of the last engraving will show that

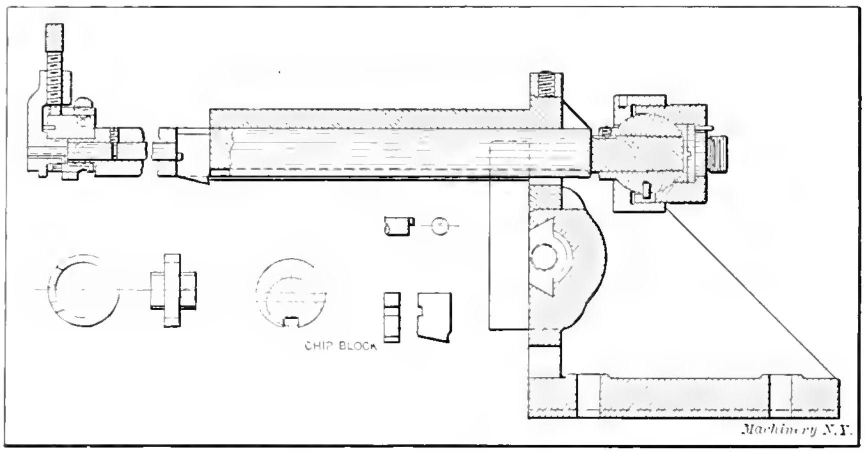

Fig. 7. Details of the Shaper Keyseating Attachment

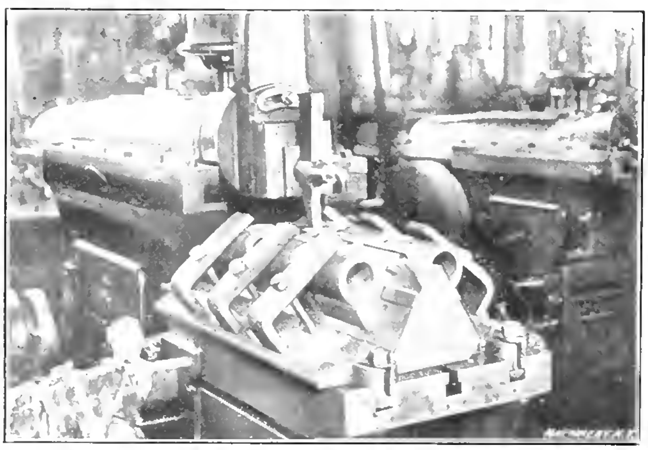

Fig. 8. Shaper Fixture for Machining Dovetails

two sets of figures and two sets of "half gears" are used, so that the figures may be pressed into two different sizes of swivel heads on the same machine.

Shaper vise jaws are tested for parallelism and the correct position of the pointer relative to the graduations on the base, on the machine shown in Fig. 16. A Brown & Sharpe dial indicator is carried on the end of a small ram, similar to that of a shaper, and it is fed out or in by means of a handwheel. The tops of the vise ways are tested by turning the vise one-quarter around and setting the indicator as shown in Fig. 17.

In Fig. 18 are illustrated three adjustable scraping blocks,

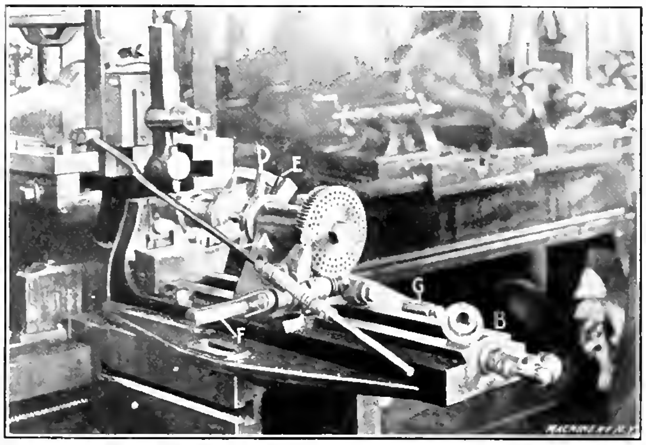

Fig. 6 Shaper Attachment for Cutting Bushings with Solid Keys

the variation in size being obtained by taper gibs which may be firmly locked wherever set. *A* is a block used for marking and gaging while scraping for stroke nuts; *B*, for slides and *C*, for column V's. In using these scraping blocks, the procedure is much the same as in using ordinary flat scraping surface plates, the surface being smeared with lead, the block worked back and forth, and the metal touched up with a hand scraper according to the marking. For scraping in ram slides and ram clamps, as they are too large and heavy to be worked back and forth by hand, the machine shown in Fig. 19 has been especially designed. This scraping machine is portable and may be attached to any shaper under construction. Bolted to the ram head is a bracket which fits into the fork of the rocking arm of the machine in such a way as to be easily lifted out, when it is necessary to lift the ram clear of its bearings, with the chain hoist. Fig. 20 is another view of the machine showing the arm and crank motion, the position of

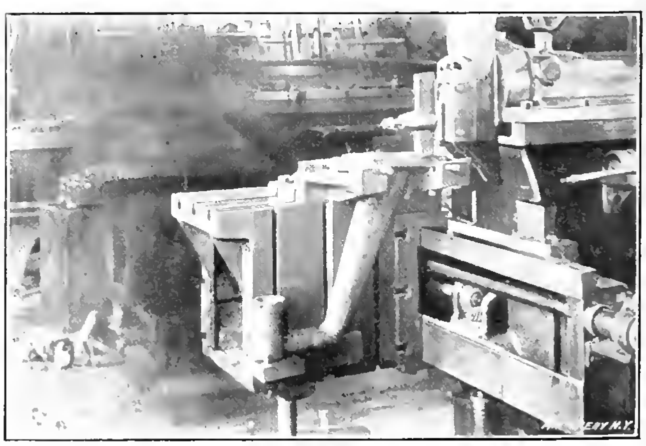

Fig. 9. Special Shaper Fixture

the motor, rheostat and switch, and the gearing.

Turning Gear Blanks and Disks for Setting Cutters—Grooving Solid Journal Boxes

Change gear blanks are first bored out, the hub faced and the keyway cut; then they are placed on a keyed mandrel and

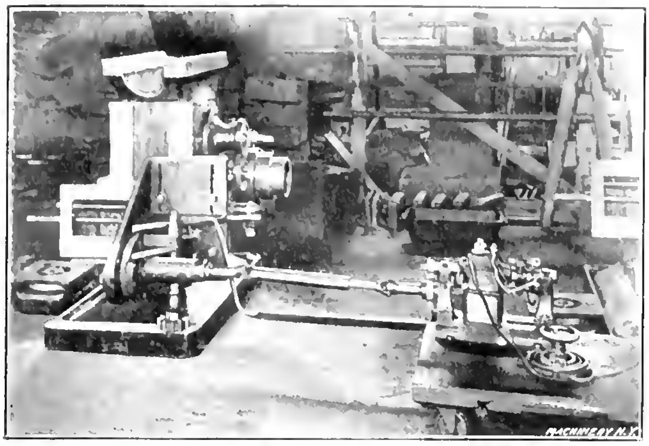

Fig. 10. Portable Electrically-driven Milling Attachment for Surfacing Shaper Base

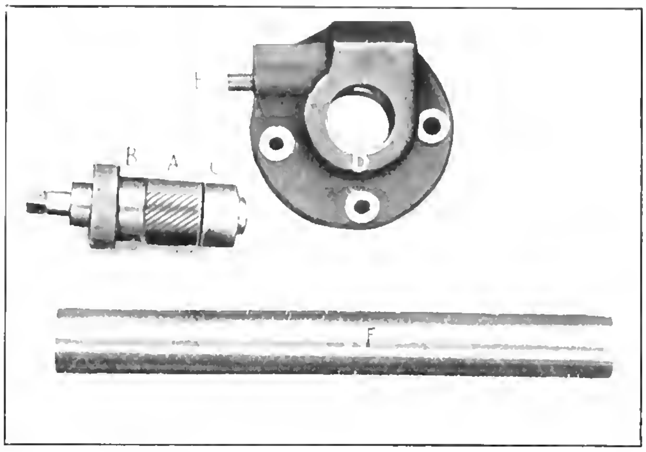

Fig. 11. Special Tools for Reaming and Testing Clamp Bolts

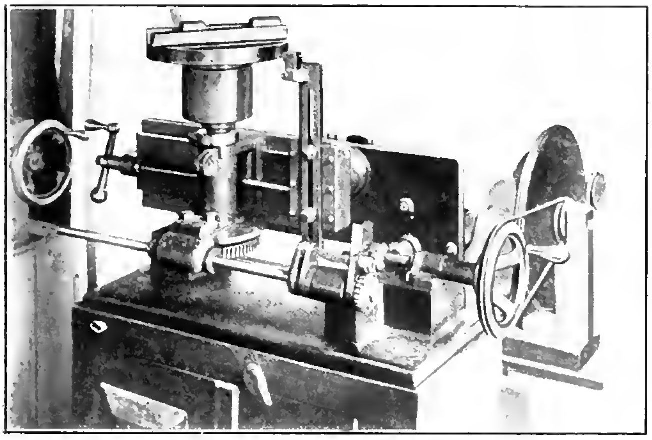

Fig. 12. Graduating Machine—Front View

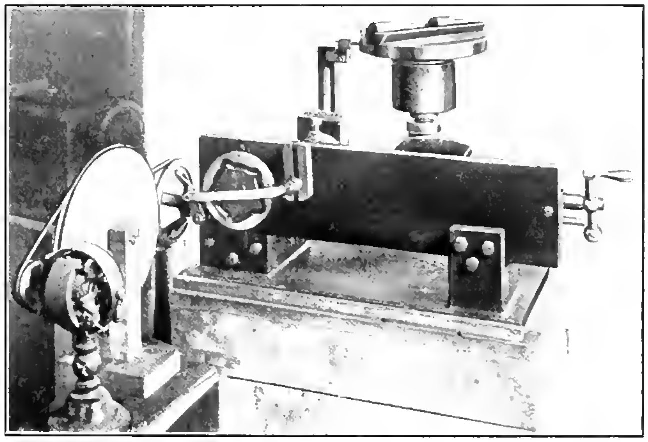

Fig. 13. Graduating Machine—Rear View

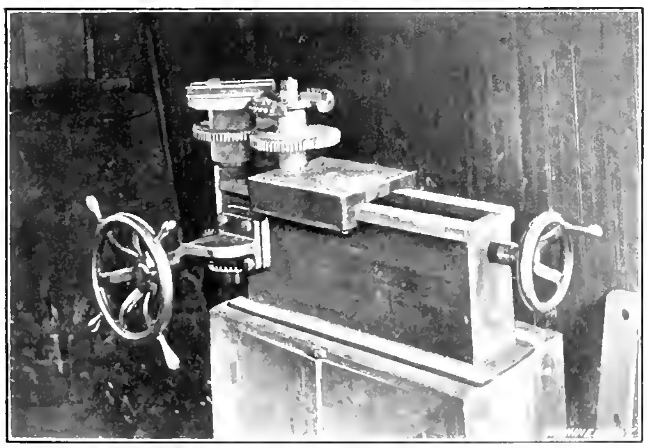

Fig. 14. Machine for Numbering Angular Graduations

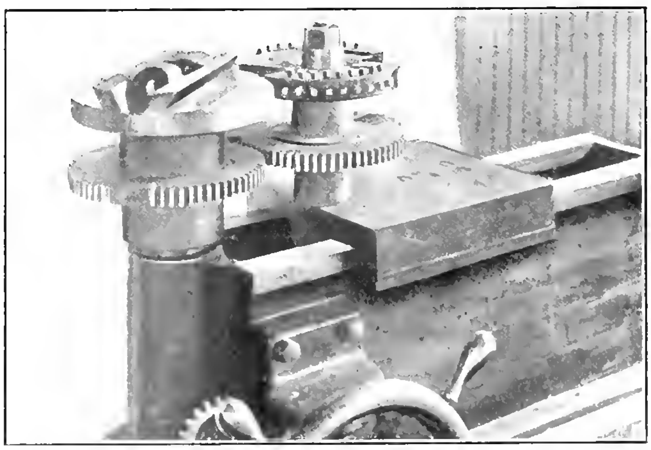

Fig. 15. Enlarged View of Numbering Machine Head

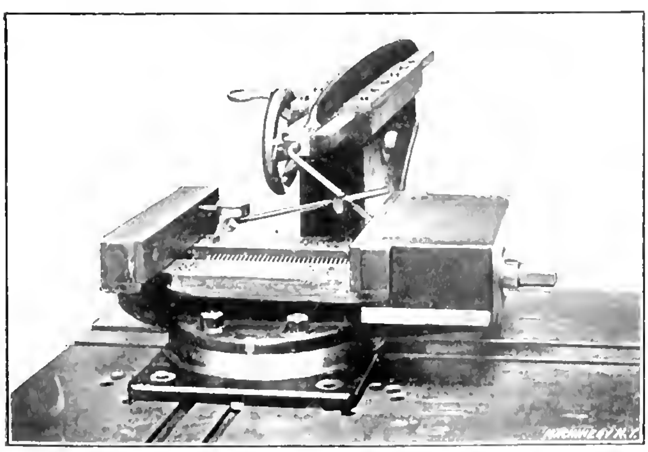

Fig. 16. Shaper Vise-testing Machine—Testing Jaw Faces

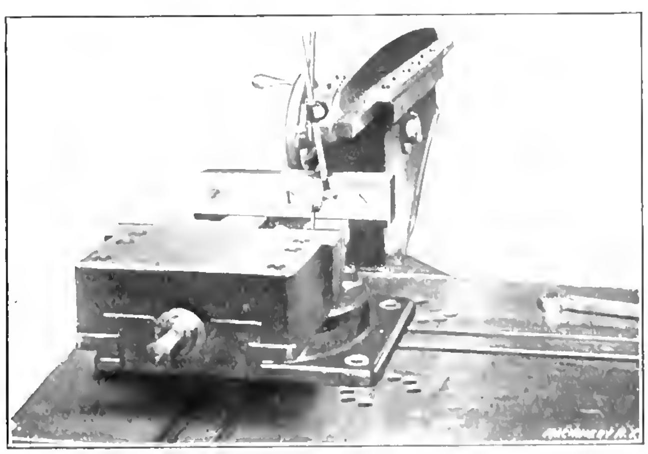

Fig. 17. Testing the Ways of a Shaper Vise

finished in a lathe fitted with a special tool carriage having two sets of tools, a roughing and finishing set, shown in Fig. 23. At *A*, Fig. 21, is a blank in position for roughing and at *B* are a number of mandrels and gear blanks. A gear is pressed on a mandrel while the cut is being taken on the one in the lathe, so as not to lose time. An arbor press which is used for this purpose is conveniently located at *C*.

In cutting gear teeth, it is common practice to set the cutter with the outside diameter of the blank and then raise the table or lower the cutter a certain number of thousandths to secure the right depth of the teeth, but to do away with the errors that are bound to creep in through setting by an off-size blank or miscalculation in the setting, a series of setting blanks, Fig. 24, is used, which are exactly the diameter that the gear for which they are marked should be at the bottom of its teeth, so that if one of these setting blanks is put on a mandrel and placed between the centers, the gear cutter may be set so that it just barely clears the rim and the operator is absolutely certain of its correctness without having to check up his table height or measure the outside of a gear blank when setting.

The principle of the solid journal box oil-grooving device, shown in Fig. 25, which is used on a drill press, has been described before, but it will stand describing again for the benefit of those who haven't seen one. The grooving cutter *A* is set into the holder *B*, which fits into the drill press spindle.

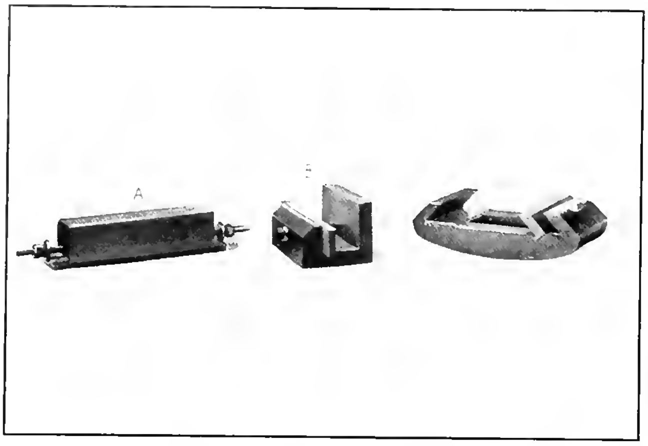

Fig. 18. Test Blocks used in Connection with Scraping

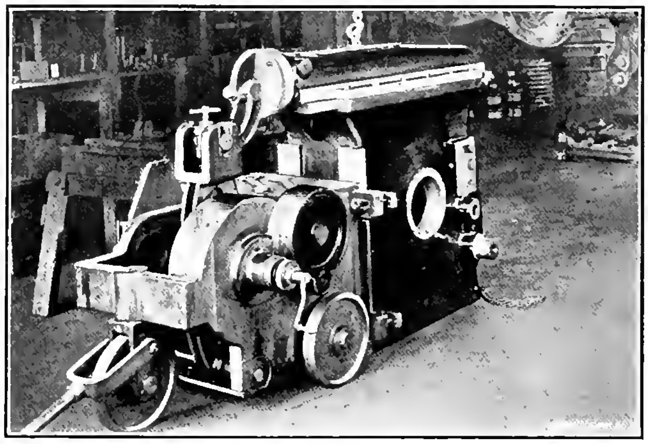
Fig. 19. Portable Machine for Moving the Ram when scraping it

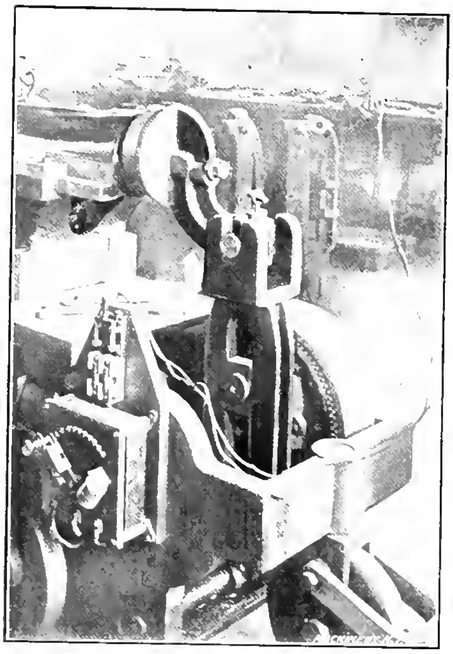
Fig. 20. Enlarged View of the Scraping Machine, showing Starting Box, Slotted Cross-head, etc.

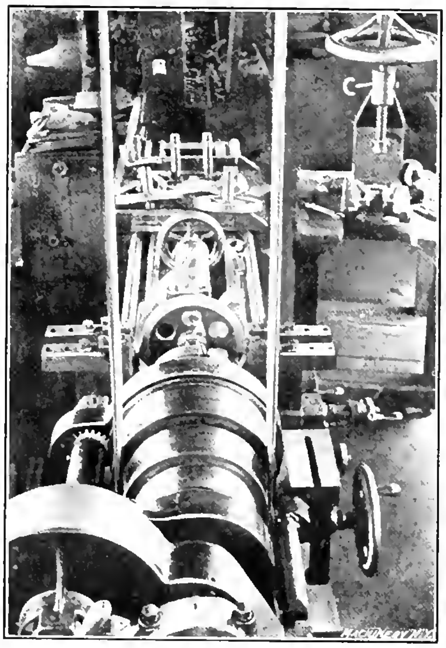
Fig. 21. View of Lathe especially fitted for Turning Gear Blanks

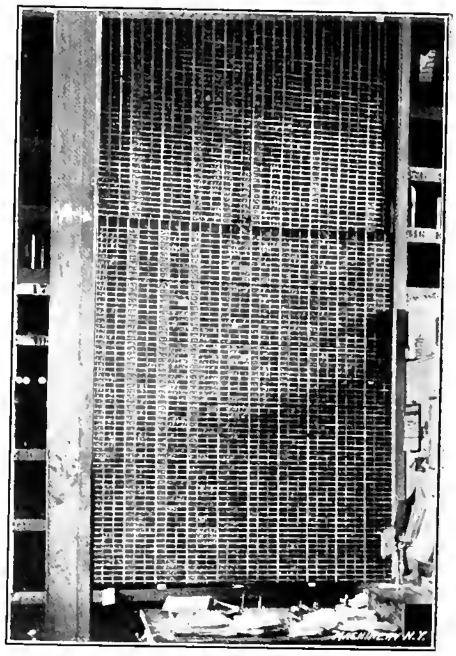
Fig. 22. Counterbalanced Stock Report Boards

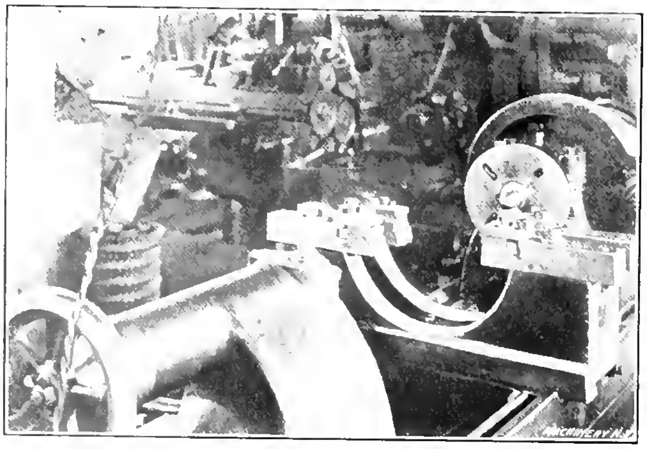
Fig. 23. Double-head Tool Carriage for Turning Gear Blanks

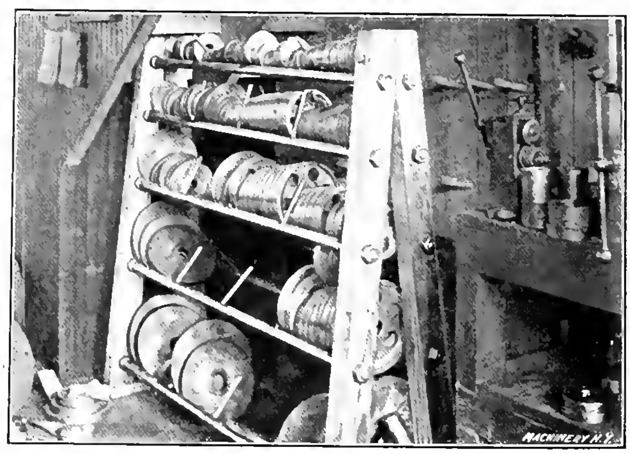
Fig. 24. Disks of Various Sizes for Setting Gear Cutters to Depth

When in use, this holder fits down over the guide *C* which has a long piece *D* in it, something like a key, but which may be forced outward by a taper wedge back of it, operated by pushing in the member *E*; this forces the wedge upward

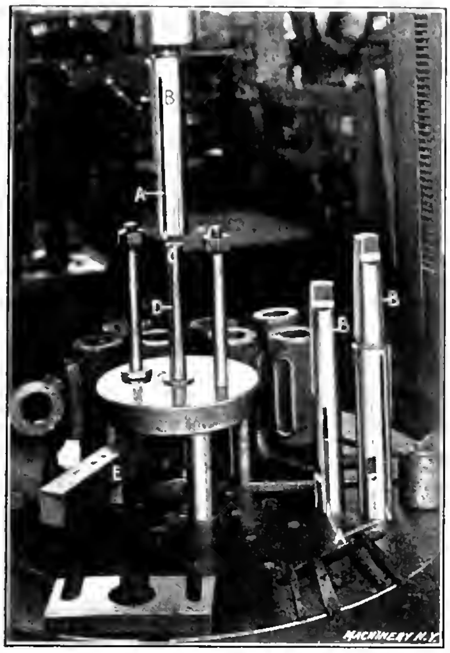

Fig. 25. Fixture for Cutting Oil Grooves in Solid Journal Boxes

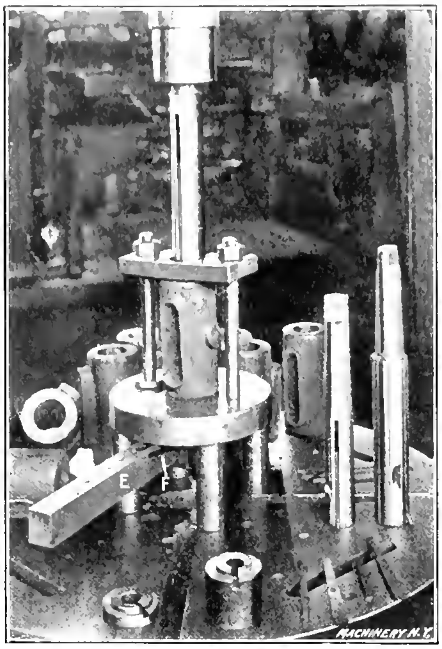

Fig. 26. Oil Groove being cut in Solid Journal Box

and pushes the piece *D* out against the cutter *B*. By working the drill press spindle up and down and gradually pushing in the member *E*, the oil groove is easily cut. Fig. 26 shows a journal box in place, and also shows the slanting slot *F* in the end of part *E* by which the taper wedge is forced upward.

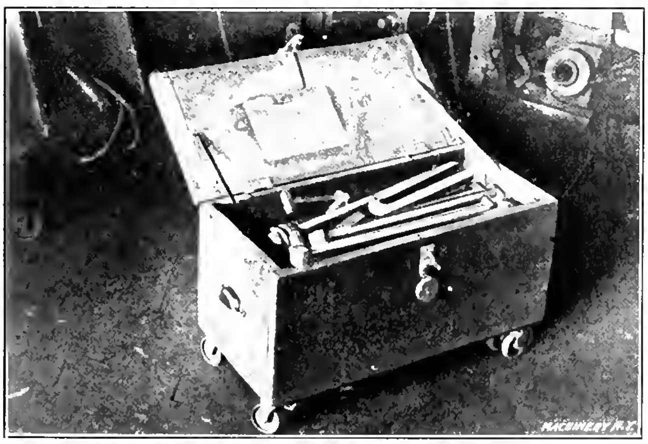
Fig. 28. Type of Chest in which Bolts and Clamps for Each Job are kept

Miscellaneous Devices

The big ruled blackboards which are used to keep track of the number of pieces in stock or orders for the various machine parts, are shown in Fig. 22. These big boards are counterbalanced, like a window, and when one is down where it can be easily read, or chalked in, the others are up out of the way. The first column shows the number of the parts; the second column the number of pieces in stock and the third column the number on order. In the engraving, one full board is shown and, above *A*, a part of another.

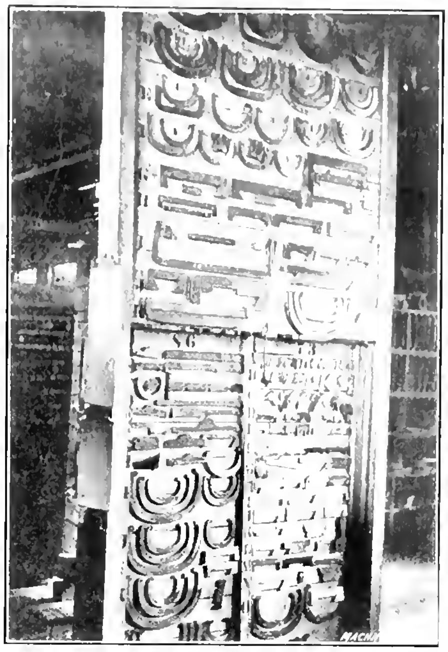
Fig. 27. Counterbalanced Gage Boards

Fig. 27 shows a set of counterbalanced gage boards, which are neat and save a great deal of space as well as trouble, for the boards are easily pulled down and no step ladder is needed to reach the upper ones.

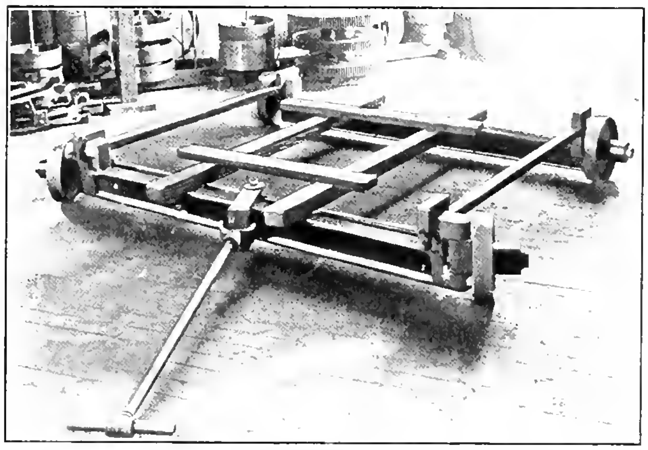
Fig. 29. Heavy Machine Moving Truck

A splendid time- trouble- and temper-saving plan carried out here, is to keep all the bolts, blocks, clamps or wedges, needed to set up any regular job, in a chest (Fig. 28), the key of which is accessible only to those who have a right to it.

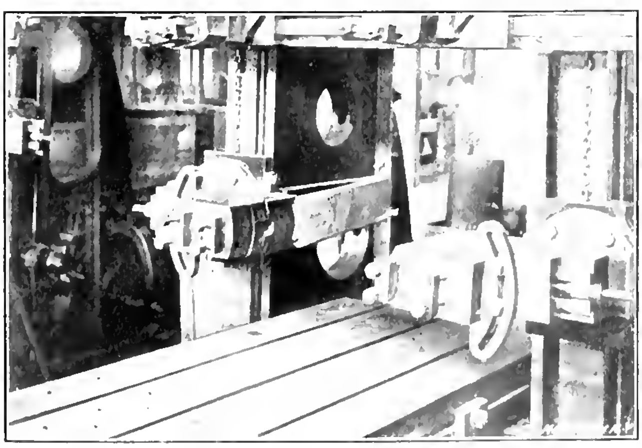
Fig. 30. Planer equipped with Reinforced Side-heads

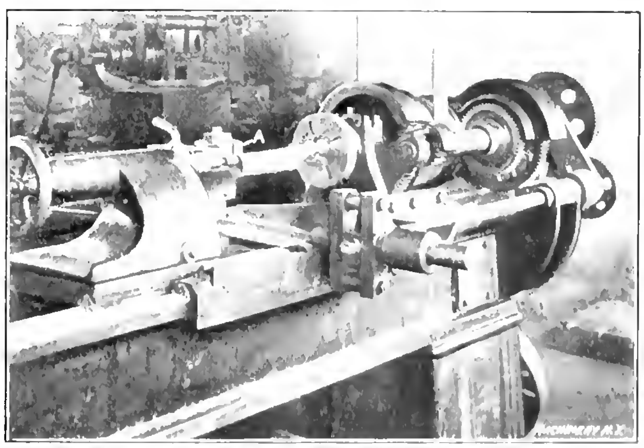
Fig. 31. Lathe with Special Eccentric Turning Attachment and Tool

Each chest is numbered to correspond to the parts to be machined, and as it is on large casters, it is easily rolled from the tool storage room to the machine on which the work is to be done. By this system a man doesn't have to keep a whole junk pile near his machine, from which to dig out his bolts or clamps, with the chance that he won't find what is needed after a half hour's wasted search, and will have to make something or rob his neighbor.

Heavy machines may be easily moved to places not accessible to a crane, by using the truck shown in Fig. 29, which is very low and strong. Special note should be taken of the steering knuckles, the long hubs of the wheels and the method of connecting the two axles.

Fig. 32. Shaper Rams with Brass Caps attached to the Finished Ends for Protection

Fig. 30 shows a planer fitted with special cross-slides and braces for its side heads, in order to secure the proper rigidity for high, narrow work.

In handling shaper rams after the heads have been finished, it has been found impossible to prevent damage to them unless the finished head is protected in some way; for this purpose easily applied brass caps have been made which are put on as shown in Fig. 32.

Instead of using two centers for eccentric work, a lathe has been fitted up as shown in Fig. 31. The mechanism is plainly shown, but the point I wish to bring out is that a single pointed cutting tool will not turn a true eccentric, as the motion of the piece being turned and its relation to the cutting point varies considerably, so that a tool like the one shown at *A* must be used to obtain the desired result.

* * *

PENSION FUND OF THE U. S. STEEL CORPORATION

The United States Steel Corporation announced early in May that it has established a pension fund for its employes. The sum of $8,000,000 has been set aside for this purpose which will be consolidated with a $4,000,000 fund given some years ago by Mr. Andrew Carnegie for the same object. The aggregate amount will be known as the United States Steel and Carnegie Pension Fund, and the net proceeds will be administered by a board of twelve trustees for the benefit of the employes of all subsidiary companies of the United States Steel Corporation. It is understood that under the tentative arrangement for the distribution of the proceeds from the fund, injured employes will receive part of their wages during the time of their disability. Single men are to receive 35 per cent of their wages, and married men 50 per cent, with an extra 5 per cent for each child under 16, and 2 per cent for each year of service over five. For permanent injuries lump sums are provided, based on the extent of the disability. In cases of death, the widow and children will receive 1½ years' wages with an additional 10 per cent for each child under 16, and 3 per cent of each year of service over five.

* * *

Don't let your work fall below inspection par by sacrificing quality for quantity.

DETERMINING DIMENSIONS OF GEARS FROM SAMPLES*

By E. WINSLOW BAXTER†

Many articles have been published in the engineering press on the subject of gearing, and formulas have been given for the solving of the different problems which arise in designing gear transmissions. There is another phase of the subject, however, which is seldom mentioned. This is the duplication of worn out or broken gears sent to the gear cutting shop by the customer who wants a new gear "just like the sample." Often these samples are accompanied by instructions, sketches, or blueprints which render the work of duplication simple, but a large number are sent in by customers to whom all gears are "cog-wheels," and the information needed to reproduce the old gear must be obtained from the sample.

The writer intends to give in the following a few of the methods by which problems of this kind may be solved, although these methods are by no means original. For testing the pitch of gears a prominent firm sells a set of three spur-gear gages having teeth cut on their periphery for all the principal diametral pitches. Such a set of gages is very handy for measuring the pitch of gear samples. However, all gears are not cut with standard diametral pitches. Sometimes they are cut with an odd circular pitch which must be determined by calculation. In the engraving accompanying the table of spur gear formulas is given the nomenclature used for regular involute teeth. All the formulas given in the following are based on the proportions given in the table.

Spur Gears

Assume that we are to reproduce a spur gear, the teeth of which are not worn more than to make it possible to measure the outside diameter with reasonable accuracy. From the known outside diameter and the number of teeth we can find the circular pitch required for selecting the proper cutter for cutting the gear. The formula used is as follows:

$$P' = \frac{3.1416 \times O}{N + 2}$$

Assume, for example, that the sample gear has 18 teeth and that the average of a number of different measurements for the outside diameter taken at different points is 4⅜ inches. Substituting these values in the formula gives:

$$P' = \frac{3.1416 \times 4.375}{18 + 2} = 0.687, \text{ or practically } 11/16 \text{ inch.}$$

When the circular pitch is found it can be approximately converted into standard diametral pitch by tables published in nearly all gear catalogues, and also in MACHINERY'S Reference Series No. 15, "Spur Gearing." The proper cutter to use can then easily be selected.

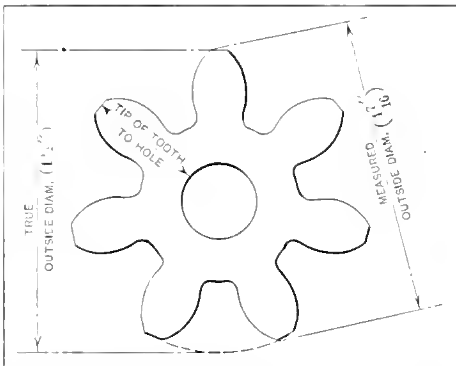

Fig. 1. Method of Measuring the Outside Diameter of a Gear with an Odd Number of Teeth

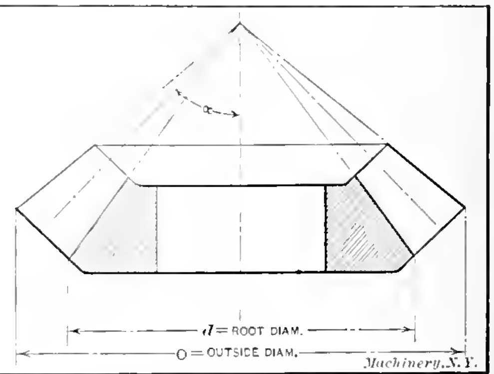

Fig. 2. Nomenclature for Bevel Gears

If the sample gear is worn so that the outside diameter cannot be accurately measured, measure the bottom diameter and substitute in the formula below:

$$P' = \frac{3.1416 \times d}{N - 2.3142}$$

* For additional information relating to gearing, see MACHINERY'S Reference Series, No. 1, "Worm Gearing," No. 15, "Spur Gearing," No. 20, "Spiral Gearing," and No. 37, "Bevel Gearing."

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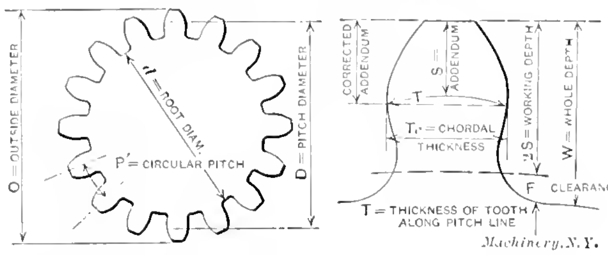
As an example assume that the sample gear has 50 teeth and that the root diameter is 3.97 inches. Then:

$$P' = \frac{3.1416 \times 3.97}{50 - 2.3142} = 0.262 \text{ inch.}$$

This circular pitch corresponds almost exactly to 12 diametral pitch.

If the sample gear has an odd number of teeth and the pitch is coarse, the outside or root diameters cannot be obtained with sufficient accuracy by direct measurement, as plainly shown in Fig. 1. In this case, however, we can measure from the hole to the tip of one tooth, multiply this dimension by 2, and add the diameter of the hole, the total sum then being the true outside diameter.

TABLE OF SPUR GEAR FORMULAS



Name	Symbol	In Terms of No. of Teeth, Diametral Pitch or Pitch Diameter	In Terms of Circular Pitch	In Terms of Diametral Pitch	In Terms of Addendum	In Terms of Thickness
Number of Teeth	N	....	....	....	....	....
Circular Pitch	P'	....	....	$\frac{3.1416}{P}$	3.1416 S	2 T
Diametral Pitch	P	....	$\frac{3.1416}{P'}$	....	$\frac{1}{S}$	$\frac{1.5708}{T}$
Addendum	S	....	$\frac{P'}{3.1416}$	$\frac{1}{P}$	....	0.6366 T
Thickness of Tooth	T	....	$\frac{P'}{2}$	$\frac{1.5708}{P}$	1.5708 S	....
Chordal Thickness	T_c	$D \times \sin\frac{90}{N}$	....	....	....	....
Clearance	F	....	$\frac{P'}{20}$	$\frac{0.1571}{P}$	0.1571 S	$\frac{T}{10}$
Working Depth	2S	....	$\frac{2P'}{3.1416}$	$\frac{2}{P}$	2 S	1.2732 T
Whole Depth	W	....	0.6866 P'	$\frac{2.1571}{P}$	2.1571 S	1.3732 T
Outside Diameter	O	$\frac{N+2}{P}$	....	....	....	....
Pitch Diameter	D	$\frac{N}{P}$	....	....	....	....
Root Diameter	d	$\frac{N-2.3142}{P}$	....	....	....	....

Bevel Gears

In duplicating bevel gears it is necessary to know the number of teeth in the mating gear and the angle of the shafts on which the two gears run. The center or pitch cone angle α (Fig. 2) of the gear must first be found.

Let N_1 = number of teeth in sample,
N_2 = number of teeth in mating gear,
α = pitch cone angle of sample,
γ = shaft angle.

Then for 90-degree shaft angles:

$$\tan \alpha = \frac{N_1}{N_2}$$

For shaft angles of more than 90 degrees:

$$\tan \alpha = \frac{\sin (180^\circ - \gamma)}{\frac{N_2}{N_1} - \cos (180^\circ - \gamma)}$$

For shaft angles of less than 90 degrees:

$$\tan \alpha = \frac{\sin \gamma}{\frac{N_2}{N_1} + \cos \gamma}$$

Having measured the outside diameter and found the center angle, we substitute these in the following formula:

$$P' = \frac{3.1416 \times O}{N + 2 \cos \alpha}$$

If the outside is so worn that we have to work from the root diameter, the following formula is used:

$$P' = \frac{3.1416 \times d}{N - 2.3142 \cos \alpha}$$

If necessary we can caliper to the hole, double the dimension and add the diameter of the hole for finding either the outside or the root diameters as already explained for the spur gears.

Worms and Wormwheels

In the case of a worm and wormwheel it is a simple matter to find the circular pitch, as it equals the distance from one worm thread to another in a line parallel with the axis of the worm. The lead equals the advance of one thread in one revolution. When the circular pitch and the outside diameter are known, then:

Pitch diam. of worm = outside diam — $0.6366\ P'$

$$\text{Tangent of thread angle} = \frac{\text{lead} \times 0.3183}{\text{pitch diameter of worm}}$$

In the case of a wormwheel, we should always determine the dimensions of the worm before starting to replace the gear, and should always know the center distance between the worm- and wheel-shafts, as the throat diameter of the wormwheel is seldom correct. The gear, therefore, should not be hobbed so as to get the same throat diameter as the sample worm-gear, but it should be hobbed with the hob corresponding to the mating worm at the correct center distance at which worm and wheel will run.

Spiral Gears

The following formulas may be used for finding the pitch diameter of spiral gears, when the outside or root diameter, the angle of the teeth with the axis of the gear, and the number of teeth are known. Let:

D = pitch diameter,
N = number of teeth,
α = angle of teeth with axis of gear,
O = measured outside diameter,
d = measured root diameter.

Then:

$$D = \frac{N \times O}{N + 2 \cos \alpha} = \frac{N \times d}{N - 2.3142 \cos \alpha}$$

The formulas given above are in all cases, of course, derived from the regular formulas for standard gears.

* * *

The following receipt for a non-shrinking alloy was recently published in the *Metal Industry*: Tin, 50 pounds, and zinc 50 pounds, gives a tough, hard metal that runs well. It is improved by the addition of 2 pounds of bismuth. By the use of heavy sprues, and by pouring cold, the slight shrinkage may be largely overcome.

PRIMITIVE BORING MACHINES

By JOSEPH G. HORNER*

In the French encyclopedia of D'Alembert and Diderot (1777) a drawing is shown of a machine for boring a cannon. (See Plate I.) A building with stone walls, supporting a single span ridge timber roof is provided with a central tower extending to a considerable height above the ridge. From horizontal beams *L* in this tower, pulley blocks *K* are hung, the lower blocks being attached to a sliding timber framing carrying the gun *H* to be bored, and sliding between vertical timber guides *Ff*, reaching from the floor up into the tower. These guides keep the gun to be bored in a fixed position in its framing throughout its vertical movements. It is suspended, mouth downwards over the boring tool, which is simply rotated. The feed is imparted to the gun as follows: The falls of the two ropes which come from the two upper blocks *K* of the suspended tackle are wound round a small drum

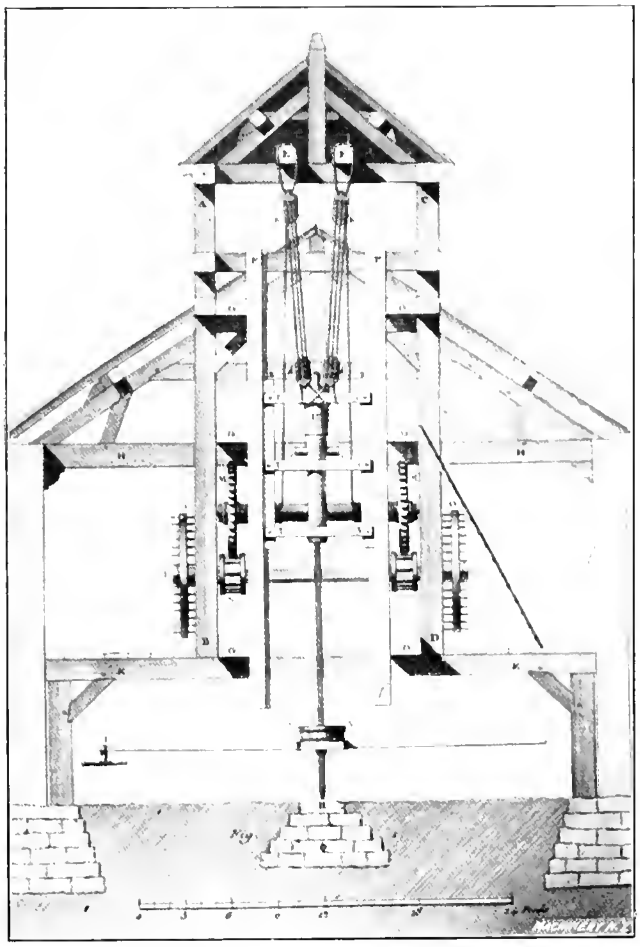


Plate I. A Gun Boring Machine of Large Proportions—Model of 1760

of several feet in length, the journals of which are carried in bearings on the uprights which carry the tower. The drum is rotated very slowly through two pairs of gears *M* and *N*, consisting of trundle pinions on a first motion shaft, and wooden cog-wheels on the drum shaft. The pinion shaft is turned by large wheels *O* on the shaft *P* with projecting pins arranged all around their peripheries. The down-feed of the gun in its sliding frame is thus controlled while boring.

The boring appliances are shown in detail in Plate II. Fig. 2 in this plate shows the vertical stem of the boring arbor broken off and carried up at *B*, and stepped into a bearing *R* below, which rests on masonry. It is rotated by a long lever with a loose handle seen at the right-hand end in Plate II, and at the left-hand end at *T* in Plate I, by which a workman or a horse pulls it around in a circle.

The remainder of the illustrations in Plate II show the boring tools, which are mostly reamers with inserted blades or milling cutters in embryo. Fig. 3 shows the boring tool *A*, having a four-sided tapered recess at *D* to fit over the end *b* of the arbor *B*. The end *A* is hemispherical, and is channeled. At the lower part of the plate the numbers 1, 4, 8, 12, 16 and 24 represent different bodies of copper which carry steel cutters to fit on the arbor *B*, the largest ones being used for finishing the bores. The tool No. 1 is used first, followed by the boring tool *A*, Fig. 3, after which the larger tools are used

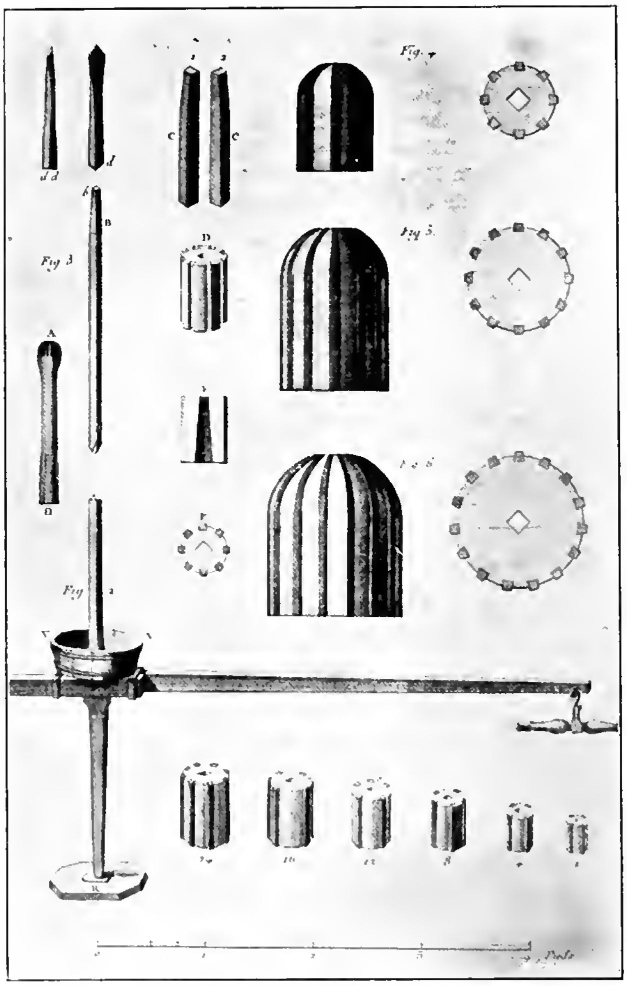


Plate II. Tools used for Boring Guns in France a Century and a Half ago

by which the diameter of the bore is gradually augmented until the boring is terminated. The details of tool 24 are shown above it; *F* is its plan, *E* its axial section, and *D* the

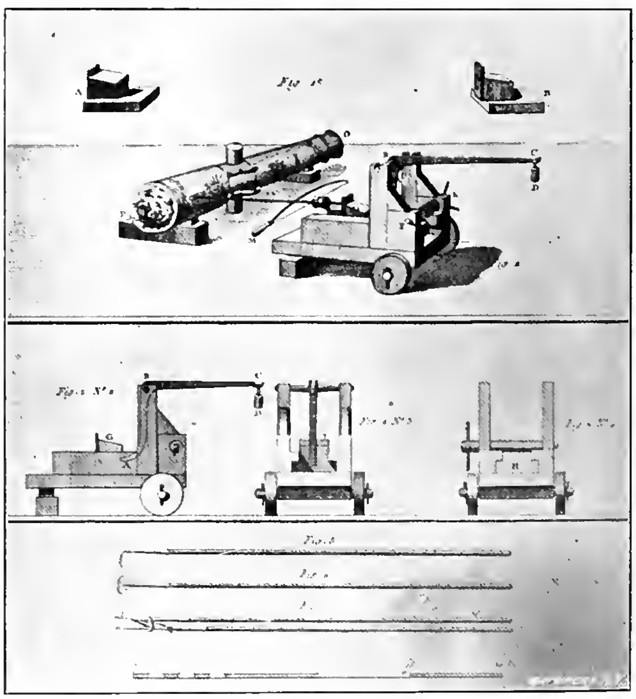


Plate III. A Portable Drilling and Boring Machine with Automatic Feed—Early French Type

body without its cutters. At *C* are seen two of the eight cutters drawn to a twice enlarged scale. The ends are bent, it is stated, for giving to the tool an opportunity to enter the bore.

Figs. 4, 5 and 6 illustrate boring tools for mortars of differ-

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ent calibers. The plan end views, showing the dovetailed setting of the cutters, are seen to the right.

The illustration at the top in Plate III shows the drilling of the touch holes in the cannon, and is an example of an early form of portable drill. The cannon which is being bored is supported on timber blocking, with wedge pieces, and the hole is being made with a fiddle drill, the bow being seen at *M*. The pressure against the drill is imparted by the lever *BC*, weighted at *D* as required. The block *G* takes the pressure of the pointed rear end of the drill. The shape of this block is seen at *A* and *B* above, giving front and rear views, the iron plate with its holes being shown at *B*. The axle *EF*, with a cross handle has a cord wound round it, the function of which is to withdraw the drill from the hole. In the middle view, Plate III, are shown side, front, and back views of the portable drilling frame.

NEW DESIGN OF HYDRAULIC CYLINDER GLANDS

By BENJAMIN BROWNSTEIN

The repacking of cylinders of large hydraulic presses of the type shown in Fig. 1 is not an easy and convenient matter, especially when the stroke is short and the cylinders large. The pressure on the rams of these presses ranges from 2000 pounds per square inch upward.

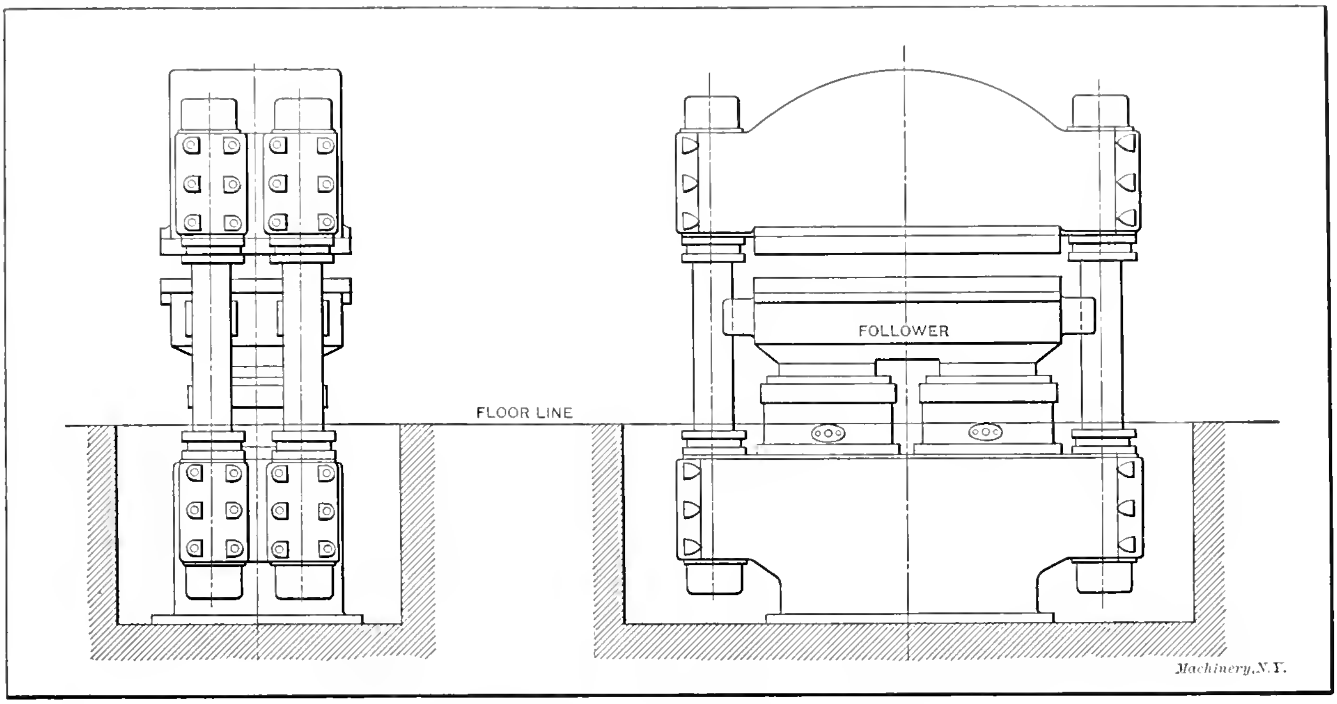

Fig. 1. Large Hydraulic Press of a Type Presenting Difficulties in Repacking the Cylinders

The usual design of the cylinder and gland is shown in Fig. 2. The gland is held down by a considerable number of studs and nuts which resist the upward pressure of the water acting on the packing at the bottom of the gland. When repacking this type of cylinder and gland, the follower is raised up from the rams and the nuts removed. This work is not very easily done, especially when the nuts are rusted

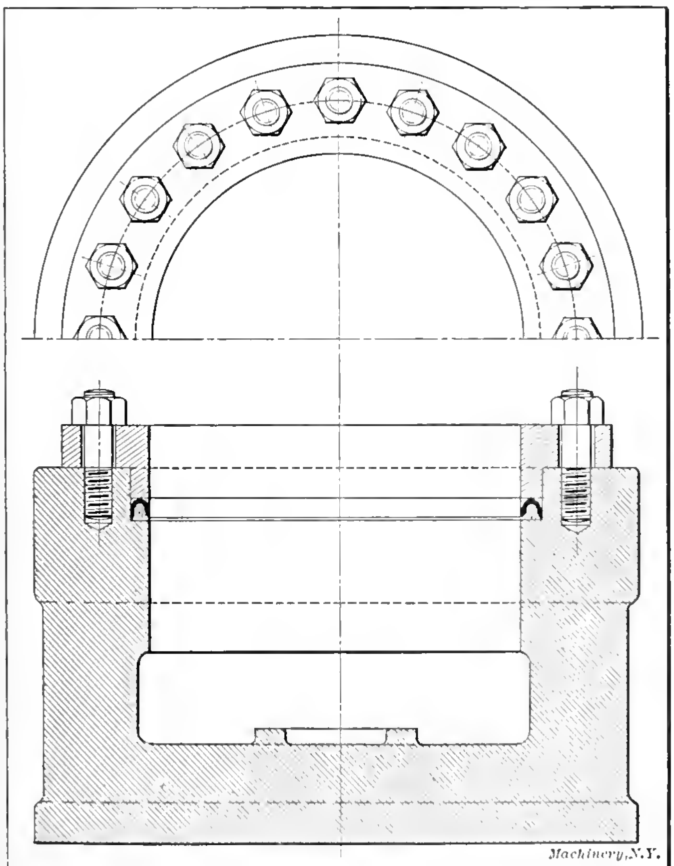

Fig. 2. Usual Design of Cylinder and Gland

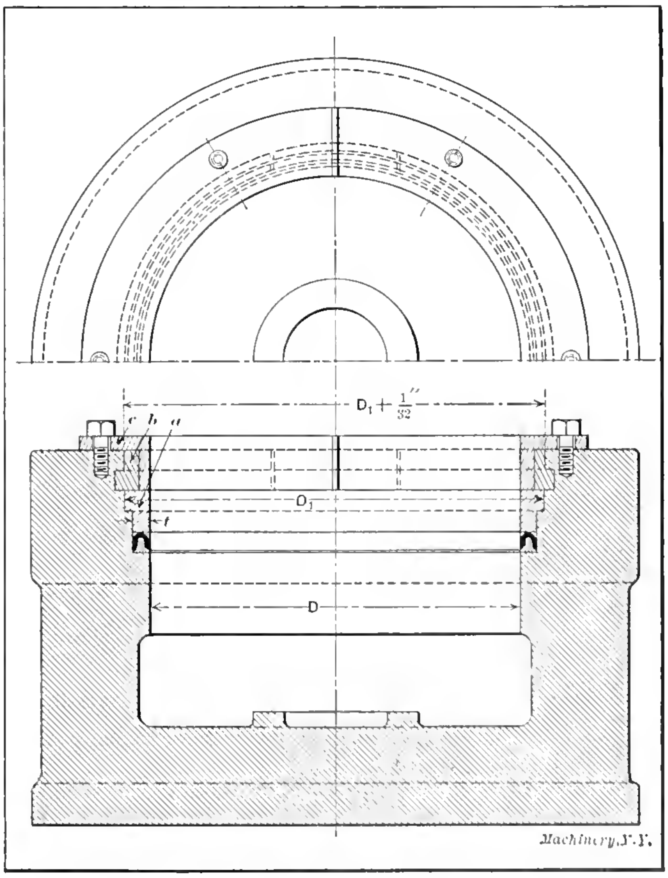

Fig. 3. Improved Design, Facilitating Repacking

in place, and when the space available prevents the use of a good-sized wrench. In many cases it is found more convenient to remove the cylinder with the ram and other parts from the press in order to repack it. Difficulty is also met with when replacing the gland and screwing the nuts home. If the nuts are not screwed down so that the tension on all the studs is equal, the load is thrown entirely upon those studs which are in greater tension.

The design of the hydraulic cylinder glands shown in Figs. 3 and 4 eliminates the troublesome studs and nuts; it allows the cylinder to be repacked without taking the press apart (the follower is simply raised up from the rams); it is stronger than the design with the greater number of studs,

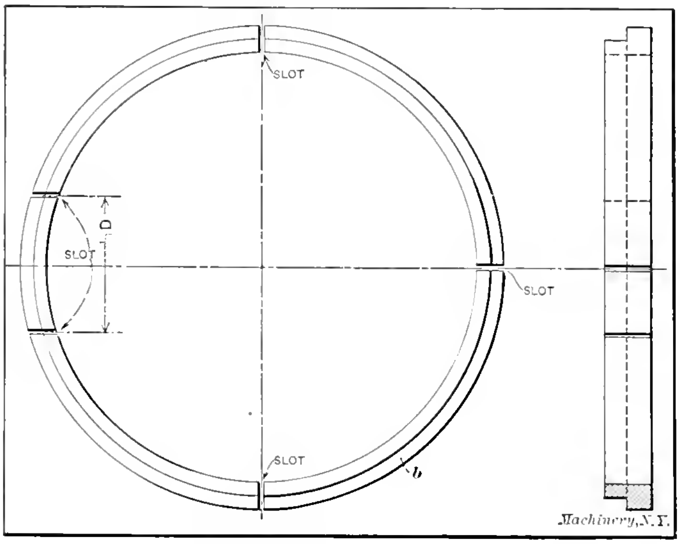

Fig. 4. Detail of Gland Bushing

as can be easily seen from studying the illustration Fig. 3, and is, therefore, capable of carrying a greater pressure and will give less trouble. In Fig. 3 is shown a section of the cylinder and cylinder gland. The gland is divided into three parts, *a* the bottom gland, *b* a gland bushing which is shown in detail in Fig. 4, and *c* the top gland. The bottom gland *a* is made solid and put in after the leather and hemp packing is inserted in its proper place. Then the gland bushing *b* is

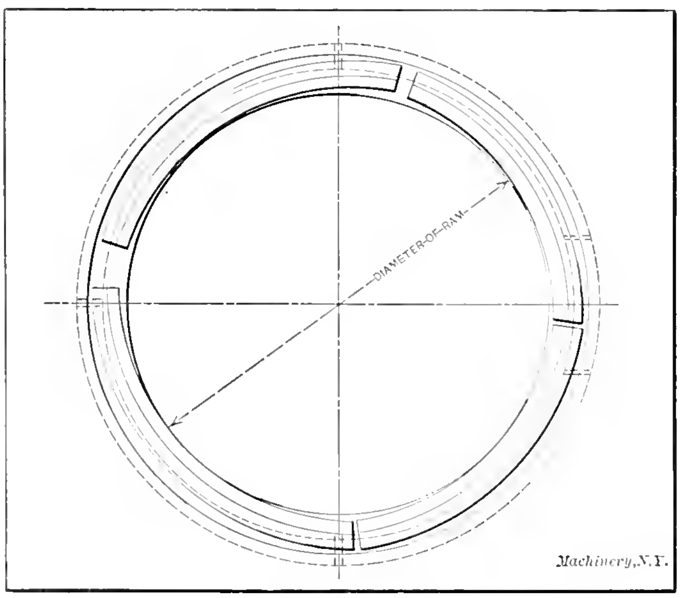

Fig. 5. Diagram showing how Bushing Sections can easily be removed and replaced

put into place. This bushing is made in five or more sections as shown in Fig. 4, according to the diameter of the cylinder and the thickness of the parts making up the gland. By making the bushing in this way the sections can easily be put in or taken out without removing the ram from the cylinder as will be apparent from a little study of the engraving Fig. 5.

The top gland *c* which is shown split but which can be made solid if the design of the press allows it, is then put into place and held down with two, four or six cap-screws or studs and nuts, as desired, the number of screws depending upon the size of the cylinder. It will be seen in Fig. 3 that this design of gland and cylinder eliminates the difficulties common to the general design shown in Fig. 2. This method of packing is superior in every way.

It is not possible to give all the proportions of the gland, as the most important factors, the diameter of the cylinder and the pressure per square inch are variable quantities, but the following may be stated as a general formula for calculating the stress on the gland.

Let P = pressure per square inch on ram,
t = thickness of bottom gland = width of packing,
P_1 = total pressure on gland *a* per inch of mean circumference,
S = safe shearing stress of flange of gland bushing *b*.

Then

$$P_1 = Pt, \text{ and } t = \frac{P_1}{S}.$$

* * *

AEROPLANE FLIGHT FROM LONDON TO MANCHESTER

A new record in aviation was established by Louis Paulhan, the French aviator, April 27 and 28, when making a flight from London to Manchester, England, and thereby winning a prize of $50,000 offered by the *Daily Mail*. According to the rules of the prize it was to be paid to the first aviator who traversed this distance of 185 miles, making only two stops and completing the journey in twenty-four hours. This is the greatest feat so far performed in aviation and is rewarded by the largest sum offered as an aviation prize. Mr. Paulhan started from London at 5.31 P. M., April 27, and continued in one uninterrupted flight as far as Litchfield, where he arrived at 8.10 P. M., after having covered 117 miles in two hours and thirty-nine minutes at an average speed of 44 miles per hour. From this point he resumed his journey at 4.9 A. M. the following morning, and arrived at Didsbury, near Manchester, at 5.30, completing the remaining 66 miles of the journey in 81 minutes at an average speed of 48.8 miles per hour. Mr. Paulhan competed with Mr. Grahame White, an Englishman, for this prize. Mr. White's efforts also deserve to be recorded. He started from London at 6.33 P. M. and stopped at Roade, 60 miles away at 7.55 P. M. In an effort to over-reach his rival he resumed his flight in the dark at 2.50 A. M., but had to again descend at 4.30 A. M. Starting again at 5.02 A. M. he found the wind conditions so adverse that he was compelled to descend at Litchfield at 5.20 A. M. for a second time.

Mr. Paulhan now holds both the long-distance record and the altitude record for aeroplanes. The week before his flight from London to Manchester he went a distance of 130 miles "cross-country" in France without alighting. At Los Angeles last January he won the altitude record for the heavier-than-air machines, rising to a height of 5000 feet.

* * *

ARTIFICIAL RUBBER

Dr. Carl Harries, professor of chemistry at the University of Kiel, Germany, has discovered a process of making artificial rubber. The product is said to have all the characteristics of natural rubber. The importance of the discovery to the automobile world can hardly be overestimated. The enormous consumption of rubber in the manufacture of tires has jumped to a price of $2.50 or more a pound, for pure Para rubber, from about 75 cents a pound less than two years ago. It is said that the artificial rubber is as tough and elastic as the natural product, and is a light brown to white in color. At present the manufacture is very costly, but it is expected that the process will be so simplified and cheapened as to produce the artificial rubber cheaper than the natural rubber. It is anticipated by some optimistic persons that the natural rubber industry will eventually suffer the same fate as that of the natural indigo industry. To-day artificial indigo, manufactured by German chemists, has virtually ousted the natural article from the market entirely.

THREADING OPERATIONS—2

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

The producing of a correct lobe on the cam for threading, and a knowledge of the various threading attachments and devices used, is essential, as was explained in the previous installment, but careful consideration should also be exercised in the selection of suitable dies and taps if good results are to be expected. The nature of the material to be threaded, of

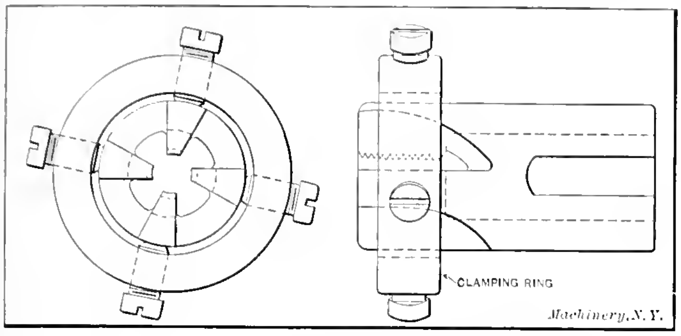

Fig. 11. Spring Screw Threading Die and Adjusting Ring

course, governs to a certain extent the particular design of die or tap to use. The various types of dies and taps, and die and tap holders, will be briefly reviewed.

Spring Screw Threading Dies

In Fig. 11 is shown a common form of spring screw threading die with its adjustable ring. Dies of this type are used to a large extent on the Brown & Sharpe automatics, but the results obtained are not always entirely satisfactory. There are a number of objections to this type of die, some of which are here given. The common method of making these dies is to hob them out with a tap larger in diameter than the basic screw and then close them in by means of the

TABLE VI. ADJUSTABLE ROUND SPLIT SCREW THREAD BUTTON DIE SIZES FOR A. S. M. E. STANDARD SCREWS

Size of Screw and Number of Threads Per Inch	External Diameter	Pitch Diameter	Root Diameter
0.060 — 80	0.060	0.0519	0.0424
0.073 — 72	0.073	0.0640	0.0535
0.086 — 64	0.086	0.0759	0.0640
0.099 — 56	0.099	0.0874	0.0739
0.112 — 48	0.112	0.0985	0.0827
0.125 — 44	0.125	0.1102	0.0930
0.138 — 40	0.138	0.1218	0.1028
0.151 — 36	0.151	0.1330	0.1119
0.164 — 36	0.164	0.1460	0.1249
0.177 — 32	0.177	0.1567	0.1330
0.190 — 30	0.190	0.1684	0.1431
0.216 — 28	0.216	0.1928	0.1658
0.242 — 24	0.242	0.2149	0.1834
0.268 — 22	0.268	0.2385	0.2040
0.294 — 20	0.294	0.2615	0.2236
0.320 — 20	0.320	0.2875	0.2496
0.346 — 18	0.346	0.3099	0.2678
0.372 — 16	0.372	0.3314	0.2841
0.398 — 16	0.398	0.3574	0.3101
0.424 — 14	0.424	0.3776	0.3235
0.450 — 14	0.450	0.4036	0.3495

adjusting ring shown. This produces an imperfect thread if a tap much larger in diameter than the basic size of the screw is used. The correct method of tapping out a die of this kind is to use a taper tap which gives clearance at the back of the die, as is necessary. This necessitates the making of taper taps, as can be easily seen, which adds to the expense of the die. This type of die is also difficult to harden without springing the prongs, thus causing chattering and producing a thread which is not spherical in shape. Making a die with three prongs or cutting edges obviates chattering and produces a more nearly perfect thread. When cutting a small screw, the work sometimes breaks off in the die, leaving it practically useless, because in drilling the broken pieces out, the thread in the die is sacrificed in most cases. A type of die which overcomes this latter objection is shown in Fig. 12, the die here shown being split, allowing the broken screw to be easily removed. The location of the cutting edges on spring screw threading dies should be radial for brass, and about 0.1 of the diameter ahead of the center for Norway iron, machine steel, etc.

*Associate Editor of MACHINERY.

Adjustable Round Split Screw Threading Dies

This form of die has an advantage over the spring screw threading die for the following reasons: It can be hardened without springing out of shape, and can be held more rigidly, which produces good results; and although it cannot be ground to advantage, its first cost is so much less that it can be discarded when dull. On account of the rigid manner in which this die can be held, the cutting edges in all cases can be located ahead of the center about 0.1 of the diameter which gives good results. An improved method of laying out button dies was described in the March, 1909, issue of MACHINERY.

TABLE VII. ADJUSTABLE ROUND SPLIT SCREW THREAD BUTTON DIE SIZES FOR A. S. M. E. SPECIAL SCREWS

Size of Screw and Number of Threads Per Inch	External Diameter	Pitch Diameter	Root Diameter
0.073 — 64	0.073	0.0629	0.0510
0.086 — 56	0.086	0.0744	0.0609
0.099 — 48	0.099	0.0855	0.0697
0.112 — 40	0.112	0.0958	0.0768
0.112 — 36	0.112	0.0940	0.0729
0.125 — 40	0.125	0.1088	0.0898
0.125 — 36	0.125	0.1070	0.0859
0.138 — 36	0.138	0.1200	0.0989
0.138 — 32	0.138	0.1177	0.0940
0.151 — 32	0.151	0.1307	0.1070
0.151 — 30	0.151	0.1294	0.1041
0.164 — 32	0.164	0.1437	0.1200
0.164 — 30	0.164	0.1424	0.1171
0.177 — 30	0.177	0.1554	0.1301
0.177 — 24	0.177	0.1499	0.1184
0.190 — 32	0.190	0.1697	0.1460
0.190 — 24	0.190	0.1629	0.1314
0.216 — 24	0.216	0.1889	0.1574
0.242 — 20	0.242	0.2095	0.1716
0.268 — 20	0.268	0.2355	0.1976
0.294 — 18	0.294	0.2579	0.2158
0.320 — 18	0.320	0.2839	0.2418
0.346 — 16	0.346	0.3054	0.2581
0.372 — 18	0.372	0.3359	0.2938
0.398 — 14	0.398	0.3516	0.2975
0.424 — 16	0.424	0.3834	0.3361
0.450 — 16	0.450	0.4094	0.3621

In Fig. 13 is shown a type of adjustable round split button die as used by the Northern Electric & Mfg. Co., Ltd., of Montreal. This type of die has been found to give such favorable results that it is used by this firm in preference to all the other types for screw machine work. In Tables VI and VII are given the sizes as used by the above firm in making their

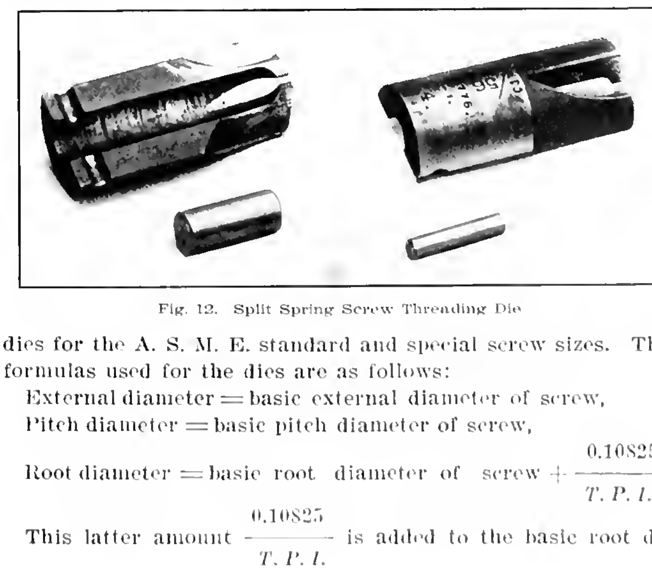

Fig. 12. Split Spring Screw Threading Die

dies for the A. S. M. E. standard and special screw sizes. The formulas used for the dies are as follows:

External diameter = basic external diameter of screw,

Pitch diameter = basic pitch diameter of screw,

$$\text{Root diameter} = \text{basic root diameter of screw} + \frac{0.10825}{T.\,P.\,I.}.$$

This latter amount $\frac{0.10825}{T.\,P.\,I.}$ is added to the basic root di-

ameter to provide for wear. While the sizes as given have been used by the firm mentioned, for a considerable time, theoretically it is not the correct way of making the die, because, to cut a clean thread, a die should have clearance as shown at *a*, Fig. 14, and as a screw is generally cut below the maximum diameter, the sizes as given would not provide any clearance at all; in fact it would be just the reverse, as the die would have to be closed, instead of opened up. The writer would suggest that when good results are desired the die should be tapped out smaller than the basic screw, and then opened up, as this would give a good clearance as shown enlarged for clearness at *a*, Fig. 14. Making the root diameter of the die the same as the minimum screw would give the desired results. This has been experimented with and the results obtained were perfectly satisfactory. The following formulas should be used for obtaining the sizes of adjustable round split button dies:

External diameter = basic external diameter of screw,

Pitch diameter = minimum pitch diameter of screw, or

$$\text{basic pitch diameter of screw} - \frac{0.168}{T.P.I.+40},$$

Root diameter = minimum root diameter of screw or basic

$$\text{root diameter} - \left(\frac{0.10825}{T.P.I.} + \frac{0.168}{T.P.I.+40}\right)$$

Making the external diameter equal to the basic external diameter allows for clearance, which is necessary, as the external diameter of the die should not be used for cutting the screw to size. This should be accomplished either by a finishing box-tool or by the cross-slide forming tools. It is obvious that making the dies to the sizes given in the formulas permits them to be used longer and still cut a clean thread. The work should be turned slightly smaller than the finish diameter required, depending on the material and the pitch of the thread.

TABLE VIII. MACHINE TAPS FOR A. S. M. E. STANDARD SIZES

Size of Screw and Number of Threads Per Inch	Manufacturing Limits						Diameter of Shank, Stubbs' Wire Gage or Inches	Length of Threaded Portion	Length Overall
	External Diameter		Pitch Diameter		Root Diameter				
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			
0.060 — 80	0.0632	0.0623	0.0538	0.0533	0.0466	0.0447	51	⅜	1¼
0.073 — 72	0.0765	0.0755	0.0660	0.0655	0.0580	0.0560	47	½	1⅜
0.086 — 64	0.0898	0.0888	0.0780	0.0775	0.0689	0.0668	42	9/16	1⅜
0.099 — 56	0.1033	0.1021	0.0897	0.0892	0.0793	0.0770	36	9/16	1½
0.112 — 48	0.1168	0.1155	0.1010	0.1004	0.0888	0.0862	31	⅝	1½
0.125 — 44	0.1301	0.1288	0.1129	0.1122	0.0995	0.0968	29	⅝	1½
0.138 — 40	0.1435	0.1421	0.1246	0.1239	0.1097	0.1069	26	⅝	1½
0.151 — 36	0.1569	0.1555	0.1359	0.1352	0.1193	0.1164	21	11/16	1½
0.164 — 36	0.1699	0.1685	0.1489	0.1482	0.1323	0.1294	17	11/16	1½
0.177 — 32	0.1835	0.1819	0.1598	0.1590	0.1411	0.1380	12	¾	1⅝
0.190 — 30	0.1968	0.1952	0.1716	0.1708	0.1515	0.1483	8	¾	1⅝
0.216 — 28	0.2232	0.2215	0.1961	0.1953	0.1745	0.1712	¼	1	2½
0.242 — 24	0.2500	0.2483	0.2184	0.2176	0.1931	0.1896	9/32	1	2½
0.268 — 22	0.2765	0.2747	0.2421	0.2412	0.2144	0.2108	9/32	1	2½
0.294 — 20	0.3031	0.3013	0.2653	0.2643	0.2346	0.2309	5/16	1	2½
0.320 — 20	0.3291	0.3273	0.2913	0.2903	0.2606	0.2569	11/32	1	2¾
0.346 — 18	0.3559	0.3539	0.3138	0.3128	0.2796	0.2758	⅜	1	2¾
0.372 — 16	0.3828	0.3808	0.3354	0.3344	0.2968	0.2928	13/32	1	2¾
0.398 — 16	0.4088	0.4068	0.3614	0.3604	0.3228	0.3188	7/16	1	2¾
0.424 — 14	0.4359	0.4338	0.3818	0 3807	0.3374	0.3333	15/32	1	2¾
0.450 — 14	0.4619	0.4598	0.4078	0.4067	0.3634	0.3593	½	1	2¾

TABLE IX. MACHINE TAPS FOR A. S. M. E. SPECIAL SIZES

Size of Screw and Number of Threads Per Inch	Manufacturing Limits						Diameter of Shank, Stubbs' Wire Gage or Inches	Length of Threaded Portion	Length Overall
	External Diameter		Pitch Diameter		Root Diameter				
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			
0.073 — 64	0.0768	0.0758	0.0650	0.0645	0.0559	0.0538	47	½	1⅜
0.086 — 56	0.0903	0.0891	0.0767	0.0762	0.0663	0.0640	42	9/16	1⅜
0.099 — 48	0.1038	0.1025	0.0880	0.0874	0.0758	0.0732	36	9/16	1½
0.112 — 40	0.1175	0.1161	0.0986	0.0979	0.0837	0.0809	31	⅝	1½
0.112 — 36	0.1179	0.1165	0.0969	0.0962	0.0803	0.0774	31	⅝	1½
0.125 — 40	0.1305	0.1291	0.1116	0.1109	0.0967	0.0939	29	⅝	1½
0.125 — 36	0.1309	0.1295	0.1099	0.1092	0.0933	0.0904	29	⅝	1½
0.138 — 36	0.1439	0.1425	0.1229	0.1222	0.1063	0.1034	26	⅝	1½
0.138 — 32	0.1445	0.1429	0.1208	0.1200	0.1021	0.0990	26	⅝	1½
0.151 — 32	0.1575	0.1559	0.1338	0.1330	0.1151	0.1120	20	11/16	1½
0.151 — 30	0.1578	0.1562	0.1326	0.1318	0.1125	0.1093	20	11/16	1½
0.164 — 32	0.1705	0.1689	0.1468	0.1460	0.1281	0.1250	17	11/16	1½
0.164 — 30	0.1708	0.1692	0.1456	0.1448	0.1255	0.1223	17	11/16	1½
0.177 — 30	0.1838	0.1822	0.1586	0.1578	0.1385	0.1353	12	¾	1⅝
0.177 — 24	0.1850	0.1833	0.1534	0.1526	0.1281	0.1246	12	¾	1⅝
0.190 — 32	0.1965	0.1949	0.1728	0.1720	0.1541	0.1510	8	¾	1⅝
0.190 — 24	0.1980	0.1963	0.1664	0.1656	0.1411	0.1376	7	¾	1⅝
0.216 — 24	0.2240	0.2223	0.1924	0.1916	0.1671	0.1636	¼	1	2½
0.242 — 20	0.2511	0.2493	0.2133	0.2123	0.1827	0.1789	9/32	1	2½
0.268 — 20	0.2771	0.2753	0.2393	0.2383	0.2087	0.2049	9/32	1	2½
0.294 — 18	0.3039	0.3019	0.2618	0.2608	0.2276	0.2238	5/16	1	2½
0.320 — 18	0.3299	0.3279	0.2878	0.2868	0.2536	0.2498	11/32	1	2¾
0.346 — 16	0.3568	0.3548	0.3094	0.3084	0.2708	0.2668	⅜	1	2¾
0.372 — 18	0.3819	0.3799	0.3398	0.3388	0.3056	0.3018	13/32	1	2¾
0.398 — 14	0.4099	0.4078	0.3558	0.3547	0.3114	0.3073	7/16	1	2¾
0.424 — 16	0.4348	0.4328	0.3874	0.3864	0.3488	0.3448	15/32	1	2¾
0.450 — 16	0.4608	0.4588	0.4134	0.4124	0.3748	0.3708	½	1	2¾

Machine Taps

Internal threading is more difficult to accomplish than external threading on the automatic; the reason for this is, of course, that the tap, when it once enters the work, cannot be reversed to relieve the clogging of the chips, as can be done in hand tapping. The spindle also, revolving at a high rate of speed, has a tendency to break the tap—it is at this point that the tap generally breaks, as the chips lodging in the flutes of the tap prevent it from reversing. For this reason the land should be just strong enough to resist the cutting pressure, leaving plenty of chip space without reducing the cross-section of the tap too much. The flutes in the tap are generally cut radially with the center, and slightly deeper than the root of the thread, the amount, of course, varying according to the diameter of the tap and the pitch of the thread. For brass work the ordinary tap is generally used with the teeth cut radially with the center. In Tables VIII and IX are given the manufacturing limits, as adopted by the Northern Electric & Mfg. Co., Ltd., Montreal, for the A. S. M. E. standard and special sizes. The taps are made from Stubbs' imported drill rod. The diameters of shank used are given in the tables, and also the length of the threaded portion and the overall length. All taps 0.100 inch diameter and less have three flutes, and all taps over 0.100 inch diameter have four flutes. The formulas used by the above firm for the manufacturing limits are as follows:

TABLE X. FORMULAS FOR FINDING MANUFACTURING LIMITS FOR TAP AND DIE SIZES

No. of Threads Per Inch	Value of $\frac{0.10825''}{T.P.I.}$	Value of $\frac{0.112''}{T.P.I.+40}$	Value of $\frac{0.224''}{T.P.I.+40}$	Value of $\frac{0.336''}{T.P.I.+40}$	Value of $\frac{0.168''}{T.P.I.+40}$	Value of $\frac{0.6495''}{T.P.I.}$	Value of $\frac{1.2990''}{T.P.I.}$
80	0.0014	0.0009	0.0019	0.0028	0.0011	0.0081	0.0162
72	0.0015	0.0010	0.0020	0.0030	0.0015	0.0090	0.0180
64	0.0017	0.0011	0.0022	0.0032	0.0016	0.0101	0.0203
56	0.0019	0.0012	0.0023	0.0035	0.0018	0.0116	0.0232
48	0.0023	0.0013	0.0025	0.0038	0.0019	0.0135	0.0271
44	0.0025	0.0013	0.0027	0.0040	0.0020	0.0148	0.0295
40	0.0027	0.0014	0.0028	0.0042	0.0021	0.0162	0.0325
36	0.0030	0.0015	0.0029	0.0044	0.0022	0.0180	0.0361
32	0.0034	0.0016	0.0031	0.0047	0.0023	0.0203	0.0406
30	0.0036	0.0016	0.0032	0.0048	0.0024	0.0217	0.0433
28	0.0039	0.0016	0.0033	0.0049	0.0025	0.0232	0.0464
24	0.0045	0.0018	0.0035	0.0053	0.0026	0.0271	0.0541
22	0.0049	0.0018	0.0036	0.0054	0.0027	0.0295	0.0590
20	0.0054	0.0019	0.0037	0.0056	0.0028	0.0325	0.0650
18	0.0060	0.0019	0.0039	0.0058	0.0029	0.0361	0.0722
16	0.0068	0.0020	0.0040	0.0060	0.0030	0.0406	0.0812
14	0.0077	0.0021	0.0041	0.0062	0.0031	0.0464	0.0928

External diameter:

$$\text{Maximum} = \text{basic external diameter of screw} + \left(\frac{0.10825}{T.P.I.} + \frac{0.224}{T.P.I.+40}\right)$$

$$\text{Minimum} = \text{basic external diameter of screw} + \left(\frac{0.10825}{T.P.I.} + \frac{0.112}{T.P.I.+40}\right)$$

Pitch diameter:

$$\text{Maximum} = \text{basic pitch diameter of screw} + \frac{0.224}{T.P.I. + 40}$$

$$\text{Minimum} = \text{basic pitch diameter of screw} + \frac{0.168}{T.P.I. + 40}$$

Root diameter:

$$\text{Maximum} = \text{basic root diameter of screw} + \frac{0.336}{T.P.I. + 40}$$

$$\text{Minimum} = \text{basic root diameter of screw} + \frac{0.112}{T.P.I. + 40}$$

The only changes from the A. S. M. E. formulas (see MACHINERY, December, 1907) for the taps are the minimum external diameter, and the minimum pitch diameters. The reason for increasing the minimum external diameters can easily be seen by comparing the results as obtained by the formulas used by the Northern Electric & Mfg. Co. and the A. S. M. E. respectively. For example: Take a tap 0.164—36 pitch. The minimum external diameter given by the A. S. M. E. is 0.1656 inch. Now the maximum or basic screw is 0.164 inch. This leaves 0.0016 inch for wear, when the tap has been made the minimum size. This amount has been found not to be sufficient. The minimum external diameter, as found by the formula used by the Northern Electric & Mfg. Co., is 0.1685 inch, which gives 0.0045 inch over the basic screw. As will also be noted, this decreases the limit between the maximum and minimum external diameters of the tap, allowing only 0.0014 inch. In all cases the limits as derived by these formulas have been found to be sufficient. It will also be noted that the minimum pitch diameter is also increased to extend the life of the tap. In Table X the results as obtained by the various formulas are given, which simplifies the calculations necessary in determining the limits, as the amounts given are added to the basic sizes of the screw. In the last two columns are given the single and double depth of the thread.

As has previously been mentioned, an ordinary machine tap is suitable for cutting brass, but it does not give satisfactory resnlts when tapping Norway iron, machine steel, etc. In Fig. 15 is shown a tap which gives good results in threading Norway iron or machine steel. This tap should be slightly tapered towards the back for clearance, and also to eliminate friction. The end is ground at an angle of about 55 degrees, and slightly cupped at the center, aud backed off as shown. A groove, as shown, is ground the entire length of the threaded portion, after the tap has been hardened. This allows the oil to penetrate to the point in threading, and also provides clearance for the chips to back out. When made from Stubbs' imported drill rod and carefully hardened, this tap can be worked at from 35 to 40 surface feet per minute, which would be impossible with an ordinary tap. Taps for threading copper have their flutes cut spirally and should also have an odd number of flutes. A right-hand spiral about one turn in 12 inches should be used.

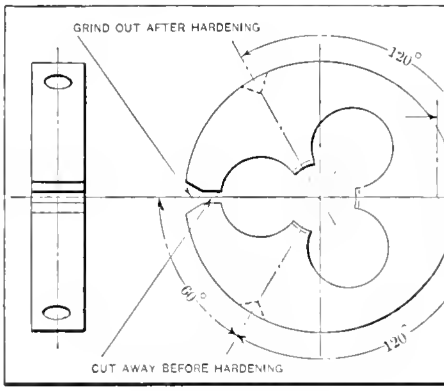

Fig. 13. Adjustable Round Split Button Die

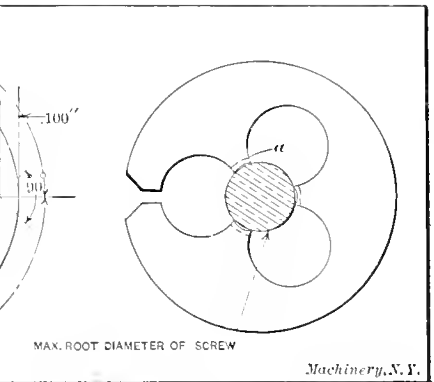

Fig. 14. Illustration showing Clearance for Adjustable Round Split Button Dies

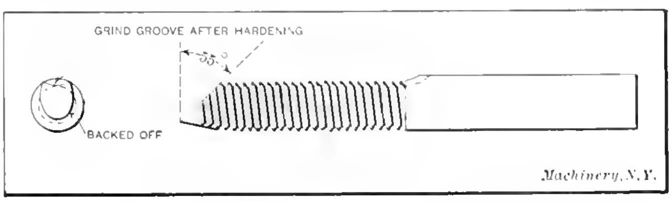

Fig. 15. A Suitable Tap for Norway Iron and Machine Steel

Tapping Drills

The tapping size drills as recommended by the A. S. M. E. are not suitable for general work, as I presume many who have experimented with them have learned to their sorrow. The question of tapping drills cannot be settled by giving a table and saying that the sizes therein contained are the best.

Of course, to a certain extent, the sizes used in various shops do not vary greatly, but nevertheless there is really no standard size. Considering this the writer submits a list of tapping size drills which have been adopted by the Northern Electric & Mfg. Co. for general work. These sizes have given good results in practice. The sizes as given in Table XI are used for all classes of work and material. The amount of thread obtained by these sizes is from ⅝ to ¾ of a full thread.

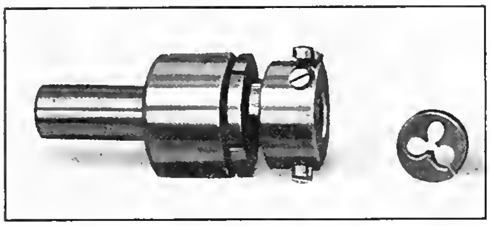

Fig. 16. Button Die Holder of the Draw-out Type

Speeds for Dies and Taps

As a general rule, a die can be operated at a higher rate of speed than a tap, for the following reasons: A die can be left harder than a tap on account of the weak cross-section of the tap, and as the tap is easier to re-sharpen, it can therefore, be left softer. Another reason is that the die can be supplied with oil much easier than can the tap. The following surface speeds have been found suitable for taps and dies made from ordinary carbon steel and used on the materials specified:

Surface Speeds for Dies

Material	Feet per Minute
Brass (ordinary quality)	190-200
Norway iron and machine steel	30-40
Drill rod and tool steel	20-30

Surface Speeds for Taps

Material	Feet per Minute
Brass (ordinary quality)	150-160
Norway iron and machine steel	25-30
Drill rod and tool steel	15-20

When the diameter of the tap and the surface feet per minute are given, the revolutions of the spindle can be found by the following formula:

$$R = \frac{12 \times S}{D \times \pi}$$

where R = revolutions of the spindle,
S = surface feet per minute,
D = external diameter of tap or die.

When the surface speed and diameters are required the formula takes the following forms:

$$S = \frac{\pi \times D \times R}{12} \text{ or } D = \frac{S \times 12}{R \times \pi}$$

Die and Tap Holders

The manner in which a die or tap is held when being applied to the work has a considerable bearing on the results obtained. For this reason careful consideration should be exercised when deciding on the type of die or tap holder to be used. The die or tap holders as supplied by the Brown & Sharpe Mfg. Co. give satisfactory results in most cases, and, therefore, the writer would suggest that for general automatic work these holders should be used. In Fig. 16 is shown a button die holder of the draw-out type, as made by the above firm. This holder gives good results when the work is not required to be threaded up to a shoulder. In Fig. 17 is shown an improved design of releasing button die holder also made by this firm, a section through the holder being shown at *A*. The main feature of this die holder is that it can be reversed without shock; therefore, when threading small screws it has less tendency to break the screw off in the die. At *B* and *C* are shown two views taken from the cross-section *X Y*. At *B* and *C* are also shown two small balls *e* which are used, allowing this die holder to reverse without shock. The operation of this die holder is as follows: When the die holder or spindle *a* draws out from the body *b*, the driving pins *c* are also withdrawn so that the radius on the end of these pins is drawn out flush with the plate *m*. Thus when the machine spindle is reversed the spindle *a* revolves with the work, the centrifugal force throwing the ball *e* out of the deep part of the pocket as shown at *B* into the position as shown at *C*. This locks the holder, allowing it to be backed off the work. This holder can be used either for right- or

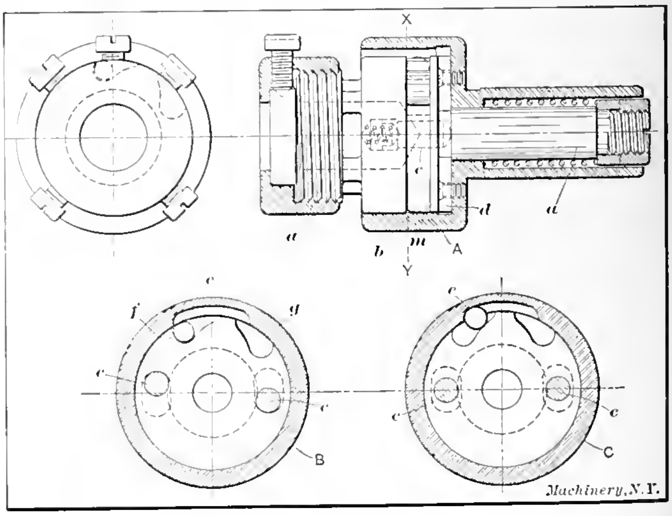

Fig. 17. Illustration showing Operating Parts of Releasing Button Die Holder

TABLE XI. TAP DRILLS FOR A. S. M. E. STANDARD AND SPECIAL MACHINE SCREWS

Special sizes are marked *

Size of Screw and Number of Threads Per Inch	Size of Tap Drill	Decimal Equivalent of Tap Drill	Size of Screw and Number of Threads Per Inch	Size of Tap Drill	Decimal Equivalent of Tap Drill
0.060 — 80	56	0.0465	*0.177 — 24	27	0.1440
0.073 — 72	53	0.0595	*0.190 — 32	19	0.1660
*0.073 — 64	53	0.0595	0.190 — 30	20	0.1610
0.086 — 64	49	0 0730	*0.190 — 24	21	0.1590
*0.086 — 56	50	0.0700	0.216 — 28	13	0.1850
0.099 — 56	45	0.0820	*0.216 — 24	14	0.1820
*0.099 — 48	46	0.0810	0.242 — 24	5	0.2055
0.112 — 48	42	0.0935	*0.242 — 20	7	0.2010
*0.112 — 40	43	0.0890	0.268 — 22	1	0.2280
*0.112 — 36	43	0.0890	*0.268 — 20	1	0.2280
0 125 — 44	37	0.1040	0.294 — 20	¼	.0.2500
*0.125 — 40	37	0.1040	*0.294 — 18	¼	0.2500
*0.125 — 36	38	0.1015	0.320 — 20	J	0.2770
0.138 — 40	32	0.1160	*0.320 — 18	J	0.2770
*0.138 — 36	33	0.1130	0.346 — 18	19/64	0.2968
*0.138 — 32	32	0.1160	*0.346 — 16	19/64	0.2968
0.151 — 36	30	0.1285	*0.372 — 18	21/64	0.3281
*0.151 — 32	⅛	0.1250	0.372 — 16	P	0.3230
*0 151 — 30	⅛	0.1250	0.398 — 16	11/32	0.3437
0 164 — 36	28	0.1405	*0.398 — 14	11/32	0.3437
*0.164 — 32	28	0.1405	*0.421 — 16	⅜	0.3750
*0.164 — 30	28	0.1405	0.424 — 14	U	0.3680
0.177 — 32	24	0.1520	*0.450 — 16	13/32	0.4062
*0.177 — 30	24	0.1520	0.450 — 14	25/64	0.3906

left-hand threading simply by inserting the balls *e* in the various pockets, *e. g.*, when ball *e* is placed in pocket *f* it will cut a right-hand thread, and when placed in pocket *g* it will cut a left-hand thread. This holder is used to advantage especially when cutting up to a shoulder. In Fig. 18 is shown a releasing tap holder. The spindle *A* carries a pawl *a*, which is held back against the shoulder *C* by the spring *b*. When the spindle *A* draws out, the bevel portion on the pawl *a* allows it to slide past the block *B*, thus allowing the spindle *A* to make one revolution when the opposite face of pawl *b* comes in contact with the block *B*, thus allowing the tap to back out of the work. A blank bushing *d* is shown in the holder.

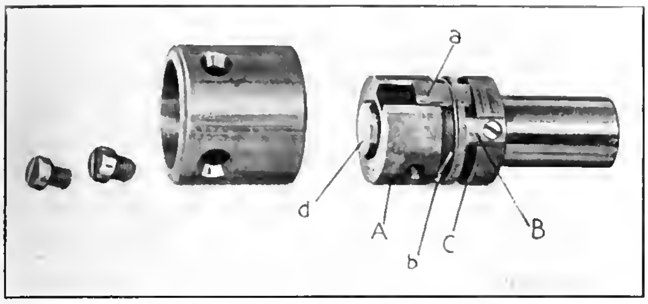

Fig. 18. Releasing Tap Holder

Using Two Taps

When a full thread is desired and the size of the tap will not stand the cutting pressure, it is sometimes found convenient to use two taps. The first tap should be ground tapered somewhat similar to a starting tap which is used for hand tapping. The taper should extend back equal to the distance that the tap is to go into the work so that the first thread left in the work will be to the full diameter. The second tap is left with a full thread. To set the taps, the dogs on the drum should be set so that the spindle will be reversing at about the same point on both the thread lobes. Then the first tap is set and made to travel into the work the desired distance. The second tap is then set in the turret, the distance from the face of the turret being the same as for the first tap. If this procedure is followed, little difficulty will be encountered. A reversing tap holder as shown in Fig. 18 is preferable to the draw-out type for this purpose, as the taps are not required to be set as accurately.

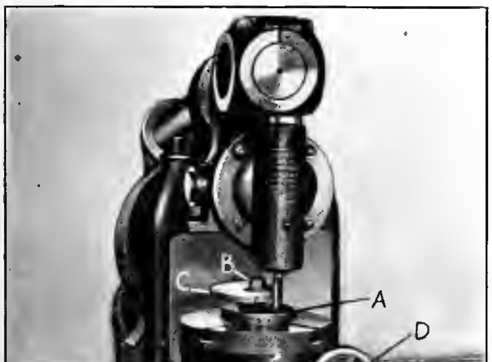

Fig. 19. Cutting Thread Lobe on a Circular Milling Attachment

Cutting the Thread Lobe

In Fig. 19 is shown the circular milling attachment (mentioned in the previous installment of this article) in position on the Brown & Sharpe universal milling machine, which is equipped with the vertical milling attachment. Before cutting the cam the various lobes are laid out in their respective positions as designated on the drawing, and the superfluous metal is removed either by shearing in a punch press or by drilling a series of 3/16-inch holes about 1/16-inch from the outline of the various lobes. The cam is then placed on block *A*, as shown, which has a projecting stud, nut *B* being used to hold the cam down tight against the face of this block. The block is held to the circular milling attachment by two screws not shown in the illustration. To cut the cam, raise the knee until the end mill passes the lower face of the cam *C* as shown and bring the end mill into position at the bottom of the lobe, in other words, at the point where the die would start on the work. Then feed the end mill in the desired distance. The micrometer collars on the shafts carrying the handles *D* and *E* are then set at zero. Referring to Fig. 10, which was given in the previous installment of this article, we find that the lead on the lobe is one thousandth inch for each 3½ minutes of its circumference, but the smallest division on this attachment is five minutes. We will, therefore, revolve the attachment five minutes for each 0.00175 inch that we feed the cam in, continuing in this manner until that side of the lobe is finished. The attachment is then swung around and the other side of the lobe completed in the same manner. Milling the cam in this manner leaves a series of slight flats on the lobe which can be removed by filing, giving the cam lobe an approximately true curve.

* * *

REMOVAL OF CHIPS WHEN REAMING

By T. COVEY

Jim, the apprentice boy, started one morning to fasten some angle-plates onto some castings that were to be used as jigs, and it was not desirable to have the screw and dowel-pin holes go through both pieces; in other words they were "blind" holes. He had been instructed to drill the screw holes first, making the holes in the angle-plate a little larger than the screws that went through them so that the plate could be shifted slightly. Then, to set the plates accurately where they are wanted, clamp them fast with their own screws, and then drill and ream dowel-pin holes through the angle-plates into the casting. He was busy reaming these dowel-pin holes, and in order to get the reamer to go clear down to the bottom found it necessary to frequently remove it and clean out the chips, which was very troublesome on account of the necessity of using oil. A toolmaker who was going to finish the jigs, being about ready to start work on one of them, came up to see how he was progressing. "You seem to like to probe around in that hole with that little flattened wire," said he. "What is the object?"

"How do you suppose I can get a reamer into a hole that is half full of chips," said Jim; "if they were dry I could blow them out with this little bent pipe, but oily ones don't blow worth a cent."

"If you were to fill that hole you have just reamed full of oil and force the reamer down into it quickly, what would be the result?"

"Why, the oil would squirt up the sides of the reamer I suppose."

"Exactly! Now if you were to fill one of the holes that you haven't reamed full of oil and were to go ahead and ream it, the result would be the same; that is, the oil underneath the reamer would be forced up along the sides of the reamer just the same only not so fast; still it would be plenty fast enough to carry the chips out as fast as the reamer made them. Try one and see how it works—only after you start the reamer down, keep it going down; if you lift it up the oil will be sucked into the hole and the chips with it where they would soon settle to the bottom."

"Say, that works all right," said Jim.

"Yes, with large holes though, that would not be a very profitable way to use oil; but then with large holes it is easy to get the chips out, so it is not necessary."

* * *

According to an estimate by the *Elektrotechnische Zeitschrift* the actual available water power on the European continent, after deductions have been made for water power which cannot be commercially exploited, is about 36,000,000 horsepower. Of this more than 14,000,000 horsepower is available in Sweden and Norway, 6,000,000 horsepower in Austria-Hungary, and in France and Italy about 5,500,000 horsepower each.

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MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

JULY, 1910

PAID CIRCULATION FOR JUNE, 1910, 26,617 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

Ralph E. Flanders, for five years an associate editor of MACHINERY, has resigned to return to practical work, a change which he has long desired to make, and which deprives trade journalism of one of its ablest writers. Mr. Flanders is a mechanic of wide practical knowledge, and an all-around fine fellow whom it was a pleasure to have on our staff. As our readers know, he is the author of *Gear Cutting Machinery* and is an authority on gear practice, in which line of work his experience will undoubtedly be of great value to our friends, the Fellows Gear Shaper Company, with whom he will be connected.

Our best wishes for his success go with him. L.

* * *

THE BENEFITS OF COOPERATION

The recent meeting of the National Machine Tool Builders' Association exemplifies some of the benefits that come from hearty, whole-souled cooperation. One hundred and sixteen concerns, many of them competitors, came together to promote the common good, which means not only the good of the members, but also of their customers. The association aims to be the means for interchanging ideas by which manufacturing costs shall be reduced, machine design improved, and knowledge of important matters affecting the trade, generally disseminated. But of more importance, it has proved to be a means of inspiration. No one who heard the address on the Cincinnati Continuation School could help being inspired with the feeling that to help others is to help one's self—that altruism has a commercial value. If the employer raises the standard of intelligence and living for his employes, he will surely raise the standard of his product and increase his own prosperity.

The gospel of cooperation is being preached everywhere, but few fully understand and apply it. Cooperation is the keystone of the arch of civilization. A hundred weak threads twisted together make a rope which the strongest man cannot break—many working together accomplish what is impossible for a few. Cooperation in the machine tool business means better shop management, better shops, better men, better product, and better employers. It is as far removed from the popular idea of the trust method of conducting business as one pole is from the other. The initiative of individuals is not stifled, but stimulated. Secret methods have no place in the proceedings, which are characterized by frankness and liberality throughout.

* * *

NEW FIELDS FOR MECHANICAL ENGINEERS

H. L. Gantt's paper, "The Mechanical Engineer and the Textile Industry," read at the Atlantic City convention of the American Society of Mechanical Engineers outlines a new field for the profession. It shows that one important industry in which many opportunities exist for effecting very large economies of operation and improving the grade of product, has been practically neglected by engineers. As an illustration, Mr. Gantt described the common, crude method of bleaching cloth, which requires operatives to work in unhealthful surroundings and results in an irregular product and much confusion in bringing together the cloth of different mills when the bleaching is completed. The improvement as described was effected by designing simple apparatus which enabled the cloth to pass progressively from one bath to another without break and almost without the aid of human labor.

The changes were of so simple a nature that practically any mechanical engineer would have worked out essentially the same means of accomplishing the desired result, had he been required to improve the existing conditions. But strange as it will seem to the readers of this journal, practically every bleachery in this country or Europe is following the old crude method, illogical in plan and unsatisfactory in product. Parallel conditions, not so readily improved perhaps, exist in the textile industry generally, and doubtless in many others which so far have not received the critical attention of trained minds. The technical colleges have largely devoted themselves to the training of power plant engineers, neglecting fielos of endeavor where vastly greater economies are possible.

* * *

GRINDING GAS ENGINE CYLINDERS

There is an honest difference of opinion, shared by engineers and manufacturers alike, as to the desirability of internally grinding gas engine cylinders. Those opposed to the practice say it is a useless refinement practiced by certain automobile manufacturers more for the purpose of making a good talking point than for anything else. They say that the bored cylinder has exactly the kind of surface required to quickly wear the piston rings to a smooth bearing, and that after lapping it is more likely to be tight than a ground cylinder. The parallel grooves left by the boring tool catch and hold the lubricating oil and check gas leaks, on the principle of action of the so-called water packing grooves sometimes provided in the valve stems and piston rods of hydraulic mechanisms.

The supporters of piston and cylinder grinding make three principal claims for the practice, *viz.*, interchangeability, improved wearing surfaces and the saving of one set of piston rings. By grinding both cylinders and pistons, perfect interchangeability may be secured at low cost, all scraping, filing and fitting being avoided. Anyone acquainted with the economies of a strictly interchangeable system of manufacture will fully appreciate this feature. Fitting, in the common way, is a time-consuming process, especially when done by the use of abrasives. When finished by grinding, the wearing surface is perfect at the start, and the cylinder begins its work with a standard size bore. This latter condition is impossible with the boring and lapping method. Lapping will wear the bore of the common automobile engine cylinder 0.006 inch larger perhaps, and then it may be neither round nor straight. The process wears out a set of piston rings and a new set must be furnished after the finishing operations are completed, which, of course, means double cost for piston rings.

Judging from the experience of users, it appears to an unprejudiced observer that grinding machines, of both the external and internal types, will be among the machine tools most highly prized by gas engine builders when they fully understand and appreciate their possibilities and economies, and have trained workmen to use them efficiently.

FORCE REQUIRED FOR BENDING

It is a curious fact and one not very creditable to the authors, that practically all the text-books on mechanics treat bending stresses and resistance to bending from the view-point that bending is to be resisted. In the design of most machines and structures this view-point is perfectly correct, but if the designer requires to know the force that will actually bend a bar or beam, he will find no direct information on the subject in the great mass of engineering literature. Of course, it does not require profound reasoning to deduce the fact that the ordinary beam formulas apply just the same whether the beam is to bend or resist bending, but doubtless it would comfort the callow engineer to be assured that, for example, $P = \frac{S\,l\,t^2}{6}$ can be used to find the force required to bend a plate held at one edge, if he will but insert a value S equal to or slightly greater than the elastic limit of the material.

* * *

WHERE ARE OUR MARKETS?

The total value of metal working machinery manufactured in the United States amounted to $32,408,766 in 1905, the last year for which census figures are available. The value of the same product in 1900 was $24,737,904, and the same proportionate increase during the past five years would bring the total for 1910 to $42,000,000 or more.

Our exports for each of the years from 1905 to 1909 inclusive, were as follows:

Year	Europe	Canada	West Indies, Central and So. America	Asia	All other Countries	Total
1905	$3,718,824	$150,180	$143,148	$245,066	$ 75,447	$4,332,665
1906	5,825,505	169,206	207,060	114,507	129,334	6,445,612
1907	8,423,471	261,272	329,255	255,551	99,507	9,369,056
1908	6,859,319	551,155	544,435	514,430	226,896	8,696,235
1909	2,853,605	223,650	345,447	88,374	128,958	3,640,034

A comparison of these figures shows that the great market for American machinery is at home; and while due attention should be given to foreign outlets, the home market is the one which best repays cultivation, for this belongs to American manufacturers and cannot be taken away from them unless there is a material change in conditions. There is no doubt that our home market can be substantially increased, even though the process may be a slow one, and one requiring attention to problems other than those purely commercial. The manufacture of machine tools is a basic industry, and a larger home market for its product can be created by an increased development of the resources of the country, for which there are vast opportunities. In proportion to its area and natural wealth, the country is as yet sparsely settled; but the opportunities for development are being monopolized, and natural resources that could be used in various industries are held out of use. Under such conditions the country cannot develop as rapidly as if its resources were open to such enterprise as would make the best immediate use of them.

The proper use of our natural resources is not contrary to the idea of conservation. It is true that the consumption of coal and other mineral wealth gradually exhausts the supply, but no other resources of the country diminish or decrease in value through proper use. Among those which, with proper care, should be virtually inexhaustible, are the water power, a valuable natural asset, the forests, which can and should be replanted, and the land itself, which, for agricultural and other purposes is to a very large extent held out of use. If we really want to create larger home markets, monopoly in these natural resources must be opposed by logical and intelligent methods, and the greatest possible freedom given to competitive enterprise wherever it manifests itself. Thus a much greater home market than the present one can be created, and the United States can become more independent of foreign trade, for which the competition is constantly increasing.

GOULD & EBERHARDT'S APPRENTICESHIP SYSTEM*

By FRED L. EBERHARDT†

With the necessary requisites in mind we select applicants for apprenticeship from our public grammar and high schools by applying to the superintendent of public schools and his principals; also to our Newark Technical School, Municipal Labor Bureau, and by advertising in the daily papers, alternating our advertisements by first appealing to the boys themselves and second to the parents, approaching the latter from the standpoint that they should not overlook their responsibility in considering their sons' future welfare and earning power. Too many parents look only at the present and think, because their boys can earn $6, $7, $8, or $9 per week, that it is helping them more than to put the boys out at lower wages, and no doubt there is a good deal of truth to this contention. But, if the boy is made of the proper mettle and has the natural ability, he would be destined for far greater results in a few years than if he had not started on a trade at all. We would lay great stress on the need of educating parents to allow their boys who have a mechanical inclination to serve an apprenticeship of say, four years, in a well-regulated factory. While not making it obligatory, we strongly advocate our apprentices attending the Newark Evening Technical School, from which a number of our apprentices have been graduated.

At present we have about 65 apprentices, all bound and indentured according to the apprenticeship laws of New Jersey, and have none who are not bound in this manner.

We have practically two forms of apprenticeship, one for young men about seventeen years of age, embracing what we term our regular course and covering a period of four years of 10,800 hours, and another for two years, or 5400 hours, called our "one-branch," and intended for young men 21 years and older. Reckoning a year at 2700 hours, in the case of our four-year course, we have a first period of 2000 hours at 8 cents per hour, a second 2000 hours at 9 cents, a third 2000 hours at 10 cents, a fourth 2000 hours at 11 cents and a fifth 2800 hours at 12 cents. This makes a total of 10,800 hours.

The total hours in each period are required to be completed before the next advance in pay is made. We require that the apprentices' parents shall pay us $1 per week during the first four periods, which amount forms the collateral for a bond which the father or guardian is required to execute. This amount is returned at the expiration of the term, if the said term is completed in a satisfactory manner. However, if for any reason the terms of the papers are violated or the young man runs away, the money paid on account is forfeited. Incidentally, I would say that the amount which we pay the young man, as stated above, is larger than what it was formerly. We made it sufficiently more for the purpose of enabling the parent to pay back the $1 per week to make good the bond. In this way, we feel, we make it more feasible for a worthy young man, so to say, to pay his own way so far as securing a bondsman is concerned, a collateral bond always having been one of our requirements.

The regular apprenticeship course includes work at the vise, lathe and planer. In addition, milling machine and gear cutting machine experience, and also other work, is afforded to those boys who show ability to absorb.

Our experience has taught us that there is so great a variation in capacity that wherever we see a boy who shows ability we do not hesitate to advance him, and when we find a boy who does not possess ability we strongly advise him and his parents to have him take up some other line of work. This we do within the first 4000 hours of service. It does not always take 4000 hours to determine this, but there are times when, before taking summary dismissal measures, we try out a boy at more than one branch, or place him with different foremen, so that, in the final disposition of the case, neither the parent nor the boy can say that he was not given a fair trial. For all these efforts expended on the boy up to this time, should he prove deficient and be dismissed, we require that whatever money has been paid on account of the bond be

* Abstract of paper read before the Convention of the National Machine Tool Builders' Association, in Rochester, N. Y., May 25, 1910.
† President of Gould & Eberhardt, Newark, N. J.

forfeited. This is, in a measure, partly to compensate us for the time spent, work spoiled, etc., in giving the boy a chance to demonstrate, in our opinion or judgment, whether or not he is suited for the trade. The necessity for this measure does not occur often, but we feel that it is absolutely necessary to have some such method of procedure.

Our second form of apprenticeship, called our one-branch, is for young men who, having attained their majority, realize the necessity for learning some trade and regret not having been given the opportunity in earlier years. This apprenticeship, as stated, is for two years, or 5400 hours, divided into periods of 2700 hours each, the first at 12 cents per hour and the second at 14 cents per hour. We require the young men themselves to pay us $1 per week, the same as before explained. This amounts to about $165 in the four-year course and $130 in the two-year course, and in each case is paid back at the expiration of the term when completed in a satisfactory manner. This latter amount is also subject to the same penalties as previously mentioned.

At the present time we have seven in our drafting-room. Our chief draftsman and three journeymen draftsmen were our own apprentices at the machinist's trade. Another is an apprentice at the machinist's trade, and has been given drawing-room privileges and practice. One of the journeymen draftsmen is foreign born and a trained technical graduate. We do not include instruction in the foundry or pattern-shop generally, although all of the apprentices who gain drawing-room experience have access to and come in contact with the work in the pattern-shop and foundry. For the foundry and pattern-shop we have similar but special and separate courses.

All of our apprentices during their apprenticeship are furnished with the necessary tools required in the several branches, and we pass free title to them upon the apprentice completing his term.

* * *

CASEHARDENING PRACTICE AT THE JUNIATA SHOPS OF THE PENNSYLVANIA R. R.

We are now able to give more detailed information on casehardening practice at the Juniata Shops of the Pennsylvania Railroad, as described in the June, 1910, number of MACHINERY, on page 824 of the engineering and railway editions. This information relates particularly to the method of packing the work, and to the use of test pieces to determine the quality and depth of the hardening. The following formula is used as a packing mixture:

11 pounds prussiate of potash.
30 pounds sal soda.
20 pounds coarse salt.
6 bushels powdered charcoal (hickory preferred).

The whole is mixed thoroughly, using about 30 quarts of water in the mixing; the above quantity is sufficient to harden three boxes of material containing the following parts:

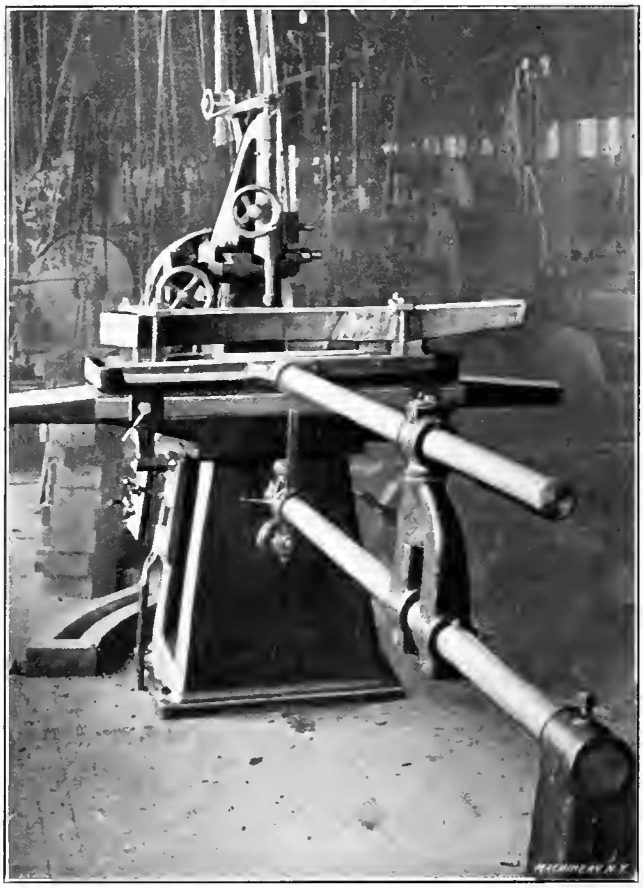
2 links, 2 link blocks, 2 link-block pins, 2 valve-rod pins, 4 knuckle-joint pins, and 24 gibs for spring rigging.

The box required to hold these parts measures 40 inches long, 16 inches wide, and 12 inches deep; the time required to harden them properly is fourteen hours. Smaller parts, like link die plates, eccentric-rod jaw pins, and nuts below 1 inch, are usually packed in smaller boxes, or pipe 8 inches in diameter, which require between four and five hours heating. Link motion bushings and similar light parts are also packed in small boxes or pipe and require from two and a half to three hours.

The following method is pursued in packing the material: The bottom of the box is covered to a depth of 2 inches with the compound; the parts to be hardened are placed solidly, so that the compound is in contact with the bottom surface of the work; care is taken, however, that the work does not touch the sides of the box or other pieces in the box. After the first layer of the material is placed, it is covered on all sides and on the top with the compound, and is solidly packed with a suitable implement—a bolt with a large head will do. After the first layer is packed the same process is repeated, being sure to have sufficient compound between the two layers to prevent contact. There should not be less than 2 inches of compound on top of the last layer. The lid which fits inside the box is then thoroughly sealed with a luting of fire clay.

When in the furnace, the box rests on rollers to allow the flames to pass under it. The furnace is kept at a bright red heat, but not hot enough to scale or blister the work; when the material has soaked in the fire a sufficient length of time, the box is withdrawn to a trestle which is flush with the floor of the furnace, and stands parallel with and close to the water tank. The lid is then removed from the box and, if links are being hardened the link is turned on edge and a bar passed through the slot in the link and lifted by two men, being plunged into the water endwise; the bar is then withdrawn and the link is allowed to remain in the tank until cold.

The best results are obtained when the contents of the box can be emptied into the water at once. The tank used has a line of $1\frac{1}{2}$-inch iron pipe connected with the service pipe, running around the four sides and close to the bottom, with $\frac{1}{4}$-inch holes drilled about $1\frac{1}{2}$ inch apart. This supplies cold



Hammett Grinding Machine for Finishing the Slots of Locomotive Links

water to the work and drives the hot water to the top, where it is carried to the sewer by means of an overflow pipe.

With each box of material to be hardened a test piece is used, the same as described in the article last month. In the case of links, the test piece is $1\frac{1}{4}$ inch thick by 3 inches wide, and 12 inches long; this test piece is stenciled with figures giving the class of engine, the construction number and the date of hardening. After the links are taken out, the test piece is broken under hydraulic pressure and examined for depth of hardening, after which it is also subjected to a file test. Smaller parts are similarly tested. These test pieces are kept for two years or more for reference. It is possible to put from 1/16 inch to 5/32 inch depth of case on the link work in fourteen hours' time, and 1/16 inch on bushings and other small parts in from two and a half to three hours' time. All parts to be casehardened must be thoroughly cleaned.

It was stated that the slots of the valve gear links are ground accurately to fit the radius templet shown in Fig. 24 of the article in the June number. The accompanying illustration shows the machine on which this grinding is done. It is a vertical spindle machine, as may be seen, the work being clamped to the top of a flat table. This work table is free to swivel, and to move in and out on top of the longitudinal slide which carries it. It is guided by a long radius rod, as shown, which is attached to a pivot adjustable to any required radius.

AUTOMOBILE FACTORY PRACTICE

THE OLDS MOTOR WORKS, LANSING, MICH.

By ETHAN VIALL.*

To the man traveling through Michigan for the first time, it almost seems as if the sole product of the state were auto

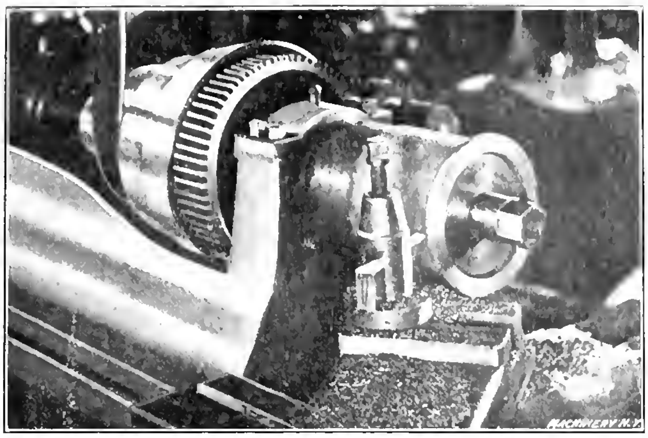


Fig. 1. Turning the Chucking Flange on Piston Ring Casting

mobiles, furniture and breakfast foods, and a fair-sized town that doesn't boast of a factory for the production of at least

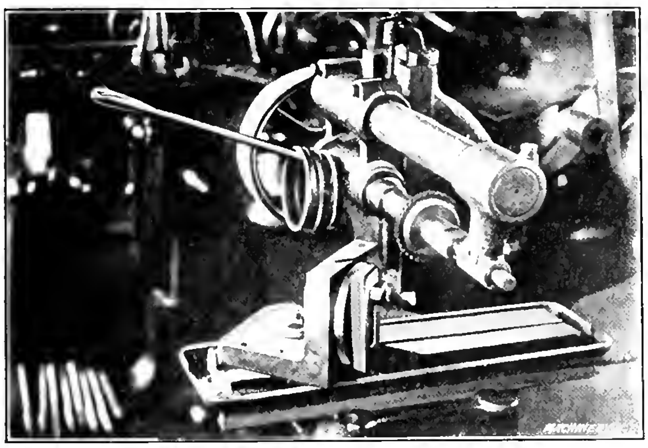


Fig. 3 Machine in which Piston Rings are split

one of these, is apparently out of the running and should at once shake up its chamber of commerce or its commercial

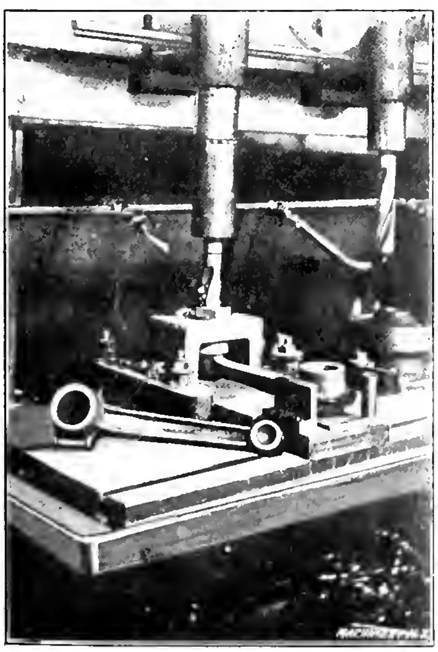


Fig. 5 Drilling Wrist pin End of Connecting rod Forging

club or whatever it happens to possess for the stimulation of its growth. The production of furniture or breakfast foods does not concern us, mechanically speaking, to the same ex-tent as do automobiles, though if we sit in a good comfortable chair while eating our breakfast we are in better condition to enjoy our automobile ride later.

The first automobiles the writer ever saw of any one make, in respectable numbers, were those little curved-dash Oldsmobile runabouts, so familiar a few years ago, which were made

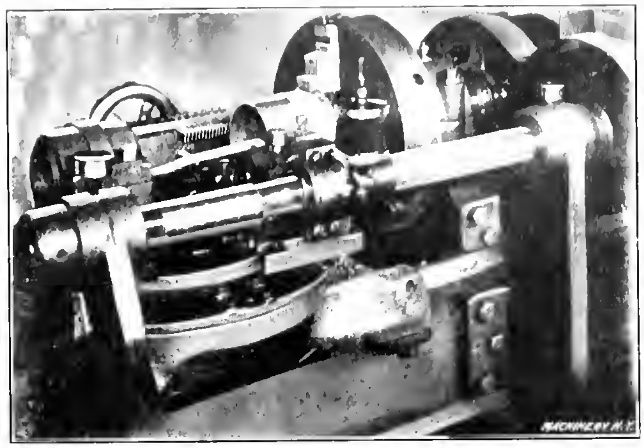


Fig. 2 Turning the Outside and Cutting off Piston Rings

at Detroit. To-day the Olds Motor Works has large factories at Lansing, Mich., where they are producing thousands of

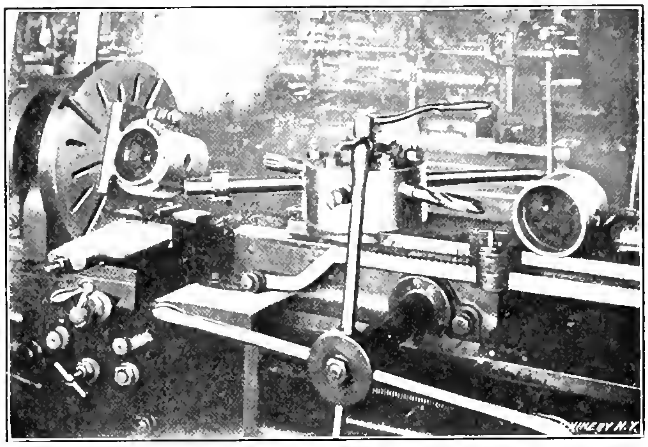


Fig. 4 Turret Lathe set up for Drilling, Boring and Reaming Wrist-pin Bosses

Oldsmobiles, some of them sixty horsepower six-cylinder cars. The shop practice, while not radically different from that of

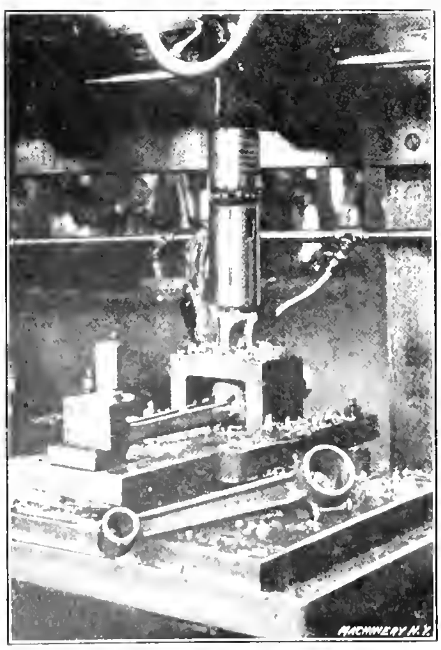


Fig. 6 Drilling Crank end of Connecting rod

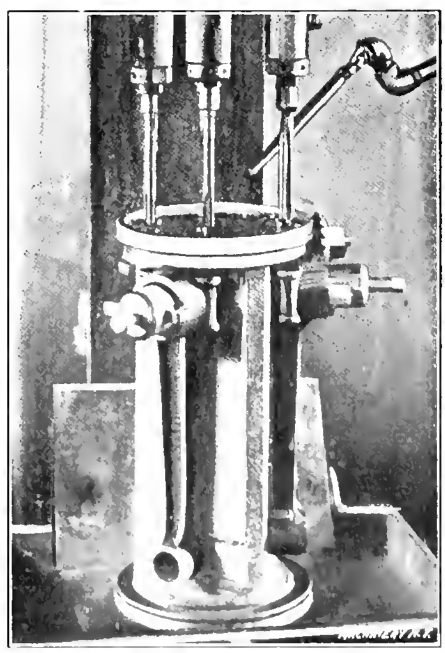


Fig. 7 Drilling, Reaming and Finish Reaming Cap-screw Holes

other similar factories, is nevertheless interesting and well repays the student of practical mechanics who is fortunate enough to have an opportunity to inspect the factory and its methods. Mr. Robert Pierpont is the factory manager

*Associate Editor of MACHINERY.

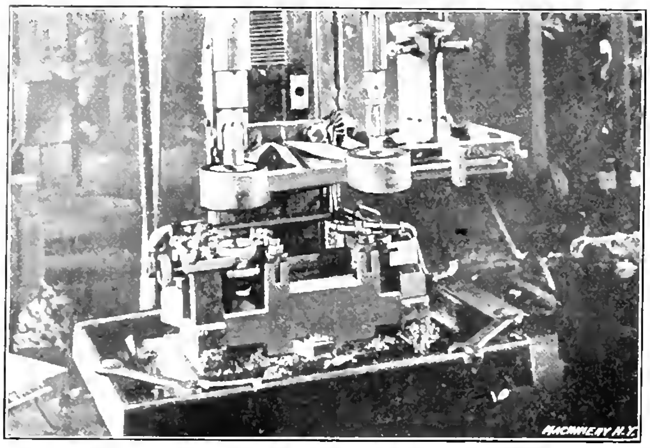


Fig. 8. Fixture in which Connecting-rod Ends are reamed

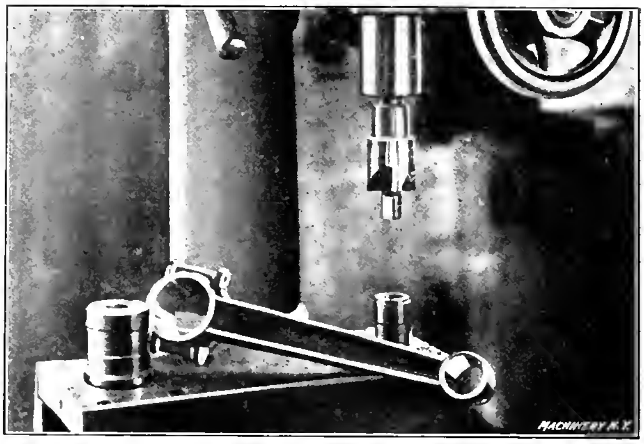


Fig. 9. Tool and Fixture for Facing Bearings to Width

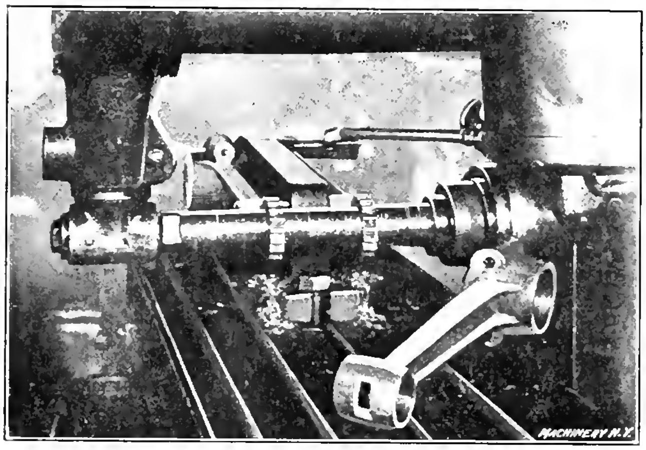


Fig. 10. Milling Oil-slots in the Connecting-rods

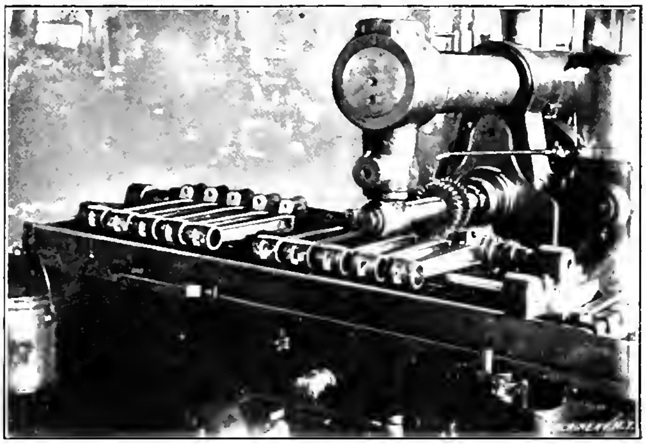


Fig. 11. Sawing off the Caps and facing Seats for Bolt Heads

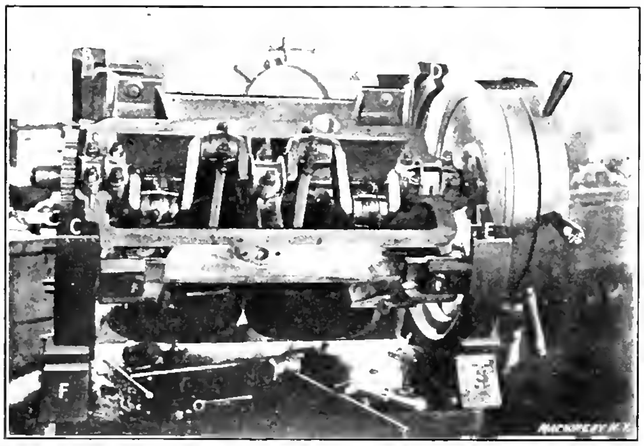


Fig. 12. Revolving Fixture in which Rods are assembled on the Cranks

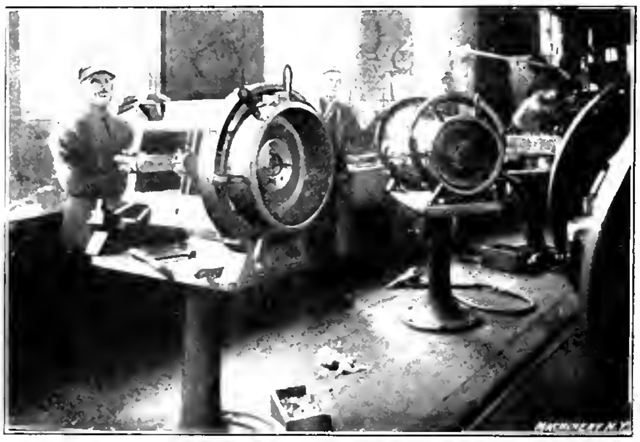


Fig. 13. Another View of the Revolving Assembling Stands

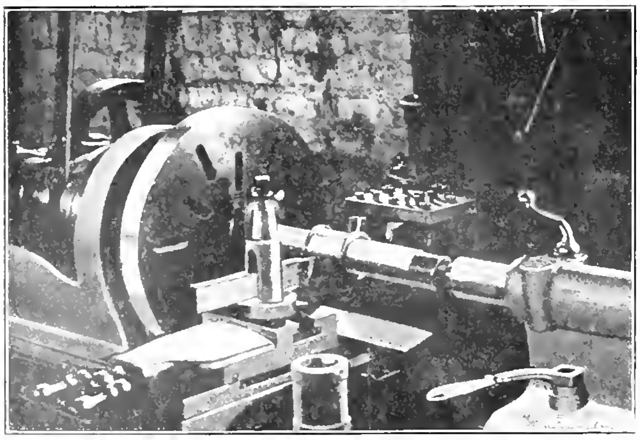


Fig. 14. Turning the Outside of Connecting-rod Bushings

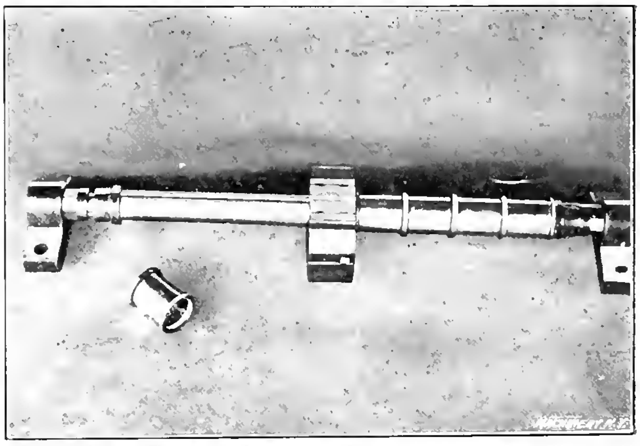


Fig. 15. Mandrel used when splitting Connecting-rod Bushings

Packing Rings and Pistons

The cast-iron sleeve from which the piston rings are made is first placed on an expanding mandrel and the flanged end turned, as shown in Fig. 1; it is then caught in the grooved jaws of a universal chuck, Fig. 2. The machine shown in

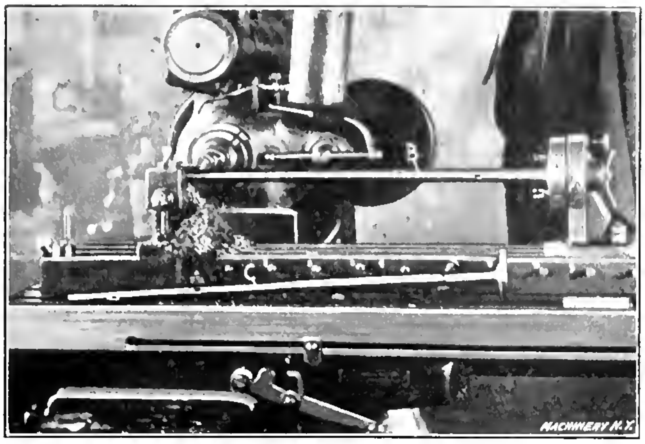


Fig. 16. Fixture for Holding Cam-shafts while Milling for Woodruff Keys

this engraving is a lathe to which has been added the turning attachment shown, which turns the outside of the rings eccentric and cuts them off; the inside of the ring not being bored out as is the practice in many shops. Just why so many shops spend time and trouble boring out the inside of the

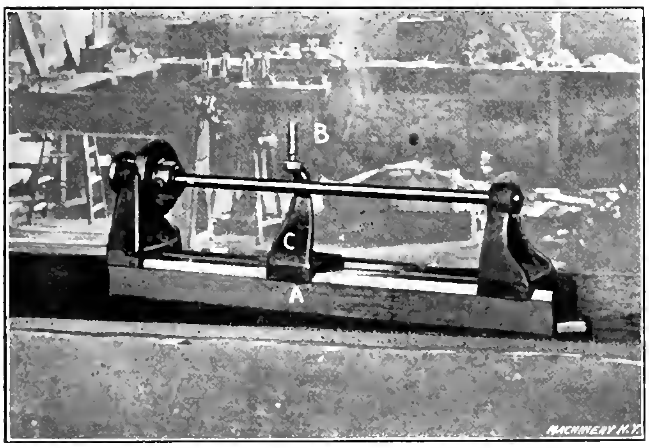


Fig. 17. Inspector's Fixture for Testing Cam-shaft Keyways

ring is not clear, as it not only takes so much more time, which, of course, increases the cost, but also decreases the value and life of the ring by the removal of the hard surface. After being turned and cut off, the rings are placed in a jig and split by using two milling saws properly spaced,

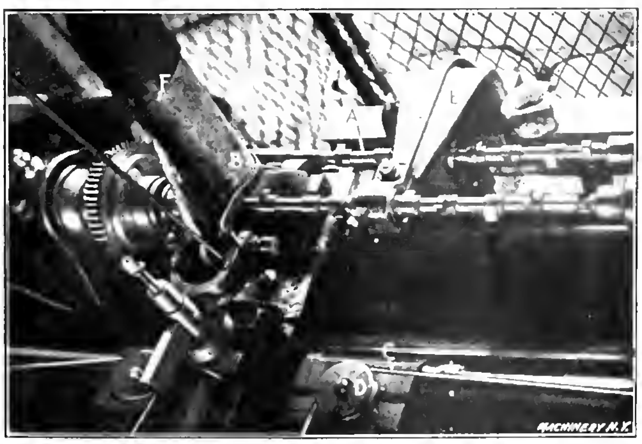


Fig. 18 Top View of Lathe equipped with Cam-grinding Attachment

as shown in Fig. 3; they are then compressed in sleeves, clamped on a flanged mandrel and ground as usual.

Wrist-pin holes in the pistons are drilled and reamed, after which the inside ends of the bosses are faced with a double-end mill in a turret lathe fitted as shown in Fig. 4.

Steps in Connecting-rod Production

The first machine shop operation on a connecting-rod consists in surfacing the ends of the bearings on a milling machine, there being 3/32 of an inch difference in the width of the bearings; the rod is then placed in the jig shown in Fig. 5 and the small bearing drilled out, after which it is placed in another jig and the large end drilled, the proper spacing being obtained by using a plug in the small end as shown in Fig. 6. Next both ends of the connecting-rod are finish-reamed in the jig, Fig. 8. The ends are then faced to the exact thickness, by using a butt mill with a pilot which fits the holes in the bearing posts of the jig, Fig. 9. From here the connecting-rod goes to the triple drilling jig, Fig. 7, where the clearance holes for the cap-screws are rough drilled and finish reamed; all three operations are performed simultaneously, so that a finished rod is taken out and a new one put in every time the jig is indexed. The next operation consists of milling a slot

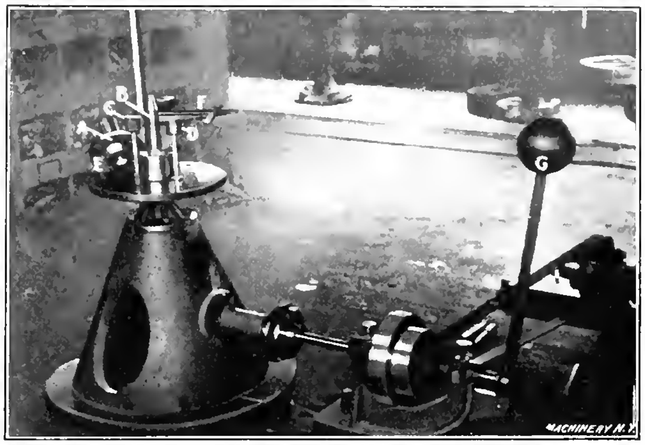


Fig. 19. Machine used for Balancing Flywheels

in the small end for the oil hole, as shown in Fig. 10. The rods are then placed, ten at a time, in the milling jig, Fig. 11, where the caps are cut off and the inner ends, or bosses of the cap bolt-holes, faced in two operations; one cut is taken, the connecting-rods are turned over on the clamping mandrel and the final cut made. After the Parsons' white bronze bushings

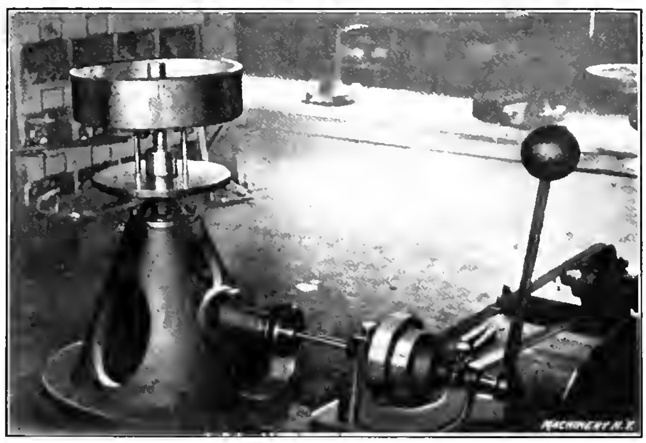


Fig 20. Balancing Machine with Flywheel in Place

have been pinned into the large end, the rods are placed in the pistons, but they are not put onto the crankshaft until ready for assembling as shown in Fig. 12. In connection with this last engraving and Fig. 13, the scheme used to revolve the flywheel and crankshaft, while assembling and adjusting, by means of a handled band strapped to the rim of the flywheel, is made plain. The revolving assembling stands shown are also very unique as well as efficient, the motor case being bolted to the inside of a pair of cast-iron rings resting on guides bolted to a base, which is swiveled to the top of a cast-iron stand; this arrangement always keeps the center line of the crankshaft parallel with the floor, still allowing universal movement in any other direction. Referring to Fig. 12, the flywheel band is shown at *A*, while *B*, *C*, *D*, and *E* are the ends of the wheel segments which are removed to put in or take out the motor; *F* and *G* are guides or pillows

for the wheels. In Fig. 13, H, I, and J show the wheels complete, with segments in place.

The white bronze split bushings, used on the crank ends of connecting-rods, are first chucked, bored out and reamed, and then placed on a mandrel, as in Fig. 14. The hub is turned with the tool in the regular toolpost and the flanges finished with the gang tool in the holder placed on the back of the cross-slide. After being turned, the bushings are split by being placed eight at a time on the mandrel, Fig. 15; they are clamped tight by screwing up the nuts on each end of the mandrel, and then split with a thin milling saw, the mandrel being turned half way around for the last cut.

Milling and Grinding Cam-shafts

There is a very neat fixture used in the milling machine department for milling Woodruff keyways in the cam-shafts.

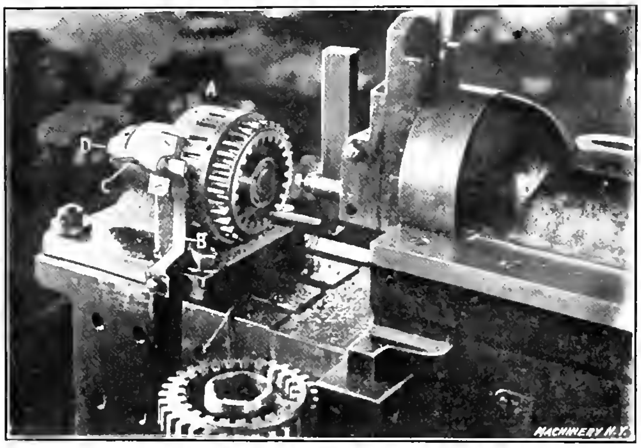


Fig. 21. Cutting Inside Clutch Teeth on a Shaper

This fixture, Fig. 16, is made with an index head A, used to give the proper position of the keyways on the shaft B, the spacing lengthwise of the shaft being obtained by carriage stops. A finished cam-shaft is shown at C. After being milled, the positions and sizes of the keyways are tested by an inspector, using the fixture shown at A, Fig. 17, which also has an accurate indexing head. The size and central position of the keyways are tested by a plug B, in the sliding part C.

The cams are ground, after being keyed and pinned to the shaft, by using a special grinding attachment fitted to a lathe,

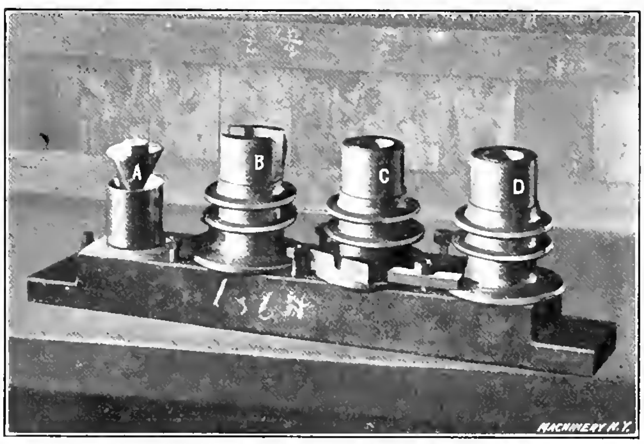


Fig 22. Milling Fixture in which Work is held on Expanding Plugs

Fig. 18. The master cam-shaft A, is geared to the lathe head so as to revolve at the same rate as the shaft to be ground. The cams on the master shaft impart motion to the carriage and grinding wheel through the roller B, the carriage being held to the work and to the master cam by the weighted cord C, which passes around pulley D and another pulley not shown. The master shaft and the shaft to be ground are both supported in the middle by the steady-rest E. The emery wheel held by the fork in the toolpost, is run by a round belt passing over a long overhead drum, and the dust is carried off through the pipe F. Very rapid and satisfactory work is done with this attachment.

Balancing Flywheels

All flywheels are balanced on a Defiance balancing machine shown in Figs. 19 and 20. Fig. 19 shows the machine with the balancing or floating head A, to which the flywheel is fastened, lying on the revolving table; this floating head fits over the pin B and is driven by the rubber-headed pins C and D, which come in contact with the part E; F is an arm used to steady the operator's hand while holding a piece of chalk to the revolving rim of the flywheel. Putty is stuck onto the inside of the flywheel rim to bring it to a running balance, and the amount of putty used forms a basis for judging the amount of metal to be drilled out. The machine is set in motion by throwing over the ball-lever G, which engages the frictions.

A Novel Shaper Device

Inside teeth on a special clutch gear, are first drilled and then shaped out, using the indexing fixture A, Fig. 21. The inside blank is, of course, counterbored to allow clearance for the cutting tool. The spacing spring B is lifted from the notch, when indexing, by means of the eccentric lever C. The gear itself is held by an expanding chuck, the taper plug of which is operated by the nut D.

An application of the expanding chuck or plug in a milling fixture is shown in Fig. 22. This fixture is made to hold fonr pieces: A shows the expanding plug; B, a slotted piece, and C and D, blanks ready to he milled. In addition to using the expanding plugs, the pieces are also clamped on the flanges by straps, as shown, the bolt holes of which are open on one side to facilitate removal.

* * *

PENSION SYSTEM OF THE WESTERN ELECTRIC COMPANY

In March, 1906, The Western Electric Co. set aside $400,000 out of its profits as a permanent fund for pensions for aged and disabled employes. Since that time another appropriation and interest has been added so that the fund now totals nearly $600,000. All employes who have reached the age of sixty and have been in the company's service for twenty consecutive years are entitled to pensions, whether able to work or not, and are not debarred from going into other business if they accept the pension privileges. Employes who have been twenty-five years in the company's service and reached the age of fifty-five, and those who have been thirty years in the service, irrespective of age reached, may be granted a pension on the recommendation of the president. The annual allowance for employes retired on account of age is one per cent of the average annual pay during the ten years preceding retirement for each year of active service. The pension board may, however, base the pension upon the average annual pay of the ten consecutive years of service during which the retired employe was paid the highest rate of wages. The pension is paid monthly until death, and at the discretion of the board may be continued to the widow or orphans for a period not exceeding one year. The Western Electric Company employs about 20,000 men.

* * *

Halley's comet, which was a disappointing spectacle to the comparatively few who saw it in April and May, is said to have been traveling at the rate of 1000 miles a minute when nearest the sun. This enormous speed, fifty times that of a cannon ball, is practically the same as that of the earth in its orbit about the sun. A 0.22 caliber (short) rifle bullet weighing 30 grains moving with the same velocity would have enormous energy and penetration. Substituting the values in the kinetic energy formula, $E = \frac{Wv^2}{2g}$ in which $E =$ energy, in foot-pounds; $W =$ weight, in pounds; $v =$ velocity, in feet per second; $g =$ acceleration of gravity in one second or 32.2 feet, we have $E = \frac{30 \times 88{,}000^2}{2 \times 32.2 \times 7000} = 515{,}000$ foot-pounds. The penetration would be about 28,000 pine boards $\frac{7}{8}$ inch thick if at this high velocity it were proportional to that of rifle bullets at common velocities!

WEIGHTS OF CYLINDRICAL PRESSURE TANKS*

By C. R. WHITTIER†

As the gallon is the common unit of capacity for liquids, it is a great convenience and saving in time to be able to state the weight of a tank in terms of gallons without first converting this into the usual linear dimensions. In general, the weight of such tanks will vary anywhere from two to eight pounds per gallon capacity. It is possible, however, to obtain closer estimates than this when the diameter is known, and a method of stating weight in terms of gallons, pressure and diameter is of great assistance in shortening calculations. This method is worked out below.

First, let us consider the weight of a seamless tank with flat heads. Let

G = capacity in gallons,
T = thickness of shell in sixteenths of an inch,
D = diameter in feet,
L = length in feet,
P = pressure in pounds by gage,
W = weight in pounds.

The steel used in pressure tanks weighs about 490 pounds per cubic foot, and the plates vary in ordinary practice by steps of one-sixteenth of an inch. This is, therefore, the most convenient unit for thickness. A plate of steel, one foot square and 1/16 inch thick, weighs about 2.55 pounds. The ordinary method of estimating the weight of this tank would be to estimate the weight of the shell and heads independently. It will, however, be more convenient for our calculations to estimate the heads in terms of length of shell, just as the length of rivet necessary to form the rivet head is commonly taken as one and one-half diameter.

The area of one head is $\frac{\pi D^2}{4}$. The circumference of the tank is πD. Let x equal the length of shell, the area of which is equal to the area of the head. Then,

$$\pi D x = \frac{\pi D^2}{4}, \text{ and } x = \frac{D}{4}.$$

Hence, the length equivalent to both heads equals $\frac{D}{2}$. The weight of the tank may then be expressed as follows:

Weight = 2.55 × thickness in 16ths × circumference × (length + one-half diameter),

or,

$$W = 2.55\ T \times \pi D \times (L + 0.5\ D) = 8\ DT\ (L + 0.5\ D).$$

To save bracing, the heads of pressure tanks are commonly dished to a radius equal to the diameter of the shell. To find the area of the spherical segment, assume for simplicity that the diameter of the tank equals 2. The distance from the center of the sphere to the original flat head is given by solving the right-angled triangle whose hypotenuse equals 2 and one side equals 1. This distance, therefore, equals $\sqrt{4 - 1} = 1.732$, and the height of the segment $= 2 - 1.732 = 0.268$. The area of this spherical segment = height × circumference of a great circle $= 0.268 \times 2\ \pi D$, and, as $D = 2$, the area $= 1.072\ \pi$. The area of the flat head was $\frac{\pi D^2}{4}$, and as $D = 2$, the area $= \pi$.

We thus see that the area and weight of the spherical head is about 7 per cent more than the flat head. This holds true for all dimensions. In riveted pressure tanks varying from 4 to 8 feet in diameter, however, the dished heads are commonly made 1/16 inch thicker than the shell. As the shell thickness averages ⅝ inch and the head thickness 11/16 inch, the heads are, on an average, 10 per cent per square foot heavier than the shell. This is sufficiently close for our present purpose. Multiplying the two percentages: $1.07 \times 1.10 = 1.18$; that is, for ordinary dished heads, to obtain the equivalent length of shell, the increase over the equivalent length for the flat heads first mentioned is 18 per cent.

In the same manner, the manhole, nozzles, reinforcing plates, inside pipes, supports, etc., which are commonly used in such tanks, can be estimated in percentages, and transformed to an equivalent length of shell. Without going into these numerous details, it will be sufficient to state that it is found that these factors increase the equivalent length of shell from $L + 0.5\ D$ to $L + D$, very closely. The formula therefore now stands:

$$W = 8\ DT\ (L + D)$$

Having thus determined the general form of our equation and its main factors, it now becomes necessary to make an allowance for the increase in weight due to joints, rivet heads, variable thickness of metal, etc. Of course, this could also be reduced to equivalent length of shell, but this allowance can also be made by increasing the numerical coefficient by a certain percentage, and this method gives the most convenient formula. It is best done by comparison with the actual finished weights of tanks which have been constructed. Ordinarily, in place of 8, it will be found necessary to make this coefficient between 9 and 10. It can be easily determined for any tank by dividing its actual weight by $DT\ (L + D)$. For instance, in a line of tanks, nearly one hundred in number, varying from 5/16 inch to ⅞ inch in thickness, from 4 to 8½ feet in diameter, and from 5 to 50 feet in length, with pressures varying from 50 to 200 pounds per square inch, it was found as the result of the above determinations that the coefficient 10 gave the closest average for all the tanks, the maximum variation being very slight each way. We, therefore, have for this line of tanks:

$$W = 10\ DT\ (L + D).$$

This is an exceedingly simple formula for determining the weight of similar tanks when the diameter, thickness of shell and length are known. It now remains to substitute gallons and pressure for length and thickness.

Ignoring, for the present, the additional capacity given by dishing the heads, the capacity in cubic feet of our cylinder = area × length $= \frac{\pi D^2}{4} \times L$. As 7.481 gallons equals one cubic foot, the capacity in gallons is:

$$G = 7.481 \times \frac{\pi D^2}{4} \times L = 5.876\ D^2 L.$$

Adding about 2 per cent as a fair average for the additional capacity obtained by dishing the heads, we have:

$$G = 6\ D^2 L.$$

These tanks are usually designed with a factor of safety of 5, using steel of 55,000 to 60,000 pounds ultimate tensile strength.

The standard longitudinal seams are as follows:

A. A double strap, triple riveted butt joint, of an efficiency at the common thicknesses varying from 83 to 88 per cent.

B. A double riveted lap joint, with an efficiency ranging from 60 to 74 per cent.

C. A single riveted lap joint, with an efficiency from 51 to 59 per cent.

The process of reduction is too long to be given here, but by plotting and deducing the equation for the ordinary diameters, thickness and pressures, the following formulas can be deduced:

For A, $T = 0.01\ PD$
For B, $T = 0.013\ PD$
For C, $T = 0.016\ PD$

For the double strap, triple riveted joint, we therefore have:

$$W = 10\ DT\ (L + D) \qquad (1)$$
$$T = 0.01\ PD$$
$$G = 6\ D^2 L$$

By substituting the value of T in (1) we have:

$$W = 10\ D\ (0.01\ PD)\ (L + D) = 0.1\ PD^2\ (L + D) = 0.1\ PLD^2 + 0.1\ PD^3.$$

As $\frac{G}{60} = 0.1\ D^2 L$, we have by substitution:

$$W = P\frac{G}{60} + 0.1\ PD^3, \text{ or } W = P\left(\frac{G}{60} + 0.1\ D^3\right)$$

* With Data Sheet Supplement.
† Address: 204 W. 111th St., New York City.

In a similar manner; for the double rivet lap joint:

$$W = P\left(\frac{G}{46} + 0.1\ D^3\right)$$

For the single riveted lap joint:

$$W = P\left(\frac{G}{37} + 0.1\ D^3\right)$$

Summary of Formulas

We have, then, the following simple formulas for determining the capacity, thickness and weight of tanks of the class referred to:

For capacity $G = 6\ D^2 L$.

For double strap, triple riveted butt joints, $T = 0.01\ PD$

For double riveted lap joints, $T = 0.013\ PD$

For single riveted lap joints, $T = 0.016\ PD$

Then by dimensions:

$$W = 10\ DT\ (L + D)$$

By capacity:

For double strap, triple riveted butt joints, $W = P\ (G/60 + 0.1D^3)$

For double riveted lap joints, $W = P\ (G/46 + 0.1D^3)$

For single riveted lap joints, $W = P\ (G/37 + 0.1D^3)$

Example

For example, assume a tank 5 feet diameter by 20 feet long, for 200 pounds pressure, with double strap, triple riveted longitudinal seams:

By linear dimensions:

$T = 0.01 \times 200 \times 5 = 10$ sixteenths, or 5/8 inch.

$W = 10 \times 5 \times 10 \times 25 = 12{,}500$ pounds.

$G = 6 \times 25 \times 20 = 3000$ gallons.

If capacity, diameter and pressure are given, we have by the capacity formula:

$W = 200\ (50 + 12.5) = 200 \times 62.5 = 12{,}500$ pounds, which is the same result as before.

For all preliminary work, this short-cut method will be found sufficiently accurate. It can be readily supplemented by the ordinary summation method when desirable. Three of the Data Sheets accompanying this number contain tables and diagrams of the data here deduced.

* * *

CONE VS. GEARED DRIVE*

By R. K. LeBLOND†

Some years ago, I wrote an advertisement which appeared in trade papers, in which I stated that a double friction back gear was the best drive that had ever been applied to a machine tool. I suppose when the committee was looking around for different modes of entertainment and instruction, some member suggested that we could have a debate on the relative merits of the cone and geared drive, and as I had so fearlessly expressed my opinion, some one suggested my name. I did not like to show the "white feather," so I am here to-day to defend my stand as originally taken on cone drives, although we manufacture both styles of machines.

The question of cone- and gear-driven machines is very similar to the tariff—each side has a great many good points on which to base an argument. Free trade, for instance, is practically advocated by all college professors, and as a well-known writer remarked, all graduates ,as they emerge from college, are ardent free-traders, but as they get into the practical workings of life, most of them are soon converted to the tariff policy.

This condition exists in the cone and geared head proposition. Theoretically, the geared head drive has the most advantages, and the present development is along the geared head lines, but practically and commercially, the cone drive is more than holding its own, and as we gather our costly experience from miscellaneous experiments on gear-driven machines, we discover that the old reliable cone drive is still an important factor in machine tool design.

We all realize that the demand for the gear drive originated with the advent of high-speed steel; in other words, when the cutting tools were perfected to such an extent that they could stand the speeds and the heat generated by these speeds, the old-style cone drives were found lacking in power, and some of the manufacturers immediately decided upon a method of gearing to increase the power. This, in my judgment, was a temporary and poor remedy, and very costly to the manufacturer. While I am loth to say it, very few of the lighter classes of machine tools were scientifically designed, and gear drive design was begun more or less on a hit-and-miss plan.

In looking over the various gear drives that have been produced in the last few years, we are naturally surprised at the varied mechanisms employed, at the ignorance displayed in the selection of metals, the pitches of gears, the size and material of shafts, oiling facilities, etc. While this is a defect in individual construction, and not a fundamental defect of the geared head, it all goes to show that the development has been more or less experimental, and extends through the complete range of frictions, tumbling gears, sliding gears *a la* automobile, etc.

As a matter of fact, all the advantages claimed for the geared head machine, can be obtained better with a variable speed motor and comparatively few mechanical changes. The electrical changes can be obtained with a much smaller friction loss—that is, more efficiently; the change increments are much smaller and the speeds can always be obtained while the machine is in motion without stopping for changes and without a countershaft, etc. In other words, the variable speed motor drive is the ideal geared head.

The common defects in all gear-driven machines are: lack of efficiency, expense of maintenance, and the increased first cost. This holds true regardless of the changes being made in one unit or distributed in two, one being placed on the ceiling. We will take these comparisons up separately:

Efficiency of the Geared Machine

In extreme cases but 40 per cent of the power applied to the machine is delivered to the cutting tool or spindle. In the case of feeds, as shown by Mr. DeLeeuw's experiments [See "Efficiency Tests of Milling Machines and Milling Cutters," MACHINERY, December, 1908.] the friction on the shafts and gears has reduced this as low as 2 per cent and under the very best conditions, 20 per cent of the power applied. Of course, this is an extreme case and is due primarily to the fact that the reduction is so great and that the power has to pass through a screw, which as we all know, is a very inefficient method of power transmission. But in the construction of various designs of geared head machines, we see the worm and worm-wheel, and bevel gear, as well as spur gear.

I recently visited a large machine tool plant. In going through the shop with the superintendent, we stopped at their single pulley driven 16-inch lathe. As we were standing there, an office boy brought a copy of an order for one of these machines to which the purchaser wished to apply a one-horsepower motor. The superintendent immediately said this was impossible, because it takes more than one horsepower to turn the machine over. This was a friction head construction. At the same time, tests made on these lathes by different authorities, under the old belting conditions, resulted in establishing the power consumption of one half horsepower under actual working conditions.

Efficiency of Cone Drive

Now in comparison with this, take the old-fashioned cone. On the direct speeds, or open belt speeds, we can obtain an efficiency as high as 95 per cent, and in the extreme cases of transmitting power through the back-gear it is very seldom lower than 75 per cent. This difference in efficiency has to be taken up by the machine itself. In other words, it is a destructive element. It means friction on the journals, friction on the gears, heat generated which has to be taken up by the body of the machine, and wear in general, from all of which the user obtains no benefit and which goes into the maintenance charge.

Of course, it is an easy matter for the exponents of the geared drive to say that the power factor in machining costs is so slight that it is not to be considered. That is true, to a great extent, but when analyzed it will be found not to be simply the difference in the coal bill.

As an instance, a production man in one of the largest plants in the East, had formerly purchased all all-geared ma-

*Paper read before the National Machine Tool Builders' Convention, Rochester, N. Y., May 24-25, 1910.

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chines. At that time he was simply serving the concern in the capacity of equipment purchasing agent. His position later was changed, and he was given charge of not only the purchasing of tools, but the maintenance as well, whereupon, after thorough investigation, he quit purchasing geared head machines entirely, and purchased nothing but cone-driven machines. The reason given was that he found that the maintenance of the geared head machines outweighed and outclassed the advantages of quick-speed changes, the increased driving power, and all other claims made for the tools.

I think you will find, if you will carefully investigate your overhead charges, that the increased cost of the geared head machine added to the increased maintenance cost added to the increased power cost, will more than outweigh all the advantages claimed by exponents of the all-geared machines.

Fallacy of Instantaneous Speed Changes

I would like to say a word about speed changes. The advocates of the geared machines always harp upon the advantages of instantaneous speed changes. As a matter of fact, one of the best known makers in this country places a plate on his machine, on which he states positively that the machine must be stopped when changing speeds. Another builder has to throw in and out back gears when making the change of speeds which necessitates the stopping of the machine. The only instantaneous change machines are the friction clutch machines, which are always more or less a cause of annoyance and trouble.

Another claim made for this type of machine, which is not lived up to except in a very few cases, is that the machines can be driven direct from the lineshaft and require no countershaft or overhead works. This is more of a theoretical than a practical advantage, as nine out of ten times the machine has to be placed so it requires a special jack-shaft and I have always found it the best plan, when machinery was idle, to stop it as close to the lineshaft as possible, and not have moving parts on the machine.

The "Old Reliable" Cone Drive

Now for the "old reliable" cone drive. When I say "old reliable," I do not mean the old-fashioned cone which was small in diameter and of narrow face. I mean, as I stated in the original proposition, the double-friction back-geared cone, which can be made of large diameter and proper face, the two ratios of back gearing enabling a cone to be designed so the old small step is entirely eliminated. With this type of drive, twice the power can be delivered to the spindle as with the same size pulley on a geared drive.

While I realize that the geared drive can be constructed so that the size and speed of the pulley is practically limitless, the fact remains that all the designs on the market today, are fairly well within the range of the modern cone sizes, used on similar machines. Further than this, there is no limit to the power that can be obtained by the cone drive. The Alfred Herbert Co. of Coventry, England, has demonstrated this in some of its new design machines in which they use the cone running at a very high speed, as a driver, and use the double back gear, never using the direct cone speeds. Of course, this construction is simply a development of the old style drive with which we are familiar on Lincoln type millers and machines of that description, but this combination of the cone drive, will give more power than is required by any machine in the market to-day, and will give it with less friction loss; in other words, with greater efficiency than any geared head machine on the market.

As to the belt-shifting feature on the cone-driven machine, that can be easily eliminated with a belt-shifting device, and is eliminated without that device where the belts are of moderate width and length, by the operator. He does not have to stop his machine to make the changes and practically performs an instantaneous speed change. The ideal drive today is large cone diameters with not overly wide steps.

As an example of the drift of actual practice in this line, I would like to cite planers. In our shop we have used four different designs of geared speed devices on our planers, all of which have been uniformly unsatisfactory. We have recently noticed that a prominent planer maker has "dropped" to this condition and is going back to a cone for his cutting changes. There is also one of the best planer makers in the United States who has always used a cone variator. We also know a prominent boring mill manufacturer who has found that the most practical way to obtain speed changes is through a cone.

In these instances, it is not a question of original cone design. It has been a development in which the cone has actually been found to be the most satisfactory method of obtaining these speed changes. This has also been exemplified in feeds. For instance, take grinding machines. Brown & Sharpe Mfg. Co. and Norton Grinding Co. are both using cone belts on their feed changes, after both had experimented and tried out different forms of gear changes.

Effect of Belt Pull on Spindle

Now I will speak about the fallacy of the belt pull on the spindle. With the geared head machines, of course there is no belt pull on the spindle, but there is the gear pressure, which in slow speeds, is multiplied many times and is considerably more than the belt pull. Further than this, on a cone-driven machine, the belt pull is not a detriment, but a possible advantage. It simply serves to counterbalance the weight of the moving parts, namely the cone and spindle. In my machine tool experience, I have never heard of a lathe spindle wearing upward. We know positively from our experience with second-hand lathes, that the spindles are invariably lower than the tailstocks, so this would positively determine that the wear of the spindle is downward in spite of the belt pull.

It is an indisputable fact that in ninety-nine machines out of every hundred, the cone drive is capable of furnishing much greater power than is required for the machine as operated, that is, the machines of to-day are not worked to fifty per cent of their pulling capacity; if they were worked to capacity, it would be a mighty bad thing for the machine tool builders, and would be the means of "calling a great many bluffs," as we all realize that there are a great many guarantees made with the absolute knowledge that the machines cannot stand up to the work continuously, and after the first trial, there will be no attempt to continue production on the same scale, which simply proves that the excessive pulling power, in ninety-nine cases out of a hundred, is not a legitimate requirement. The purpose of machining to-day is not to make shavings, but to do accurate work.

I maintain that you cannot get as good average production with a geared machine as you can with a cone-driven machine. I realize that on certain jobs a saving in time might be shown on a geared machine, but if two shops, one equipped with double-friction back-geared cone machines and the other with all-geared-head machines, both under equally efficient management, were taken as examples, the cone drive shop would be found to produce more work, or to produce the same work at a much lower cost.

In summing up this matter we arrive at the following conclusions: The advantages claimed for the all-geared machines have not been obtained; there is not a single all-geared machine on the market to-day in which instantaneous speed changes are obtained, or the required number of speed changes, without a multiplicity of friction clutches; there is not a geared machine on the market in which proportionate efficiency is realized; there is not a geared machine on the market for which the maintenance charge is not greater than for the cone head machine; there is not a geared machine on the market which can be produced for anything like the same first cost.

For the cone-driven machine, we can get a larger proportion of speed changes than is permitted by the geared head designs; practically the same power at the cutting tool; eliminate vibration and excessive wear; and get a cheaper first-cost machine.

* * *

It is stated by Mr. William W. Bird in the *Journal of the Worcester Polytechnic Institute* that belts of single thickness will stand a stress of 60 pounds per inch of width with only occasional taking up and will have a fairly long life, provided the pulleys are not too small. The permissible stress for double and triple belts would be 105 and 150 pounds, respectively.

A FEW FORGING OPERATIONS

PRACTICE IN THE C. H. & D. R. R. SHOP, LIMA, OHIO

By ETHAN VIALL*

A number of interesting forging operations are to be seen in the blacksmith shop of the C. H. & D. R. R., in Lima, Ohio, not the least of which are those pertaining to the making of drawbar pockets; the bulldozer forming tools for making them and the various operations are illustrated in Fig. 1. The first operation after the bar is cut to length and one end heated, is to punch the four holes and bend the gib, which is all done at one stroke of the bulldozer ram, using the tools *A* and *B*. *C* is a stop for the stock, so made that it springs back out of the way as the end of the gib-former strikes it, and returns again to position as soon as released. The springs shown on each side of the member *D* are used to operate the strippers on the face of the punching die. Usually the end of the gib is trimmed at the same heat and immediately after bending, using the trimming shears *E* and *F*. If a number of pockets are to be run through, they are all finished on one end in this way, by which time the ends of the first ones have been cooled enough to be handled easily, when the other end is heated and finished in the same manner. For several reasons it is not advisable to depend on stops to locate the middle of the pocket while forming the loop, so it is obtained by measurement, being marked with a chisel. The pocket is then bent in the forming punch and die *G* and *H*, in which it is located by means of the chisel mark just mentioned and a corresponding mark on the former, being clamped in position by an eccentric clamp operated by the lever *I*. It will be noticed that the former used here is solid and not of the wing type so frequently seen, and the results are just as good, apparently, as those obtained by using the more elaborate formers, no dangerous straining or tearing of the metal being noticeable. The pockets are riveted onto the drawbars by first heating the long rivets red hot, driving them home, and then upsetting the end in the pneumatic machine shown in Fig. 2. This machine is operated by an old air cylinder and the end of the upsetting plunger is cupped out to the shape required on the head of the rivet. In Fig. 2 a drawbar and pocket with one rivet in place, is shown resting on its side, held up by the chain hoist.

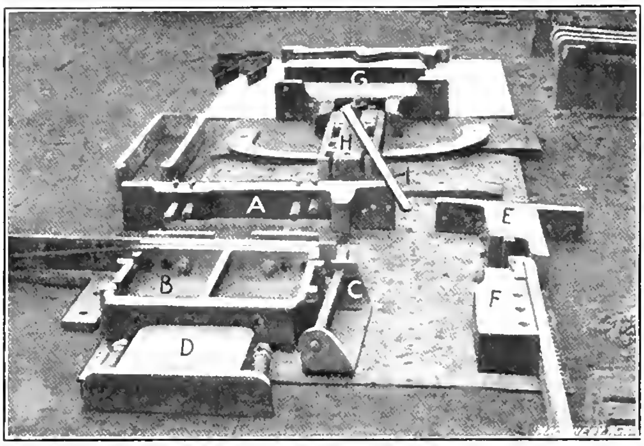

Fig. 1. Drawbar Pocket Forming Tools

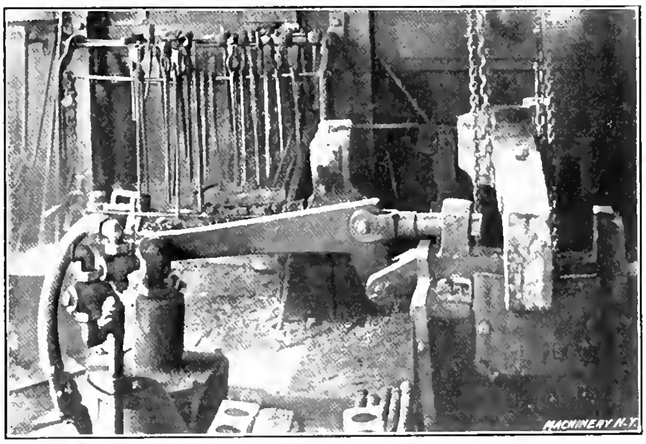

Fig. 2. Pneumatic Device for Setting the Rivets at One Stroke

Fig. 3. Front View of Bolt Heating Furnace and Forging Machine

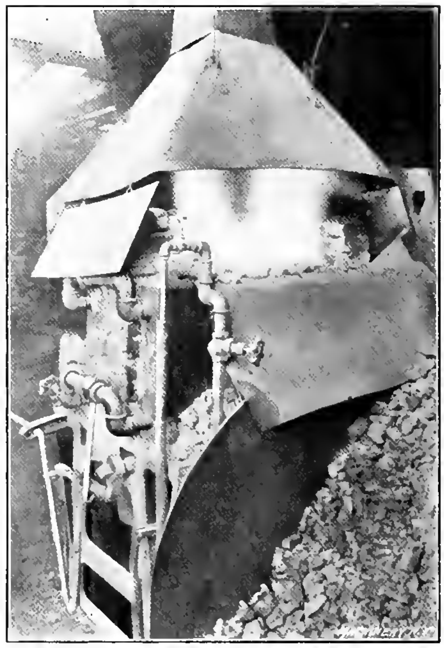
Fig. 4. Rear View of Water Jacketed Heating Furnace

The long rivets or bolts used for the foregoing job as well as other kinds, are headed in a regular forging machine fitted with suitable dies, the heating being done in the special coke burning furnace, shown in Fig. 3, which is the design of A. L. Woodworth, the blacksmith foreman, who is also secretary of the International Railroad Master Blacksmiths' Association. A rear view of this furnace is shown in Fig. 4. The furnace consists of a cast-iron frame 24 x 48 x 30 inches high to which is attached a blast box 12 x 12 x 48 inches long. This box is closed at the bottom with a door which fits closely to prevent the blast from escaping. At the top is a dump grate which supports the fire. This grate is level with the top of the frame and, when dumping, it swings down into the blast box. The top of the furnace consists of two cast-iron boxes, or water front and back, and these are 4 inches thick, 24 inches wide and 48 inches long, and are connected at each end with $1\frac{1}{4}$-inch pipe so as to allow a free circulation of

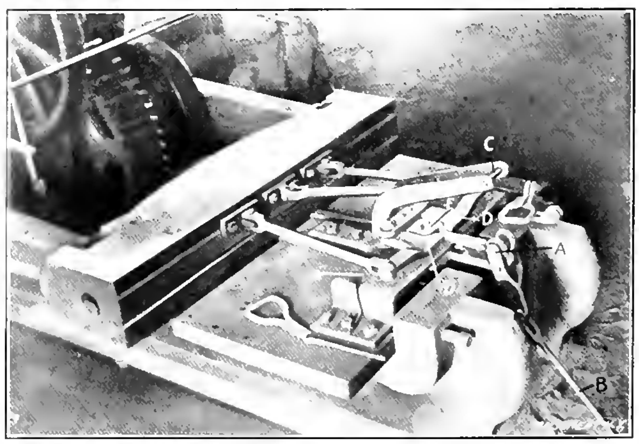

Fig. 5. Brake Hanger Former in Position at Forward End of Stroke

* Associate Editor of MACHINERY.

water, which keeps the furnace cool and comfortable for the operator. The front casting has a slot 3 inches wide by 36 inches long, left so that blanks may be fed in and heated for the bolts. This furnace is very satisfactory when coke is used for fuel.

Mr. Woodworth also designed a unique bulldozer attachment for forming brake hangers. This attachment is shown in operation in Fig. 5 forming the hangers similar to a large cotter. The rod is cut off to the desired length and then inserted between the stops at *a*. As the ram advances on its forward stroke the two wings or formers *D* bend the rod around the block *E*, forming the loop. A pin is then inserted

Fig. 6. Brake Hanger Former in Position at End of Return Stroke

at *A*, around which the second loop is formed, and the rod *B* connected to pin *C*. The slide is shoved in close and as the ram returns on the backward stroke, as shown in Fig. 6, it forms the loops on the end of the hanger. The pin at *A* is now pulled out, the slide pulled back and the finished piece removed, leaving the former ready for the next piece. It should be mentioned that these hangers are bent while red hot, of course. The working parts of this attachment shown fastened to the bulldozer are clearly illustrated in the line engraving shown in Fig. 7.

* * *

The increase in the sizes of warships is proceeding at a rapid rate. The English cruiser battleship *Lion*, which is now being constructed, will displace 21,000 tons and have a total length of 700 feet. The engines will develop 70,000 horse-

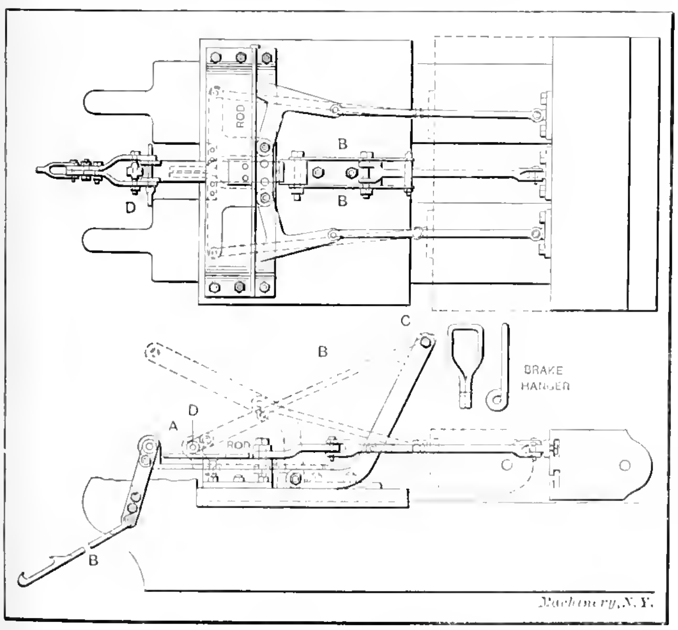

Fig 7 Details of Brake Hanger Former

power. The speed of the vessel is expected to be twenty-seven knots and it will be equipped with ten 12-inch guns. As an example of the possibilities of engineering this battleship is a wonderful achievement, but from the point of view of the purpose of engineering it is one of the paradoxes of the age, because the purpose of engineering is to construct means for easy production—not for destruction.

PROPERTIES OF SECTIONS FOR PUNCH AND SHEAR FRAMES*†

By ALTON L. SMITH‡

The convenience of the tables of properties of rolled steel sections as published in the structural steel makers' handbooks impresses anyone who has occasion to compute the strength of such material. Machine frames cannot be standardized sufficiently to permit of similar tables which would be useful to the designer of machinery, but it is with a view to the simplifying of the work of selecting proper sections for punch and shear frames that the table in the accompanying Data Sheet Supplement has been compiled. The values were computed by slide rule, and it is believed that they are accurate enough for all practical purposes.

To illustrate the use of the table, consider the punch frame shown diagrammatically in Fig. 1. The "reach," or distance from the center line of punch to the back of gap, is 24 inches. Assume that the maximum pressure, *P*, tending to force the jaws apart is that due to punching a 1-inch circular hole in soft steel plate 1 inch thick, or say about 157,000 pounds. Consider the section at *TX*. The action of *P* is such as to produce a tensile stress on the section to the left of the neutral axis *N*, with a compressive stress to the right of *N*, both due to flexure; and, besides, there is a tensile stress distributed uniformly over the section.

It is usually sufficient to determine the maximum tensile stress to the left of *N*.

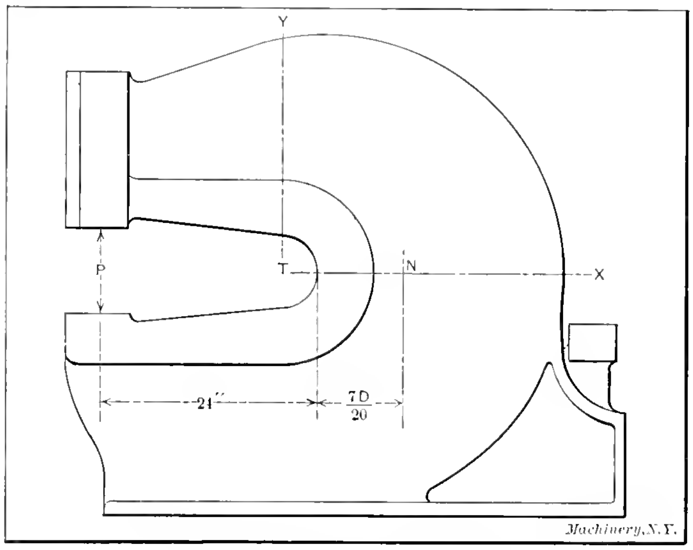

Fig. 1. Diagrammatical View of Punch Frame

Maximum tensile stress = flexure tensile stress + uniformly distributed tensile stress.

$$\text{Flexure tensile stress} = \frac{\text{Moment of } P \text{ about } N}{\text{Tensile section modulus of section } TX}.$$

$$\text{Uniformly distributed tensile stress} = \frac{P}{\text{Area of section } TX}.$$

Assume 3,000 pounds per square inch as the allowable maximum tensile stress for cast iron.

Trial Solution

Assume that D in Fig. 2 is about 30 inches. Then $\frac{7D}{20} =$ $10\frac{1}{2}$ inches. If the stress due to flexure only is considered, the required section modulus for tension would be

$$\frac{157{,}000 \times (24 + 10\frac{1}{2})}{3{,}000} = 1{,}800, \text{ about.}$$

As no allowauce has been made for the additional tensile stress uniformly distributed over the section, a section must

* With Data Sheet Supplement.

† The following articles on the design of punch and shear frames have previously been published in MACHINERY: "Design of Punch and Riveter Frames," Novemoer, 1905, engineering edition; "Strength of Punch and Shear Frames," February, 1907, engineering edition; "The Designing of Machine Frames," August, 1908, engineering edition; "The Design of Curved Machine Members under Eccentric Load," December, 1909, engineering edition. See also MACHINERY'S Reference Series No. 21, "Examples of Calculating Designs," Chapter II.

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be selected whose tension modulus is somewhat greater than 1,800, say about 2,500.

The table in the Data Sheet Supplement gives a great variety of shapes and proportions, the only dimensions common to all being the depth of section, D, and the distance of the neutral axis from the extreme tension fiber. This location of the neutral axis represents average practice and insures an economical distribution of metal. Generous fillets and rounded corners should, of course, be used on the final section.

Suppose that a deep narrow section is desired, similar to that in Fig. 2, in which the dimensions are as follows: $D =$ 10 inches, $B = 7$ inches, $b = 4$ inches, $H = 1.98$ inch, $\frac{t}{2} = h =$ $\frac{5}{8}$ inch, A (area) $= 26.3$ square inches, and S_t (section modulus for tension) $= 78.6$. This section of the table is not, of course, large enough, but a similar one which is large enough may be found easily as follows:

If two sections A and B are similar in all respects, then

$$\frac{\text{Area of } A}{\text{Area of } B} = \frac{(\text{Any dimension of } A)^2}{(\text{Corresponding dimension of } B)^2}, \text{ and}$$

$$\frac{\text{Section modulus of } A}{\text{Section modulus of } B} = \frac{(\text{Any dimension of } A)^3}{(\text{Corresponding dimension of } B)^3}.$$

$$\frac{\text{Required section modulus}}{\text{Modulus of section from the table}} = \frac{(\text{Required } D)^3}{(D \text{ of section from the table})^3}$$

Hence, $\frac{2{,}500}{78.6} = \frac{(\text{Required } D)^3}{(10)^3}$. This last equation solved for D gives $D = 31.7$ inches, nearly. As the large section will be exactly similar to the small one, the area of the large section is found from the equation

$$\frac{\text{Area of required section}}{26.3} = \frac{(31.7)^2}{(10)^2}$$

and area $= 264$ square inches, about.

The neutral axis will be $\frac{7}{20} \times 31.7$, or 11.1 inches from the extreme tension fiber.

This trial section may now be tested for the maximum stress on it.

$$\text{Flexure tensile stress} = \frac{157{,}000 \times (24 + 11.1)}{2{,}500} = 2{,}200$$

pounds per square inch, about.

$$\text{Uniformly distributed tensile stress} = \frac{157{,}000}{264} = 594$$

pounds per square inch, about.

The total tensile stress is, therefore, 2794 pounds per square inch.

If this result had not been near enough to the 3,000 pounds per square inch assumed, another section could have been selected and worked out in the same way to get a closer result. The depth D of the required section being 31.7 inches as compared with 10 inches of the similar section given in the table, each of the dimensions of the required section will be 3.17 times the corresponding one given in the table. Hence $D = 31.7$, say 32 inches, $B = 22.2$, say 22 inches, $b = 12.7$, say 13 inches, $H = 6.3$, say $6\frac{1}{2}$ inches, $t/2 = h = 1.98$, say 2 inches. The webs thicken gradually from the neutral axis to the tension flange so as to avoid too sudden a change in the section. For selecting the section at TY, Fig. 1, the procedure would be the same except that there would be no uniformly distributed stress to be added as in the case of section TX.

The method here given for determining the stress on the section TX is the one which has been commonly used. It is correct for straight beams and until recently has been considered approximately correct for curved beams. Investigations by Bach and others, however, indicate that the maximum stresses in curved beams of ductile material are very much greater than those found by the method used here; but a quick and accurate way of applying the new theory to general sections has not yet been devised. Cast-iron punch frames whose sections have been determined by the old analysis have apparently stood up under their loads for years, although the maximum stresses in them as determined by the new analysis are so great as to threaten serious injury. [See article by Prof. Rautenstrauch in the Journal of the

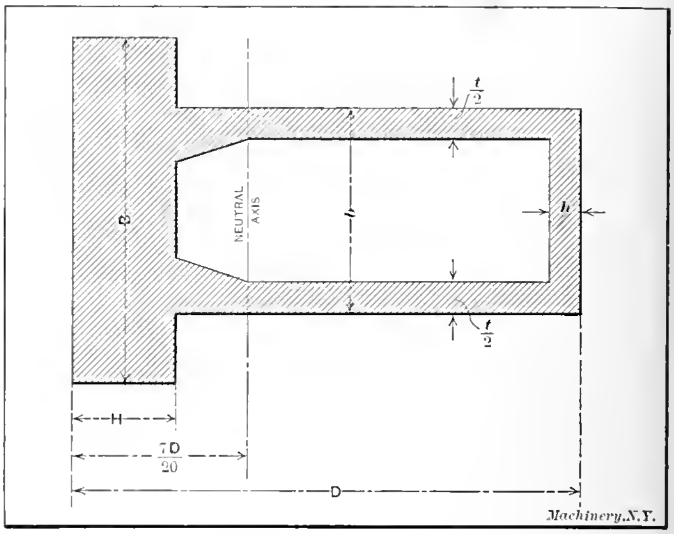


Fig. 2. Section of Punch Frame

American Society of Mechanical Engineers for mid-October, 1909. See abstract in MACHINERY, December, 1909, engineering edition: "The Design of Curved Machine Members Under Eccentric Load."] Until the new theory has been more thoroughly verified by experiments, however, the old method will doubtless be used by most designers.

* * *

CANCELLATION OF ORDERS*

By C. WOOD WALTER†

There is no force so potent in the manufacturer's daily "struggle for existence" as the machine-tool order. We are all smiles on a "big-order day," full of optimism after a "big-order month," and ready to enlarge our plant, increase our force, and bring out a new line after a "big-order year"—all of which would show good judgment if orders always turned into shipments—but there are times when they do not. It does not take a long memory to go back to the fall of 1907, when orders vanished from our books like a beautiful dream, and (to quote the immortal bard) "like an unsubstantial pageant faded into thin air." Our fat order books shrank into nothingness—almost over night—and instead of being six months behind on orders, as we were wont to boast, most of us, in about sixty days, got six months ahead. As a result we were obliged to cut down the working force and increase the costs, thereby cutting out profits. This deplorable condition was due to the fact that the demand fell off, but it was also largely due to the fact that many of the orders on our books were not contracts, but simply *guesses* as to what the buyers *thought* they *might* need.

There are two classes of orders, so-called, in the machine-tool business:

1. Orders from the machine-tool dealers for stock. This kind of order, when not limited, does not have a high degree of validity—and perhaps necessarily so—for no manufacturer should force his agent to take stock when the agent's sales do not justify his previous estimate. In so doing we are simply using the agent's money, thereby crippling our selling department and increasing the costs of marketing our goods. The agent's stock order is not good business—stocks can be more economically and more intelligently carried and maintained by the manufacturer at one central point in his warehouse than by his agents in their expensive stores at various points. This is not inconsistent with the policy of carrying a proper line of sample machines on the agents' floors. Agents' stock orders, for the most part, serve only to record the agent's judgment as to what the future demand may be in his

*Paper read before National Machine Tool Builders' Association Convention, Rochester, N. Y., May 24-25, 1910.
†Address: Cincinnati Milling Machine Co., Cincinnati, Ohio.

territory. Many manufacturers, therefore, no longer accept agents' stock orders. Where they *are* accepted, it should be for limited quantities only, and they should be made not subject to cancellation.

2. Orders from the actual purchaser, the user of the machines, placed with the dealer or with the manufacturer direct. Many manufacturers are coming to regard this as the only order that is truly significant. But even this order, as commonly understood, falls short of being an actual contract. A large percentage of machine-tool buyers, to-day, place their orders with the mental reservation that they can easily meet a change in their plans, or a change in the market demand, by a cancellation of the order any time prior to shipment date. To some extent this cancellation privilege has been written into the order with the sanction of the dealer, or against his protest. To some extent the dealer has encouraged the buyer to reserve machines, subject to cancellation, and such reservations have been turned in as orders to the manufacturer who forthwith proceeds to invest his money to fill "the large orders on his books." I do not speak of the cancellation based on failure to deliver or on any legitimate grounds.

Now it does seem as though the machine-tool order as it exists to-day, might most profitably be subjected to a reform, so that it shall represent a contract, not subject to cancellation—the option of granting a cancellation to rest entirely with the vendor. The time to work this reform is now, while the demand is strong and there is no anticipated decline in sight. Consider what an added stability would be given to our industry to-day, if the unfilled orders on our books represented actual contracts not subject to cancellation! Consider what a change such a condition of our order books would have made in the fall of 1907, when the slump struck us—and yet this is just what an order means in many other lines of business. Why not in our line?

Let us review a few of the evil results that follow from the present practice of filling our books with so-called orders which do not represent binding contracts:

1. The manufacturer invests his money in materials and wages to finish machines on order, only to find when they are finished, that he may not have orders for them.

2. The manufacturer increases his production schedule to keep pace with his big order book. When his order book suddenly collapses under wholesale cancellations, he is left with a big stock on hand and coming out, with consequent heavy interest charges and often with heavy contracts for materials which he himself cannot cancel. This situation forces him to curtail immediately and run on a losing basis. It is bad enough to suddenly strike a market where new orders are scarce, without having to face a wholesale disappearance of the orders on hand.

3. Manufacturing on the basis of an artificial demand (as reflected in an artificially padded order book) makes also an artificial demand for material and labor, and a consequent increase in their cost. This is equally true for the dealer, who pays out his money to sell the goods, and increases his salesman's wages because the salesman is piling up big sales—which finally may largely disappear under cancellations.

4. Most disastrous of all, these wholesale cancellations under a slump in the demand, leave the manufacturers with such an over-production on hand, that the stability of prices is immediately and most seriously threatened. It becomes a matter of self-preservation for the weaker concern to cut prices. It is a matter of credit to this organization, that a disastrous and demoralizing break in prices did not follow the wholesale cancellation of orders and cessation of buying in the fall of 1907. This was prevented largely through the educational propaganda carried on by this association among its members to arouse them to a study of the real cost of the manufacture and sale of machine tools, and the right of every manufacturer to a decent profit beyond that cost—if he is to perpetuate himself in the business.

But our industry should not be subjected to such a strain as this. Once a demoralizing break in prices of this kind takes place, it takes years to recover. Now it is my opinion that we will take a long step in the direction of preventing this possibility, if we will cut out the cancellation privilege. Consider some of the benefits which would follow the establishment of the practice that would make a machine tool order not subject to cancellation.

1. The manufacturer may make his contracts for materials, arrange his manufacturing schedule, regulate the growth of his plant, with an actual knowledge of the amount of his product which he has absolutely sold, and which will stay sold.

2. The machine-tool dealer or agent may proceed with the development of his business, with the definite knowledge that he has earned so much profit based on his sales already made, instead of facing the possibility of a threatened and finally absolute loss when he is confronted with a flood of cancellations.

3. If the manufacturer can regard orders as actual and absolute sales, he can then intelligently and economically govern the amount and variety of stock he shall make, since he may approximately measure the actual and real demand for his various items of product.

4. Under a slump in the demand (which in the beginning is often more or less artificial), the orders remaining on the books, if actual and collectable, may be sufficient, in the whole industry, to bring about at least a partial resumption of business and restoration of confidence—at least the manufacturer would have time to reorganize his production without the disaster of sudden and drastic curtailment. This same benefit would accrue to the dealer as well.

Perhaps the simplest manner in which to bring this about, is for the different groups of competitors in this association to agree together to notify their agents that, beginning with a certain date, all orders on the manufacturers' books, and all orders to be entered in the future, must be considered "not subject to cancellation." This makes it possible and reasonable for the dealer to insist upon the same conditions from the consumer—and the consumer will find that he is asked to meet a regulation which is only reasonable and economic, and which is presented to him by all dealers and manufacturers alike, and he will soon yield to it as an established custom of trade, and ask in turn the same conditions of those who buy from him.

* * *

MAKING AN AUTOMOBILE STEERING WHEEL

By M. E. DAWSON

The steering wheel on an automobile, to the average person not familiar with the building of the entire machine, appears as only a drop in the auto manufacturing bucket, and yet if this small part of the automobile were manufactured in a shop by itself, the shop would be considered quite a large plant.

A section of the steering wheel ring on one of the leading makes of automobiles is shown in Fig. 1. The arms, center hub, and outer ring comprise the spider or metal portion and to this spider is secured a wooden ring of mahogany or other suitable wood. This wooden ring is "built up" and finished in two separate sections, each section having four segments. In the wood portion of this steering wheel only the best mahogany is used, and high-grade aluminum is used in the metal spider. The finished wheel must go through a critical inspection; defective material or workmanship, bad joints, "dutchmen," putty fillers, etc., are all causes for the inspector to put his blue-pencil mark on the wheels. In order to reach this stage of perfection in the construction of the wheel, and to turn them out in numbers sufficient to meet the requirements, every detail piece of work is done by special tools. I will not attempt to show more than one of these special-built tools, but from this may be learned to what extent this special tool building is carried on.

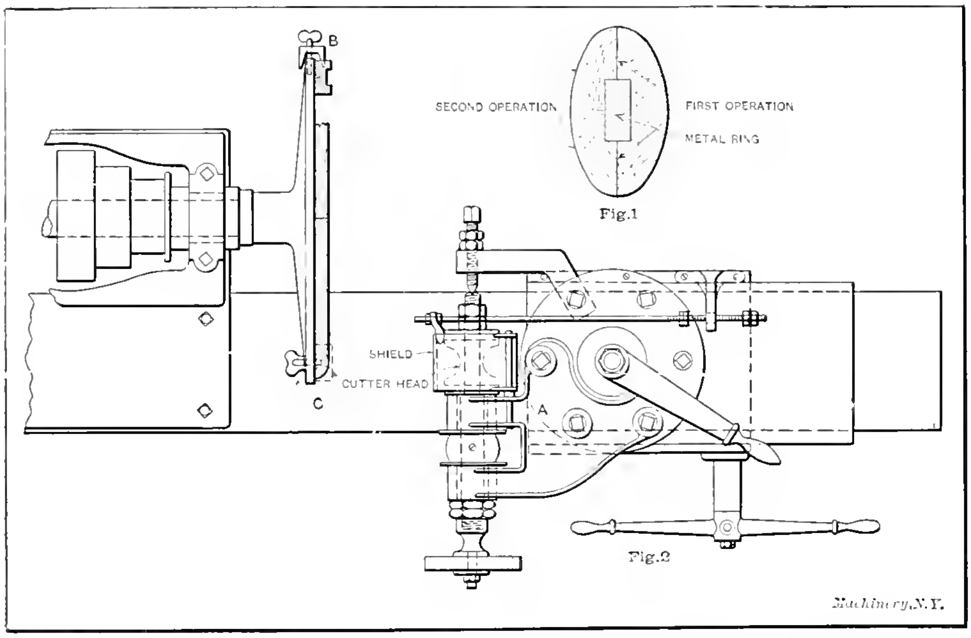
In the plan view, Fig. 2, is shown a reconstructed turret lathe, having an attachment for shaping the hand ring, a half of which is shown chucked on the faceplate. No change whatever is made in the tailstock or rather the turret head; the headstock, however, is set over so as to bring the center line of the stock to be turned in line with the center of the turret head. The cast-iron bracket *A* has two bearings which support the cutter spindle of the attachment. The cutter head consists of two steel collars—one butting against a shoulder

and the other loosely mounted on the spindle. Between these collars are clamped the cutter knives by means of the set- and lock-nuts as shown.

The cutter spindle is driven by quarter-turn belt, running over a deep-flanged pulley on the overhead countershaft, which is the same shaft that drives the lathe. The driving pulley on the countershaft is so located that the belt becomes tight as the cutter spindle approaches the work and loose when it is drawn away, thus relieving the constant high tension on the bearings, which saves wear and tear on both the bearings and belt. An emery wheel attachment is mounted on the end of the spindle and is a part of the lathe outfit. So as not to interfere with the movements of the operator, the emery wheel spindle is removed when it is not in use.

The first operation on the rim includes facing the joint and cutting the rectangular recess in which the metal rim of the wheel fits. The work is held during this first turning operation by pinch dogs, such as are shown at *B*; during the second operation on the opposite side, the rim is held by screws *C*, which pass through the faceplate and into the wood. The cutter spindle revolves at a high rate of speed, while the faceplate revolves more slowly, the speed being in proportion to that of the cutter spindle. The cut is gaged by collars on the cutter spindle, which come against the faceplate.

In Fig. 3 is shown a detail of the shield or cover which is over the cutter-head. This shield is automatically operated by the reciprocating action of the turret carriage, through the medium of a rod which is attached to the shield and passes through a stationary bracket as shown. When the cutter is at work, the shield is held in a position clear of the faceplate, and at the same time it directs the chips away from the operator. The shield is hinged, and on top of it there is an arm having a slotted hole through which the lifting rod passes. This rod, as indicated, is threaded to provide for adjustment. When the operator is in the act of removing the finished rim from the faceplate, it is impossible for any part of his person to come in contact with the cutter, owing to the protection of the shield.



Figs. 1 and 2. Section of Steering Wheel and Turret Lathe fitted with Special Turning Attachment

* * *

An interesting optical instrument has been introduced in Paris. It is made in the form of a walking stick provided with optical devices which enable a person to look over a crowd, the hats of ladies, fences, walls, etc. The stick consists of a hollow tube near the top of which is mounted half of a small field glass. The rays of light pass through the lenses and strike a prism inside of the stick, by means of which they are reflected at right angles to another prism at the lower end where they are again reflected in a horizontal direction, so that the objects open to the view of the field glass can be clearly seen by the eye.

OPERATION AND CONSTRUCTION OF THE SUB-PRESS DIE*

By ROY PLAISTED†

When constructing a blanking die, the class of work for which it is intended and the amount required should determine to a great extent the cost of the tool and the degree of accuracy necessary. Where only a limited number of blanks are required and a variation of a few thousandths is allowable, a die can oftentimes be made very cheaply that is good enough; for instance, in the manufacture of cheap jewelry where only a few thousand blanks of a certain kind are wanted, a die of cheap steel, three-eighths thick, soldered to a plate and run with a soft punch, meets all the requirements. On the other hand, on a class of work where accuracy is the essential feature and the die is in constant use until worn out, the best of material and workmanship is necessary. In shops where this class of work is handled, the sub-press die is usually depended upon to produce it. A die of this type is shown in the accompanying engraving. It is doubtless familiar to many of the readers of MACHINERY, as dies built upon this principle have been extensively used in nearly all the watch factories in this country for several years, and are constantly growing in favor in most shops where high-grade dies are used, though as yet they are not in general use to the extent that they would be if the many advantages to be derived from their use and the saving that could be effected were better known. It is true that the first cost of a die of this kind is considerable, but the long life of the tool and the excellence of its work make it a profitable investment.

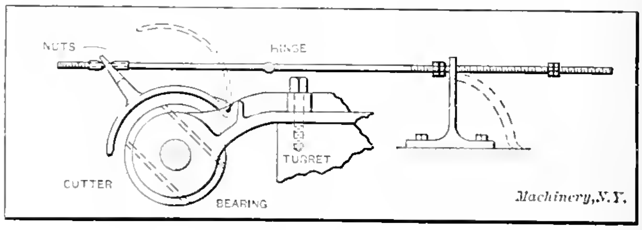


Fig. 3. Cutter Guard with Automatic Adjustment

A brief description of a sub press die for producing the blank shown at *A* follows: The upper half of the casting or cylinder *B*, is shouldered onto the base *C* to which it is attached by screws *D*; it is also doweled in position by the two pins *E*. The plunger *F* runs in a casing of babbitt shown at *G*, the wear in which is taken up when necessary by screwing down the tightening nut *H*, which forces the babbitt down and in at the same time, as the cylinder is bored on a slight taper. The plunger has three semi-circular grooves milled along its length to prevent its turning. Attached to the plunger is the die *I*, which cuts the outside of the blank, and the small punches *J* which are held in the back-plate *K* and supported by the shedder *L* which is backed up by the heavy spring *M* the tension on which is obtained by screwing down screw *N* which nas a small hole running through it to allow

* For additional information on the subject of punch and die work see MACHINERY, August, 1904, "Punches and Dies for Making Hinge Springs for Novelty Boxes" and "Notes on Die Making"; July, August and September, 1906, "Punch and Die Work"; July, 1906, "Progress in Simple Press Work"; October, 1906, "Blanking and Piercing Dies for Washers"; December, 1906, engineering edition, "Sub-press Work at the Sloan & Chace Shops"; February, 1907, "Making Blanking Dies to Cut Stock Economically"; March, 1907, "Construction of Split Dies for Press Work"; March, 1907, "Helpful Hints for Toolmakers"; May, 1907, "Sectional Punches and Dies"; June, 1907, engineering edition, "Novel Ideas in Die Making"; October, 1909, "Drawing Dies for Hollow Rivets"; January, 1910, "Die Beds or Bolsters for Presses"; April, 1910, "Automatic Punch Press Work"; June, 1910, "Out-of-Date Die Making Methods." See also MACHINERY's reference series pamphlet No. 6, "Punch and Die Work"; No. 13, "Blanking Dies," and No. 26, "Modern Punch and Die Construction."

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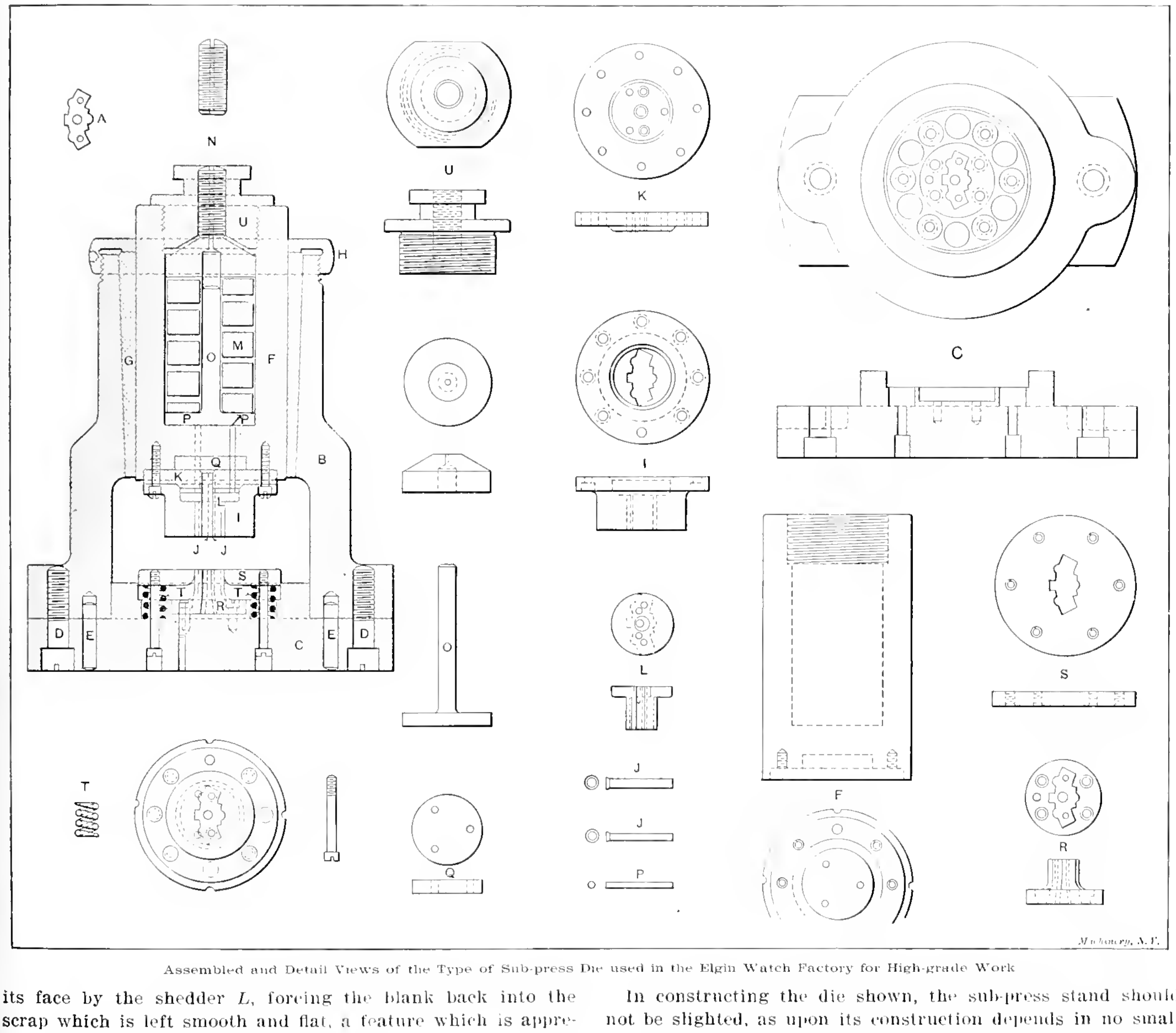
the air to escape. The center piece O and the three pins P placed between the spring and shedder, supply the tension necessary to operate the latter. The hardened disk Q is pressed into the plunger behind the back-plate as indicated, to take the thrust of the small punches. The base C is recessed to receive the base of the larger punch R which has three openings for the three small punches J, clearance being provided to allow the scrap punchings to pass through. The stripper in the lower member is shown at S, the resistance from the springs T doing the work.

In operation the plunger descends with the ram of the press and the stock caught between the two flat surfaces is held firmly in position at the time it is struck, thereby preventing any creeping or distortion of metal during the blanking. The outside of the blank and the pierced holes are cut simultaneously. Upon the return stroke of the ram, the tension from the small springs T forces the stripper S back over the punch R which still has the blank pressed firmly against part of the press work is entrusted (through a mistaken idea of economy) to an inexperienced operator who has a very vague idea of the cost of the tools he is setting and to whom the shearing of a die is only a part of the day's work. Another point in favor of the sub-press is the fact that owing to the small punches being supported nearly their entire length, it is possible to pierce smaller holes in comparatively thick stock, than can be accomplished with any other die, it not being unusual to successfully punch holes in stock considerably over twice the diameter of the punch. A narrower bridge can also be left between blanks and a much better blank obtained than with any other form of die. The blanks are not only free from burrs, but they are always of a uniform size, the die being straight instead of having clearance, as is the case in the open die (where the blanks have to pass through) so that the first blank punched is an exact duplicate of the one produced when the die is worn out, which, obviously, means a longer life for the die.



Assembled and Detail Views of the Type of Sub-press Die used in the Elgin Watch Factory for High-grade Work

its face by the shedder L, forcing the blank back into the scrap which is left smooth and flat, a feature which is appreciated wherever the reel-feed is used.

The many advantages of this type of die over the open die are apparent to anyone seeing it in use. The fact that the sub-press is a self-contained tool, being in nowise dependent upon the ways of the power press in which it is run, and the consequent ease with which the die can be set, means a great saving in time, as all that is necessary is to attach the cap U to a T-slot in the gate of the ram, clamp the base to the bed of the power press, and adjust the stroke. Not only is it a time-saver, but it also possesses another distinct advantage in that it does not necessitate a careful lining up of punch and die, as dies of this kind are always in perfect alignment. This makes it impossible to set a sub-press die up so as to "shear" it, a feature which should not be overlooked, as usually this

In constructing the die shown, the sub-press stand should not be slighted, as upon its construction depends in no small measure the proper working of the die. If the stands are well made, they can be used indefinitely for different dies, owing to the means provided to adjust for wear. It is a disputed point whether the plunger should be babbitted before or after the punch and die are fitted. Some prefer to make the punch and die first, enter the punch into the die attached to the plunger, and pour the babbitt, but it is generally conceded that the better way is to babbitt the plunger first; in fact, most manufacturers at the present time buy them already fitted up from one of the several companies manufacturing them for the trade. One advantage in having the plunger babbitted first is that it can be run continuously for a day or so to free it up well and secure a good bearing, the large nut being set up occasionally. In this "working out," the

plunger is sure to creep a trifle, probably caused by the babbitt not flowing evenly and, obviously, it is much better for this change to take place before the alignment of the punch and die. In recessing the cylinder to receive the base, the proper way is to place the plunger on the centers of the lathe with the cylinder attached and recess and face out on the bottom, using the plunger for a mandrel. With this method one has the assurance of knowing that the plunger is exactly central and in a vertical position with the base, which cannot be said when the plunger is babbitted last.

In milling the three grooves in the plunger, it is well to space them unevenly, as it will then be impossible for the aforementioned press operator or anyone to insert it in any but its proper position. In locating the holes in the back-plate and shedder, a round master plate is usually used, thus insuring greater accuracy. This master plate can be laid away for duplicating the die. In boring the holes in the master plate, they should be made a trifle larger than the largest hole in the work, which gives clearance for the boring tool to pass through. When boring the back-plate, it and the master plate should be set perfectly central with each other and then fastened with a drop of soft solder on opposite sides. Having done this, a taper pin is inserted in the center of the face-plate of the bench lathe, and turned up on the end that projects, to the size of the holes in the master plate. One of the holes in the master plate is then wrung onto the pin, after which the master plate is clamped to the faceplate and one of the holes bored. No further indicating is required, as it is simply necessary to change from one hole to another upon the pin until all are bored. The holes should be left small, so as to correct the error from hardening, by grinding.

When grinding, the work is placed upon the master plate in the same manner and position as when boring, the grinding being done by means of a steel lap several thousandths smaller than the hole, the enlarged end of which is charged with diamond dust. [This process is more fully described in Mr. A. L. Monrad's excellent article in MACHINERY for December]. In separating the die from the master plate, the best way to remove the solder is to turn it off with a brass lathe tool before the work is removed from the faceplate.

When making the die *I*, great care must be exercised, as the die is straight and the templet must be worked through without any clearance; not only is this necessary for reasons before mentioned, but to allow an even sliding fit for the shedder. In case it is impossible to avoid a little clearance, it can sometimes be corrected in the lapping operation after hardening.

* * *

MEAN RADIUS OF THE FRICTIONAL FORCES OF A DISK BRAKE

By JOHN S. MYERS*

In the article on friction disk brakes on page 485 of the engineering edition of MACHINERY for February, the author assumes the center of tangential force to be at the center of gravity of the narrow sectors into which the disk may be imagined to be divided, while the editor inserts a note explaining that formulas have been found to give better results which assume the center of tangential force to be at the mean radius of the disk. As the writer has seen these two different ideas elsewhere, it was thought well to investigate the subject mathematically. The results confirm the statement as given by the editor. The assumptions upon which the investigation is based are as follows:

1. The coefficient of friction remains constant for varying pressures.

2. The wear of any one element of the surface is proportional to the work done upon it, *i. e.*, proportional to the pressure and velocity.

3. The disks remain flat under service, *i. e.*, they wear as fast at the outer edge as at the inner edge.

Assumption (1) would be far from true for conditions of perfect lubrication, but for slightly greasy surfaces such as those of a brake it is approximately correct. Assumption (2) would also be far from true for perfect lubrication, but seems reasonable for the ordinary conditions met with in disk brakes. Assumption (3) is almost self-evident, for, if one portion of the disk were to wear faster than another, it would be relieved of the load, thus equalizing the wear.

Let w = wear per unit pressure and velocity in unit time,
W = wear at any radius r,
N = revolutions in unit time,
P = pressure per unit of area.

$$\text{Then } W = wP2\pi rN \text{ or } P = \frac{W}{2\pi wrN} \qquad (1)$$

Now, using in the following demonstration the methods of calculus, let dA = area of any ring having a radius r and a breadth of dr, r being variable.

$$\text{Then } dA = 2\pi r dr. \qquad (2)$$

and if dF = the pressure on this ring,

$$dF = PdA = \frac{W2\pi rdr}{w2\pi rN} = \frac{W}{wN}\,dr. \qquad (3)$$

Let D = diameter of disk, then integrating (3) we have

$$F = \frac{W}{wN}\int_0^{\frac{D}{2}} dr = \frac{WD}{2wN} \qquad (4)$$

Now let dm = the moment of the ring about the center; then

$$dm = rdF = \frac{W}{wN}\,rdr. \qquad (5)$$

Integrating (5) gives

$$m = \frac{W}{wN}\int_0^{\frac{D}{2}} rdr = \frac{WD^2}{2wN4} \qquad (6)$$

Now let R = the lever arm of the total force F; then

$$R = \frac{m}{F} = \frac{WD^2 2wN}{2wN \times 4WD} = \frac{D}{4} \qquad (7)$$

which is the distance from the center of the disk to the center of gravity of the normal pressure on the disks. According to assumption (1), the coefficient of friction remains constant for varying pressures; hence the center of the tangential or frictional forces coincides with the center of the normal pressure as given by equation (7). The significance of equation (7) is, that for a complete disk the mean radius of the frictional forces is equal to the arithmetical mean radius of the disk.

Such disks, however, are seldom complete disks, but are annular rings in which the inside diameter is sometimes as great as half the outside diameter. For such disks let

D = outside diameter
D_1 = inside diameter,
m_1 = moment of the disk about the center,
F_1 = total normal pressure on disk,
R_1 = the lever arm of F_1 = also the mean radius of the tangential frictional forces.

From equation (6) we may write

$$m_1 = \frac{WD^2}{8wN} - \frac{WD_1^2}{8wN} = \frac{W}{8wN}(D^2 - D_1^2) \qquad (8)$$

From equation (4) we may write

$$F_1 = \frac{WD}{2wN} - \frac{WD_1}{2wN} = \frac{W}{2wN}(D - D_1) \qquad (9)$$

$$\text{Then } R_1 = \frac{m_1}{F_1} = \frac{W(D^2 - D_1^2)}{8wN} \times \frac{2wN}{W(D - D_1)} = \frac{D + D_1}{4} \qquad (10)$$

Now $\frac{D + D_1}{4}$ is the arithmetical mean radius of the disk, and hence unless the disks are working under conditions approximating those of perfect lubrication, they will wear in such a manner as to make the mean radius of the tangential frictional forces at least approximately equal to the arithmetical mean radius of the disk.

* * *

According to the *Brass World*, an aluminum alloy containing an average of 96 per cent aluminum, 2.5 per cent copper, 0.75 per cent manganese and 0.75 per cent silver can be rolled and drawn and is then much stronger than pure aluminum. The rolling may be done either hot or cold.

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GRINDING ECONOMY*

H. DARBYSHIRE†

Being one who is much concerned with grinding processes I was naturally interested in Mr. Thacher's useful contribution, "Economy in Grinding," in the May issue.

His remarks on the hints which are afforded by demonstrators being disregarded or forgotten by operators are to my own knowledge too true, but I would like to venture a friendly criticism on one point in his contribution which I trust he will receive in the spirit in which it is tendered. Mr. Thacher in speaking of spotting work off for steady-rest purposes seems to recommend it especially for hardened work, and if this is his general practice his experiences must be of a happier nature than my own or of those I usually encounter. As these experiences of his are a result of observations made in the works of the Brown & Sharpe Mfg. Co. we may assume that in this particular case it may be good practice and may be due to some special process of hardening or annealing.

It is, however, common knowledge that pieces of work which are hardened almost invariably contain internal stresses. To spot places off to within 0.001 inch of the finished size would mean disaster in general cases. Further than that it is within my own experience that this characteristic is not confined to hardened work but may be met with in soft pieces which have been machined by the more modern methods. I refer more particularly to work done on the modern turret lathe, and have found that pieces machined by this means are not to be relied on without a consistent previous rough grinding process over the whole surface. Cold-drawn material will display similar peculiarities, and the inference in both cases is fairly obvious. In the case of cold-rolled stock we may safely assume that the severe process it goes through in the course of manufacture is the cause of the trouble, and the pressure of the steadies in the bar turret lathe may very easily account for difficulties met with in grinding work which comes from the bar turret lathe. A case in point is the ordinary sensitive drill spindle shown in Fig. 1. I have had these spindles come from the engine lathe (made from forgings), and ground them without trouble; other batches which come from the turret lathe have displayed what I may term a devilish peculiarity. If I roughed down say portion *A* to within a finishing limit this portion would be some 0.003 inch out of truth when portion *B* was ground to size, or *vice versa*. In fact I found the only possible way was to rough off the skin in the first place on both *A* and *B*. With all due respect to Mr. Thacher's experience I think that economy in steady shoes is of less account than is quality and truth of work in the grinding machine. The real advantages of grinding might well be described as follows, in which will be used some of my previously written matter:

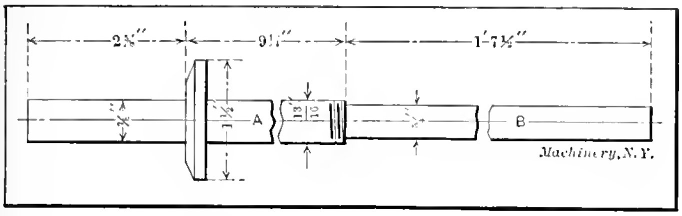

Fig. 1. Sensitive Drill Spindle which gave Trouble when ground after being turned in a Turret Lathe

The gratifying advantages which may be obtained from the use of high-speed steel are limited to a certain point, that point being where a very small amount of material must be left and extreme care exercised in arriving at the precise dimensions. For this final finishing it may be claimed that the grinding machine is the most rapid and economical tool to use, for the following reason: It removes this small amount of material in the shortest comparative time; it arrives at the desired dimensions by a series of rapid and minute chips which cover the whole surface repeatedly and whose depth is under perfect control, any variation in its shower of sparks being constant and visible evidence of its change of form either through distortion or accident; and finally it allows of the actual surface finishing being the last operation, thereby removing all those errors and distortions which may be a result of hardening on other previous operations. The fact that a ground surface is superior to that produced by a file or water cut is indisputable, and the rapid manner in which a fixed dimension may be obtained is another recommendation; that the result is effected by a series of minute chips with a visible index of their depth is another point in its favor. In order to start a finishing cut in the lathe and control its size, the length of its traverse, in most cases, requires a sense of touch which may have taken years to attain; to obtain a similar result, but a better surface, in the grinding machine is a far easier matter because another of the senses is enlisted. Given a few days' practice with a grinding machine, an operator can judge to 0.001 inch the depth of cut he is taking by the shower of sparks displayed.

We are indebted to Mr. Thacher's contribution for some valuable time-saving hints which those who may adopt will find of some value, but there is also an economic side to the grinding question which he does not touch on and which may be well worth consideration.

In some six years' experience as a demonstrator of grinding processes, it has been my privilege either to work in or to have entry into most of the principal shops in Europe, and with a few happy exceptions I have not seen a grinding plant run on what I consider truly economic lines. Most of these places are factories where I have personally installed machines and have made special efforts to instruct and hustle operators into making time and, incidentally, getting a better quality of product than I produced myself. In a few instances, on revisiting these factories it has been my pleasing experience to find that the said operator has excelled both my own and his former efforts and is doing both my company and myself a service. This, however, is the exception rather than the rule and it may be profitable to consider some of the causes which may lead up to these deplorable exceptions:

The prime causes are the apathetic attitude of the supervision or the skepticism of the management which fails to recognize the advantages of the old saying that "what is worth doing is worth doing well," and so fail to give as much attention to a plant which, although a somewhat modern innovation, is certain to give large returns if properly handled. We live in an age where "time is money" and much valuable time may be lost on a grinding job with either improper gaging methods, the absence of gages or an absurdly restricted limit of tolerance.

Piecework seems to be a necessity, owing to a failing in human nature, for it is easier and fairer to pay a man for what he does than it is to get him to do what he is paid for. This being the case, it is as necessary on a grinding job as it is on any other, and to get the maximum output requires that the operator should be assisted as much as possible.

It is the duty of the demonstrator to prove that a given job can be done in a given time without superhuman exertion, and after this it is up to the shop supervision to see that the standard of efficiency is adhered to. Apart from speed this said standard of efficiency should be maintained by a careful system of gaging with as much limit as is compatible with the quality of work required, and for this purpose a system of limit or tolerance gages is admirable; those inanimate pieces of metal with their "go on" and "not go on" have to my own knowledge reduced the amount of bad language and ill-feeling which was prevalent in many shops. They do away with that friction between the grinding and inspection departments which comes from depending on the individual sense of feeling with the micrometer caliper. To be more explicit, an examiner may have the delicate sense of touch of a lady and the grinding operator that of a navvy.

I have mentioned the necessity of giving as broad a tolerance as possible, for it is quite apparent that if this be done the output of an operator may be materially increased; as an illustration of this I may cite a case which is still fresh in my mind. A few weeks ago a 6-inch by 32-inch Norton plain grinder was put in a local factory for the grinding of the valve stem shown in Fig. 2. The stems were made of a high quality of cast steel and were hardened with about 0.012 inch

* For previous articles on grinding see "Economy in Grinding," May, 1910, and the previously published articles there referred to.

† Instructing operator, Norton Grinding Co., 73 Broomfield Road, Coventry, Eng.

to 0.015 inch left on their diameters for removal by grinding. Now a valve stem is given a few 1/1000ths inch play, and it would seem as if a tolerance of 0.001 inch would be as fine as would be necessary. However, this particular firm is very nice over its work and bears a reputation for quality which is second to none in Europe and so it insisted on a limit of 0.00025 inch, + and —.

The slot on the radial end of the valve was very convenient for using a thumb nail driver on the catch plate of the grinder and 80 per hour were produced to the limits demanded. A 24 L alundum wheel of 2-inch face was used and the automatic cross feed was two teeth, or 0.0005 inch per stroke of table. The wheel would duplicate about 20 turns before losing its size but the rather fine limit required some extra care and judgment of the sparking towards the last chips. If the tolerance had been double that demanded it would have been easily possible to produce 100 per hour, for practically no gaging would have been required.

A little knowledge is proverbially a dangerous thing and it has been my own experience to be often tied down to limits so fine as to be absurd when the class of work was taken into consideration. It is generally those "rule-of-thumb" people

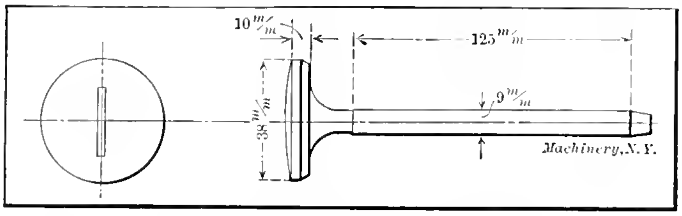

Fig. 2. Valve for Motorcycle Engine, Production of which was greatly reduced because of the Small Tolerance allowed

who make this mistake and in the fulness of their knowledge they despise all modern gaging methods. The first expense of installing a proper gaging system would seem to have terrors for them and the want of it may be costing them thousands of dollars per year. They ask for work of so accurate a nature that it may demand the patience and skill required for standard gage making and so limit the production of a machine as to make it painful to watch the operator who is tending it.

A great time-saving factor in the work of a grinding machine is the manner in which the work is prepared for the machine's reception; the modern grinding machine is undoubtedly a rapid stock remover and within certain limits will beat the lathe all hollow, but if some amount of judgment is not exercised in preparing work its full economic advantages may not be realized. It is, of course, impossible to lay down any fixed rule for grinding allowances, for these must depend on the shape and condition of the work, but I find that the leaving of an allowance of 0.015 inch to 0.030 inch on a diameter is the most economical for general work on a modern machine.

There are at the present time many engineers who are skeptical on the grinding subject and I suppose that until the end of time we shall have the old fogy element with us.

On the other hand there are those who are too optimistic and either expect too much or have mistaken notions as to the grinding machine's mission. Here is an illustration of how some little tactful suggestions proved of service in one of many parallel cases. A 20-inch by 30-inch by 168-inch Norton plain machine was installed in a factory, mainly for the purpose of grinding chilled rolls for the oil seed crushing trade. The rolls, Fig. 3, which were 16 inches face by 48 inches long came into the factory rough turned and were bored to the required dimensions; steel axles were afterwards forced in by means of a hydraulic press until they took the shape, when finished, as shown in the sketch. The principal of the firm was a smart business man and had a scheme outlined for a revised method of manufacturing these rolls which at first sight seemed quite reasonable. He proposed to turn the shafts to size for the press fit and leave 1/16-inch on the axle portion for finishing, which was to be removed by grinding. The first two experimental rolls were put through in this manner but they failed to clean up on the axle portion, this no doubt being due to distortion caused by the high pressure required for forcing in the axles and probably also some little error in alignment of holes in the rolls; the roll portion also took an excessively long time to grind. It was proposed to the principal that in the future he have ¼ inch left on the axle portion and that after forcing in he have them recentered true with the roll portion and a rough turning cut taken over the ends, but with a perseverance worthy of a better cause he proposed to adhere to his method, but to leave 3/32 inch on the axle ends; this was done for the next pair of rolls and as a guarantee had been given with the machine the time test was taken. This guarantee, by the way, was to grind a roll and axle ends complete in 2 hours, removing 1/32 inch of material from the diameters. In spite of the excessive amount (3/32 inch) left on the axles, two rolls were ground complete in 3 hours 50 minutes, this including getting out the fillets with wheel turned to shape. Since this incident occurred, the principal of the firm, being a reasonable man, has recognized that his scheme did not work out profitably and acting on suggestions offered he now prepares his work in the following manner:

He turns the axles to size for the press fit but leaves ¼ inch on the end portion; they are afterwards centered true by gripping one end in a chuck and running the roll portion in a fixed steady; the axles are then turned to within 0.030 inch of size. By following this scheme he is enabled to save some 60 per cent of the grinder's time and a similar amount in his annual cost of grinding wheels.

There is a little matter connected with a grinding plant where serious losses often occur and when the reasons for what I may term a mistaken idea of economy are analyzed it resolves itself into an absurdity.

In this I am referring to the provision of diamonds which are a necessity for the truing of the grinding wheels. I have seen some grinding plants where there have been from 20 to 40 operators at work and it has been the rule to provide one diamond truing tool for some five or six operators. There would, in these cases, seem to be an impression that something is saved by restricting the supply of these apparently expensive but necessary tools. It would almost seem as if the word "diamond" has some cabalistic qualities and that its weight compared with its price is a kind of bogy to men who are otherwise sane.

The question resolves itself into this: If five men have the use of one diamond tool, the said tool is likely to have the

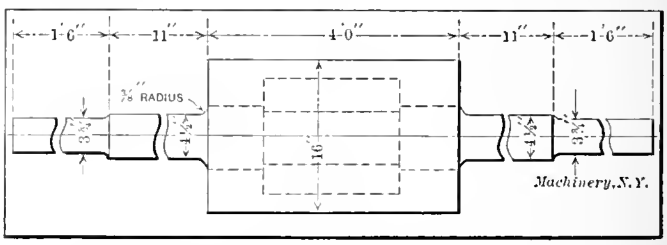

Fig 3. Chilled Roll for Oil Mill that made Trouble in Grinding until Procedure in Operations was changed

wear and tear of five tools and so far there is nothing gained by this parsimony; on the other hand there are likely to be some losses which may easily occur and perhaps be unnoticed. A wheel may become glazed and so be somewhat ineffective until the diamond is applied. Here the individuality of the operator will display itself; he may have that "tired feeling" and prefer to put up with the defect in his wheel to his employers' loss rather than search amongst his mates for it. Another class of operator is so socially inclined that he may be unable to make this search without having a few seconds' chat with each of those he inquires of as to the diamond's whereabouts; if five men have the use of one diamond tool no one can be truly made responsible for it if it gets lost, and when this does occur the whole plant is inconvenienced and delayed until it is replaced. Another point to consider is that if only a single diamond is allowed to five operators it will get dulled more rapidly. Now a dull diamond has caused and still causes endless trouble and losses in a grinding plant. It is responsible for much of the skepticism which exists on grinding matters generally, and like all other cutting tools it should be kept in the proper cutting condition.

MACHINE SHOP PRACTICE*

CHIPPING

The finishing of surfaces by chipping and filing is practiced comparatively little to-day, as the improved tools now in use have largely eliminated such work, though at times even in a modern shop it is necessary to resort to the hammer and chisel, particularly in erecting and general repair work. To reduce a plain surface by chipping, requires considerable skill which can only be acquired by practice. A few general suggestions, however, will doubtless be of value to anyone who desires to become proficient in this particular work.

The various types of chisels commonly used for chipping are shown in Fig. 1. The flat chisel *A* is used for a general class of work. The cutting edge *e* is either ground straight for light work or made slightly convex for heavy chipping to prevent the corners from breaking. The angle at the end should be about 60 degrees, though a greater or less angle is advisable when the metal is either exceptionally hard or soft. A cape chisel is shown at *B*. This has a narrower cutting point than the flat chisel, and is used principally for cutting grooves, etc. The side chisel *C* differs from the flat type *A* in that it is ground and beveled on one side only, which permits it to be used on surfaces which could not be reached with a double-angle end; it is also used for chipping the sides of keyways, slots, etc. The diamond point shown at *D* is adapted to chipping V-grooves, squaring corners, etc., while the grooving chisel *E* is for cutting oil-grooves or for similar work. The half-round chisel *F* is known as a gouge, and, as its shape indicates, is used on curved surfaces.

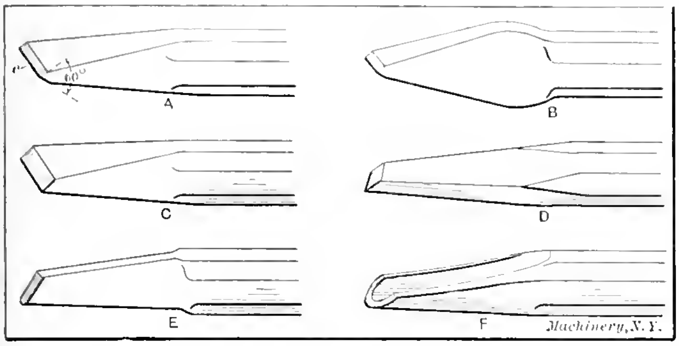

Fig. 1. Different Types of Chipping Chisels

Most workmen who are not accustomed to chipping, proceed very awkwardly, principally because of fear of striking the hand, and in order to avoid this, the eyes are continuously fixed on the head or striking end of the chisel. It is not necessary, however, to look directly at the chisel head in order to hit it, as a little practice will show, but it is important to continually watch the cutting end, as the chip being removed determines whether the chisel should be raised or lowered to increase or decrease the depth of the cut. The hand holding the chisel should be quite close to the striking end to obtain better control, and it is well not to grip the chisel shank with the thumb and forefinger as an accidental blow on the relaxed muscles will be less painful than when the chisel is gripped tightly by the entire hand.

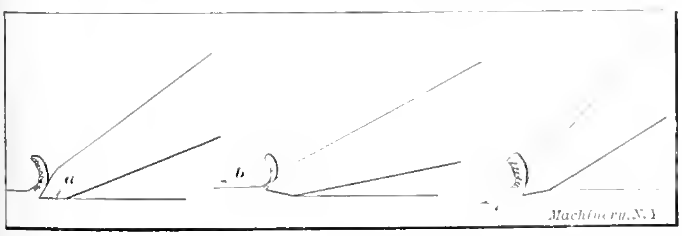

Fig. 2. View showing how Depth of Cut is altered by Position of Chisel

The way in which the position of the chisel alters the depth of the cut is illustrated in Fig. 2. As each successive blow is struck, the chisel tends to move along the plane of the supporting surface *a*, so that lowering the striking end causes the point to move upward, and raising it has the opposite effect, as illustrated by the arrows *b* and *c*.

When it is necessary to reduce a broad flat surface by chipping, a number of grooves *d* of uniform depth are usually first cut across, as illustrated in Fig. 3, and then the metal remaining between these grooves is removed by a broader chisel of the flat type. By this method, the broad chisel cuts more easily as there is no resistance at the corners and sides. It is advisable before chipping a surface that needs to be carefully finished, to chamfer the corner where the cuts end (as at *f*) to prevent the stock from breaking out below the depth line.

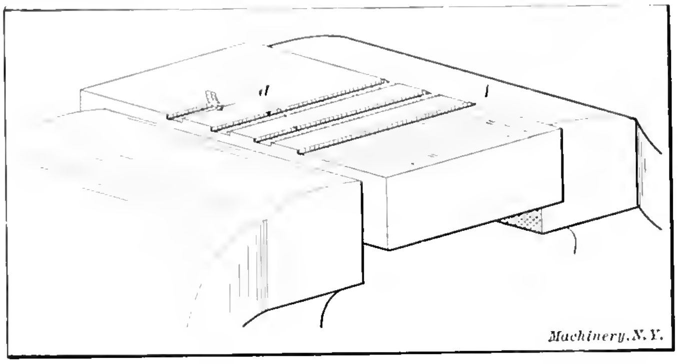

Fig. 3. Method of Chipping a Flat Surface

Whenever there is considerable chipping to be done, a pneumatic hammer, a type of which is illustrated in Fig. 4, should be used if one is available. The chisel, with the shank inserted in the hammer, is held in the left hand and the hammer with the right. By manipulating the lever *l*, the admission of air to the cylinder and consequently the speed of the hammer blows is regulated. The small flexible hose through which the air is supplied is connected at *h*. When beginning a cut, the hammer should be started gradually so that the movement of the chisel may be more easily controlled. Both hammer and chisel should be held firmly against the work and at an angle which will depend on the depth of cut desired. When the hammer is working at full speed, the cutting movement of the chisel is almost continuous, owing to the rapidity of the blows. This continuous cutting action makes it possible, of course, to take a smoother cut and to work more rapidly than is possible by hand chipping. The pneumatic hammer is also widely used for riveting, beading boiler flues, and for many other kinds of similar work. When used for these various purposes, special tools are, of course, employed.

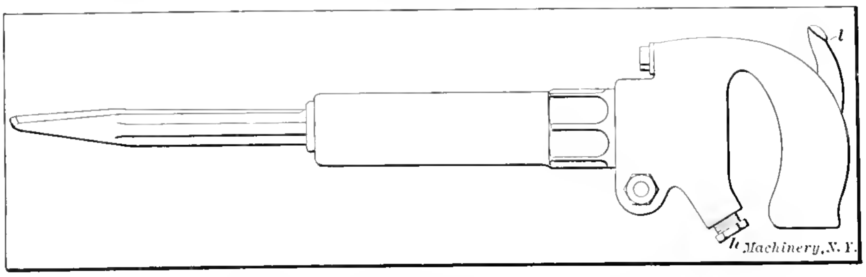

Fig. 4 Pneumatic Hammer arranged for Chipping

* * *

The German Consul-General at Budapest reports to his government that, owing to the large demand for metal working machinery and metal goods in Hungary, the home factories cannot keep pace with the orders. He states further that the Hungarian Parliament, therefore, has decided to build five machine tool works, which will employ 860 men, and that arrangements have also been made for the erection of twenty other works and foundries which will employ from 4,000 to 5,000 men. It would appear from these reports that Hungary would, at the present time, offer a good field for machine tools.

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* With Shop Operation Sheet Supplement.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

TIPPING SHOP TOOLS WITH HIGH-SPEED STEEL

In no shop that I have been in is the practice of using small pieces of high-speed steel to tip tools made of an inferior grade of steel carried out to a greater extent than it is in the shop of Wm. Barker & Co., Cincinnati. Mr. Barker makes lathe, planer and shaper tools and special drills, by using machine or a low grade of carbon steel for the body and making the cutting edge of a small piece of high-speed

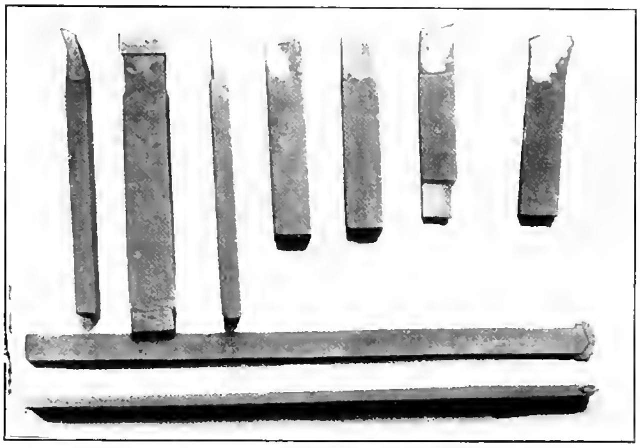


Fig. 1 Lathe and Planer Tools, and Spindle Drills tipped with High-speed Steel

steel "brazed" on. Of course, nothing original is claimed for this, as it has been done in many railroad shops and other places for some time, but Mr. Barker has carried the idea farther than is usual.

In Fig. 1 are shown a number of lathe and planer tools and two long drills used for drilling out lathe spindles, tipped in this way, while in Fig. 2 are four drills, a lathe tool, and a wide channeling tool for the planer, which is tipped on each end of the crosspiece with a cutter. In tipping a tool with high-speed steel, the piece should be so fitted that a close union is made when brazed. It will be noted that the drill tip is fitted into a slot in the end of the bar, and it is usually a good plan to pin the tips in place on the other tools,

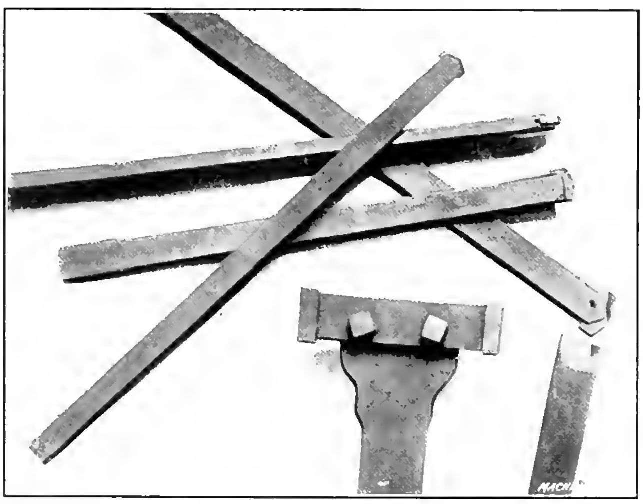


Fig. 2 Spindle Drills and Large Double-tipped Channeling Planer Tool

with a small pin, so that they will not slip out of position while in the fire. Ordinary brass spelter is not suitable for high-speed steel; copper should be used instead, with borax as a flux. A convenient way to obtain good copper for brazing is to take a small piece of electric wire, scrape off the insulation and file a small slot in the recess of the tool for it to lie in. Brazing is, of course, done in the usual way except that the heat should be higher. Tips put on tools in this way will stand considerable rough usage without coming off; in fact, if the work is well done one has trouble loosening a piece with a hammer, if one cares to try the experiment.

Cincinnati, Ohio. ETHAN VIALL

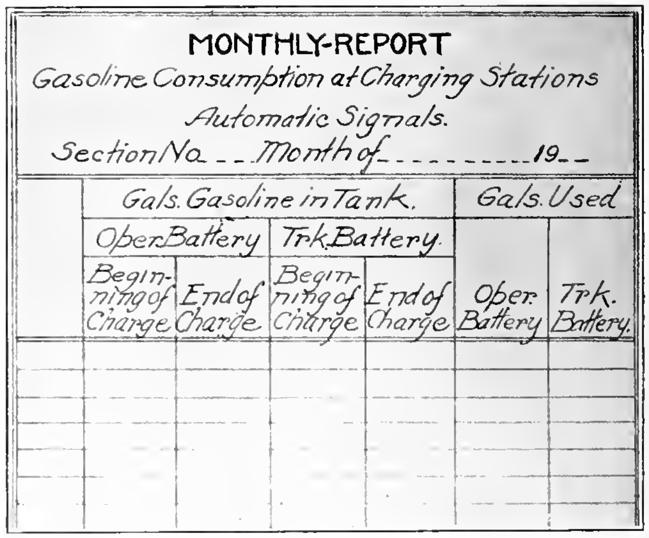
METHOD OF MAKING BLUE-LINE PRINTS

In the May number of MACHINERY a process by which blanks can be printed on blueprint paper, giving as a result blue lines on white background, is described. I desire to submit an entirely different and simpler method which I have made use of, that will doubtless interest draftsmen and office men in general.

All the material necessary is a sheet of some ordinary grade of carbon paper, a No. 6 or 8 drafting pencil having a blunt, smooth point, a blank sheet of common typewriter paper, and a smooth, hard drafting-board or table.

After the desired form or sketch has been carefully laid out and all the lettering finished lightly in pencil on the blank sheet, place the carbon paper with the carbon side upon the table. Then lay the blank paper (with sketch up) on top of the carbon and after fastening both to the table with thumbtacks, proceed to trace the sketch with the hard pencil, being careful to press quite hard and uniformly as the lines of the sketch are followed.

By examining the carbon it will be found that wherever lines have been drawn, no matter how small a letter or figure was made, a good impression was reproduced on the face of the carbon. The latter may then be used the same as a tracing



MONTHLY-REPORT
Gasoline Consumption at Charging Stations
Automatic Signals.
Section No. __ Month of __________ 19__

	Gals. Gasoline in Tank.				Gals. Used	
	Oper. Battery		Trk. Battery			
	Beginning of Charge	End of Charge	Beginning of Charge	End of Charge	Oper. Battery	Trk. Battery

A Blue-line Print made by using Carbon Paper as a Negative

to print through. It should be exposed from 2 to 3 minutes, according to the speed of the paper used, and after the latter has been washed out thoroughly, the desired result will be accomplished.

Carbons prepared in this manner, which I have been using for some time, appear to be as good as when made. In order to save time in printing, several carbons can be made from the original sketch or by tracing over prints. By placing these in a large printing frame, a number of blanks can be printed simultaneously on one large sheet. By filing these carbons in indexed envelopes or between indexed sheets, they will last almost indefinitely and will be convenient to get when needed.

The accompanying engraving shows a fair sample of the prints produced by this method. A. G. PANCOST

Elkhart, Ind.

CLEARANCE SPACE OF GAS ENGINE CYLINDERS

In designing the cylinders of a gasoline motor, one of the first things to determine is the volume of the clearance space. In order to find this, the compression which the motor is to have must be known. In automobile motors the compression varies all the way from 60 pounds to 100 pounds per square inch gage. The formula most generally used for finding the clearance space is:

$$\frac{p_1}{p_2} = \left(\frac{v_2}{v_1}\right)^n \quad \text{or} \quad p_1 = p_2\left(\frac{v_2}{v_1}\right)^n$$

where p_1 = compression pressure in pounds, absolute,
p_2 = initial pressure,
v_1 = volume of clearance space,
v_2 = total volume of cylinder (piston displacement plus clearance space).

The value of n given varies from 1.21 to 1.41. This value of n varies with the engine speed, valve timing, valve diameter,

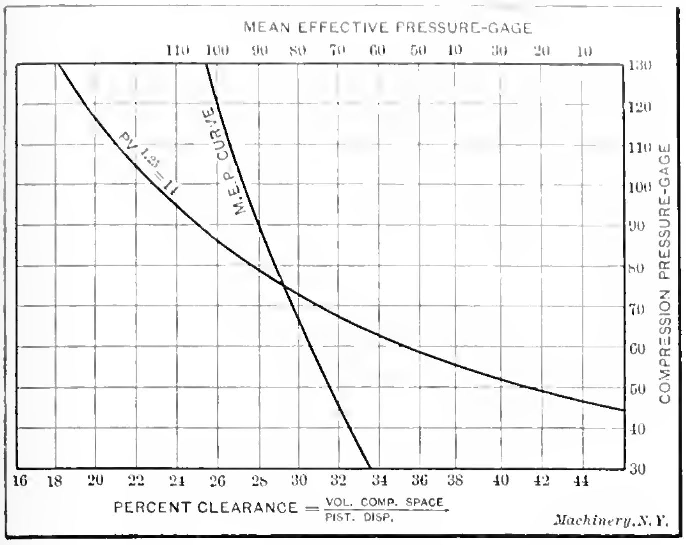


Chart for Determining Percentage of Clearance Space in Gas Engine Cylinders

valve lift, size and shape of the inlet pipes, and temperature of jacket walls. It will be seen from this that the compression cannot be calculated exactly, since it depends on so many variable quantities. It has been found by making tests of a number of gasoline motors that a value of n=1.25, when the initial pressure is 14 pounds gives very close results.

Using this value the accompanying diagram was plotted. To find the percentage of clearance for a given compression, find the compression in pounds gage in the column at the right, and follow across to the compression curve, thence to the bottom of the diagram where the percentage of clearance is read.

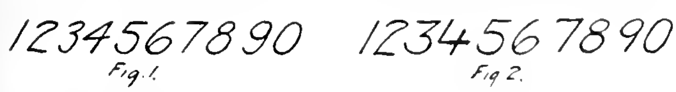
To find the mean effective pressure for a given compression, take the compression in the column to the right, as before, and follow across to the M. E. P. curve, thence to the top where the mean effective pressure is read.

These curves give values which come very close to the average for automobile motors. HERBERT C. SNOW

East Cleveland, Ohio.

PLAINER LETTERS AND FIGURES IN THE DRAFTING-ROOM AND SHOP

I agree with Mr. W. S. Rowell in his statement in the May issue of MACHINERY regarding the importance of plainer letters and figures in the drafting-room and shop. In our shop we have met with difficulties common to all in arranging our standard style of figures, and as the above writer has expressed a wish to have this matter discussed in your columns,



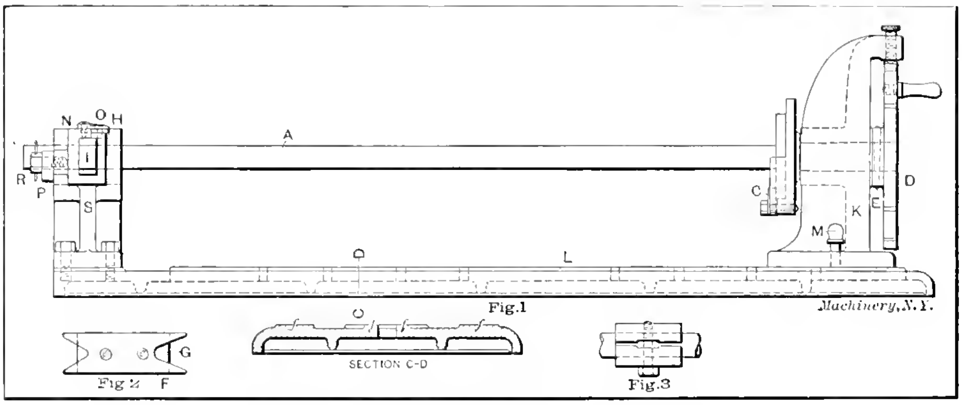
the benefit of my experience in this subject may be of interest to your readers.

Each man in our drawing-room, previous to the introduction of more modern methods and standardization in the drafting department, was allowed to use whatever style of letters and figures he was most proficient in. This, in itself, tended to confuse the workmen in the shop, and a standard style, as illustrated by Fig. 1, was adopted, and religiously adhered to. This style, we thought, was just about the "real thing," being in our estimation the easiest to make and the plainest set of figures we could adopt. When carefully formed, the figures, as illustrated, show clearly and unmistakably on original drawings and tracings, but we soon found that due to occasional blurring of blueprints in spots, the figures were not so easily distinguished on the prints. The first common mistake discovered was the taking of 1 for 7. To remedy this, we simply added a small projection to the horizontal line of the 7, as shown in Fig. 2. The second difficulty was caused by the 3 and 8, which was overcome by changing the shape of the 3 as shown. The next step was to change the 9, making it with a straight tail to avoid confusion with the 6 and 0. After these changes had been made, we thought we had a practically "fool-proof" set of figures, but we found that some of the toolmakers persistently read the 9 with the straight tail as 4, so we were obliged to make the latter figure as used in ordinary writing, with the top open.

The result of our efforts is shown complete in Fig. 2, and, as finally adopted, this set of figures has been in use for several months with a surprisingly small number of mistakes. I believe the figures are hard to improve upon and might well be adopted by many firms. DESIGNER

FIXTURE FOR LOCATING CAMS ON CAM-SHAFTS

An inexpensive fixture by means of which cams may be quickly located on their shafts for drilling and reaming the taper pin holes, is illustrated in the accompanying engraving. All the cams are placed in their relative order on camshaft A (Fig. 1) which is attached to the dividing-head shaft



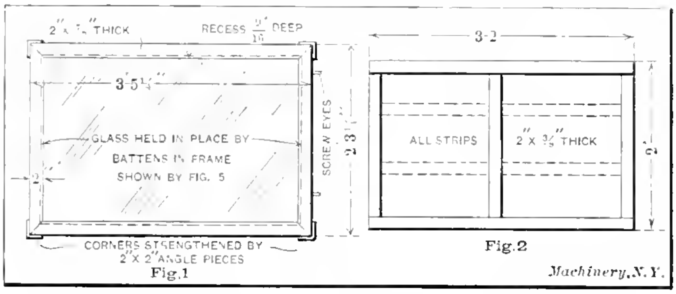
Figs. 1 to 3. Fixture for Locating Cams on Cam-shaft

by a clamp C as shown. Cam stop F, Fig. 2, is milled out to receive the exhaust cam on one end and the inlet cam on the other end. The plate G is to hold the cam in the proper position for drilling, under the bushing H. The stop F is inserted in the slot I, after which the dividing head K is moved along on the table L to the first division, which is located by the pin M. D is the dividing plate with which a pin engages to locate the cam-shaft at the proper angle. After drilling, the latch N is moved to one side, and plate O is removed so that the hole can easily be reamed. A lock P with a recess in the center the size of the cam-shaft is provided to support the shaft while drilling and reaming the holes. The end of this supporting piece is dropped down by loosening screw R, the other end being on a pivot; after the next cam is located for drilling, P is replaced. This fixture may be used for milling keyways in cam-shafts by replacing the casting S with one having a slot in the top as shown in the plan view, Fig. 3. C. G.

A CONVENIENT BULLETIN-BOARD

In presenting the work in machine drawing at the Worcester Polytechnic Institute it has been found very desirable to have a place in which references and data may be posted for the student's use. Blueprints, MACHINERY'S data sheets and numerous other data can thus be posted from time to time as

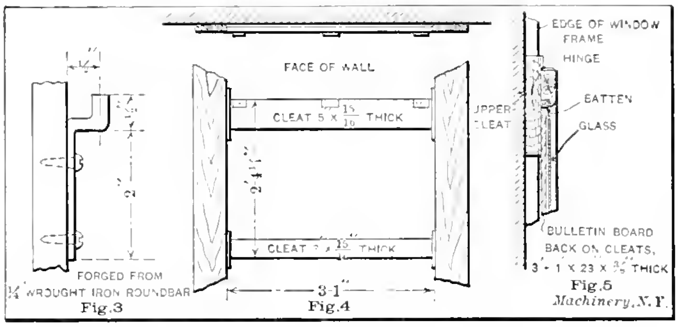
various lines of work are taken up. Bulletin-boards are used for this purpose, being placed about the drawing-room in the open spaces between the windows. As these boards were originally made they were rather inconvenient, it being necessary to remove them from their fastenings on the wall when it was desired to take out or put in new material. The original form of the board is shown in Figs. 1 and 2. The frame was supported by means of screw hooks and eyes. The back-board



Figs. 1 and 2. Original Form of Bulletin-board with Improvements

shown in Fig. 2 (solid lines) was held in a recess cut into the back of the frame, by means of buttons. It was made up of 2-inch by 3/8-inch strips, covered with canvas. The prints or drawings were pinned or pasted onto the canvas.

The question then arose concerning the best and least expensive plan for the alteration of these frames. After some thought the changes were made as shown by Figs. 1, 2 and 3. The corners of the frame which holds the glass were strengthened by 2 inch by 2 inch angles. The supports shown by Fig. 3 were substituted for the screw hooks, and four additional strips were put into the back-board (shown by dotted lines)



Figs. 3, 4 and 5 Improvements which made the Bulletin-board more Convenient

to be used for receiving thumb tacks. The back-board was then hinged to the supported end of the frame.

One of the frames was changed as shown by Figs. 4 and 5. The chief advantage of this frame over the others is the solid white pine back-board, and the cost for making the changes was much greater. The drawing shows the frame supported from above, but it could be supported at the ends just as well.

Worcester Polytechnic Institute. JAMES C. DAVIS

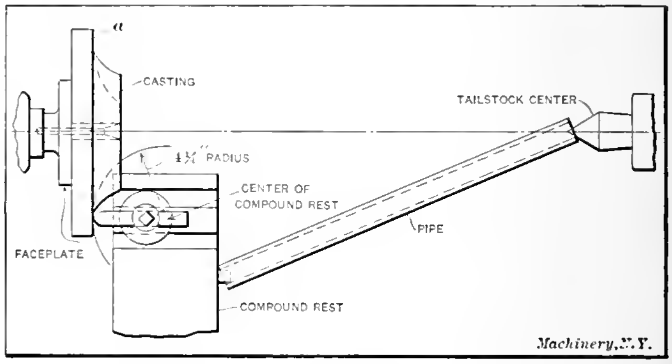
METHOD OF PREPARING TRACING CLOTH

It is a well-known fact that neither the glossy nor the dull side of tracing cloth takes ink readily without being prepared in some manner. The usual way is to sprinkle powdered soapstone or chalk on the tracing cloth and rub it over the surface with a piece of cloth. This helps somewhat, but not enough to be perfectly satisfactory. After trying various methods, I have found a way which gives excellent results, and that is to sprinkle the powdered soapstone on the cloth as usual, but rub it in with a blotter instead of with a piece of cloth, using a circular motion and considerable pressure; of course it is necessary to brush away the superfluous powder. The use of a blotter has an abrading effect and it is just harsh enough to give the cloth a surface which will take the ink readily and still leave the pens unharmed. I find it to be an advantage to repeat this process each morning in case the tracing is not finished the day it is started; the rubbing of the blotter over the lines already inked in does absolutely no harm and, if anything, makes the lines more dense. A trial will convince the draftsman that the cloth will take the ink better by this method, than by any other.

Chicago, Ill. ROBERT A. LACHMANN.

TURNING A RADIUS WITH A COMPOUND REST

The accompanying illustration shows a method of turning a radius on wheels which were used for centrifugal pumps. These castings were larger than the standard size; and having only a few of these and as in all probability we would never have an order for a larger quantity, it was thought impractical to make a special fixture for machining them. The following method was used: The wheels were bored and faced on each side and the part at *a* turned parallel to the starting point of the radius. A small drawn-in chuck was then used for holding the castings tightly against the faceplate, as shown. The two bolts used for keeping the compound rest from revolving were released just enough to allow it to revolve freely, and the tool set in the tool-post at right-angles to the faceplate, and at a distance out from the center pin of the compound rest, equal to the radius required on the casting. The carriage was then fastened to keep it from moving. Then one of the screws which was used to hold the gib in the compound rest was removed and a stud inserted in its place. A length of pipe, as shown, was then placed on



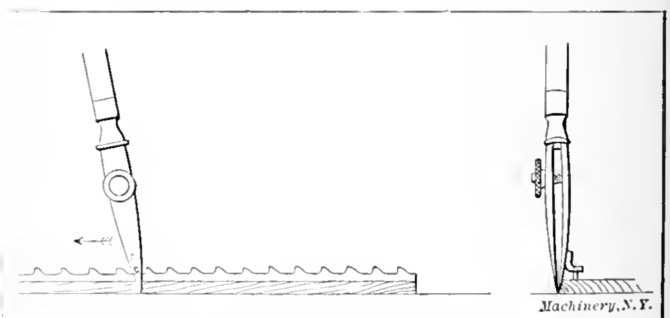
Turning Radius on Centrifugal Pump Casting

this pin and on the tailstock center. By bringing out the tailstock center, the pipe forces the compound rest around in a radius, turning off the superfluous stock and producing the correct radius on the piece. 1/64 inch was left for finishing and after all the castings had been roughed out they were then put on again and the finishing cut taken.

Toronto, Canada. JACK E. HAILSTONE

A SIMPLE DOTTING ARRANGEMENT

The illustration shows a dotting device which the writer uses in place of the expensive wheel and other dotting pens which are sold. The advantage of this is its cheapness, and the fact that either dotted or full lines can be drawn without any change whatever. A little rack with a series of rounded



Pen Attachment and Rack for Drawing Dotted Lines

teeth is attached with cement or other adhesive to the face of a straightedge or T-square, a little way back from the edge. On the back of the inner pen blade a small piece of brass is soldered, with its end turned at right angles to lie parallel with the face of the straightedge. This brass pin is set to such a height that when the pen is tilted over, about as illustrated, the pin just clears the bottom of the grooves in the rack, consequently permitting the pen to ink on the paper. In use, the pen is moved along, keeping it at the angle shown, and the teeth cause it to jump up and down, producing a series of dashes on the paper. A dotted line can be drawn in this way as fast as a full one, and without any of the fatigue, and fidgetiness which is caused when one dots

in the usual manner. The pen should be held lightly, to let it rise and fall in an easy manner. By simply bringing the pen into a vertical position, the brass pin will clear the tops of the rack teeth, and a full line can then be drawn. Probably if a roller were fitted on the pin, the pen would work along the rack in an easier manner, but the writer has not tried this. The rack was made from a piece of hack saw blade by reducing its width, taking out each alternate tooth, and rounding off the remainder to suitable outlines. Of course any form of dotting may be produced by shaping the teeth suitably. FRED HORNER

Bath, Eng.

SPEEDS AND FEEDS FOR CARBON OR HIGH-SPEED TWIST DRILLS

To obtain the maximum cutting power and life from a twist drill it is essential that the speed and feed be adapted to suit the particular material being drilled. The accompanying charts give actual working speeds and feeds and represent good general practice.

In drilling, the aim should be to use moderate speeds and heavy feeds, as chips take a great deal less power to produce than powder. The rubbing action which takes place with fine feeds soon spoils the cutting edge. For drilling steel a good supply of lubricant should be maintained. Speeds and feeds should be reduced when drilling hard materials.

Birmingham, England. V. BROCKBANK

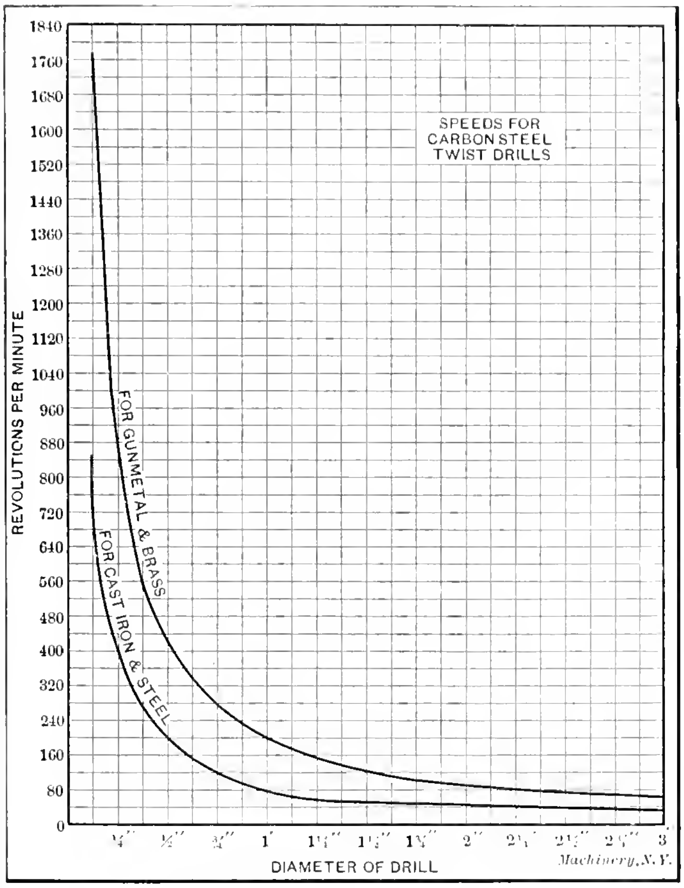


Fig 1. Speeds for Carbon Steel Twist Drills

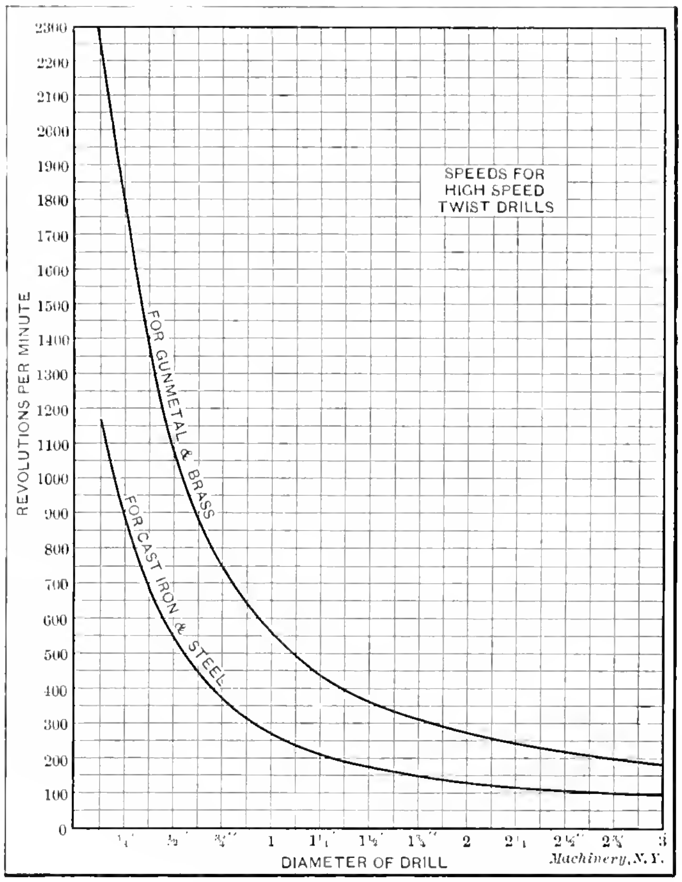


Fig. 2. Speeds for High-speed Twist Drills

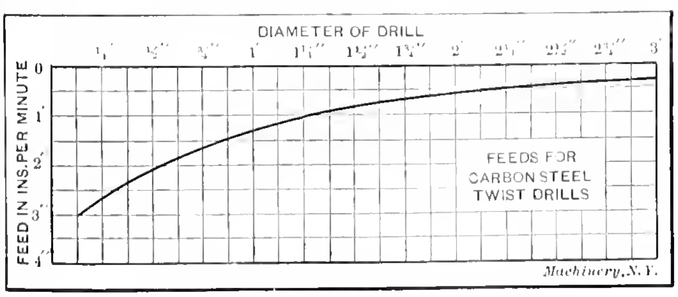


Fig. 3. Feeds for Carbon Steel Twist Drills

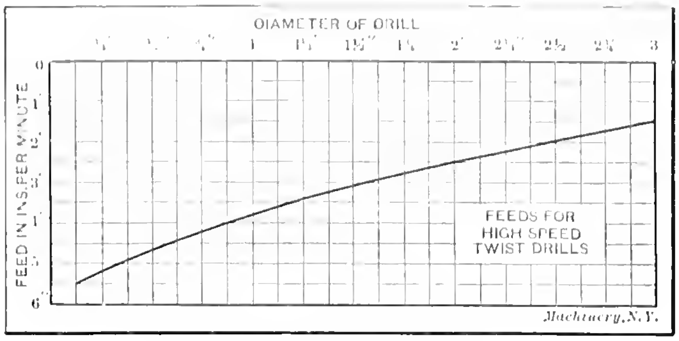


Fig. 4. Feeds for High-speed Twist Drills

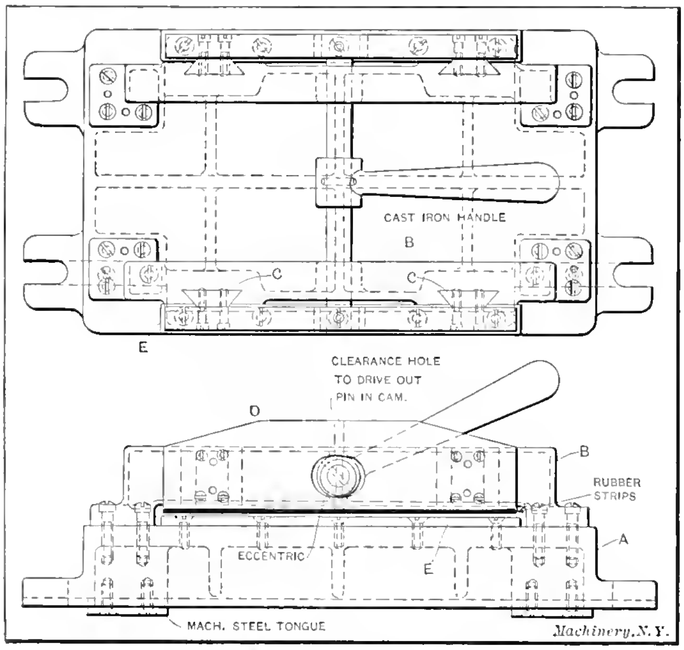
A FIXTURE FOR STRADDLE MILLING

For straddle milling thin castings such as cabinet parts for adding machines, typewriters, etc., where there are no machine surfaces on which to clamp or locate the work, milling fixtures of a type similar to that herein described and illustrated may often be successfully used, as they are quickly operated, rigid in construction, and comparatively inexpensive. The fixture shown in the accompanying illustration is designed for use on a double-headed milling machine to straddle mill the two sides of a thin brass casting, and is constructed as follows: The base of this fixture marked *A* is a gray iron casting of the box type, suitably ribbed internally, and also externally, to give it the necessary rigidity, and provided at its ends with feet which have slots in them to receive the clamping bolts used in attaching the fixture to the platen of the milling machine. It is also provided on its under surface with two steel tongue blocks which fit into the groove on the milling machine platen, serving to align the fixture properly.

The casting *A* is machined on the top and bottom, and to its upper surface the cast-iron brackets *B* are fastened by means of heavy fillister head screws and dowels. These brackets are stiffened by suitable ribs, and are provided on their outer sides with dove-tailed ways, in which slide vertically the steel guides *C*, to the outside of which are attached the long clamp strips, *D*. These strips are of steel and are channeled on their lower edge for the full length of the strip, and into these channels are inserted heavy rubber pressure shoes, which serve to conform to the irregularities in the surface of the unfinished casting which is being clamped, and to hold it securely upon the tool steel resting strips *E*. In the center

of each of the clamp strips D are elongated holes in which operate eccentrics of hardened tool steel; these are attached to the end of a steel shaft which runs across the fixture and has a bearing in each of the cast-iron brackets B. To the center of this shaft is attached an operating handle of cast iron by which the clamping strips are depressed forcibly enough to secure the work; when at this position the eccentric is thrown over its dead center, retaining the clamps in their positions during the machining operation.

A modification of this fixture may be designed to be operated by compressed air instead of by hand, by making its general construction the same as the device shown in the accompanying illustration, but replacing the operating handle by a lever at whose extremity is a piston which operates in a suitable air cylinder, the air inlet and outlet of which are controlled by a small valve of the taper plug type, equipped with a small lever handle. This, of course, makes the operating of the fixture very much easier than by hand, and when the character of the work is such as to warrant the extra expenditure, this valve may be so located that it will be tripped by a projection on some part of the milling machine in such a manner that, when the machine platen returns after the cutting stroke is made, to a point where the work is out from under the cutters, the clamps will be automatically released, leaving the fixture in a loading position. It is then only necessary to place the work into position and throw in the power feed on the milling machine table, whereupon the air



Straddle Milling Fixture for Thin Castings

valve will be tripped, clamping the work before it reaches the cutters. Of course, these air operated fixtures can only be used in factories which are supplied with compressed air, properly piped to the various machines, but they are great labor- and time-savers, and where the character of the product will permit of their usage, the saving of time will soon pay for their cost. C. Nosrac

ESTIMATING WEIGHTS OF ROLLED STOCK

To arrive mentally at the weight of round steel per foot of length without recourse to tables (which are not always at hand) it is sufficient to know that by squaring the number of quarter inches in the diameter of the bar and dividing the result by 6, the answer gives the weight in pounds per foot of length. Expressed as a formula this would be $\frac{(4d)^2}{6}$, where d = diameter of stock in inches of tool steel.

Anyone who wishes to work this out for a round machine bar with an area of cross-section of 144 square inches will find that it is based on 489 pounds per cubic foot. On ⅛-inch sizes like 1⅛-inch, for instance, it will be easier than squaring 4½ quarters to take even figures and say $4 \times 5 = 20 + (\frac{1}{2})^2 = 20.25 \div 6 = 3.375$ pounds per foot.

In dealing with large diameters and squaring the larger numbers, the method of squaring by the use of the nearest tens simplifies the procedure. For example, take 4½-inch round; 4½ = 18 quarters and in squaring 18 consider it as two less than 20. This difference of 2 from 18 leaves 16 for the other multiplier. $16 \times 20 = 320$, and adding the square of the difference which is $4 = 324 \div 6 = 54$ pounds per foot. For a proof to the eye of the correctness of this method of

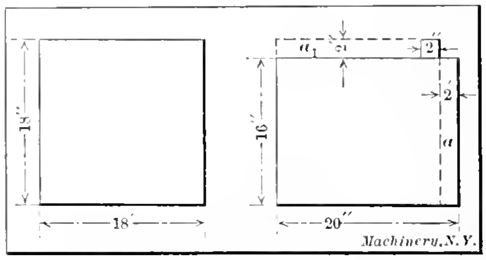


Diagram Showing Correctness of Squaring

squaring refer to the accompanying diagram; here the dotted position a of the rectangle would manifestly fit in at a_1, and complete the square.

Hexagon stock is about 10 per cent heavier than round; square stock, about 28 per cent heavier than round. It is, however, easier to get the weight of square or rectangular sections by multiplying the area per square inch of cross-section by 10, which will give the weight per yard of length. This is based on 480 pounds to the cubic foot, the weight of iron and a unit of length which was in common use when iron was generally used. "Weights per yard," however, have almost entirely disappeared except in connection with rails, and section books now give the weights of material in pounds per foot. The weight per foot is easily arrived at by taking 1/3 of the figures given above for iron and by adding 2 per cent for weight of steel.

The weight of sheet iron is found by using the number of thousandths of thickness considered as a whole number and dividing by 25 for the answer in pounds per square foot. Hence ⅛-inch plate = 125 thousandths ÷ 25 = 5 pounds. This, too, is based on 480 pounds per square foot and is 2 per cent too light for steel, which would then weigh 5.1 pounds in the above example. The result obtained by using a block 12 inches thick is

$$\frac{12 \times 1000}{25} = 480 \text{ pounds, for iron,}$$

To this add 2 per cent for sheet steel $= 480 + 9.6 = 489.6$ pounds.

By using the foregoing simple formulas one is entirely independent of tables and is equipped for work whenever it appears, without book aid in each case. Robt. S. Brown

New Britain, Conn.

DIVIDING A CIRCLE INTO EQUAL PARTS

In the May number of Machinery a method was given by Robert Wilkinson for dividing a circle into any number of equal parts, and readers were called upon for a geometric proof.

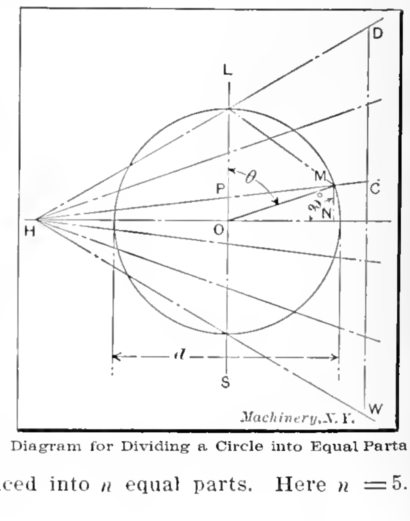


Diagram for Dividing a Circle into Equal Parts

The method as given is neat and interesting, but it is an approximation and exact only for certain particular cases. There is no geometric proof for it. The line AB of Mr. Wilkinson's diagram is a method for spacing the diameter LS into a given number of equal parts, and is not a part of the problem. In the figure given herewith the diameter LS is spaced into n equal parts. Here $n = 5$.

The point H is located by describing an equilateral triangle on LS, making the lines LH and SH equal to LS and equal to d. The line HPM is drawn through the second division P; then LM is the desired nth part of the whole circle. A variation, perhaps an improvement, would be to draw the line DW. Extend HL and HS to DW. Space off the distance DW and draw HMC through the second space C (new section). To prove that LM is in the general case an approximation, we will compute its true value. Draw HON, OM, and MN. We then have $OMN = LOM =$ angle θ, which is the angle to be computed. $MN = OM \times \cos\theta$. $ON = OM \times \sin\theta$.

$$LP = 2\frac{LS}{n} = 2\frac{d}{n}, \quad OP = \frac{d}{2} - 2\frac{d}{n} = \frac{d}{2}\left(1 - \frac{4}{n}\right)$$

$$HO = \frac{d}{2}\sqrt{3}.$$

From the similar triangles MNH and POH we get the proportion:

$$\frac{MN}{PO} = \frac{ON + HO}{HO}$$

and when the values are substituted this becomes the quadratic equation

$$\sin^2\theta\left[3 + \left(1 - \frac{4}{n}\right)^2\right] + 2\sin\theta\left(1 - \frac{4}{n}\right)^2\sqrt{3}$$
$$= 3 - 3\left(1 - \frac{4}{n}\right)^2$$

giving the desired angle.

$$\sin\theta = \frac{\sqrt{9 - 6\left(1 - \frac{4}{n}\right)^2} - \left(1 - \frac{4}{n}\right)^2\sqrt{3}}{3 + \left(1 - \frac{4}{n}\right)^2}$$

Testing this equation for various values of n, we get,

for $n = 2$ $\quad\sin\theta = 0$ $\quad\theta = 180$ degrees. Exact
for $n = 3$ $\quad\sin\theta = \frac{1}{2}\sqrt{3}$ $\quad\theta = 120$ degrees. Exact
for $n = 4$ $\quad\sin\theta = 1$ $\quad\theta = 90$ degrees. Exact
for $n = 5$ $\quad\theta = 71$ degrees, 57 minutes, 20 seconds.

This is 2 minutes 40 seconds too small, for $\frac{360}{5} = 72$ degrees.

The error is $\frac{1}{8100}$th of the whole circle and is negligible for graphical purposes.

for $n = 6$ $\quad\sin\theta = \frac{1}{2}\sqrt{3}$ $\quad\theta = 60$ degrees. Exact
for $n = 7$ $\quad\theta = 51$ degrees, 31 minutes, 5 seconds. Not exact, because $\frac{360}{7} = 51$ degrees 25 minutes, 43 seconds.

for $n = 360$ $\quad\sin\theta = 1$ degree, 5 minutes, 48 seconds, but $\frac{360}{360} = 1$ degree.

GEORGE B. GRANT

Philadelphia, Pa.

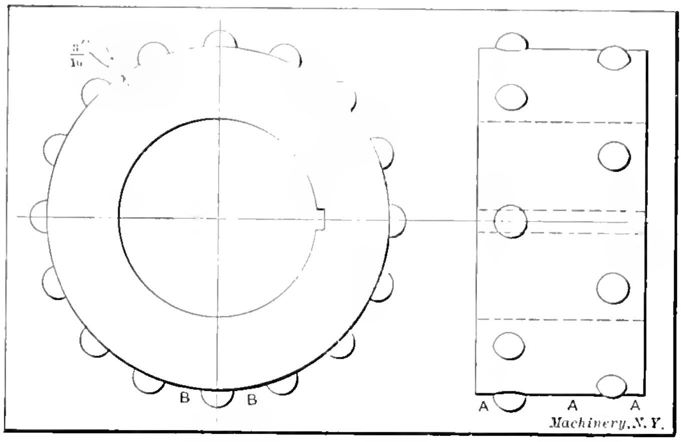
[Methods for dividing a circle into any number of equal parts have also been received from Prof. W. L. Benitz, University of Notre Dame, Notre Dame, Ind.; W. A. Knight, Columbus, Ohio, and Harry K. Reinoehl, Massillon, Ohio.—EDITOR.]

MAKING EMBOSSING ROLLERS

In reading the article entitled "The Detail Engineer" in the May number of MACHINERY, I was much impressed by the answer of Mr. Steelworth when he replied to the "old man" that he did not believe in "modern practice." In these days when special machines and advanced methods are available for doing different classes of work, the same methods are not followed that were a decade or so ago, and figuratively speaking, what is standard practice to-day, is an obsolete method to-morrow. Now I will ask, "What is modern practice? Can we follow it and how far?" To give an illustration of this, I had charge of a shop a few years ago and an order came in for a pair of rollers which were to be used for embossing straps for boxes. I had previously instructed one of the toolmakers to carry out my orders in making these rollers, but when he saw that my method was contrary to "modern practice," he sought to enlighten me and said that it would be impractical to make the rollers in this way. He claimed that to make these rollers accurate, a universal milling machine was required, and it would also require an expert diesinker. I came to the conclusion that the job was beyond his skill and relieved him of it. I may mention that this man was also a graduate of the "modern practice" school. After determining the size of the rollers, I bored, turned and keyseated them. After this I coppered the faces of the roller, and laid them out for an equal number of projections. Then, with a parting tool, I removed the superfluous stock at A, leaving ridges around the periphery of the roller. The superfluous stock at B was removed by putting the roller on an arbor and then placing this on the centers in a shaper, and planing out the remaining material. This left a series of small squares around the periphery of the roller. The roller was now put in the vise and each projection carefully filed around to the line which was made with the dividers. After rounding all the projections to the marks, I filed them as spherically as possible. Then I made a female punch of the exact shape required and used this for forming the projections into a spherical shape. The roller was then hardened in the usual manner. The female roller was laid out for an equal number of indentations to correspond to the male roller and the holes drilled with an ordinary twist drill and reamed to the size required, which would be equal to diameter of the projections on the male roller, plus twice the thickness of the material. This roller was also hardened in the usual manner. Some will probably say that this is not "modern practice," and perhaps it is not, but as one toolmaker could not make the rollers with any kind of practice, and as by using this method the rolls were made in an accurate manner, which was satisfactory to the customer, I would like to know what others have to say about "modern practice." I believe a better term for this would be "common sense practice."

L. ROSENTHAL

Passaic, N. J.



Male Roll for Embossing Box Strap

CALCULATING THE WEIGHTS OF STEEL PLATES

For obtaining the weights of steel plates, the accompanying table may be used to advantage. First, multiply the length of the plate by its breadth, and then the product by the constant given in the table opposite the thickness of the plate.

Thickness	Constant	Thickness	Constant
3/16	0.0526	9/16	0.158
1/4	0.07	5/8	0.1748
5/16	0.0874	3/4	0 2096
3/8	0.1048	7/8	0.2452
7/16	0.1226	1	0.28
1/2	0.14	..	......

Cincinnati, Ohio. FRANK W. HOLCOMB.

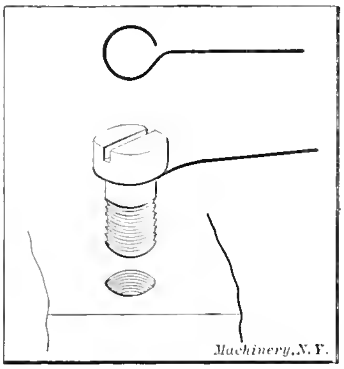
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

INSERTING SMALL SCREWS

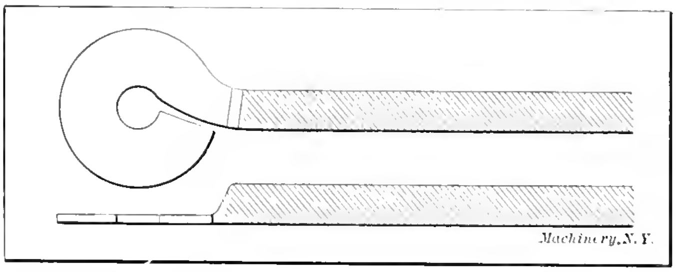
The illustration shows a method of holding very small screws ready for insertion in their holes, when one finds it clumsy and difficult to hold them with the fingers and manipulate the screw-driver. Take a piece of fine wire and bend the end into a loop equal in diameter to the body of the screw. When the latter is dropped into the ring thus formed, it will be supported steadily so that it can readily be inserted into the hole. After two or three turns with the screw-driver, remove the wire by simply pulling it, which will straighten it and free the screw.



Bath, Eng. FRED HORNER

SCRAPER MADE FROM SQUARE FILE

For several years I have used a scraper, made from a square file, that has been very serviceable for scraping babbitt boxes in getting clearance for the shafts. I find that I can rough

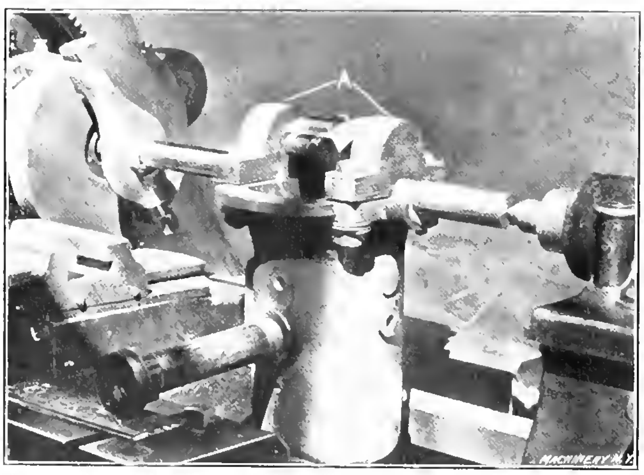


scrape a box quicker with one of these scrapers than with any other I have used, finishing up with a smoothing scraper. The scraper illustrated was made from a $\frac{3}{8}$-inch square file. The scraping end is $1\frac{1}{2}$ inch in diameter and $\frac{1}{8}$ inch thick. The size of the end will depend, of course, on the size of file used.

J. T. CROMACK

METHOD OF LAPPING PISTON RINGS IN A LATHE

The accompanying illustration shows a simple and effective method of lapping piston rings and cylinders of small gas engines. The piston rings are pinned in place, and the crank-



shaft assembled. The piston is then inserted in the cylinder and the crankshaft placed on the centers of the lathe, wooden blocks *A* being used instead of regular caps to hold the crank-shaft in place. A mixture of pulverized glass and lard oil used as an abrasive gives very satisfactory results.

Cleveland, Ohio. JOHN W. WICKERMAN

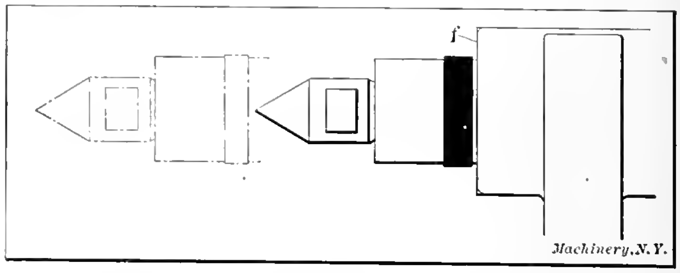
USING BROKEN TAP SHANKS FOR HACKSAW PINS

The shanks of No. 6 taps make excellent pins on which to stretch hacksaws either in hand or power frames. Ordinary soft pins are generally used for this purpose, and it is well known that they will only stand up for a few weeks when in constant use. Tap shanks are to size, and tempered just right, and they out-wear soft pins many times.

Middletown, N. Y. DONALD A. HAMPSON

DEPTH GAGE FOR TAILSTOCK DRILLING

When the tailstock of a small lathe is used for feeding up drills, there is no way of gaging the depth to which the drill has penetrated, unless the spindle happens to be graduated, which is far from usual. A kink which may not be known generally is to use a stout rubber band on the spindle as a



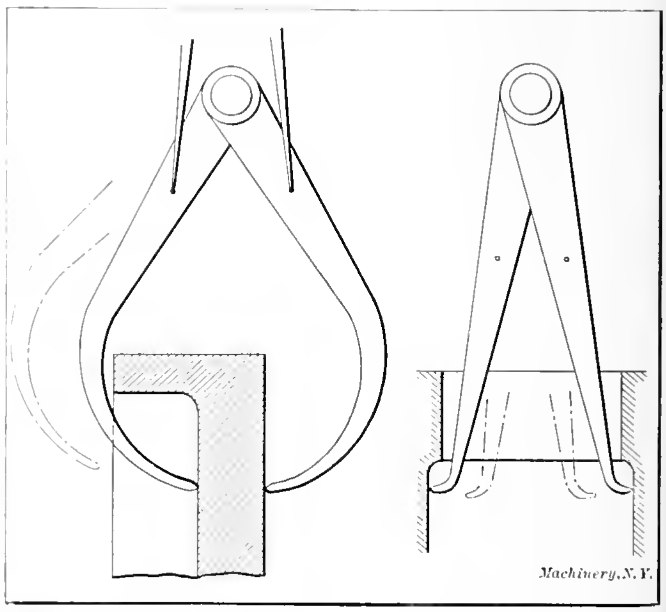
gage. When the drill begins to cut, this band should be against the face *f*; it is then easy to determine the amount of feed by measuring the distance that the band stands away from this face, as indicated in the drawing by the dotted out-line.

FRED HORNER

Bath, Eng.

CALIPERING OVER FLANGES

When it is necessary to gage the thickness of a piece of work which lies behind a flange, the ordinary calipers are of no use, because the dimension is lost as soon as the cali-pers are opened for removal. The view to the left shows



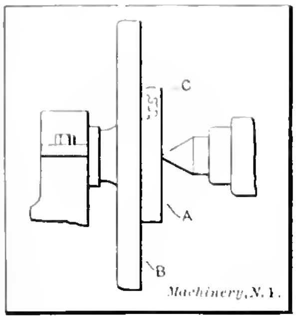
a neat method of enabling the setting to be repeated. All that need be done is to make a fine prick-punch mark on the face of each leg, and carefully measure the distance these are apart with the points of a pair of dividers. After the calipers are removed by opening them until they will clear the pro-jecting flange, they should be closed in again until the punch marks again coincide with the divider setting, when the dis-tance between the caliper points will equal the thickness of the work. If this is done with care, very accurate results may be obtained. The same method is applicable to inside calipers when taking the size of chambered recesses, etc. The caliper setting is changed (as shown by the dotted lines in the right-hand view) to get them out of the narrowed hole, and then they are again opened until the punch marks are the correct distance apart.

FRED HORNER

Bath, Eng.

FACING A DIE BLANK IN THE LATHE

In a small shop where a shaper was not available, the following method was used for facing the die blank: The die blank *A* was centered and placed on the faceplate *B* of the lathe. The tailstock center was then located in the center and a bolt *C* clamped in position against one edge, acting as a driver. While this method is not up-to-date, it appeared to me as being ingenious.

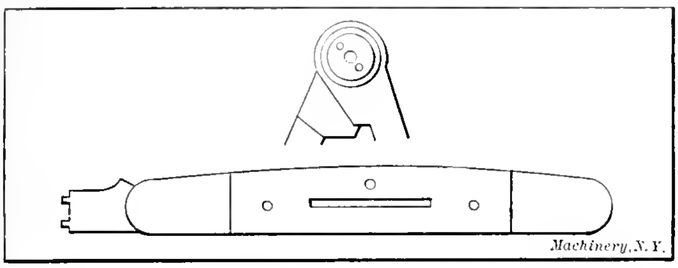


L. Rosenthal

Passaic, N. J.

COMPASS KEY

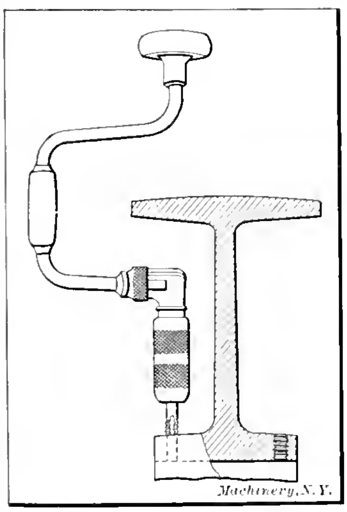
The sketch shows the novel use made of a broken knife blade, by filing the end of the broken blade to the shape shown, and using it as a compass key. In sets of instruments containing compasses with the style of joint shown, a separate key is usually provided, but the latter is small and inconvenient to use, and is often lost from the set in a little while. I keep the other blade of this knife sharpened to a razor edge for erasing.



Designer

USING A CARPENTER'S BRACE FOR TAPPING

A convenient method of tapping a hole in a position where an ordinary tapping wrench could not be used on account of the location of the hole, is shown in the accompanying illustration, the hole being in the hub of a pulley in front of a spoke. A monkey wrench could have been used for the purpose, but would have been awkward. As it was, the mechanic used an ordinary carpenter's ratchet brace for holding the tap. With the right-hand ratchet he tapped the hole, and with the left-hand ratchet withdrew the tap. This method was, of course, much more rapid than using a wrench, and also enabled the mechanic to push on the tap while tapping and pull on it while withdrawing.

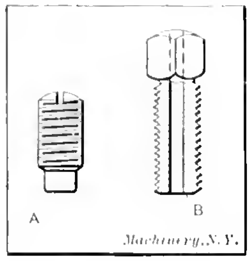


H. Prime Kieffer.

New York City.

METHOD OF SPOTTING FOR PILOT SET-SCREWS

We had some cast-iron gears to be located on a machine spindle and held in place by a pilot set-screw shown at *A*. The spindle was made from tough steel, and it was necessary to drill the hole for the pilot screw with a motor drill. We tried to spot the spindle with a tapping size drill, the result being that by the time the hole was deep enough in the spindle, the drill had cut away part of the threads in the gear. We also tried spotting the spindle with a center punch which was made the size of the tapping drill, but this also gave poor results. The screw shown at *B* was then made with a 1/8-inch hole drilled through the center and hardened. This screw was then screwed into the tapped hole in the gear and used as a jig. After drilling the 1/8 inch hole, the screw *B* was removed and the hole enlarged with the tapping size drill, without removing any of the thread. After the screw was made it was found to be useful for other jobs where pilot set-screws were used for holding handles, facing cutters, gears, etc. It was useful, not only as a jig, but also as a clamp for holding the parts in position while spotting.

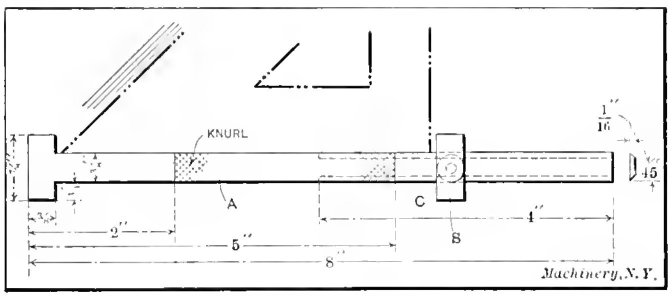


A. Nielsen

Cleveland, Ohio.

HOME-MADE SECTION LINER

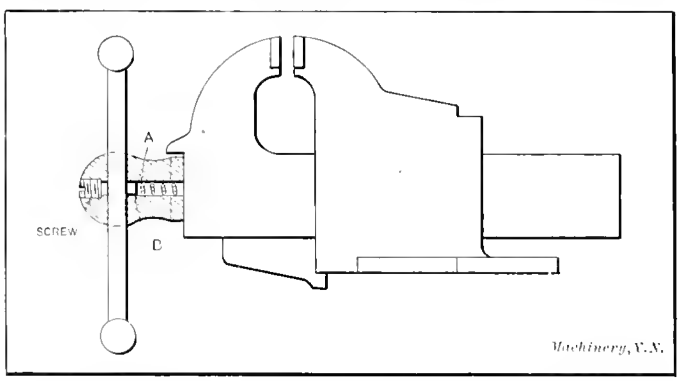
I recently visited a shop where several of the draftsmen were supplied with the home-made section liner shown in the accompanying engraving. This instrument is easily and cheaply made, as it consists of only three pieces. All the parts are made of cold-rolled steel, and are casehardened. The casehardening is not essential but will add to the life of the instrument. The bar *A* is shaped to fit the sliding block *B*, which is clamped in position by the small screw *C*. In operation, the instrument and the triangle are alternately moved along the edge of the T-square, the spacing having been adjusted by clamping the block *B* in the desired position. The end of the bar *A* should be burred slightly, to prevent the block from sliding off. A projecting pin instead of the knurling on the bar, may be preferred by some as a means of moving it along.



Designer

HAND PROTECTOR FOR VISE HANDLES

In the March issue of Machinery, Mr. A. G. Johnson shows a device for protecting the hand from a falling vise handle. His device consisted of a piece of rubber which is placed under each ball. The accompanying illustration shows another device which is used for this purpose. A spring *A* inserted in the head of the vise screw presses against plunger *B*, preventing the handle from falling.



A. Nielsen

Cleveland, Ohio.

CLAMPING STRAP FOR JIGS

For holding one or more pieces in a vise or jig where an even pressure throughout the entire length is sought, the concave strap has proved effective. A word of explanation will suffice for those unfamiliar with it. The strap is bent so as to have a uniform curve throughout, and is placed with the

convex side next to the work. Then when the bolts on the ends are tightened, holding the strap down its entire length, the parts in the center of the jig are held as securely as the ones at the end, which is not the case when a straight strap is used. Planing one side of a cold-rolled sheet-steel strap will give it about the proper curve. For example, a piece 3/4 by 1 1/4 by 8 inches long planed down to 3/4 by 1 inch will spring about 1/8 inch, which is usually a good average deflection. DONALD A. HAMPSON

Middletown, N. Y.

DIAMOND TOOL HOLDER FOR THE BENCH LATHE

A diamond tool holder for use in a bench lathe is shown in Fig. 1. This holder is attached to the tailstock and is very convenient for the reason that it enables the operator to dress the wheel without moving the slide rest when the latter is set to a position. The surface of the emery wheel is dressed flat

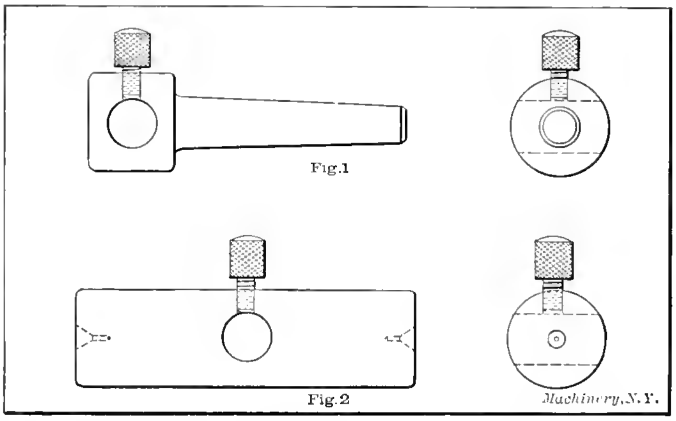


Fig. 1

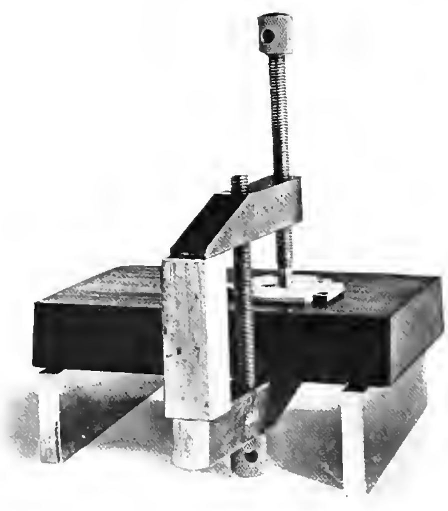
Fig. 2

and parallel by turning the handle of the tailstock back and forth. Another very handy diamond tool holder is shown in Fig. 2. This holder is held between the centers of the lathe, and the diamond tool is held stationary by placing its handle on a rest. The emery wheel is trued by moving the slide rest to and fro. The diamond tools are held in each of these holders by tightening the knurled screws shown. A. L. MONRAD

East Hartford, Conn.

CLAMPING TEMPLET TO DIE BLANK

Having recently seen in MACHINERY and other mechanical papers clamps made especially for holding templets on the face of die blanks while scribing the outline, the accompanying engraving is submitted showing the manner in which the ordinary tool-maker's clamp may be used for this purpose. The engraving is self-explanatory: One of the jaws of the clamp is reversed and a piece of wood or metal is used for

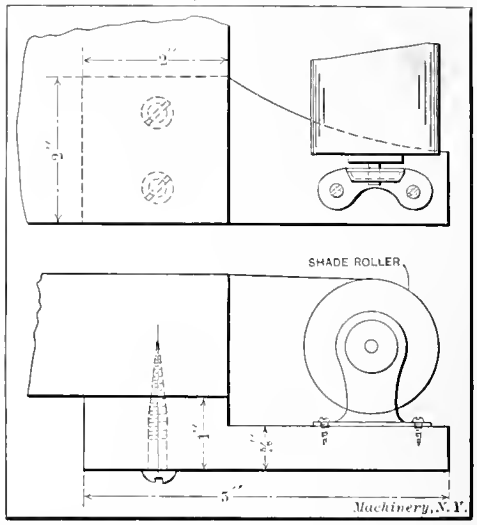


blocking up the outer end. The chief advantage of this little "kink" is that it does not necessitate the expense or trouble of adding an extra tool to the kit, as the clamp shown is a tool that every diemaker has. ROY PLAISTED

New York City.

COVER FOR DRAWING-BOARDS

The device illustrated herewith is a simple and inexpensive arrangement for protecting drawing-boards from dust and dirt. Black oilcloth mounted on an ordinary shade roller and

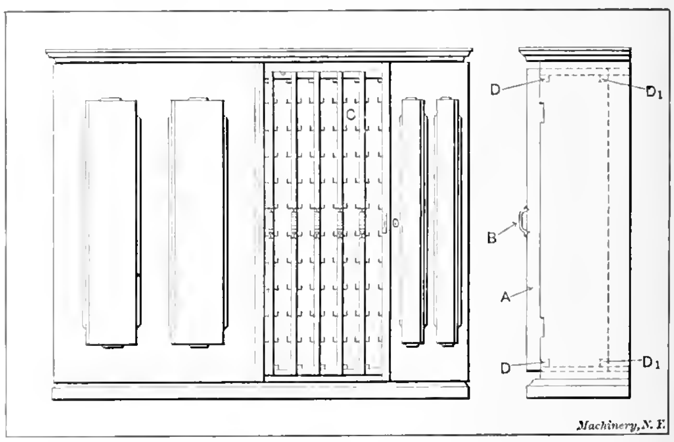


hangers on the back of the board, are used as shown. The blocks for supporting the fixtures should be arranged so as to bring the top of the roller slightly below the level of the back of the board, to keep dust from entering at the back. The roller should also project far enough from the back edge to clear whatever kind of parallel attachments are used in connection with the board.

The cover can be drawn down and rolled up like an ordinary window shade, and makes a very efficient and satisfactory covering. DESIGNER

TOOL-ROOM CASE FOR GEAR CUTTERS

A simple form of case or cabinet for gear cutters is illustrated herewith. It is specially constructed in its interior so that each cutter may be kept in an individual place. The interior is divided into compartments by slides *A*, which have rows of hooks *C* on each side, upon which the cutters are hung. Each slide is provided with a handle *B* so that it may easily be withdrawn from the case when a cutter is to be re-



moved. Blocks D_1, attached to the rear of each slide, make it impossible to pull the slides entirely out, as they strike against the blocks *D* attached to the case. The number of hooks should, of course, be determined by the size of the cutters. The advantages of using a case of this kind are as follows: The cutters can always be easily found when wanted; they are kept in good condition; the case is good for the tool check system; and last, but not least, the cutters are in an orderly condition. L. H. GEORGER

Buffalo, N. Y.

* * *

It is stated in the *Brass World* that plaster of Paris will harden rapidly if 0.25 per cent of sodium bisulphate is added to it. The sodium bisulphate should be dissolved in the water used for making the plaster. The strength of the hardened mass is also stated to be increased nearly three times.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

SOLUTION FOR CLEARING BLUEPRINTS

Dissolve enough bichromate of potash in water to color the water a deep orange—or about one tablespoonful to eight gallons of water. Wash the blueprints in clear water before and after using the solution. E. RAY CROFT.

Chambersburg, Pa.

REMOVING RUST FROM STEEL

A good method for removing rust from steel is to first rub the object with sweet oil, and then after a day or two, rub it with finely powdered unslacked lime until the rust disappears. Then give it again a coating of oil with a woolen cloth, and put it in a dry place. E. W. NORTON.

ANNEALING STEEL HAVING HARD AND SOFT SPOTS

To anneal steel having hard and soft spots, remove the scale, and heat slowly and evenly to a little above a dark red. Immerse in fresh water until almost cool. Heat immediately to a dark red and anneal in the usual way.

C. F. EMERSON.

PORTLAND-TAR CEMENT

A valuable cement used in marine practice and other places where elasticity is desirable, is made by mixing Portland cement in gas tar until the consistency is that of stiff putty. It must be applied immediately as it hardens quickly. It is not affected by water and never becomes brittle, a fact that makes it very valuable around the tailshafts of steamers or wherever there is much vibration. A. L. GRAFFAM.

Fairfield, Me.

CLEANING FLUID FOR FINE FABRICS

This cleaning fluid may not be of much use in the shop, but if some machinist should get the machine shop grime on his "Sunday-go-to-meeting" trousers, he will find it useful for cleaning out the spots; it works like magic: Sulphuric ether, three drams; alcohol, six drams; chloroform, three drams; gasoline, one quart. The mixture can be used safely for cleaning the most delicate fabrics, but being highly inflammable, it must be used with caution around fires and open lights. M. E. CANEK.

REMOVING THE COLOR DUE TO THE HARDENING

If a punch, reamer or other tool is to be hardened, and the color resulting from that process is undesirable, it may be removed by the following simple method: After the part is hardened, dip it into a glass filled with muriatic acid and allow it to remain for five seconds; then plunge it into a pail of water. In this way the polish of the steel will return and the temper will not be affected. This method is much quicker than obtaining a polish by the use of emery cloth.

Buffalo, N. Y. JOHN C. MONRAD.

ELECTRICIANS' METHOD OF SOLDERING

A method of soldering that I noticed electricians using in soldering wire is as follows: The solder is melted in a pot and then poured over the joints to be soldered, by means of a small dip ladle. Then acid, paste or stick flux is applied, and the solder again applied. This makes a good joint. The solder which drops from the joint is caught by a second ladle, or in the solder pot. In some cases, when possible, the piece is dipped into the pot, the flux applied and the work again dipped. It is important in both cases to give the piece a sharp tap after the second application, to knock off any surplus solder. HERMAN JONSON

New York City.

MOTTLED CASEHARDENED ARTICLES

There are several ways of obtaining the beautiful mottled effect on casehardened articles, but one of the simplest and most effective methods is in use in the factory of the Thos. B. Jeffery Co., Kenosha, Wisconsin. Here the usual cooling tank and screen for catching the work are in use, but in addition, an air pipe is run into the bottom of the tank in such a way that when the air is turned on the water is filled with air bubbles and is violently agitated. The result of these air bubbles striking the cyanide-coated articles during the cooling process, is some of the prettiest mottled work imaginable. E. V.

RECEIPT FOR MAKING WAX TAPERS FOR CORES

Take equal parts of beeswax and powdered rosin. Melt the wax, sprinkle in the powdered rosin, and stir until well mixed. If beeswax cannot be obtained, use paraffine. This composition does not soften the core as does the ordinary paraffine taper, because the rosin goes into the core when it is baked and hardens it. If paraffine is used, it is better to make the tapers by dipping cotton wicking into the melted composition, as the paraffine makes it rather brittle. When beeswax is used, the wicking is not necessary, and the tapers can be formed in the same manner as that employed by pattern-makers in forming beeswax fillets.

Aurora, Ill. JOHN B. SPERRY.

CEMENT NOT AFFECTED BY ALCOHOL

Gold size is valuable as a cement for setting together parts of vessels containing alcohol, for it is not affected by alcohol as are some other good cements. It has been used for setting the glass covers of circular levels, the glass afterwards being burred over in the brass shell so that it is securely held mechanically. Ordinary painters' size is used, which may be prepared as follows: Boil raw oil in a pan until it smokes; then set it on fire and let it burn for a few moments. Cover the pan to extinguish the blaze and pour while warm into a receptacle containing red lead and litharge in the proportion of one ounce of each to a quart of oil. Keep at a temperature of 70 degrees for ten days and agitate once a day.

M. E. CANEK.

TO MIX LAMPBLACK AND SHELLAC

Mixing lampblack and shellac is not so simple a matter as it appears, as many an amateur and novice has found out. The tendency is to form lumps when the two are mixed, by throwing or even sifting the former into the latter. The lumps of course can be reduced and an intimate mixture obtained by considerable patience with a paddle or pestle. The whole difficulty is easily avoided if the lampblack is first wet with alcohol and thoroughly worked down into a soft paste with a paddle or spatula. The black paste is then added to the shellac and mixed uniformly by stirring. The result is a smooth flowing and working shellac. Other pigments can be treated in the same way. O. M. B.

ANTIQUE BRASS FINISH SHOP RECEIPT

It is comparatively easy to get a nice antique finish on copper or copper-plated articles, but the treatment of brass is more difficult. Most of the processes used do not give a nice, clear black, but instead, a dull or grayish black coating. When visiting the shop of the Puritan Mfg. Co., Decatur, Ill., I noticed the beautiful jet black of the brass articles made up with the antique finish, and upon expressing my curiosity as to how it was obtained, was offered the formula. The articles are first dipped into a strong, hot solution of potash, and then well rinsed in water; they are then immersed in a mixture of one part sulphuric and two parts nitric acid, and instantly rinsed in clear, cold water. Next they are placed in a bath consisting of two ounces acetate of lead and one ounce hyposulphite of soda to each gallon of water in the tank. This solution must be almost boiling when used. The brass is moved around in this until the desired black is obtained, then rinsed and dried When dry and cool spot on a rag wheel. If the brass doesn't turn black enough in the above solution, add the least bit more lead

Cincinnati, Ohio. ETHAN VIALL.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

HOW TO MAKE GEAR CUTTERS FOR JOBBING SHOPS

R. G. D.—I would like some information on how to produce a moderately accurate tooth profile, so as to be able to make gear cutters for spur and bevel gears. Being located in New Zealand where the volume of gear repair work is not great, I am unable to afford a full set of cutters which would enable me to replace any broken gear. We often have to make cutters to suit the case in hand. The usual job is to cut a gear to take the place of a broken sample. We generally manage to find some portion of the broken gear so little worn that we can make a cutter to fit. We have cut several bevel gears on these lines, but the shape of the cutter has always been a troublesome matter to obtain. When we run short of cutter blanks we have to cut up a sledge-hammer, being so far away from the world's markets, and, as we seldom have to cut more than a couple of gears with the same cutter, it does not pay to expend a great deal on special cutters. By carefully hardening the cutters made from a sledge-hammer they last all right. Any information that will help us out will be appreciated.

A.—The case is submitted to the readers for suggestions.

USE OF SUB-PRESS DIES ON THICK STOCK

D. V. Co.—We would like to know if a sub-press die can be used successfully on cold-rolled steel stock of thicknesses up to 7/32 inch?

Answered by Frank E. Shailor, Detroit, Mich.

A.—I have seen and made sub-press dies for punching stock heavier than 7/32 inch. One feature that aids greatly in stripping heavy stock is making the punches a loose fit in the dies. To obtain the proper clearance for the punch in the die for all thicknesses of stock, six per cent of the stock thickness is allowed for difference of the punch and die diameters. Therefore, on 7/32 inch stock the punch would be 0.012 inch smaller than the die. When the punch pierces the stock, the diameter of the hole is the mean between the diameter of the punch and the diameter of the die. It will be seen from this that the stripping pressure required actually decreases as the stock increases. The hole punched in the stock is cone-shaped, the top diameter being that of the punch and the bottom diameter that of the die. On account of this defect it is not considered of much benefit to use sub-press construction on heavy work except to aid in setting up in the press. If the punch were made to fit the die on this thickness of stock, the conditions would have to be exactly right; that is, the stock would have to be absolutely flat, and the stripper absolutely parallel with the face of the die in order to prevent cramping on the punches and breaking them.

POWER REQUIRED FOR BENDING SHEET STEEL AND IRON

W. J. D.—Is there any formula for the force required to bend sheet steel to a right angle? Assume for example, that the sheet is one-half inch thick and 60 inches wide, and that the force is applied $13\frac{1}{2}$ inches from the fulcrum or center of the bend. What would be the difference between the force required for bending sheet steel and sheet iron?

A.—Referring to the accompanying engraving, if we assume that the sheet to be bent is rigidly held on each side of the place where the bend is required, the force required for bending would be the force necessary to produce a bending moment which would produce a stress in the sheet steel which would somewhat exceed the elastic limit.

If P = force required for bending, in pounds,
t = thickness of sheet to be bent, in inches,
b = width of sheet to be bent, in inches,
l = distance between the application of the power and the center of the bend, in inches,
S = stress slightly in excess of the elastic limit of the material, in pounds per square inch,

then:

$$P = \frac{Sbt^2}{6l}$$

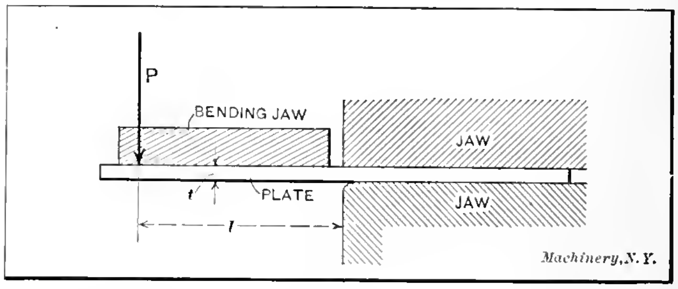
For steel plate we may assume $S = 35{,}000$ pounds per square inch and for iron plate, 28,000 pounds per square inch. Inserting the given values in the formula we find for sheet steel:

$$P = \frac{35{,}000 \times 60 \times (\frac{1}{2})^2}{6 \times 13\frac{1}{2}} = 6480 \text{ pounds.}$$

and for sheet iron:

$$P = \frac{28{,}000 \times 60 \times (\frac{1}{2})^2}{6 \times 13\frac{1}{2}} = 5185 \text{ pounds.}$$

The values of S will vary considerably for various grades of steel and iron, and also with the condition of the steel. If



unannealed the value will be higher than if annealed. This uncertainty makes calculations of this kind only approximately correct, and ample latitude must be given in designing machinery for bending to provide sufficient power for all conditions.

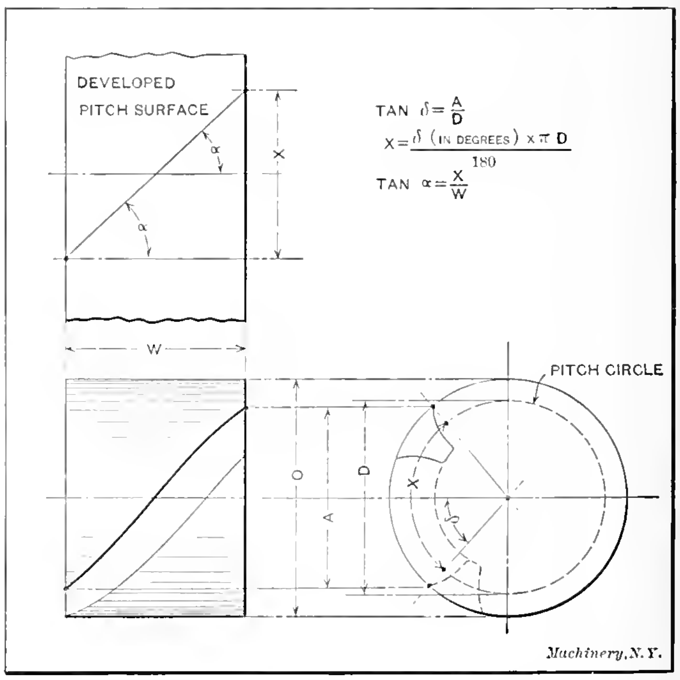
CALCULATING ANGLE OF HELICAL GEAR FROM SAMPLE

O. F. W.—There is one point I do not find explained in books on spiral gearing that I am anxious to find out about. How can you figure out the helix angle or tooth angle, when you have to make a new gear like a sample, as is often the case in jobbing and repair work, etc.? It is assumed that no drawing is furnished.

A.—To calculate the helix angle of a helical gear already cut, we will have to know the following dimensions. See the accompanying diagram:

W = width of face,
A = advance of tooth in width of face,
O = outside diameter,
D = pitch diameter.

All of these measurements are taken directly from the sample,



except that for the pitch diameter. This is obtained from the normal diametral pitch, or pitch of the cutter used, as follows:

$$D = O - \frac{2}{Pn}$$

We have first to calculate the distance on the pitch diameter which the tooth advances on the helix in the width of face. This is marked X on the diagram, and is measured on the cir-

cle as shown. To find this, we first find angle δ by the following calculation:

$$\text{Tangent } \delta = \frac{A}{2} \div \frac{D}{2} = \frac{A}{D}$$

X can evidently be found by proportion, as follows:

$$\frac{X}{2} : \pi D :: \delta : 360 \text{ deg.}$$

in which, of course, πD is the pitch circumference or $3.1416D$. This proportion may be simplified to the following expression:

$$X = \frac{\delta \pi D}{180}$$

In this, of course, δ stands for the number of degrees in the angle. If the calculation brings this to an odd number of degrees and minutes, the minutes should be reduced to decimal degrees; thus, 15° 45′ would become 15.75°.

Having thus found the advance on the pitch circle that the helix makes on the width of face of the gear, we can easily get the helical angle as shown in the development of the diagram. This development is, of course, a section of the surface of the pitch cylinder laid out flat on a drawing-board.

$$\text{Tangent } \alpha = \frac{X}{W}$$

The process we have given here is the exact one applicable to gears of any helix angle. For cases where the angle is comparatively slight, as in your case, it might be safe enough to find X approximately from A by the proportion:

$$X : A :: D : O \text{ or } X = \frac{AD}{O}.$$

This, of course, is not quite correct, as X is measured on the straight line.

* * *

DON'TS FOR THE PREVENTION OF ACCIDENTS IN THE MACHINE SHOP

By H. P. WENTWORTH*

Don't wear loose fitting garments.

Don't forget to roll up your sleeves.

Don't wear jewelry on your hands while in the shop.

Don't oil or clean a machine while it is in motion.

Don't attempt to look about you while busy at a machine—attend strictly to business.

Don't neglect to replace gear guards after removing them for cleaning, repairs or other purposes.

Don't (while at work on a stamping press) forget to remove your foot from the treadle while putting in or removing work from the dies.

Don't put your fingers in the dies to remove work; use a stick or the implement furnished for that purpose.

Don't set up or take down a job in the press until you have thrown off the belt.

Don't throw off the belt with your hand—use a stick.

Don't fail to see if the spring on the treadle is in working order before you start; it should withdraw the treadle immediately, allowing the machine to trip but once.

Don't use a weak or shaky stool or bench while working at a stamping press.

Don't allow scrap or stampings to collect on the floor.

Don't drill a piece of work until you are sure it is securely held.

Don't fail to withdraw the milling machine table far enough when removing work, to prevent the hands or clothing from coming in contact with the cutter.

Don't use a file without a handle, especially in a lathe.

Don't leave a chuck wrench standing in a chuck; always remove it.

Don't touch or jostle a fellow while he is working on an emery wheel if you can prevent it.

Don't forget to use the wheel with care as it does not take a very strenuous blow to cause it to break; especially a small one.

Don't try to stop an emery wheel with your fingers.

Don't try to talk and work at the same time; you cannot do two things at once and do them well.

Don't strike matches and throw them carelessly from you; be sure they are out.

Don't fail to report if any part of your machine is out of working order. "An ounce of prevention is worth a pound of cure."

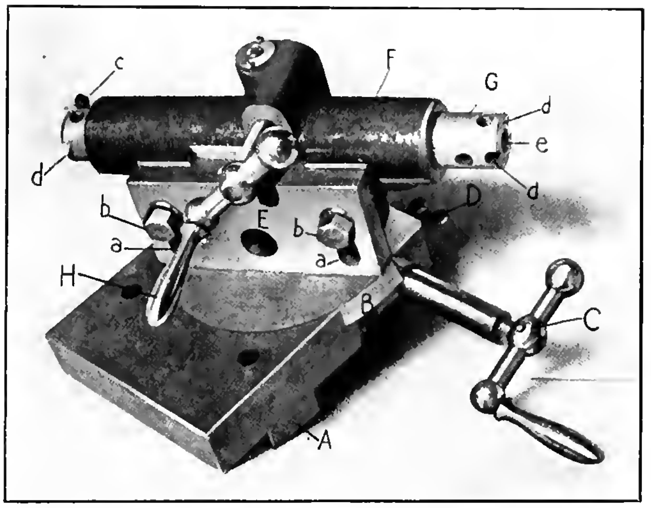
* Address: 337 Warren St., Newark, N. J.

* * *

TAPER TURNING ATTACHMENT

By WILLIAM Z. BEAN*

The accompanying illustration shows an interesting attachment for taper turning, which can be used both for internal and external work. This attachment is provided with a tongue A which is located in the T-slot of the lathe, and is held by two capscrews, which are screwed into two nuts placed in the T-slot. The desired angle is obtained by rotating the handle C, thus moving the part B on which the angular graduations are laid out in either direction. When the desired angle has been obtained, the part B is securely held by wing-nut D. Slots a are provided so that the cutting tool may be adjusted vertically to accommodate any swing of lathe, the capscrews b being used for holding the movable part in the desired position. The handle H operates the spindle G shown protruding from each end of the sleeve F.



Taper Turning Attachment for Internal and External Work

In one end of the spindle G is shown a cutting tool c which is made from 5/16 Crescent steel. Small holes d are provided in each end of the spindle G for holding these tools. A small tool suitable for internal work can be inserted in hole e, which permits this fixture to bore deep holes which are smaller in diameter than the spindle G. The hole E is used for securing another attachment which is not shown, whereby balls may be turned or castings cupped out to a given radius; but to apply this attachment it is necessary to remove the sleeve F containing spindle G and its operating handle H, when the other attachment can be secured in its place. The fact that this is a portable attachment permits it to be readily applied to the milling machine by securing the tongue A in the milling machine vise, whereby collets, convex cutters, bevel gears and work of a similar character may be turned, by securing them in a suitable fixture held on the nose of the spindle.

* Address: West Medford, Mass.

* * *

An account of the industrial operations of the Japanese government is published in the *London and China Telegraph*, and contains some matter of interest. During the past year the government's steel works produced 20,000 tons of steel plate and 25,000 tons of rails, besides about 55,000 tons of steel bars and structural material of various kinds. According to financial reports, the net profits arising from the Japanese Government's industrial enterprises for the year ending March, 1909, amounted to nearly $31,000,000, the greater part of which accrued from the tobacco and salt monopolies.

AEROPLANE FLIGHTS—ALBANY TO NEW YORK—NEW YORK TO PHILA. AND RETURN

Glenn H. Curtiss, the well-known aviator, made a remarkable aeroplane flight May 29, when he flew from Albany to New York, for which feat he received a prize of $10,000 from the New York *World*. Two stops were made during the flight, one for gasoline at a point near Poughkeepsie and a second at 214th St., New York City, for obtaining a supply of oil. The entire distance from the starting place at Albany to Governor's Island, where the flight ended is 150 miles, which was traversed in two hours and forty-six minutes of actual flying time, at an average speed of approximately fifty-four miles an hour. This is somewhat faster than the scheduled time of the Twentieth Century Limited, between Albany and New York, as this train covers its run of 143 miles at an average speed of 49.6 miles an hour. The machine used which was of the biplane type was driven by a 50-horsepower, eight-cylinder engine, connected with a two-blade propeller, which gave a horizonal thrust of 350 pounds. Two air-tight metal caissons and five air bags were attached to the aeroplane to keep it afloat in case it dropped into the Hudson River, which latter was followed by Mr. Curtiss in his flight. The trip as far as the Catskill Mountains was made at an altitude of about 1000 feet. When the mountains were reached, perilous air currents made it necessary to glide to higher levels and it is estimated that at one time the machine was 4000 feet above sea level. The entire flight which, including stops, required 4 hours, 57 minutes, was made without an accident, though at one time Mr. Curtiss states that he temporarily lost control of the machine because of adverse air currents which caused it to lurch over sidewise and downwards with considerable rapidity. This aero trip, while not quite as long as the one made by Mr. Paulhan in England, is in some respects a more wonderful demonstration of the possibilities of aero flight, as the territory traversed offered a greater variety of perils than those encountered on the trip from England to Manchester.

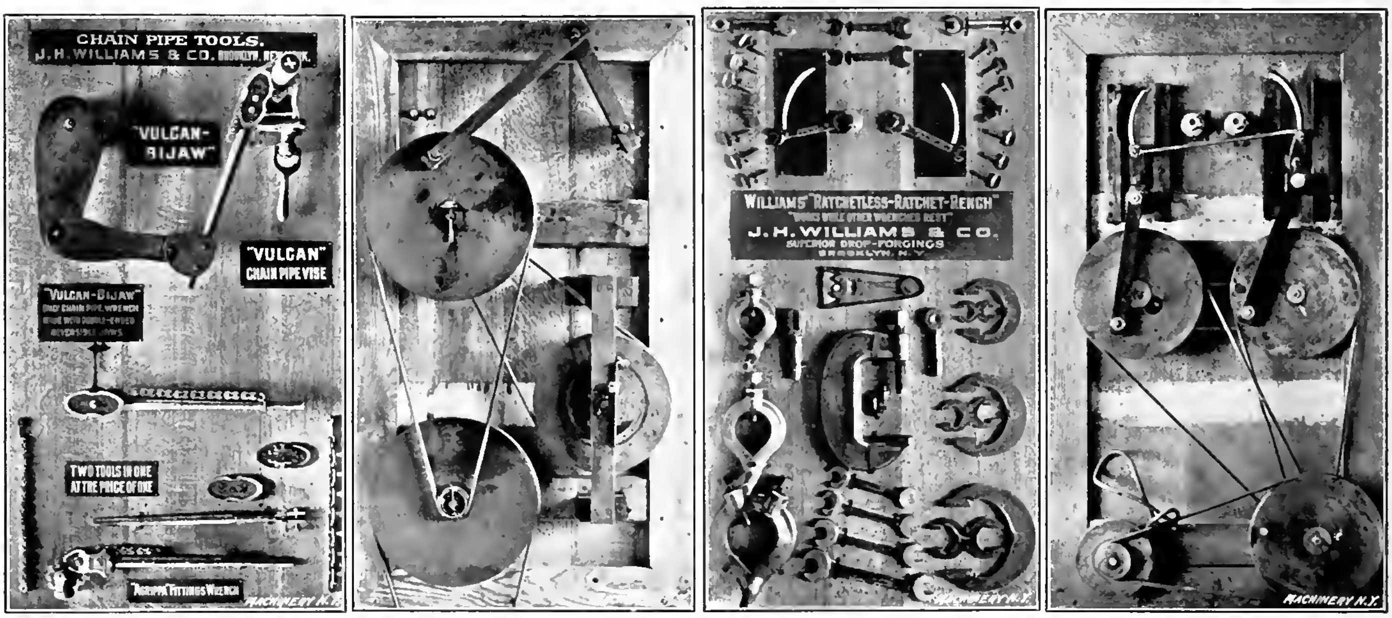
History is being made so rapidly in the progress of aviation that it is difficult for a monthly journal to keep abreast of the times. In another part of this issue is a note regarding the record of Paulhan's long-distance flight from London to Manchester. Since that portion of this issue, which went to press early in June, was printed, and the above, recording Curtiss's exploit, was written, Charles K. Hamilton made a flight from Governor's Island, New York, to Philadelphia and back the same day with a Curtiss biplane. He thereby won the prize offered by the New York *Times* and the Philadelphia *Public-Ledger* for a round-trip flight made between New York and Philadelphia in twenty-four hours. The aviator left Governor's Island at 7:36 A. M. and landed at Philadelphia at 9:26, the distance being 86 miles. He started on the return trip at 11.33 A. M. and when near South Amboy defective spark plugs forced him to descend at 12:54, the descent resulting in breaking the propeller. The propeller was repaired and the machine started again at 6:17 P. M. and reached Governor's Island at 6:40. The return distance was about 89 miles counting three miles made in the detour consequent to landing at South Amboy. Hamilton followed the line of the Pennsylvania R. R. most of the way, and a special train of three cars accompanied him going and coming.

* * *

J. H. WILLIAMS & CO.'S MOTION SAMPLE BOARDS

The accompanying illustrations, Figs. 1 to 4, inclusive, show front and back views of two classes of motion sample boards made by J. H. William & Co., Brooklyn, N. Y., for advertising their line of chain pipe tools, C-clamps, lathe dogs, standard drop-forged wrenches, Williams ratchet wrenches, snap gages, thumb-screws, etc. The motion boards were designed to illustrate the action of the Vilcan bi-jaw pipe wrench and the Williams' "ratchet" wrench, these tools being actuated by the mechanism shown in the back views. One-eighth horsepower electric motors are employed for actuating them.

The reversible feature of the ordinary chain pipe wrench with serrations at one end of the jaws only, which permits either side of the jaws to be used at will to grip the pipe is well-known, but the two-fold advantage of the double-end serrations of the Vilcan bi-jaw wrench has not yet been so generally appreciated, and the motion board was designed to show it by automatic demonstration which could be repeated *ad libitum* at small cost.



Figs. 1, 2, 3 and 4 Front and Back View of J. H. Williams & Co.'s Motion Sample Boards showing Tools and Mechanism

Many readers no doubt are unfamiliar with the "ratchet" wrench—a wrench without ratchet mechanism, but having essentially the ratchet action in use. It is a drop-forged machine wrench with one short jaw rounded so that it automatically releases the nut on the backward stroke, allowing the wrench to roll around the nut and engage the next square. The operator can use the wrench on either square or hexagon nuts without lifting and carefully adjusting it on each square as is necessary with the ordinary type. It "just naturally" falls into place on the back stroke. The motion board Fig. 3 plainly shows this action on both square and hexagon nuts.

J. H. Williams & Co. expect to show the motion boards at the leading mechanical conventions and then they will be offered to the leading machinery merchants throughout the United States for display in their stores and store windows.

* * *

According to a paper read before the Pittsburg Foundrymen's Association, large patterns made of concrete reinforced with wire have been successfully used in a foundry at Niagara Falls, N. Y. The cost of these patterns is very much less than that of ordinary wooden patterns.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

THOMPSON UNIVERSAL GRINDING MACHINE

A universal grinding machine that has been designed for the purpose of combining in a single machine, efficient means for the accomplishment of every possible grinding operation that may be required in the tool-room and general shop, is illustrated in Fig. 1. This machine is manufactured by the Thompson Grinder Co., of Springfield, O.

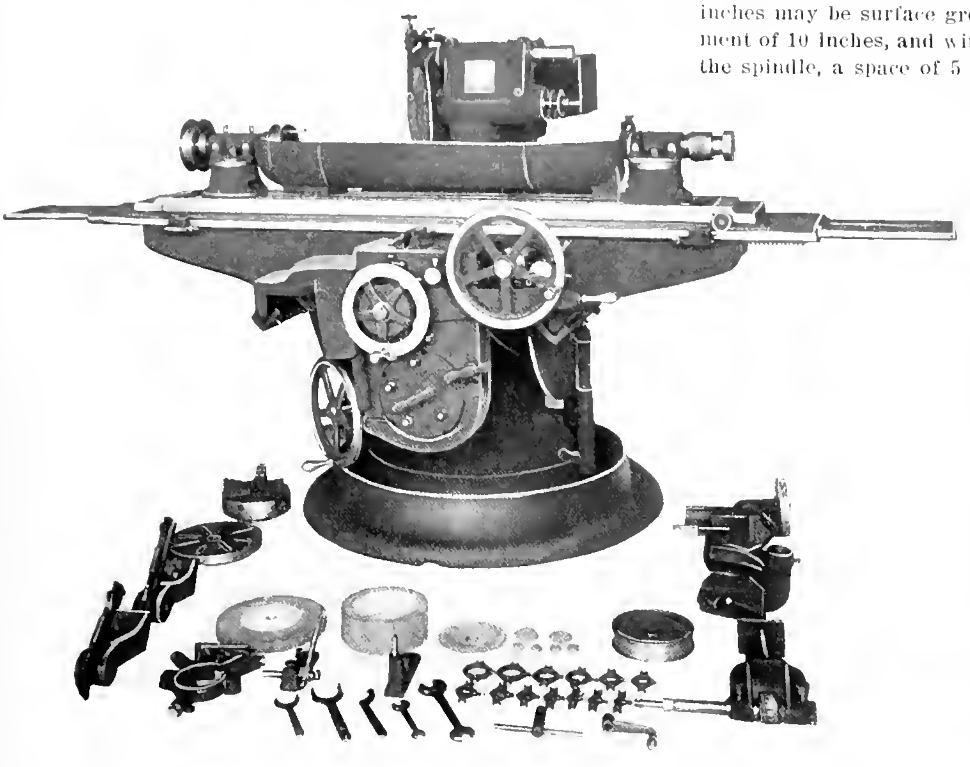


Fig. 1. Thompson Universal Grinder as arranged for Grinding Work between the Centers

The grinding wheel on this machine is maintained in a fixed position at all times, and the grinding table carrying the work to be ground, is made adjustable to any desired position relative to the wheel. The head is rigidly mounted upon a column that is solidly attached to the base, and surrounding the column is a trunk or body casting, that revolves upon a bearing on the base. This body casting carries the elevating knee, saddle casting and grinding table, which may be adjusted to a position at right angles to the spindle at either end, parallel to it, or at any intermediate position. This feature renders this machine capable of being converted in a moment's time into either a plain grinder for grinding straight or taper work between centers, a surface grinder, a knife grinder, an internal grinder, a die grinder, or a cutter grinder, each of which is perfect in its action.

Fig. 1 shows a front view of the machine as it appears when converted into a plain grinder for grinding work between centers. When so arranged, it has a capacity for either straight or taper work up to 10 inches in diameter by 36 inches long. With the table in this position, the overhead drum of the countershaft is parallel with it and, by means of a weight, the drum is automatically adjusted to the height of the grinding table, thus keeping a uniform tension on the belt.

In Fig. 2 the grinder is shown converted into a surface grinder. The spindle and grinding head overhang the table in such a manner that the full width of the table, which is 8 inches, may be passed laterally beneath the wheel. The traverse of the table is 48 inches, and therefore, work 8 by 48 inches may be surface ground. The knee has a vertical movement of 10 inches, and with a wheel 10 inches in diameter upon the spindle, a space of 5 inches will be left between the table and wheel, when the table is at its lowest level.

The internal attachment is applied to the Thompson grinder as shown in Fig. 3. The headstock and a three-jaw combination chuck are mounted on the table. The machine is in the same position as when used for cylindrical grinding. The internal attachment receives its power from a pulley mounted on the grinding spindle proper. Work 4 inches deep may be ground by this attachment.

In Fig. 4 the machine is shown set up for grinding a hob, while the illustration Fig. 5 shows it with a large faceplate mounted on the headstock spindle, thus adapting the machine for either die or surface grinding. As the engraving shows, the grinding spindle is parallel with the faceplate. Figs. 6 and 7 illustrate the arrangement of the machine for grinding end and spiral mills, respectively.

In addition to the uses mentioned in the foregoing, this grinder may he converted into a knife grinder for sharpening large paper knives. The table is swung around to a position at right angles to the spindle and a cup wheel is used. Three angle pieces bolted to the grinding table can be employed to support the knife. This simple rigging will make it possible to easily accomplish the occasional job of grinding large knives. Should the machine be used regularly for this particular work, an attachment can be furnished for holding the knife at an angle, which at the same time affords

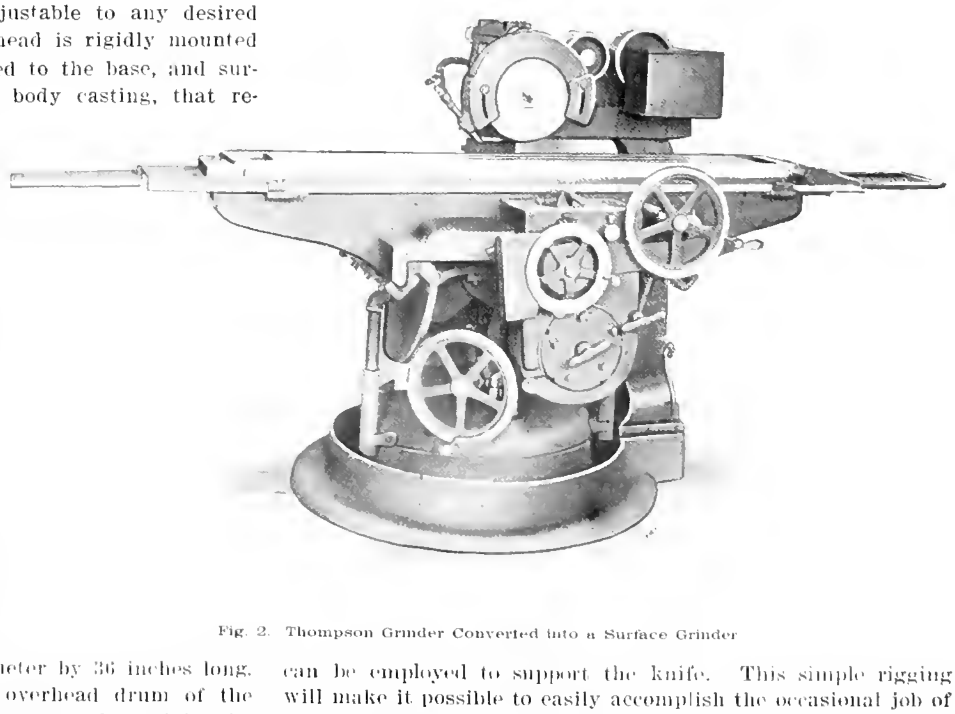


Fig. 2. Thompson Grinder Converted into a Surface Grinder

a support throughout its length.

As will be seen, this grinder, aside from being convertible into at least five distinct kinds of grinders, any of which is

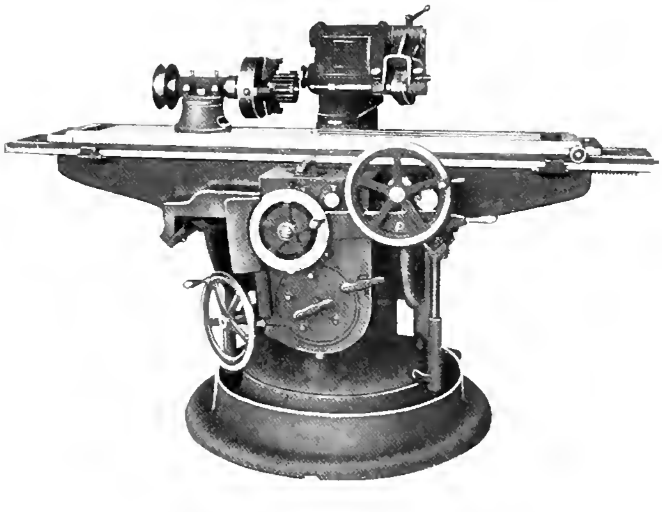


Fig. 3. Grinder Set up for Internal Grinding

capable of economical production, may also be used for many other special purposes.

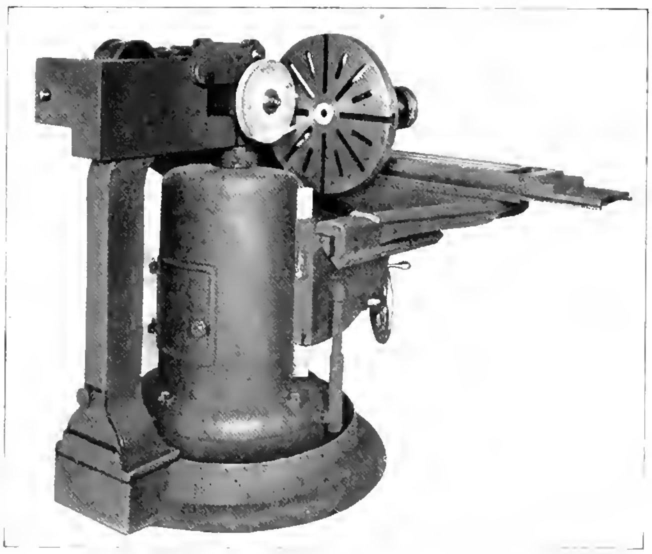


Fig. 5. Machine with Faceplate for Die and Surface Grinding

The machine has an automatic longitudinal feed to the table of 48 inches with ten independent changes, any of which is

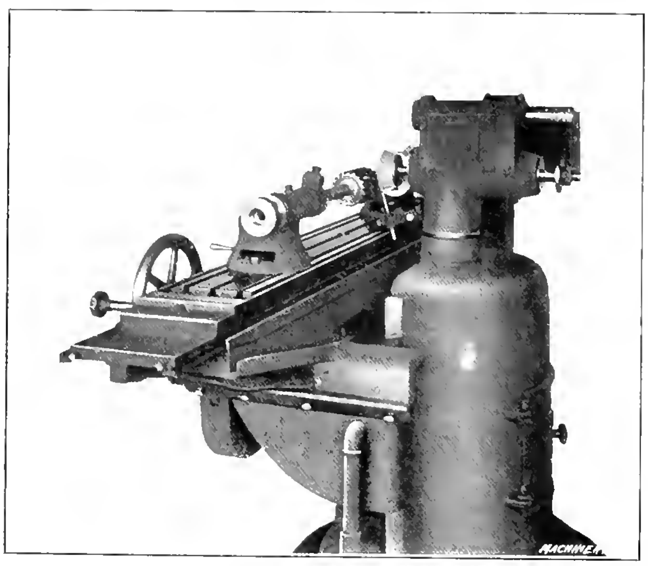


Fig. 7. Grinding a Spiral Cutter

instantly obtainable. An automatic micrometer cross-feed of 8 inches is available, and the knee has a hand vertical micrometer adjustment of 10 inches. In Fig. 8 are shown some of the interior details, giving an idea of the arrangement of the gears for doubling the number of feeds in the quick-change

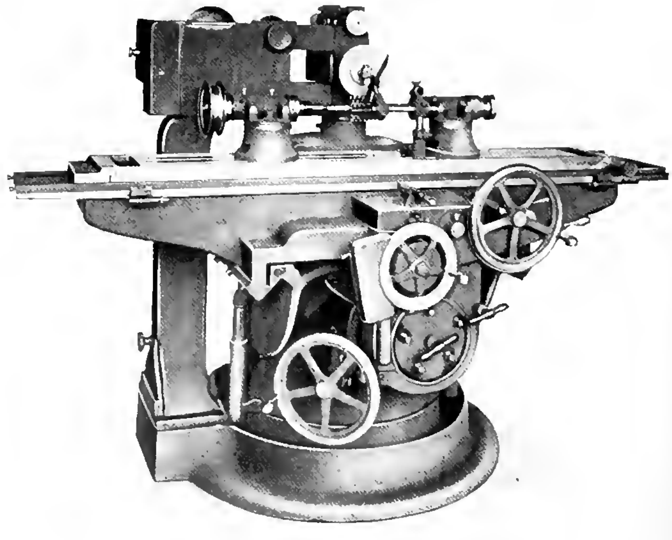


Fig. 4. Hob being ground on Thompson Grinder

gear box shown in Fig. 9. The pulleys marked A and A_1 act as idler pulleys, and the belt from the line-shaft makes a right-

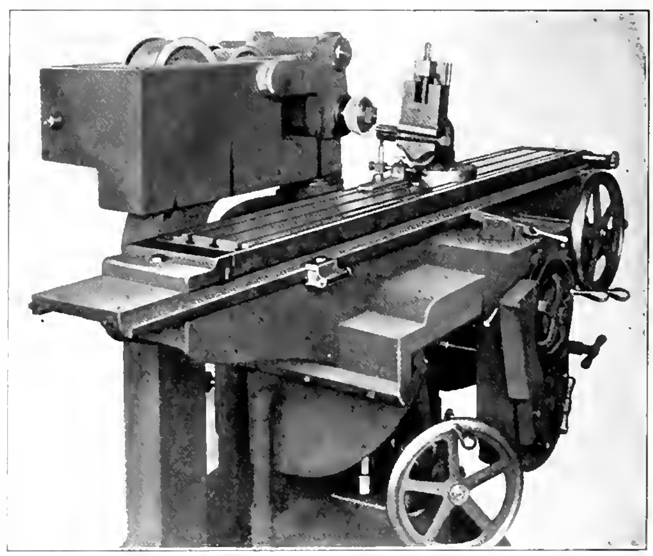


Fig. 6. Grinding an End Mill

angle turn on these pulleys, passing around the pulley mounted on the spindle B. Pulley A drives, at one end of its shaft, a

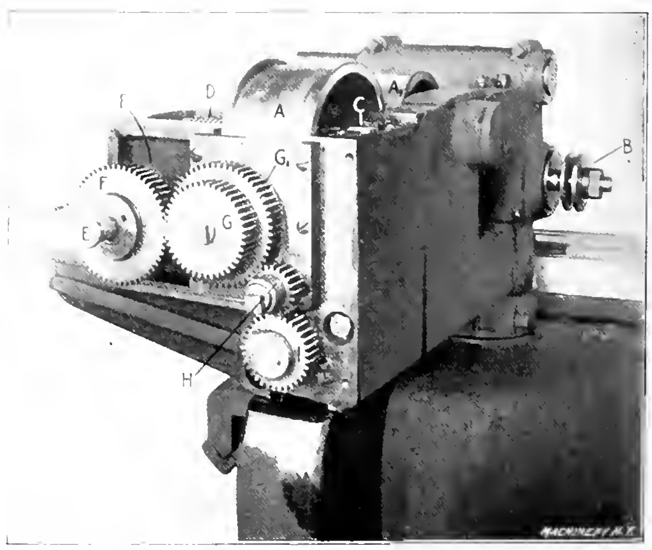


Fig. 8. Arrangement of Gears for Doubling the Number of Table Feeds

pair of 45-degree spiral gears C, which by means of a shaft extending to the base of the machine operates the pump for the water attachment. On the other end of the pulley shaft A, is

mounted the worm D meshing with a worm gear on the same shaft with the pull-pin E. Pull-pin E operates a sliding key which keys either F or F_1, to drive either G or G_1, thus giving two rates of feed. From G_1 the drive is through H and I and thence down through the body of the machine to the spur pinion J in the quick-change gear box Fig. 9. Handles K and L operate the quick-change feed mechanism, K revolving the dial, containing the five sets of change gears, and handle L being used to mesh the gears by swinging the case closed. For example, gears M and N could be made operative by turning the dial until gear M could mesh with pinion J, and gear N with O. By the engagement of slots cut in the periphery of the dial with a projecting key, the different sets of change gears are accurately located with reference to the pinion J and the gear O.

Fig. 10 gives further details of the feed mechanism, showing the way in which the reverse in the direction of the travel to the table is obtained. Gear O (Fig. 9), meshes with gear P, P

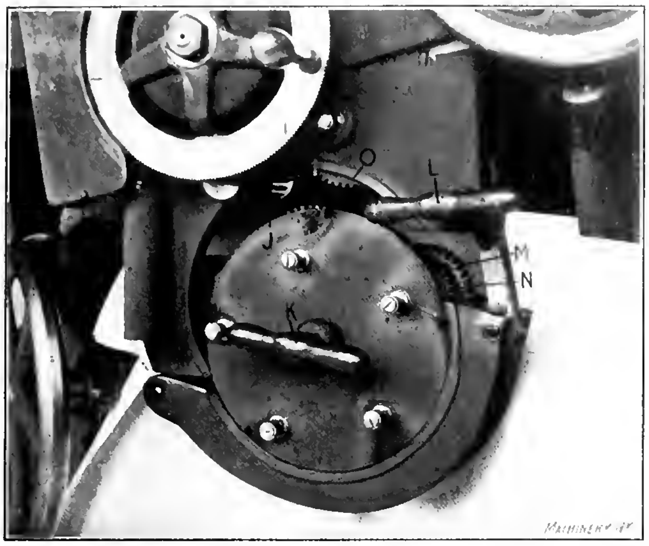


Fig. 9. Table Feed-changing Mechanism

with Q, R with S and S with Q_1. As the clutch is keyed to the shaft which operates the table travel, and gears Q and Q_1, run free on this shaft, a longitudinal table travel in both directions is obtained by means of the reversing clutch. As stated before, by this unique arrangement five changes of travel to the table are obtained by the quick-change gear box, and these

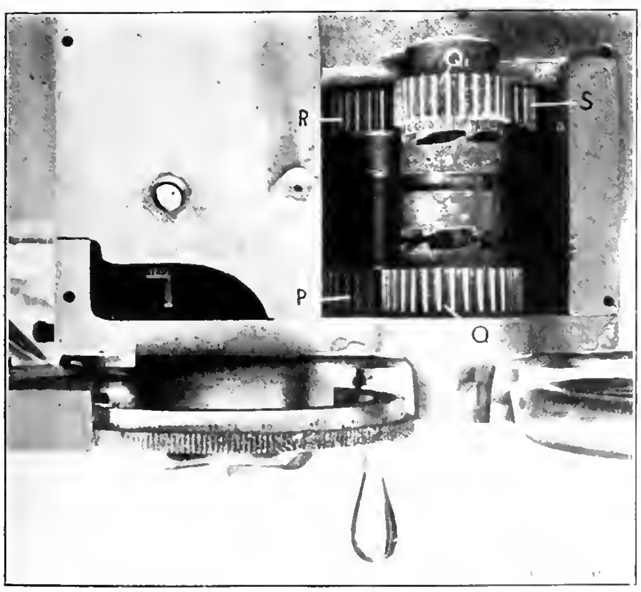


Fig. 10 Detail of Reversing Clutch Mechanism

are doubled at the back of the column by means of the pull-pin E.

Further details of the machine, especially as to the arrangement of the automatic cross feed, are shown in Fig. 11. Handwheel T operates the cross feed and handwheel U the longitudinal feed. Now when the four pawls are dropped into place in the ratchet on the handwheel T, the action of the lever V operates the cross feed. To insure engagement with the ratchet teeth of the wheel T, four pawls are used. The adjustment of the cam at W controls the amount the ratchet is advanced by the pawls, or, in other words, the

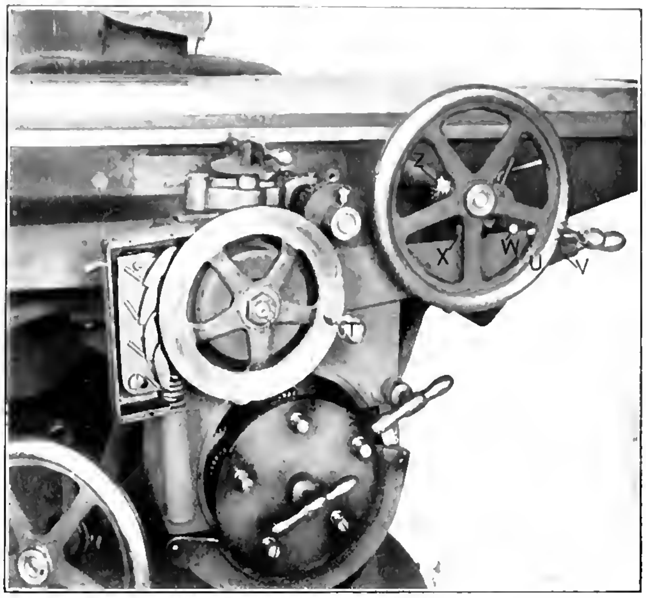


Fig. 11 Arrangement of the Automatic Cross-feed

amount of cross feed. At X is another pawl secured to the lever V. When the table travel is automatically reversed, the sprocket Z also reverses its direction, and by means of the pawl X which engages with Z, the lever V is forced down operating the cross feed automatically.

The makers have designed for this grinder a very simple countershaft as shown in Fig. 12, the drum of which ad-

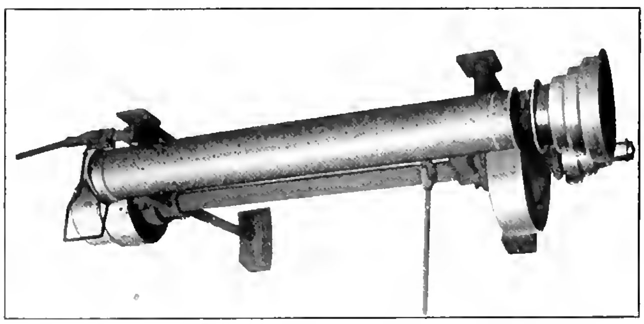


Fig 12. Countershaft and Drum with Automatic Adjustment

justs itself automatically to the difference in the elevation of the table. It is self-contained and is very easy to hang, from the fact that the bearings are held in line by a framework, which carries the drum. This framework, which also carries the bearings for the countershaft proper, has at its outer ends ball joints which rest in sockets in the hangers.

An opportunity to see one of these machines in full operation may be had by a visit to one of the demonstration shops of Hill, Clarke & Co., Inc., of Boston, Chicago, New York, Philadelphia and Cleveland.

GEOMETRIC CHASER OR DIE GRINDER

The practice of using a set of chasers or dies until they are very dull is, of course, poor, as they will not only work much more effectively if ground at intervals frequent enough to keep them sharp, but the results produced will be of a superior quality. It is also essential that the grinding be done uniformly on all the chasers in a set, in order that the work of cutting be distributed equally, and the thread produced be regular and smooth. To enable this work to be done quickly and with accuracy, the Geometric Tool Co., New Haven, Conn., has developed the chaser or die grinder illustrated in Fig. 1. This machine is adapted for grinding any make of thread chaser, whether of a stock or special type. The die to be ground is held in a universally-mounted vise, and the ad-

justments provided are such that the die may be ground square or to any radius, and the throat can also be given any desired clearance.

Before describing the method of grinding both milled and tap-formed dies in this machine, its various adjustments will be explained. The vise in which the dies are held, as is shown more plainly in Fig. 2, is pivoted to a carriage which may be moved back and forth in front of the grinding wheel by means of the hand lever *F*. The upper handwheel *C*, operates the vise for holding the chasers in the proper position for grinding, while the small knurled wheel *D* gives the proper radius for grinding tapped dies and it is set in accordance with the scale *O*, Fig. 3. The lower handwheel *A* operates the lower cross-slide and moves the vise to and from the grinding wheel. The small knurled wheel *E* is used for adjusting the vise to the right or left of the pivot to obtain the proper clearance and also for grinding right- or left-hand chasers. It is also possible to tilt the vise by means of the leveling screws *R*, which adjustment is employed when grinding Acme or square threads of coarse pitch, and also for double and triple threads. The proper length of throat or chamfer is obtained by raising or lowering the knee on which the carriage and vise are mounted, by means of a screw operated by handwheel *G*.

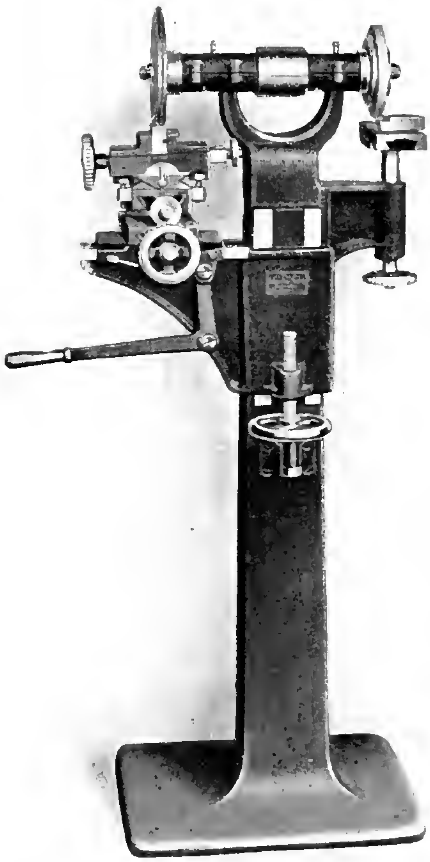


Fig. 1. Chaser or Die Grinder built by the Geometric Tool Co.

When a die is to be ground, it is clamped in the vise by means of handwheel *C*. The jaws of this vise have the same form as the clamping device of the die-head, so that the die is rigidly held in the correct position for grinding. Only one chaser is ground at a time, but as the adjustment of the vise and feed-table remain the same when once set, absolute uniformity of grinding is assured.

As milled chasers are ground mostly on the throat, the feed-table is lowered so as to bring this part of the die below the grinding wheel center. After the chaser is inserted in the chuck, it is brought up against a stop and clamped tightly. The table is then adjusted vertically by the handwheel *G* to give the proper chamfer. When a die is to be used on brass or other free-cutting metals, or if it is to be used for threading close to a shoulder, it should come in contact with the grinding wheel far enough below its center to obtain a short chamfer of, say, approximately 45 degrees. For ordinary work, the table should be set higher so that a chamfer of about 30 degrees will be obtained. When one die has been ground to the proper angle of clearance, the sleeve *B* on the lower feed-screw, which is marked with a check line, is set to indicate the amount of feed necessary. When the first die is finished and the machine is set so that remaining dies may be ground to correspond, the table is moved back for the removal of the finished die and the insertion of the second. The table is then returned to the grinding position and the die moved back and forth against the face of the grinding wheel by the hand lever *F*, while it is slowly fed forward by the wheel *A* until the check mark on sleeve *B* corresponds to a second mark on the stationary arm, with which it was previously set. When this point is reached, pins provided for the purpose form a positive stop for the feed. During this operation the swivel of the intermediate slide should be firmly clamped by handle *P*.

In addition to grinding the throat of the chaser, it is also essential that the cutting edges be touched up lightly from time to time in order to keep them clean and sharp. This is done by placing the die flat on table *K* (Fig. 2), bringing it into contact with the wheel by handwheel *J*, which controls

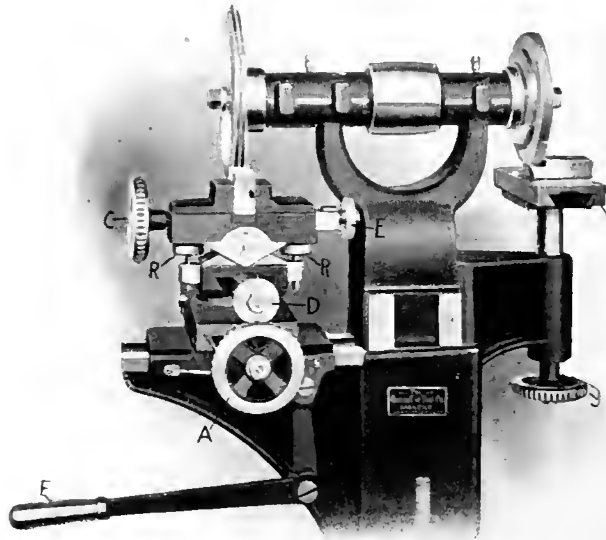


Fig. 2. Enlarged View of the Working Side of the Machine

the vertical adjustment, and moving the slide back and forth under the grinding wheel. When grinding either the face or throat of a die, all the dies of a set should, of course, be ground with the same adjustment.

In order to better illustrate the method of grinding a tap-formed die, we shall assume that a 1-inch chaser of this type is to be ground. The scale *O*, which is graduated in thirty-seconds of an inch, would first be set to the radius of the die, or to ½ inch, minus the single depth of the threads. The die is then placed in the vise against the stop and clamped. The jaws of the vise are next adjusted either to the right or left

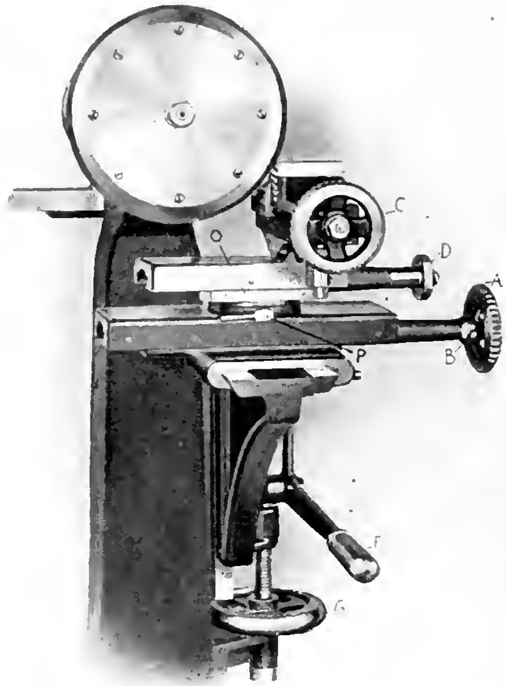


Fig. 3. End View showing Die in Position for Grinding Throat

of the center, depending on whether the thread is right- or left-hand, just enough to give the proper clearance. The swivel of the intermediate slide is then loosened and the work is oscillated about the grinding wheel, and fed in slowly by handwheel *A* until the stop is reached.

S. E. HORTON MACHINE CO.'S FACEPLATE JAWS

A new faceplate jaw has been brought out by the S. E. Horton Machine Co., Windsor Locks, Conn., that is quite different in its design from the type commonly used. This new jaw, instead of having the form of a rectangular block, is made with a broad base, which is ribbed to the body as shown in Fig. 1. This design results in a much better casting, as the metal is more uniformly distributed and, for a given weight, the support is much better, the width of the base being wider. On each side of the body, pockets are formed which serve an important purpose, in that they adapt these jaws to a wide range of work by making it possible to clamp them in positions where the ordinary jaw could not be held. As the base of the jaw is extended at each end, it may be clamped by the ends, as with the ordinary type, and the pockets provided also furnish means of clamping at the sides. Holes are drilled through the base and into the pockets on each side so that bolts can be employed when more convenient. These bolt holes also make a convenient place for dowel pins. The advantages that these various ways of clamping afford, will be apparent by referring to Figs. 2 and 3, which show the jaws mounted on a faceplate in different positions. Fig. 2 shows

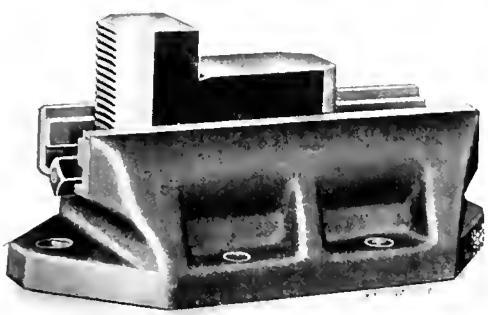


Fig. 1. Faceplate Jaw with Various Facilities for Clamping

them set in until their ends meet, in which position they may be used for holding comparatively small work. If the ordinary type of faceplate jaw were set in to the position shown in the illustration, obviously it would be impossible to clamp the inner ends as the bolt holes would be beyond the end of the T-slot in the faceplate. The pockets of this new design, however, make it easy to rigidly fasten the inner ends by simply using a strap and bolt between each pair, as the engraving indicates. These pockets also make it possible to set the jaws out to such a large radius that the outer ends overhang, as straps can then be employed, as illustrated in

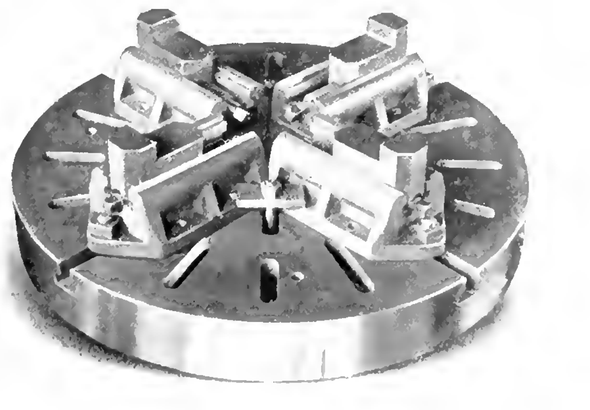


Fig. 2. Jaws Mounted on Faceplate in Position for Holding Small Work

Fig. 3, in place of the end bolt. It should be mentioned that the inner ends of the jaws are beveled to an angle of 45 degrees, so that they will fit together and support one another, when in the position shown in Fig. 2. The screws by which the sliding jaws are operated are of large diameter, and both the jaws and screws are of the same general proportions found in the heavy pattern independent chucks made by this company. The screws are provided with double thrust bearings, which reduce the wear and resulting end play to a minimum. These faceplate jaws are made either of gray iron or of true machinery steel castings, as desired. Any form of groove or rib, or double ribs, will be furnished so that the jaws will accurately fit the slots of the faceplate for which

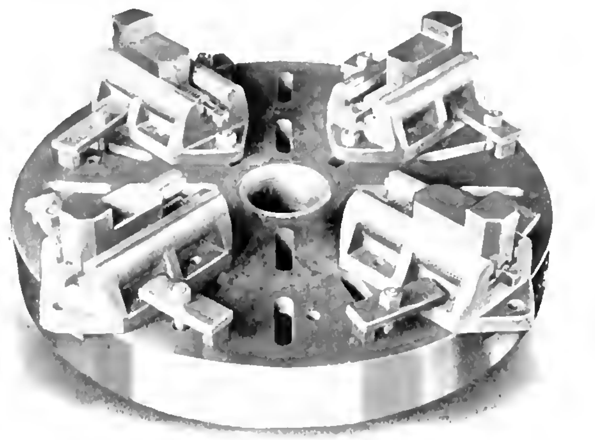
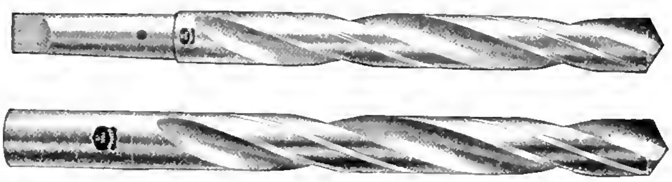


Fig. 3. Jaws set out so that Ends Overhang

they are intended. The company is also prepared to furnish special jaws for holding odd-shaped pieces, if these are required.

STANDARD IMPROVED OIL TUBE DRILL

The Standard Tool Co., Cleveland, O., has placed on the market a new oil tube drill which differs from the drills of this type formerly manufactured by this company in having steel tubes for conveying lubricant to the drill point, instead of brass. The advent of drills made from high-speed steel, with their increased speed and heavy cuts in refractory metals, proved too severe for brass oil tubes, which were too readily cut and pulled out of place, for satisfactory results. The steel tubes show a marked improvement over those of brass, and after a thorough and exhaustive test under the most severe conditions, the oil tube drill equipped with steel tubes has proved thoroughly efficient and reliable. These steel tubes are



Standard Tool Co.'s Oil Tube Drill with Steel Tubes

fitted to connect with a hole bored through the shank of the drill. This hole in the shank, with which connection is made to the oil supply, as well as the tubes themselves, may be seen in the accompanying illustration. The oil is forced through the hole in the drill shank and flows through the steel tubes, thus giving a constant supply at the cutting edges which keeps them cool and forces out the chips. The use of this type of drill will be found exceptionally satisfactory where deep holes are to be bored in steel or wrought iron. They can also be used to advantage in screw machines or in any tool fitted with means for supplying the lubricant. If necessary, the hole in the shank can be threaded for pipe connection.

ROCHESTER HORIZONTAL BORING, DRILLING, TAPPING AND MILLING MACHINE

The horizontal boring, drilling, tapping and milling machine illustrated in Fig. 1 is the product of the Rochester Boring Machine Co., Rochester, N. Y. This machine is electrically driven and it is so arranged that it can be started, stopped or reversed independently of the motor, these movements being controlled through friction clutches operated by a lever conveniently located on the saddle. Either the spindle, column or the saddle can be traversed by hand or power and with a fast or slow motion, as desired. All the operating levers and handwheels are located on the saddle, thus making the control of the machine convenient to the operator. The spindle is so arranged that the full traverse can be obtained without resetting and it is journaled in long phosphor-bronze bearings

located at each end of the saddle, that are adjustable from the outside. All the driving and feed gears are either of nickel steel, cast steel or manganese bronze and the feeding and driving mechanism is enclosed in the saddle and thus fully protected.

The motor, which is of the constant speed type, is mounted on top of the column and drives through rawhide and steel gearing to a vertical splined shaft which transmits the power to the driving mechanism in the saddle. Secured to this vertical shaft are the two friction clutches by means of which the machine is started, stopped or reversed by a starting lever on the saddle. When these clutches, which are shown at *A* and *B* in Fig. 2, are in the neutral or central position, no power is transmitted and the driving mechanism of the saddle remains at rest. When clutch *B* is engaged, forward motion is imparted to the bar, while the engagement of clutch *A* operates in the reverse direction. Through the bevel gears with which these clutches are connected, driving power is transmitted from the vertical shaft to the speed change gears *C*. These change gears by means of a tumbler gear arrangement in combination with back-gearing, give ten speed changes for the spindle, ranging from 15 to 200 revolutions per minute in geometrical progression. The intermediate shaft carrying the clutches for driving the back-gearing, has on it a pinion that meshes with and drives the large gear *A*, Fig. 3, through which the spindle is rotated by means of two splines which engage with it. The sleeve *B*, on which this gear is mounted, has a bearing in the saddle, and as clearance is provided between the bar and the sleeve, any vibration from the gears is not transmitted to the spindle.

The Feeding Mechanism

The arrangement of the feeding mechanism is also shown in Fig. 3. The sleeve *B* has teeth cut in one end which mesh with three pinions *D*, driving a planetary gear *E*. This planetary gear, in turn, by means of pinions *N*, transmits the movement to the rotary nut *L*, which engages directly with the spiral cut in the spindle. This nut has a heavy flange which rotates between large ball thrust bearings, as shown, in order to take the end-thrust from the bar in either direction. When the feed is disengaged, this nut rotates at the same speed as the spindle, with the result that the latter remains in a fixed position. By an ingenious arrangement of the planetary gear system, whereby connection is made with the feed gearing *G*, a differential rotation can be given to the nut *L*, causing it to be either advanced or retarded. Either advancing or retarding it effects the traverse of the spindle, which is thus caused to move in the direction desired. These feed change gears are driven from the intermediate shaft which drives the gear *A* for the spindle. When the feeds are disengaged, gear *F* in which the planetary pinions *D* are mounted, does not rotate, and the nut *L* rotates with the spindle which therefore remains in the same longitudinal position. When, however, the gear *F* which is connected directly with feed change gears *G* is driven by these gears, a forward or reverse rotation, as desired, is given to nut *L* (independent of the drive), and consequently a feeding movement to the spindle. The feed change gears are arranged with back-gears, and eight different feeds for the spindle are available, ranging in geometrical progression from 0.01 to 0.25 inch per revolution of the spindle. This power feed is controlled by a friction clutch which is engaged or disengaged by the clamping nut *I*. The feed can be reversed when desired, and all the feed operating levers are mounted on the saddle, a detail of which is shown in Fig. 4. The eight feed changes are obtained by means of the levers *A* and *E*, while the feed is reversed by a lever *C* located back of the handwheel used for feeding the spindle by hand.

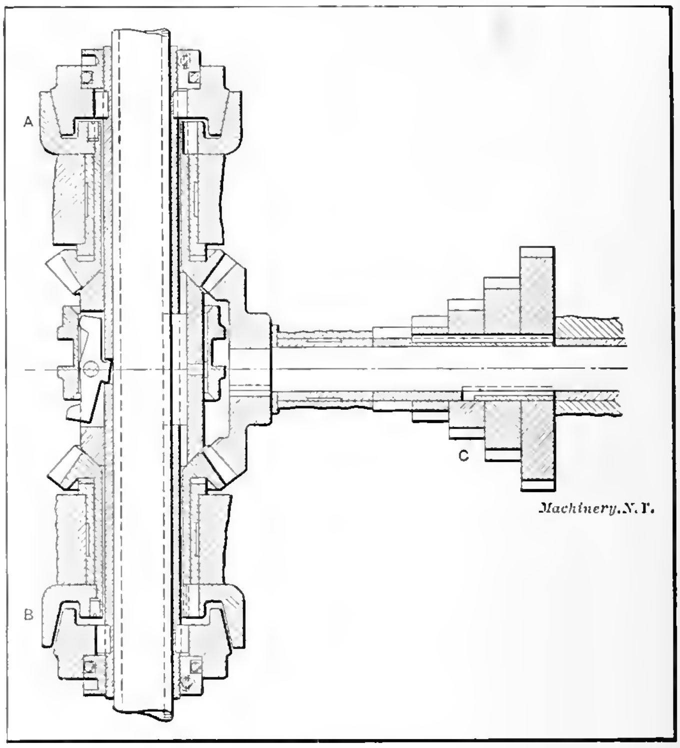


Fig. 2. Friction Clutches by means of which Machine is started, stopped and reversed

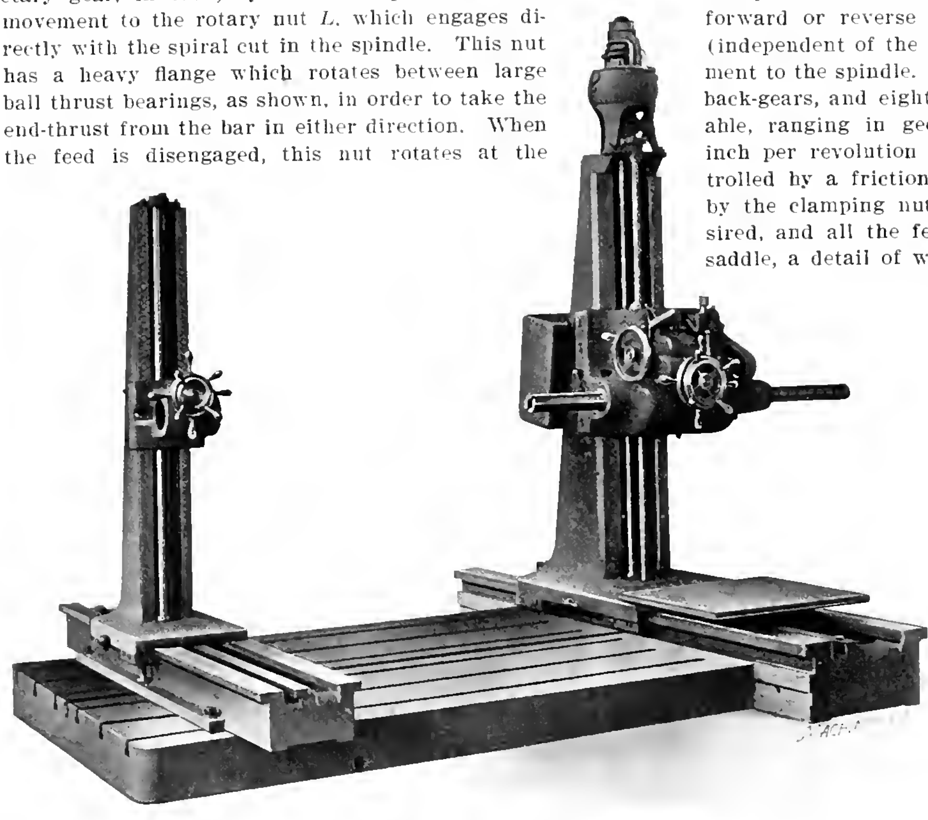


Fig. 1. Rochester Horizontal Boring, Drilling, Tapping and Milling Machine

Milling Feeds for Column and Saddle and Rapid Traverse

On the saddle two concentric pilot wheels *F* and *G* are mounted. The inner wheel *F* is mounted on a hollow shaft, which, through gearing, operates the traverse of the column, and the outer wheel *G* controls the motion of the saddle on the column. The inner wheel, which is free to slide on the hollow shaft, is provided with a double-end clutch so that pulling it outward engages a clutch on the outer handwheel through which power drive is transmitted to a rotating nut on the elevating screw which elevates the saddle. By pushing the wheel *F*, to its inner position, a clutch fixed on the hollow shaft is engaged and the vertical shaft for traversing the column is driven. As these gears connect with the feed change gears (without the back-gears) four feed changes are available in either direction for traversing the saddle or column when milling. Means are also provided for obtaining a positively-driven rapid traverse of 6½ feet per minute for the saddle, column and spindle. Whether the milling feed or the rapid traverse is engaged, depends on the position

of lever *H*. When this lever is moved over to the left, the feed gears are engaged; when it is in the middle or neutral position, as illustrated, the drive is inoperative, and when it is moved to the right, either the column or saddle may be rapidly traversed. The vertical shaft for traversing the column along its bed, transmits the motion by a pinion meshing into a rack in the base slide. This convenient arrangement for traversing the spindle, saddle, and column in any direction, in conjunction with the convenient means for starting, stopping or reversing by the manipulation of lever *J*, greatly facilitates the operation of the machine and effects a great saving in time and labor.

Miscellaneous Features

The saddle is counterbalanced by a weight sliding on the back of the column, and it is guided by large flat bearing surfaces carefully scraped to perfect contact. The bearing on the outboard column for supporting the boring-bar is also traversed by concentrically-arranged handwheels similar to those on the saddle, which are operated by hand only. The saddle column, as well as the outboard support column, has solid wedge gibs and clamping devices for locking them to the bed in any position. The slide base for the main column is provided with a groove on the side for accurately locating the floorplate, and both bases are strongly reinforced by internal ribs. The baseplate of a standard machine of the size illustrated is 6 by 9 feet, but this dimension can be varied to suit individual requirements. This floorplate is of heavy box type construction and it is rigidly attached to the slide base by means of heavy bolts.

The rated horizontal traverse of the column for this size machine is 6 feet, but it can be safely operated laterally over a distance of 7½ feet. One of the noteworthy features of this machine is that the whole length of the spindle can be used for the feed without resetting, thus giving any required range of continuous feed by using the proper length of bar. If desired, two or more bars can be furnished and also special bars in various lengths. The spindle of the machine is bored to receive a No. 5 Morse taper, but different tapers can be provided in the two ends of the bar if desired, and the latter can be readily reversed if necessary. One end of the bar can be threaded for holding milling cutters when this is required. The makers claim that owing to the absence of friction, the feed is so sensitive that small drills can safely be used even on the largest machines. Graduated scales with vernier attachments are provided for the column and base slide, as well as for the outboard support and slide. These scales are, of course, a great convenience for quickly adjusting the machine and for spacing known distances on the work. The spindle feed handwheel is also equipped with a micrometer, by the aid of which adjustments can be made to within 0.001 of an inch. This micrometer reading is very useful in gaging depths in boring, drilling and milling.

The shafts of this machine are all journaled in phosphor-bronze and the sleeves are provided with felt oil pads. A high grade of steel is used for all shafts, and cap-screws, set-screws, nuts, operating levers, etc., are casehardened. The equipment furnished with the machine includes, in addition to the machine itself complete with motor, a floorplate, outboard support, graduated scales and the necessary wrenches, spanners, etc. Special tables, boring-bars, parallels, cutters, etc., will be furnished extra if desired. The company is also prepared to build, in addition to the standard type illustrated herewith, special designs arranged to meet any feasible condition.

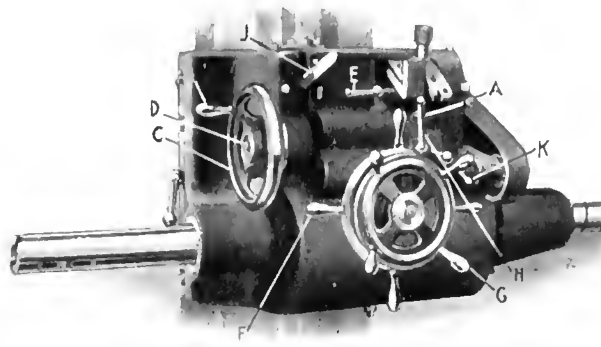


Fig. 4. View showing the Operating Levers on the Saddle

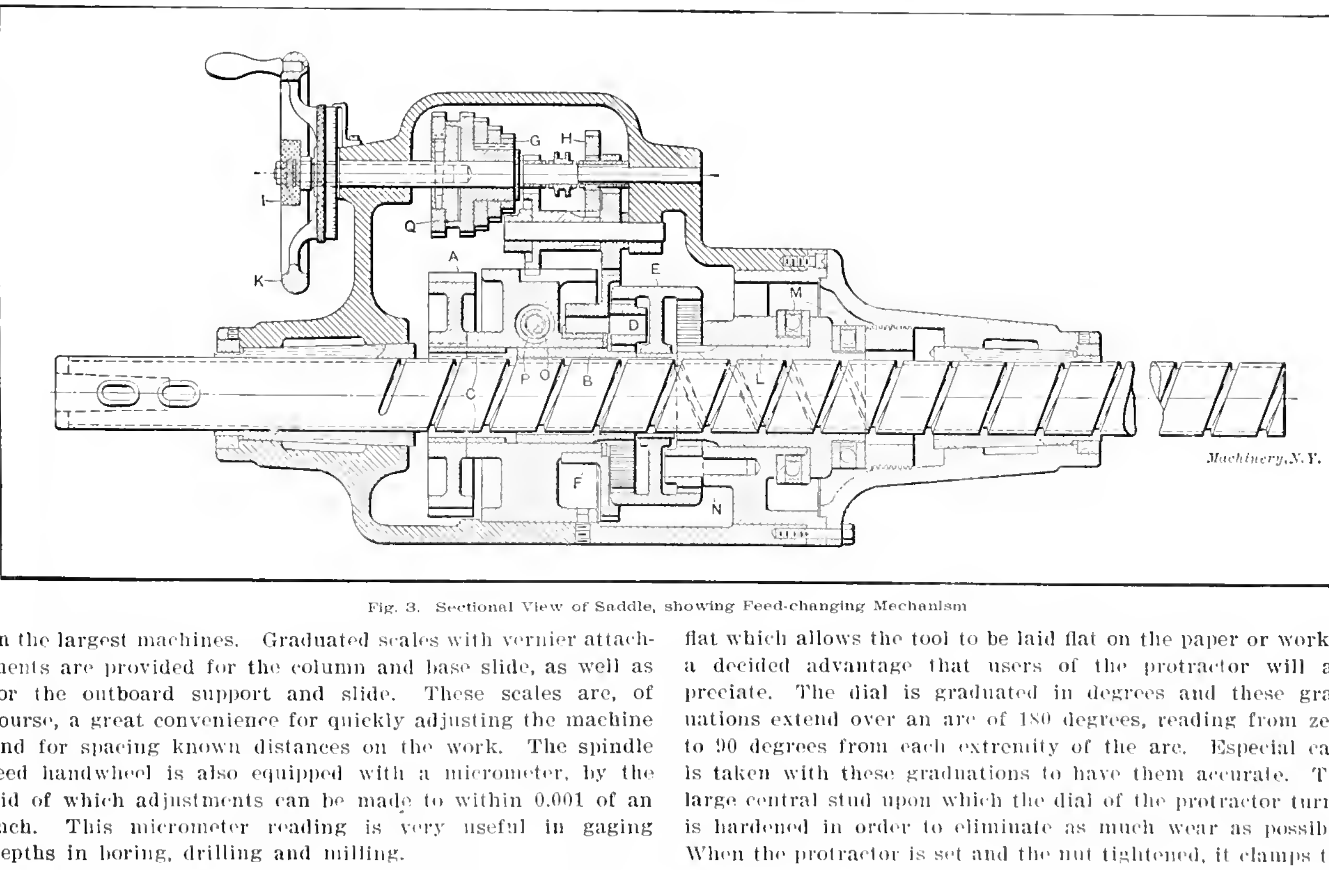


Fig. 3. Sectional View of Saddle, showing Feed-changing Mechanism

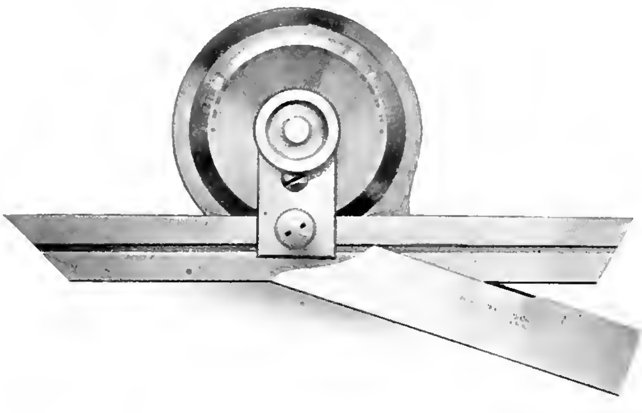
BROWN & SHARPE BEVEL PROTRACTOR

An improved bevel protractor has recently been placed on the market by the Brown & Sharpe Mfg. Co., of Providence, R. I. This protractor, which we illustrate herewith, is an accurate and inexpensive tool that is not only useful to mechanics, but is also of great service to draftsmen.

The design of this tool is simple, and it is similar to the improved universal bevel protractor made by the same company. The principal difference between the two tools is that there is no vernier on the new protractor, so that measurements cannot be made to such a degree of fineness as with the universal protractor; it is intended, however, for work not requiring great precision.

To facilitate the use of the tool, one side of the protractor is flat which allows the tool to be laid flat on the paper or work—a decided advantage that users of the protractor will appreciate. The dial is graduated in degrees and these graduations extend over an arc of 180 degrees, reading from zero to 90 degrees from each extremity of the arc. Especial care is taken with these graduations to have them accurate. The large central stud upon which the dial of the protractor turns, is hardened in order to eliminate as much wear as possible. When the protractor is set and the nut tightened, it clamps the dial rigidly in position so that there is no danger of slipping.

The blade of the protractor is free to move backward and forward for its entire length, independently of the dial, which feature adapts it to a wide range of work. This blade is



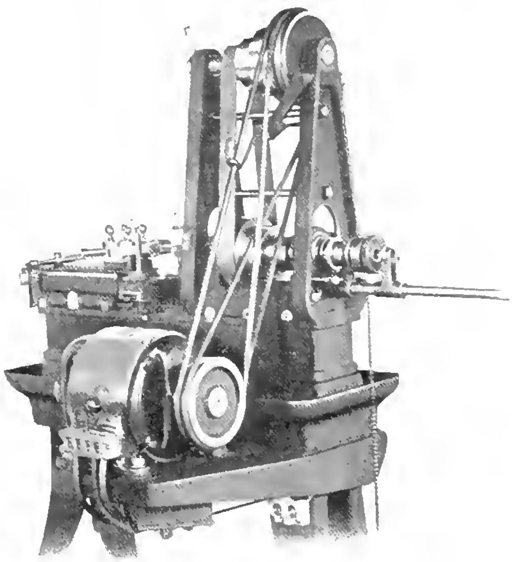
Brown & Sharpe Bevel Protractor for Mechanics and Draftsmen

clamped independently of the dial and is rigidly held in place. Great care has been taken in cuttiug the grooves, etc., so that there is very little chance for dust to accumulate and cause inaccuracies in the measurements.

GARVIN MOTOR-DRIVEN SCREW MACHINE

The standard No. 1 screw machine, which the accompanying engraving illustrates, is the type regularly built by the Garvin Machine Co., Spring and Varick Sts., New York City. This particular view shows the machine equipped with a motor drive, the motor being mounted on a bracket at the rear so as to form an integral part of the machine. The manufacturer's idea in using the regular stock machine for attaching the motor drive is of twofold benefit. In the first place, orders can be executed more promptly, and, in the second, a motor-driven portable machiue, that can be set anywhere in the factory to suit conditions, can be obtained at moderate cost.

The main belt connecting the upper and lower cone pulleys can be made endless, as the eccentric adjustment provided for the upper cone, which runs loose on a shaft, makes it possible to obtain sufficient tension to transmit the required power for operating the machine. As this adjustment is quickly

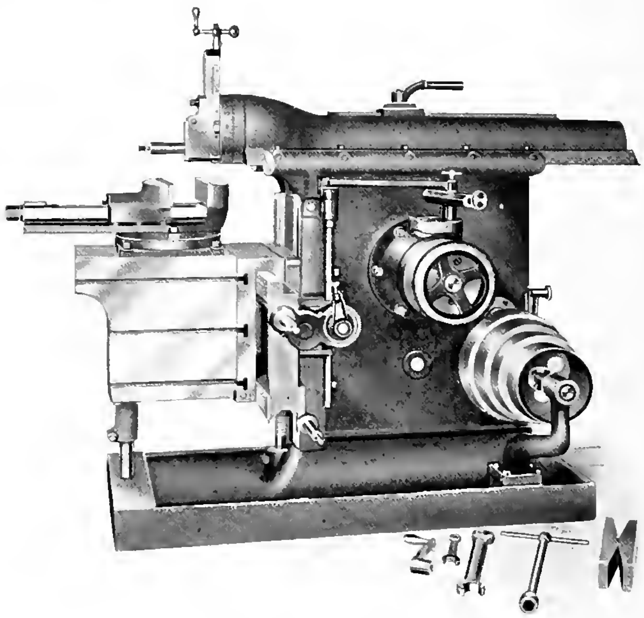


Garvin Screw Machine equipped with Motor Drive

operated, it may be used for slacking the belt prior to shifting it for obtaining speed changes. The straight and crossed belts that are used to connect the motor with the upper cone pulley, are under the control of the shipper handle shown projecting in front of the machine. These belts, which are ½ inch in diameter, run on a system of three grooved pulleys overhead, those on the outside being loose pulleys and the oue in the center, tight. The machine is started aud stopped from the front side, thus making the control convenient to the operator. A half-horsepower motor is used to drive the machine, the motor running at 1600 revolutions per minute. This machine has a capacity for stock up to 5/8 inch in diameter through the spindle, which is equipped with automatic wire feed. The weight complete, when skidded for shipment, is 600 pounds.

IMPROVED MILWAUKEE SHAPER

The shaper illustrated herewith, which is known as the "Milwaukee" shaper, is built by the Lutter & Gies Co., Milwaukee, Wis. It has been the aim of the builders of this machine to secure, both as to general design and workmanship, strength aud simplicity in all the working parts. The base is of the pan design and it is strongly ribbed inside to insure stiffness. It also projects well out from the column and affords a rigid foundation. The column is also of liberal dimensions and rigidly braced. As the engraving shows, the slides overhang at both ends, giving long bearing surfaces to the ram. The ram has a quick return and it is strongly constructed. It is provided with eight speeds, four being obtained by a four-step cone pulley, which number is doubled by the back-gears that are engaged by means of a lever at the back of the machine. The table is slotted on both the top and



Twenty-four inch Shaper built by Lutter & Gies Co.

the sides, and it has a working surface of 18½ by 15 inches on top, and 16½ by 14 inches on the side. By loosening the bolts which fasten the table to the apron, it may be revolved to any position that may be required. This is a valuable feature which adapts the tool particularly for toolmaking and die work. When the table is removed, either the vise or the work itself can be clamped directly to the front of the apron, T-slots being provided in this surface. The vise has a graduated swivel base, and it can be clamped at the side of the table as well as on the top. The tool head is also graduated and it swivels to any angle. The vertical feed is provided with micrometer adjustments. The length of stroke can be changed instantly from the working side of the machine by simply manipulating the large handwheel shown. Just what the stroke is at all times is indicated by a pointer located near the handwheel. The feeding mechanism is simple in construction, the movement being transmitted from a slotted crank to a vertical splined shaft, which is connected through bevel gears to the ratchet shaft. An adjustable table support is provided for eliminating all spring from the table when doing heavy work. All bearings such as those of the ram, apron, and slides are provided with taper gibs to permit the maintenance of the accurate fit originally given to these parts. The cross-rail screw has ball thrust bearings and a micrometer collar reading to thousandths of an inch. The elevating-screw nut for the saddle, is provided with ball bearings to eliminate friction as far as possible. The machine can be conveniently used for keyseating, as there is an opening

under the ram large enough to allow the passage of a shaft 3 inches in diameter. The stroke of this shaper is 24½ inches. The automatic cross traverse is 29½ inches and the downward feed in the tool head, 11 inches. The table has a vertical adjustment of 11¾ inches, and the vise has a maximum opening of 15⅜ inches. The net weight of the machine is about 4000 pounds.

COLBURN 24-INCH HEAVY-DUTY DRILL PRESS

A heavy-duty drill press that is of unusual interest, not only because of its constructional features, but also by reason of the results in the way of rapid drilling which it makes possible, was exhibited at the recent convention of the American Railway Master Mechanics' and Master Car Builders' Associations at Atlantic City. This tool, which is the latest product of the Colburn Machine Tool Co., Franklin, Pa., can be arranged for either belt or electric drive. Fig. 1 illustrates the electrically-driven machine that was used by the Celfor Tool Co., at the convention referred to, for demonstrating its high-speed twist drills, and which will be installed in its plant at Buchanan, Mich., for drill testing.

These machines are built on the unit system, that is the speed changing mechanism is in one separate box, the feed change gears are enclosed in another separate case, and the head is another unit, entirely independent of the other parts. The advantages of this method of construction, not only in the manufacture, but also in connection with repair work, or in the location of any defects that may develop, are well-known.

All gears used on this machine either run in a bath of oil or are made of steel and hardened. This includes the main

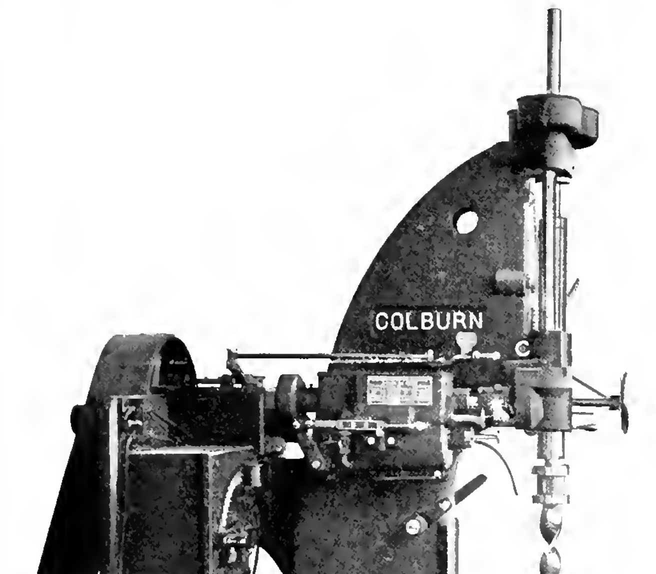


Fig. 1. Colburn 24-inch Heavy-duty Electrically-driven Drill Press

driving gears for the spindle, the bevel gears connecting the vertical intermediate shaft with the horizontal shaft at the side of the column, and the two gears connecting this latter shaft with the speed box. The main driving gears through which power is transmitted to the spindle, are helical gears which are comparatively noiseless in operation. These gears are made of steel and the teeth are ground in to insure smooth running. The gears connecting the speed box with the shaft passing through the feed box at the left side of the column, are also of the helical type and hardened.

The Driving Mechanism

The drive is through a single constant speed pulley, which is equipped with a friction clutch, by means of which the machine is started and stopped. The speed change mechanism is encased in an oil-tight box, which is filled with oil so that all the gears and bearings inside it are perfectly lubricated. All the speed changes, of which there are eight, ranging from

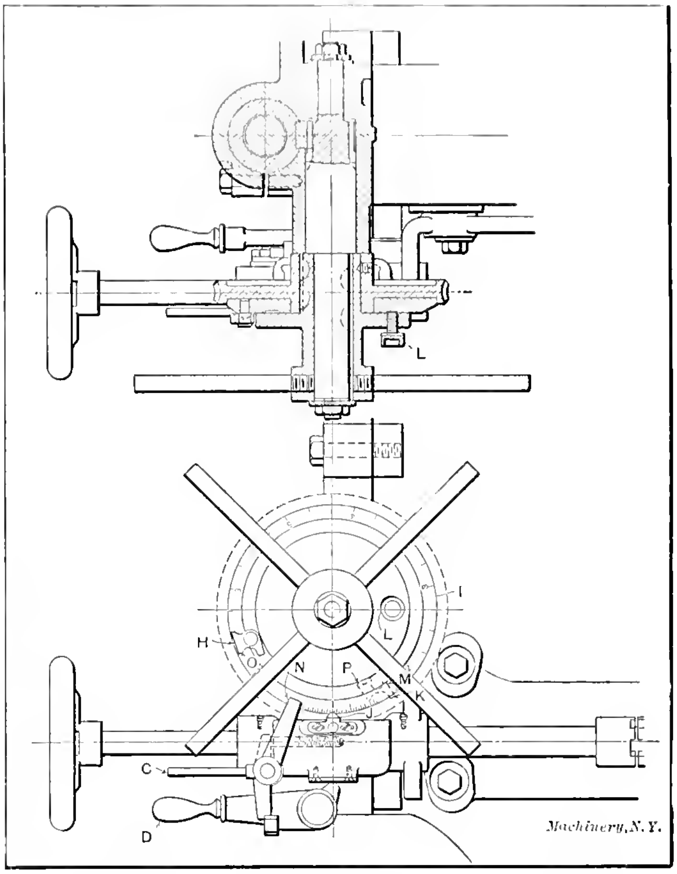


Fig. 2. Section and Elevation showing the Automatic Feed-tripping Mechanism

40 to 440 revolutions per minute, are made by two levers, conveniently located at the front of the machine. Four of these changes are effected by the engagement of a hardened dive-key with different gear combinations, while the remaining four are obtained through back-gears. The gears for the speed changes and also those in the feed box are lined with hardened steel bushings. The drive to the spindle is simple, power being transmitted through short shafts, the bearings of which are close together. The arrangement of the drive is similar to that used in recent vertical milling machine construction.

The Feeding Mechanism

All the feed changes are obtained through positive gears that are also encased and run in a bath of oil. A range of six feeds is available, which vary in geometrical progression from 0.006 to 0.040 inch per revolution of the spindle. These changes are made by means of a dive-key and back-gears. The feeding movement is transmitted to the spindle through a worm-gear of large diameter. This gear has mounted on it a dial graduated in thirty-seconds of an inch, that enables the operator to accurately measure the depth drilled. As these graduations are about ⅛ inch apart, obviously, finer measurements than 1/32 inch may be made by reading between the graduations. This dial, which is adjustable, is provided with a pawl that can be set to trip the feed at any point in 14 inches of the spindle travel, or if desired, the feed may be tripped by hand from the operator's position. A safety shear pin that is placed on the worm shaft protects the feeding mechanism from injury.

The Automatic Trip Mechanism

A detail view of the automatic trip mechanism is shown in section and elevation in Fig. 2, and the method of its operation

is as follows: If the feed is to be tripped automatically in 7 inches or less, pawl *H* is set as indicated by the dotted lines at *K*; if it is desired to trip the feed at a distance greater than 7 inches, pawl *H* is turned to the position shown by the full lines. For example, if it should be required to automatically trip the feed at a depth of 3 inches, the knurled nut *L* would first be loosened and the graduated dial *I* turned until the figure 3 on it was opposite the mark on pointer *J*, after which nut *L* would be tightened. The pawl *H* would then be set in the position shown by the dotted lines, with the result that when the drill had traveled 3 inches, the surface *M* would come in contact with the side *N* of the trip arm and disengage the feed. If, on the other hand, it were required to drill to a depth of 9 inches before the feed was automatically tripped, the dial *I* would be set with figure 2 opposite the mark on pointer *J*, and pawl *H* would be turned to the position shown by the full lines. With the pawl in this position, the contact of surface *O* with lever *N* would not throw out the feed, as the pawl, being loose on its stud, would simply turn and pass the tripping arm without moving it. After the pawl had passed the arm, it would then be in the position shown by the dotted lines, that is with the end *P* in contact with a projecting sleeve, thus preventing further rotary movement, so that when it again came around to the tripping lever, the feed would be disengaged. As one revolution of the dial is equivalent to a depth of 7 inches, it will be seen that by this simple arrangement, the feed is automatically controlled throughout a range of 14 inches. If the knurled nut *L* is loose, the feed cannot be automatically tripped at any point.

Operation of the Machine

The function of the various operating levers will be explained in connection with the elevation shown in Fig. 3. The levers *A* and *B* at each side of the column serve to start and stop the machine through the friction clutch pulley *L*. The lever *Z* mounted just above the feed box, operates the back-gears of the speed change mechanism, while handle *Y* controls the position of the dive-key in the speed box and gives four changes of speed which are indicated by raised letters, A, B, C, and D, which correspond with similar letters on an indicating plate that may be seen in Fig. 1. As before stated, these four speeds are doubled by means of the back-gears. The pull-rod *W* operates the dive-key for the feed changes, and its position is also determined by letters which correspond with those on the indicating plate. The six feeds are obtained by operating this rod in conjunction with pull-rod *X*, which is connected with the back-gears in the feed box. The lever *C* to the right of the machine, may be used to trip the feed by hand, while lever *D* throws the feed in after it has been tripped. The handwheel *E* operates the hand feed, the power feed being disengaged by pulling out this wheel and its shaft which disengages clutch *F*. The capstan handle *G* is for the rapid traverse of the spindle, the worm and gear being first disengaged by means of lever *C*. It will be seen that all the operating levers are conveniently placed; in fact, they are all within a space of 1 foot in height by 2 feet in width.

Miscellaneous Constructional Features

This machine is equipped with a lubricating system, the lubricant being taken from a tank which is located at the side of the machine. The pump is attached directly to the machine frame, and it is driven by a small round belt from the pulley hub. The lubricant, after being forced through the flexible nozzle onto the work, drains back through a strainer into the tank.

The table is of the bracket type and it is provided with extra large bearings on the column. It has a vertical adjustment of 15 inches by means of a large telescope screw that is operated by a crank at the front. This screw has been set off center to permit a boring-bar to pass through the table. The working surface of the table, which is 18 by 24 inches, contains two T-slots, and a large oil pan is provided on both sides and in the front.

The spindle of the machine is of forged high-carbon steel, and the thrust is taken on Hess-Bright ball thrust bearings. The spindle has a travel of 16 inches, and the end is bored to receive a No. 5 Morse taper. The maximum distance from the nose of the spindle to the table is 34 inches, and the distance from the center of the spindle to the face of the column is 12½ inches.

Tests

Tests made with the motor-driven machine illustrated in Fig. 1 which is equipped with a 25-horsepower constant speed, Westinghouse motor that is connected to the clutch pulley of the drill press by an 8-inch belt, showed a capacity for rapid drilling that exceeded the expectations of the designers. For example, in a test conducted by the Colburn Machine Tool Co., a 1½-inch drill was driven at the rate of 31.2 inches per

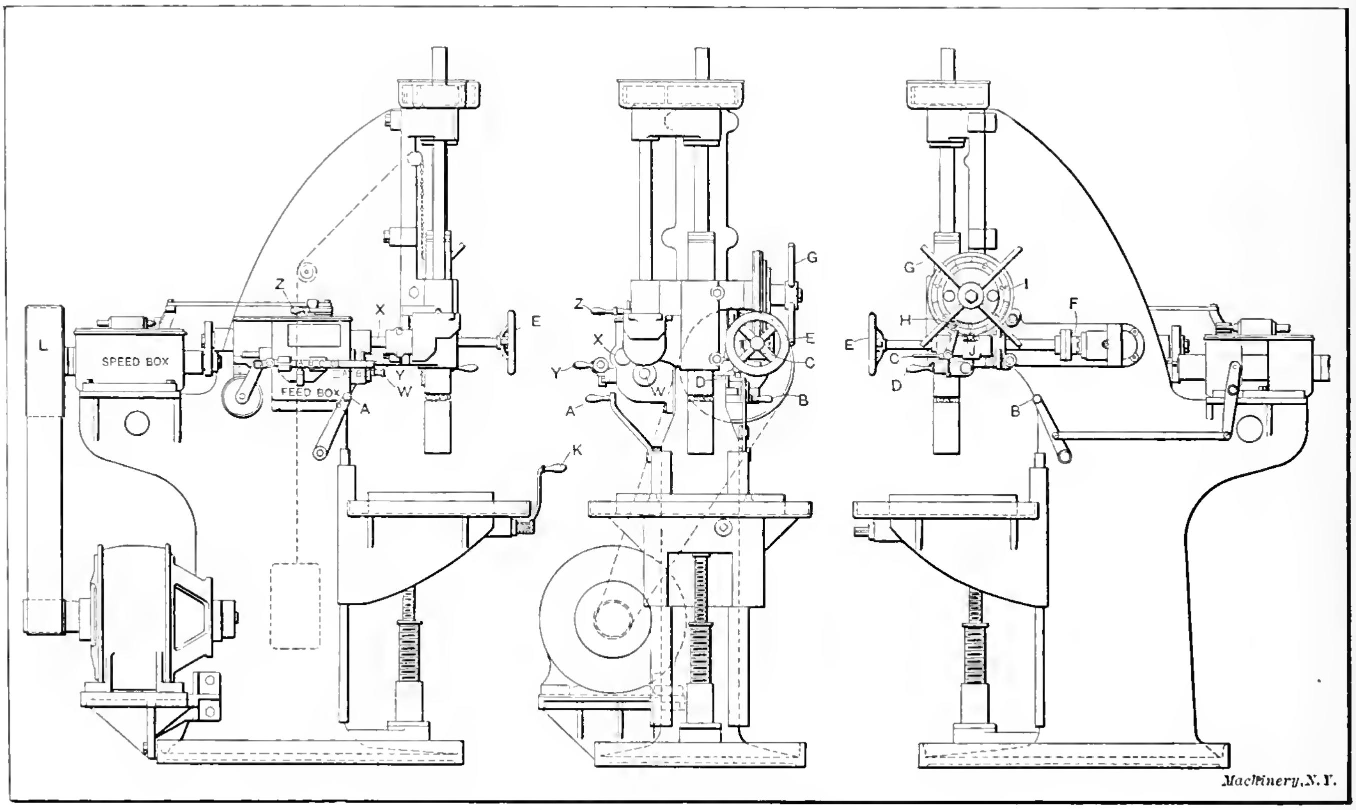


Fig. 3. Elevations of a Motor-driven Machine

minute, without injury to either the machine or drill, which illustrates in a striking way the power and strength of the machine. When, however, an attempt was made to use a little larger drill than this, the drill was burned. The makers believe, though, that it would be practical, when using a 1-inch drill, to drill holes in ordinary cast iron at a feed rate of 31.2 inches per minute. Another interesting experiment was made with a 3-inch drill, which was driven through cast iron at 11.25 inches per minute. The cutting speed was then increased from 147 feet to 262 feet per minute, without changing the feed, which gave a feed rate of 15.7 inches per minute. After the drill had penetrated to a depth of 3 inches, the fuse blew out, at which time the power consumption was 53 horsepower. Of course, this kind of drilling is not advocated, but was simply done to demonstrate the capacity of both machine and drill.

When the machines are electrically driven, the constant speed type of motor is employed. This motor is mounted on an extension of the base at the rear of the machine where it is out of the way. As the motor is located beneath the feed change box, there is practically no increase in floor space required when the motor drive is employed, as is plainly shown by the front elevation, Fig. 3. The manufacturers recommend a belt drive direct from the motor to the driving clutch pulley; this allows the machine to be started and stopped by means of the clutch without stopping the motor. Any make of constant speed motor can be used and the size should range from 5- to 20-horsepower, depending on the work to be performed.

FLICKINGER COMBINATION GAS ENGINE AND AIR COMPRESSOR

A combination gas engine and air compressor for supplying, simultaneously, power and compressed air, is now being manufactured by the Flickinger Iron Works, Bradford, Pa. Both the engine and compressor operate as a combined unit, one end of a single cylinder being used as an explosion chamber for developing the required power, while the other acts as a compressor. The arrangement is such that the machine can be instantly converted into a simple gas engine while running, and the compressor can also be thrown into commission at any time. This feature would be especially applicable to shops requiring power continuously and compressed air intermittently.

Exterior and sectional views of this gas-driven compressor are shown in Figs. 1 and 2, respectively. The gas engine or

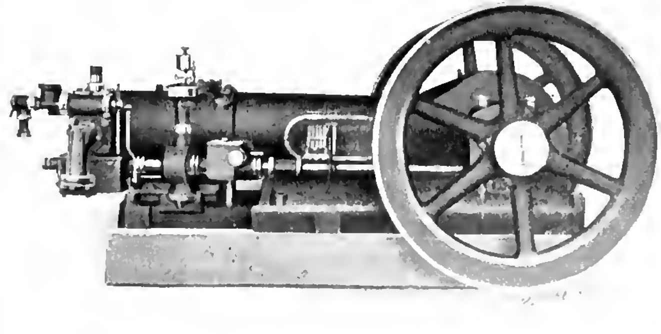


Fig. 1 Gas-driven Compressor which may be used as a Motor and Compressor, simultaneously

power end of the machine works on the four-cycle principle and it is identical in construction with the gas engine manufactured by this company. The special feature of this engine is the valve mechanism which consists of an automatic cut-off valve, controlled by a governor. This governor is of the centrifugal ball type, and the arrangement is such that the charge is throttled in proportion to the load. The ignition system used depends on the requirements, either a Bosch magneto, jump spark, or make-and-break system being employed. When the magneto is installed, it is mounted on the engine frame and driven by a transmission chain, connecting with the secondary shaft so as to make only one revolution for each spark. This spark can be advanced or retarded while the engine is running, and the same intensity of spark is produced when starting as when running at full speed.

The air compressor end of the cylinder is equipped with a mechanically-operated intake valve, which is similar to the Corliss engine valve. This valve, which is plainly shown in the sectional view, is at rest during the entire compression

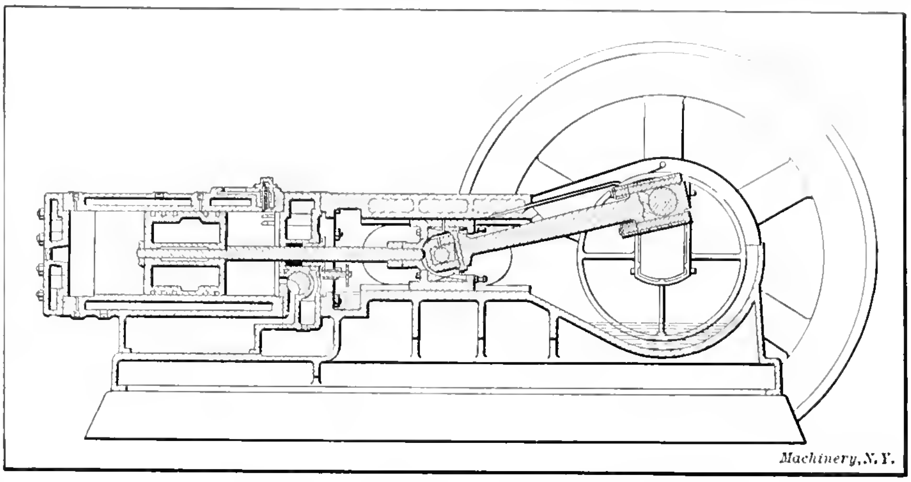


Fig. 2. Sectional View of the Combination Gas Engine and Compressor

stroke, which minimizes the wear. The discharge valves are of the standard poppet type, and have removable guides which can be taken out without breaking any pipe connections. The valves on the motor end of the cylinder are of the mushroom type. The exhaust valve is operated by a cam on the lay-shaft, while the inlet valves are opened by the vacuum created during the suction stroke. These valves, which are provided with dash pots to insure smooth working and easy seating, are so arranged that the incoming charge strikes against and cools the exhaust valves. The cylinder is furnished with a water-jacket throughout its entire length, and the front and back heads are also water-jacketed. The bed is of the bored-guide type and the main bearings are provided with interchangeable bronze liners which can be renewed at any time. The crankshafts are of the center-crank type and the journals are ground true on a special machine. The connecting-rods are forged from solid steel billets and are provided with a screw and wedge take-up on the crosshead end, and solid bronze boxes. The crank end is of the marine type and has steel boxes lined with genuine babbitt metal. All parts are made of high-grade material and the engine is rigidly constructed throughout.

These machines are built with single cylinders in sizes up to 50-horsepower. They are also made in the duplex and tandem types up to 100-horsepower and with the duplex tandem arrangement in larger units. The duplex engine can be furnished with only one side fitted with a compressing cylinder, if the power requirements are greater than those of the air.

ELMORE SENSITIVE DRILL PRESS

A very compact and conveniently-operated sensitive drill has been brought out by the Dwight Slate Machine Co., Hartford, Conn. This machine, while in the "sensitive" class, has been rigidly and substantially constructed to enable it to meet the demand for the higher speeds which the new alloy steel drills now employed have made possible and desirable.

Perhaps the most striking feature of this new design is the form of belt drive employed. This drive is so arranged that several changes of speeds may be quickly obtained while the machine is in motion, without leaving the operating position, or shifting the belt either on cones or in tension. By referring to Figs. 1 and 2, which show, respectively, single and multi-spindle machines, it will be seen that connection from the pulleys on the drive shaft to the pulleys on the spindle, is made by an endless belt. This belt, which is $1\frac{1}{4}$ inch wide and

17 feet long, passes around two driving pulleys of different diameters at the rear, and over suitably arranged idlers to two driven pulleys on the spindle. Between each of these sets of pulleys, friction clutches have been interposed, the clutch for the spindle being operated by the small crank seen near the top of the column, and the clutch for the driving pulleys by a similar crank located on the column just opposite the driving shaft. It is by means of these levers, which are self-locking in all positions, that the speed changes, of which there are four ranging from 500 to 2050 revolutions per minute, are obtained. The lower lever, which operates the clutch between the driving pulleys, also controls the starting and stopping of the machine. This construction, therefore, makes it possible to start and stop any spindle of a multi-spindle machine, independently of the others. This independent feature makes it unnecessary to employ tight and loose pulleys, the machine being equipped with constant speed drive on a single pulley.

An indicating plate, which is attached to the column, shows graphically the relative positions of the upper and lower clutch handles for obtaining the various speeds. For example, when both handles occupy a vertical position both clutches are disengaged; by moving the lower one to the left and the upper one to the right, a speed of 500 revolutions per minute is obtained; by shifting the lower one also to the right, this speed is increased to 800 revolutions per minute, etc.

The pulleys on both the driving shaft and spindle are mounted on stationary hollow quills, which arrangement relieves both the spindle and driving shaft from all belt stress. The proper tension of the belt is obtained simply by turning a knurled nut through which the screw of the idler yoke at the rear passes.

The spindles of these machines are bored with a No. 2 Morse taper hole and each spindle is counterbalanced by a flat coiled spring located in the sliding head. These springs can be adjusted to exactly counterbalance the spindle, or so as to automatically return it to its upper position. The feeding lever may be easily moved in or out for obtaining varying degrees of leverage, and it is automatically retained in any position desired by the same spring which counterbalances the spindle. Positive depth stops are mounted on each spindle quill within easy reach of the operator.

In order to make frequent oiling unnecessary and to eliminate friction as far as possible, ball bearings are used throughout. All cones and raceways are carefully hardened and ground. The clutches employed are of the simple cone type and are of large proportions, considering the duty imposed on them.

As each unit of a multi-spindle machine may be operated independently of the others, a continuous drive shaft connecting all the spindles may be used, in which case they would have the same ratio of speed changes. If it is desirable, however, an independent drive can be provided for each spindle by using varying sizes of pulleys on the lineshaft, so that the spindles can have a different speed ratio. For example, with a three-spindle machine, the speed of two of the spindles could be controlled by one drive shaft, thus providing a suitable ratio of speeds for the drilling operations, while the third spindle could be driven independently and at the proper speed for tapping, counterboring, facing and similar operations. This feature adapts the machine particularly to varied classes of work.

Another good point in the construction of this tool lies in its compactness, a comparatively small amount of floor space being required. The projected floor space for a single-spindle machine is only 20 by 33 inches, while that of one with 6 spindles is 34 by 63½ inches. As it is unnecessary for the operator to make adjustments at the rear, rows of these drills may be set back to back, thus effecting a considerable economy in the matter of floor space.

These tools are built with any number of spindles up to and including six. The distance from the center line of the spindle to the face of the column is 8 inches. The total traverse of the spindle is 13 inches, and the maximum distance from the table to the spindle is 32 inches on the single-spindle type, and 26 inches on the multi-spindle machines, which, as Fig. 2 shows, are equipped with a table-raising device. The approximate net weights of the single- and six-spindle types are 500 and 2150 pounds, respectively. The company is prepared to equip this tool with an electric drive if desired. When this form of drive is employed, the motor is mounted on a separate bracket which is attached to the rear of the column.

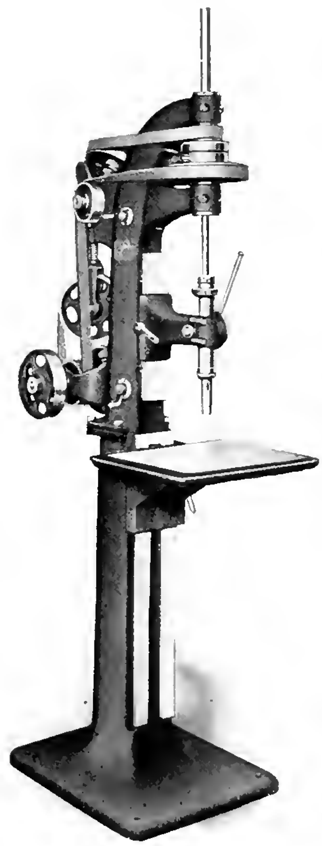


Fig. 1. Single-spindle Sensitive Drill Press, built by Dwight Slate Machine Co.

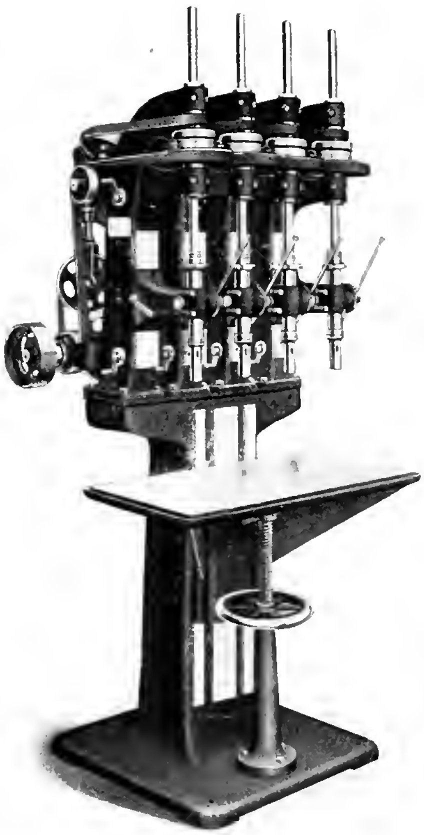


Fig. 2. A Dwight Slate Machine of the Multi-spindle Type

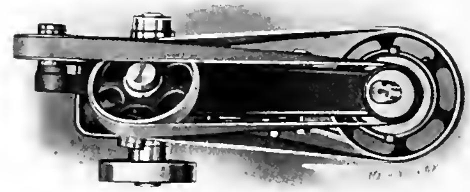


Fig 3. Plan View of the Belt Drive

BAIRD TOOL AND DIE GRINDER

The Baird Machine Co., of Oakville, Conn., is now manufacturing the tool and die grinder illustrated in Fig. 1. This machine is intended as an all-around grinder for the tool-room or for general work, and it can be used for the grinding of punches, dies, automatic machine tools, lathe and planer tools, etc. It consists of a neatly designed column on which is mounted a tool steel spindle carrying an emery wheel on each end. An adjustable tool rest is provided for one wheel to support lathe, planer or similar tools, while beneath the opposite wheel there is a table on which may be supported punches, dies and similar tools while they are being ground. The bracket on which this table is mounted can be easily and quickly adjusted vertically on the column. It is clamped rigidly in the desired position by a cam and lever, and a counterweight connected with the bracket and contained in the pedestal, keeps it from falling when the clamp is released. This counterweight also makes it easier to raise or lower the bracket. In addition to the adjustment of the bracket on the

column, a fine adjustment is provided for the table that is obtained by means of the small handwheel shown in the illustration. This fine adjustment, which has a range of 1 inch, is desirable for the grinding of dies and similar work. The maximum adjustment of the bracket on the column is 12¾ inches. The construction of the spindle and its bearings is shown in Fig. 2. The spindle has ground taper bearings which run in bronze boxes, the composition of which is the same as that required by the United States Government for bearings. These boxes are dustproof and they have simple adjustments for taking up wear, as the engraving indicates. They are provided with ring oiling devices and they can easily be replaced with new ones when this is necessary. The height from the floor to the center of the spindle of this machine is 40 inches, and the distance between the wheels is 15¼ inches. The distance from the top of the table to the center of the spindle with the table and bracket in the lowest position, is 15¾ inches, and the surface of the table is 10 by 18 inches. Two emery wheels, 12 inches in diameter with a 1-inch face, a set of wrenches, water tank, and a countershaft are furnished with this machine. The countershaft is provided with a slotted lever shipper that is operated by simply twisting a rod, and it is locked in either the on or off position.

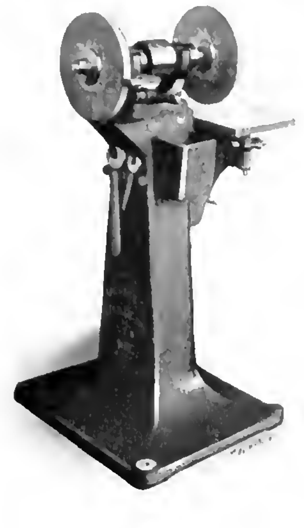


Fig. 1. Baird Tool and Die Grinder

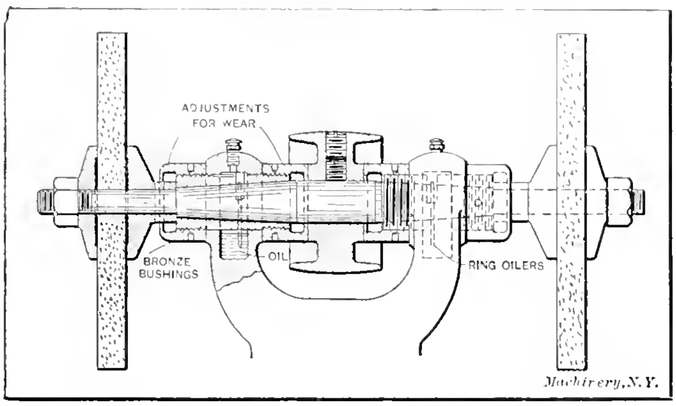
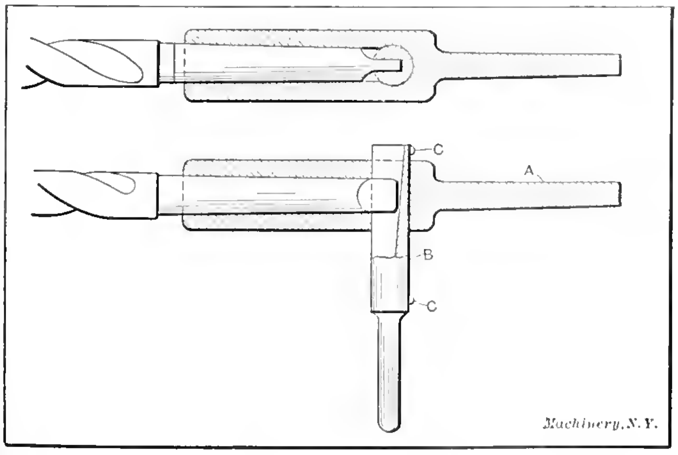


Fig. 2. View showing Construction of Spindle

LINSLEY LATHE DRILL HOLDER

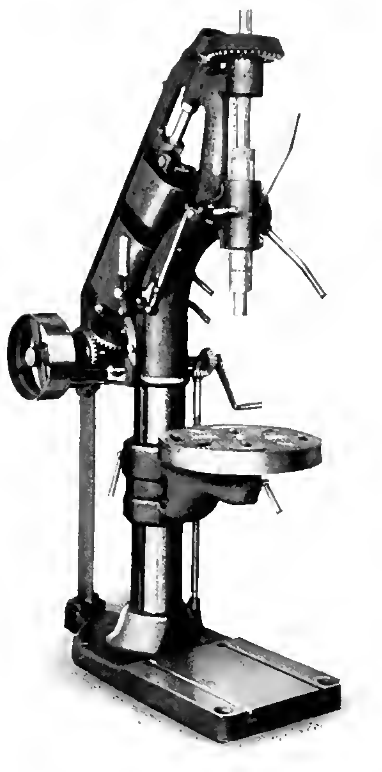
A drill holder for the lathe, which has been brought out by the Linsley Tool Co., 13370 Superior Ave., Cleveland, Ohio, is shown in the accompanying line engraving. The shank *A* of this holder is turned to fit the tailstock spindle, and the outer part or body is bored to fit the drill or tool-shank. A cross-shaft or pin *B* is provided, that slides loosely in a hole bored through the holder. This cross-pin has a groove cut in it, the sides of which extend down over the tang of the drill, thus preventing the latter from turning in the holder. As the bottom of this groove is cut on an incline, the pin *B* is also used to force the drill from the holder. When the holder is in use, the end of pin *B* rests on the lathe tool-rest. The two screw-heads *C* prevent the two parts of the holder from becoming separated when it is not in use.



Drill Holder for the Lathe

BARNES ALL-GEARED TAPPING MACHINE WITH AUTOMATIC REVERSE

In the department of New Machinery and Tools for May, 1908, and November, 1909, we illustrated and described the 20- and 24-inch all-geared drills built by the Barnes Drill Co., 602 S. Main St., Rockford, Ill. This company has now brought out a new design, which, while of the same general construction as those previously described, contains some noteworthy improvements. By referring to the accompanying illustration, it will be seen that this drill, which is of the automatic reversing type, has a single pulley for driving and reversing. A reverse speed of 1¾ to 1 is obtained by means of friction clutch gears which are mounted on the driving end of the machine instead of being on the spindle. The automatic reversing mechanism is a very desirable feature, particularly for depth tapping. It can be set so that the instant the tap reaches the required depth, the spindle will automatically reverse and back the tap out at practically twice the speed at which it entered. This mechanism can also be set so as to trip automatically (or by hand) and stop the spindle instantly without reversing its movement. The spindle may be reversed or stopped at any time by a small trip lever which is conveniently located. This machine has four direct, geared speeds and four back-geared speeds, making eight changes of geared speeds available.



Barnes 20-inch All-geared Tapping Machine with Automatic Reverse

This type is built in 20- and 24-inch sizes, and the makers claim that these machines are the strongest and most powerful upright drills of their swing. The 20-inch machine drives a 1¼-inch U. S. standard tap, running at 125 revolutions per minute into cast iron, without using the back-gears. When the back-gears are thrown in, a 1½ inch U. S. standard tap may be driven into cast iron at a speed of 50 revolutions per minute, while the 24-inch size will drive a tap up to 2 inches in diameter. With the positive power feeds added to these machines, they can be used advantageously for both drilling and tapping.

LODGE & SHIPLEY CRANKSHAFT LATHE

In the department of New Machinery and Tools of the June, 1909, number of MACHINERY, we illustrated and described a lathe manufactured by the Lodge & Shipley Machine Tool Co., Cincinnati, for turning the ends of automobile crankshafts of 2½ inches throw. Recently this firm has built a lathe for

turning much larger crankshafts, a general view of which is shown in Fig. 1. This machine is a standard 36-inch patent head lathe raised in the sand to swing 42 inches over the shear. The special attachment for holding a shaft while it is being turned, is illustrated in Figs. 2 and 3. This attachment can be easily adjusted to bring the crankpin center into alignment with the axis of the lathe spindle, and it also affords a powerful drive and rigidly supports the crank so that there is practically no springing action when taking a cut.

A swiveling chuck *A* attached to the faceplate, carries one end of the crankshaft by securely gripping it in a bearing having a hinged cap. The base upon which the chuck swivels, has a tongue which fits a planed slot passing through the center of the faceplate. This chuck can be placed with its center coincident with the center line of the lathe to turn shaft bearings, or it can be set eccentrically to any desired amount within its range, for turning crankpins. The swiveling base allows the attachment to be adjusted for shafts having pins located at different angles. A steel strip *B* bolted in the slot at one side of the chuck-plate, locates the chuck at just the proper distance off center to give the correct throw for the crankpin to be turned. The weights shown attached to the faceplate opposite the chuck are for counterbalancing both chuck and crankshaft.

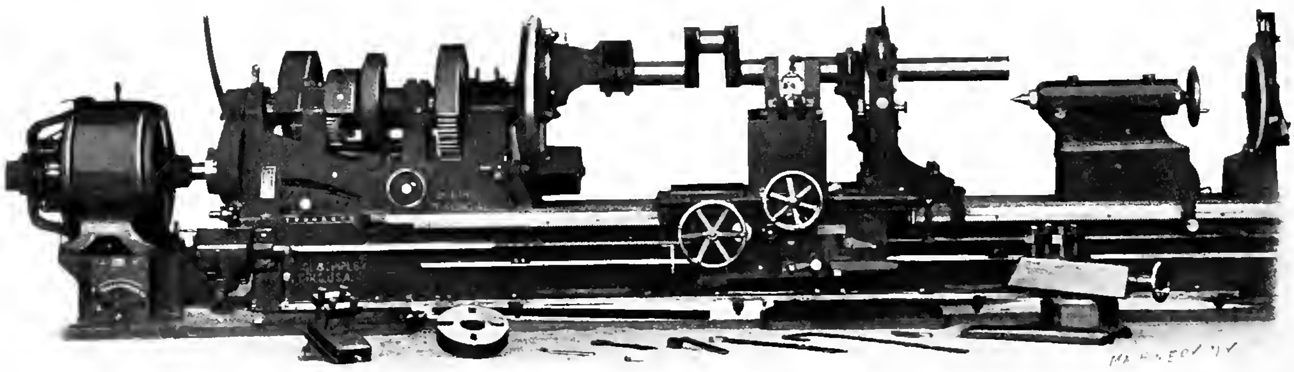


Fig. 1. Large Crankshaft Lathe built by the Lodge & Shipley Machine Tool Co.

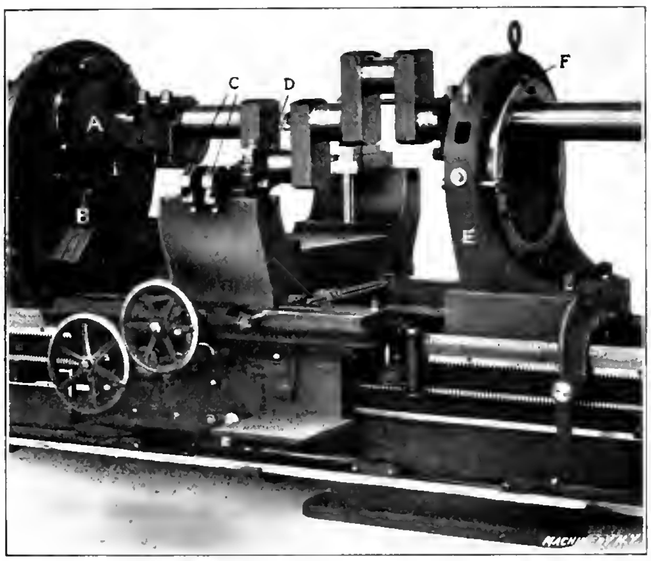


Fig 2. View showing the Crankshaft Turning Attachments

When turning the pins, the outer support *E* holds the tail end of the crankshaft. This outer support is a carrier chuck, but not a driving head, as the drive for the crankshaft is from the faceplate end only. The shaft is held at the proper distance off center by being gripped in the hinged bearing *M* which is attached to the central rotating chuck. There is an annular bearing *F* in the outer support, so that the chuck carrying the eccentrically-located shaft is free to revolve. Thus the clamping bearings of both the swiveling chuck and the outer support, always remain in line as the shaft revolves. This outer support also serves as a steady-rest, by gripping the shaft close to one of the crank webs.

Locking pins *H* and *N* bring the two clamping bearings into exact alignment with each other before the hinged caps are finally tightened to grip the crankshaft. The faceplate locking pin is carried in a bracket attached to the inner ways of the bed. A star knob on the front of the bracket furnishes convenient means for sliding the pin into or out of its seat in the faceplate. The locking pin in the outer support is similarly operated. Before placing the crankshaft in the lathe, the two locking pins are slipped into their seats, which exactly aligns both chucks, so that the shaft can be placed in them and gripped without danger of springing. The locking pins are then withdrawn, leaving the chucks and shaft free to revolve.

Connected front and rear tool-rests are used, both rests being cast in one piece with the long cross-slide that is mounted upon the bridge of the carriage. This slide has power feed as well as hand movement. An upright post gives a firm support to each tool almost out to the cutting point, and prevents excessive overhang. The front block carries three tools. Two of these tools *C* are for facing the cheeks of the shaft and are carried in a hinged holder so that they can be thrown back when not in use; the third tool *D* turns the cylindrical portion of the pin. The rear tool-rest has a holder *K* containing two cutting tools spaced just the proper distance apart to fillet the ends of the pin, and thus determine the length of the portion which is to be turned.

Since the special fixtures are needed only for turning the pins, our description has covered that work only. The turning of the bearings is a separate and previous operation, being straight turning between centers with the outer support removed, the swiveling chuck on the center of the faceplate and the tailstock center supporting the other end of the crankshaft.

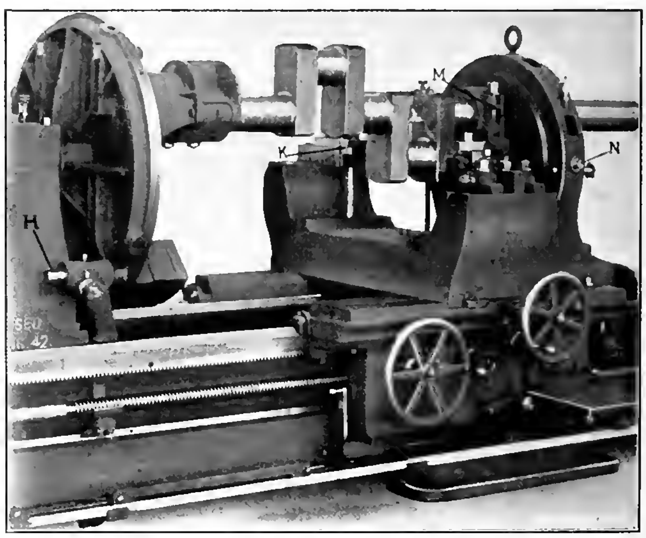


Fig 3. Another View of the Turning Attachments

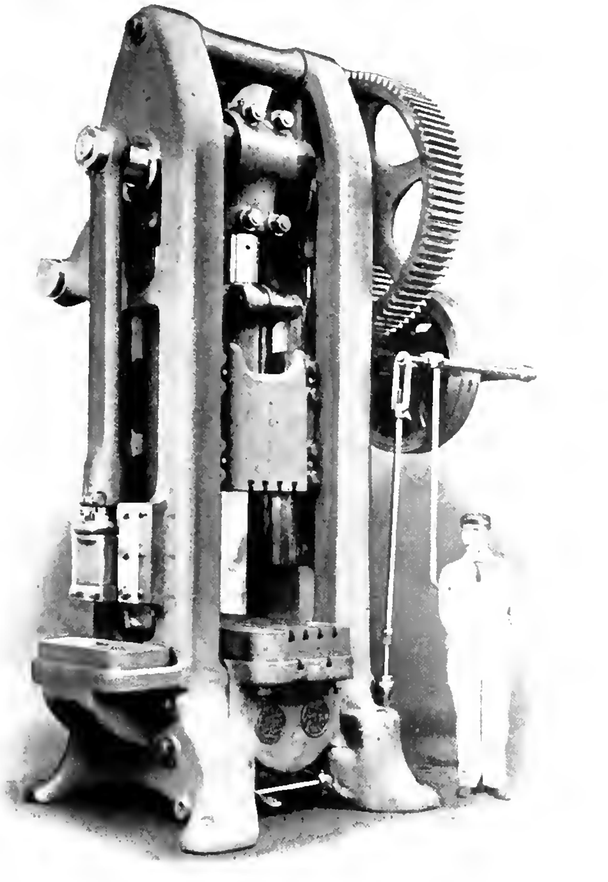
Multiple stops for length and cross feeds are included in the equipment, and greatly increase the output. These stops have already been described in detail in our description of the smaller crankshaft lathe. We will therefore merely mention here that the longitudinal stops positively determine the correct location of the carriage for all fillets and shoulders, and

that the diameter stops locate the cross-slide to give proper finished diameters when either the front or the rear tools are cutting.

Even when the lathe is not used for turning crankshafts, it will be found a valuable manufacturing tool. The equipment also includes the regular engine lathe parts, such as a small faceplate, compound rest, full swing rest, and wrenches. The crankshaft attachment can be quickly removed from the lathe, and the compound rest substituted for the connected front and rear tool-blocks, leaving the machine in shape for handling the full range of work suitable for an engine lathe.

LARGE FERRACUTE TRIMMING PRESS

The Ferracute Machine Co., of Bridgeton, N. J., has recently built from designs of its president, Mr. Oberlin Smith, several heavy trimming presses for use in a prominent locomotive works. Some of these presses are intended for pressures of 300 tons and others for 200 tons, the illustration showing one of the 300-ton presses. This machine contains a side punch for similar work of a lighter character, thus adding considerably to the capacity of the press. The distance between the columns is 32 inches and the bed measures 30 inches across and 50 inches from front to back. As the engraving shows, the bed, bolster, and ram contain T-slots for die-clamps. The bed of the side punch is 15 by 30 inches. The stroke of the

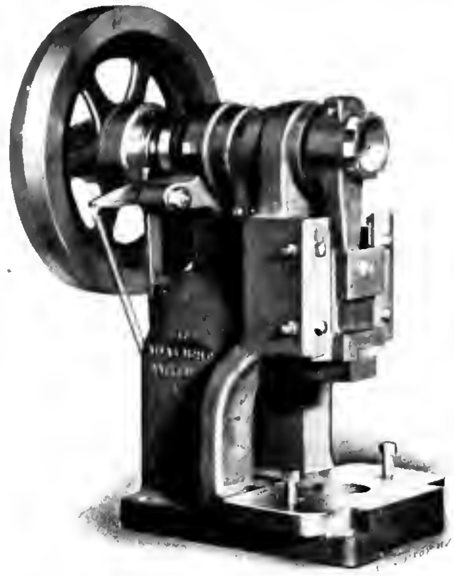


Ferracute Trimming Press of 300-ton Capacity

main press is 12 inches with a 10-inch adjustment, and the side punch has a stroke of 3 inches. The height from the bed to the ram with the latter at the top of its stroke and adjustment, is 34 inches. The drive of the machine is double-geared, the power being transmitted from the flywheel shaft by a pinion and gear to an intermediate shaft at the rear which, in turn, through a second pinion, drives the large gear which is mounted on the main shaft. This arrangement gives a gearing ratio of 50 to 1. The main shaft is a steel forging having a diameter of 9 inches at the journals and 11 inches at the crank. The flywheel is 40 inches in diameter, has a 7-inch face, and weighs 1100 pounds. This press is equipped with a friction clutch which enables the operator to start or stop it at any part of the stroke. The machine occupies a floor space 10 feet by 7 feet 6 inches. Its height is 14 feet, and the weight, approximately 68,500 pounds.

ATLAS BENCH POWER-PRESS

The small bench power-press illustrated herewith has been designed by the Atlas Machine Co., Waterbury, Conn., to meet the demand for a medium weight machine of this type. One of the interesting features of this press is the new one-revolution positive stop clutch which is simple in construction and at

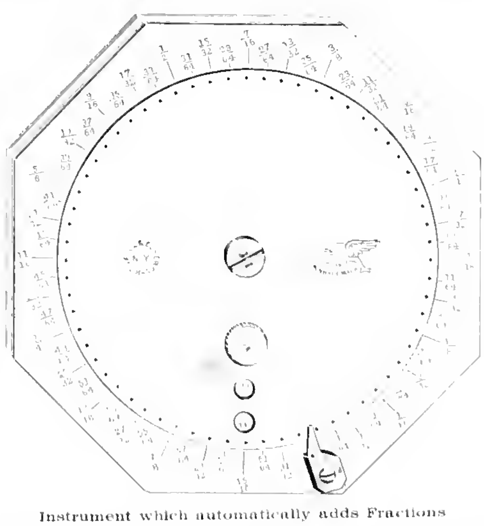


Bench Power Press made by the Atlas Machine Co.

the same time sure in its operation. This clutch, which is operated in the usual manner with a foot-treadle, is released by the striking of a cam point against a knuckle piece, that in its movement slightly raises the pull-down latch and at the same time pushes it off the clutch lever, thus releasing the lever in ample time to engage the driving key which, in turn, pulls out and stops against a positive projection, thus making it impossible for the press to repeat. To arrange the machine for continuous running, it is only necessary to loosen a nut and drop the knuckle piece against which the cam point strikes. In this clutch there are few parts to wear or to become broken, and all the parts are operated by a single spring which is of considerable length, as the engraving indicates. The stroke of this press is 1½ and 2 inches. The height from the bed to the gate (when down) is 7¼ inches, and the die-bed has a surface of 13 by 8 inches. The weight of the press complete is 375 pounds.

KEUFFEL & ESSER FRACTION ADDER

A very simple but practical instrument, by means of which fractions may be quickly added, is illustrated herewith. This fraction adder can be used for adding fractions of 64ths, or



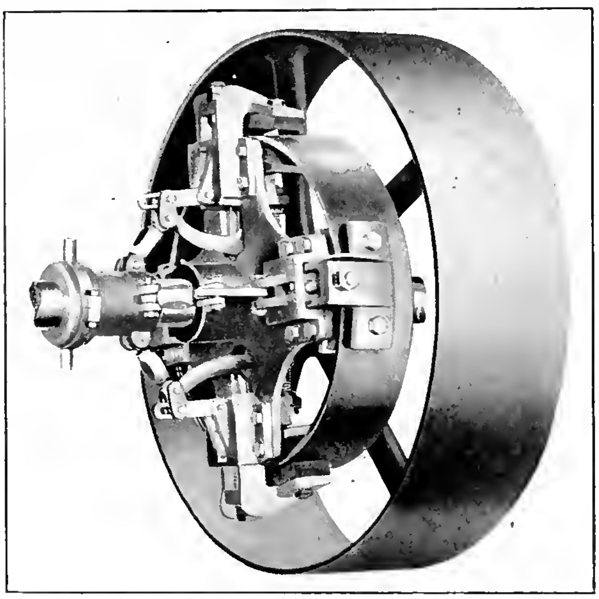
Instrument which automatically adds Fractions

multiples thereof, up to 16 integers. A white xylonite disk which revolves on an octagonal polished wood base covered with white xylonite, has near its circumference sixty-four indentations which correspond in position to the fractional grad-

uations marked on the base. At the lower edge of the base a nickel-plated stop is attached which projects over the disk as shown. If a pointed instrument or pencil point is placed in the small indentation at the circumference of the disk opposite the fraction to be added and the disk is rotated until arrested by the contact of the stop with the pointer, the fraction at which the pointer was originally set will be shown on the counter, providing the latter was set to zero by means of the milled head screw shown, before performing this operation. To add to this fraction any number of fractions, it is simply necessary to place the pointer in the indentation opposite each fraction to be added, and rotate the disk each time until the pointer comes against the stop. The counter will show each successive total through the two windows in the disk, one of these openings giving the integer and the other the fraction. The usefulness of this device will be at once appreciated by those constantly engaged in the checking of drawings or in other computations involving the addition of fractional parts. This instrument is the product of the Keuffel & Esser Co., 127 Fulton St., New York.

LEHIGH RIM FRICTION CLUTCH

A clutch that is especially adapted to high speeds and is suitable for motor-drives or wherever a quick-acting and powerful clutch is required, is illustrated herewith. This clutch, which is made by the Lehigh Clutch Co., Catasauqua, Pa., is of the opposite jaw type, that is, there are two jaws on each arm, making four sets in all, which grip the friction ring both on the outside and inside as the engraving indicates. In operation the outer jaw is drawn toward the center of the clutch and the inner one is forced away from it, the friction ring being gripped between them. A separate positive-acting lever and link are employed to operate each jaw, and connection is made with the spool by special turnbuckles. When the shoes wear, these turnbuckles provide convenient means for adjustment. No springs are used to release the clutch, but the jaws are moved from the rim by positive-acting levers, which are so arranged that the clutch may be engaged or disengaged, it is stated, with less power than is required for any other clutch of equal capacity.



Lehigh Rim Friction Clutch

The construction of this clutch is such that either the inside or the outside jaws may be adjusted independently without disturbing the other member of the pair. The wooden shoes or friction blocks which bear against the rim may be renewed, when necessary, in a very short time, as all that is required is to move the jaws away from the friction ring, loosen the two bolts holding the wooden shoe in place, and slide it along the friction ring until it clears the jaws.

The spider, the spool and the jaws are made of a special mixture of cast iron, while the operating levers and those parts which are subjected to severe strains are made of malleable iron. Each piece of the clutch is finished in jigs, thus making them interchangeable and easy to replace when necessary. This type of clutch is manufactured in all sizes from 12 to 84 inches in diameter and for transmitting from 4 to 1350 horsepower at 100 revolutions per minute.

THE DAVIS EXPANSION BORING TOOL

The Davis Expansion Boring Tool Co., Broadway and Bremen Ave., St. Louis, Mo., has developed a number of improved boring tools, one type of which we illustrate herewith. The particular tool shown, which is known as the style A head, is intended to be screwed onto the end of an ordinary arbor or shank, and it is suitable for use in either the lathe, boring mill, or drill press. One of the points of superiority of this tool over the ordinary cutter used, lies in the ease and quickness with which it can be adjusted to compensate for wear. This feature is, of course, of considerable value when boring to a given size, owing to the fact that it enables the use of higher speeds than would be considered practical with the ordinary non-adjustable tool, as the increased wear of the cutter incident to the higher speeds can be quickly taken up. This tool is adjusted to any size within its range by simply inserting a key wrench in the squared hole of the screw. This screw, which is graduated to give micrometer adjustment, operates a double-expanding tool-steel wedge that comes in contact with the cutters and forces them outward. As the expanding wedge is hardened and accurately ground to obtain a good contact with the cutters, the latter, as far as rigidity is concerned, are practically as one piece. The adjustable feature of this tool is also valuable in connection with grinding the cutters, as grinding to an exact size is immaterial, owing to the possibility of adjustment. Both cutters should, of course, be ground square, to the same length, and have proper clearance for the cutting edges, the same as with the solid type. These tools are made in all styles and in twenty-one sizes to meet the requirements and conditious of every shop.

Davis Expansion Boring Tool

ROCKFORD 14-INCH ENGINE LATHE

The engine lathe shown in the accompanying engraving is of a design that is well adapted to the work of the tool-room, as well as to general manufacturing purposes. This machine is the latest addition to the line of tools manufactured by the Rockford Lathe & Drill Co., Rockford, Ill.

The headstock of this machine is heavily constructed and it is fitted with a 5-step cone with wide face, thus making possible a powerful drive. The bearings are large and they are fitted with the highest grade of babbitt metal obtainable. The spindle has thrust bearings which are also of large proportions and the thrust can easily be taken up or adjusted in a few minutes. The tailstock is of the offset type so that the compound rest can be swung around 90 degrees or parallel with the bed. An eccentric lever is used for clamping the tailstock so that it is possible to quickly adjust it without the use of a wrench. In addition there is an auxiliary locking arrangement for securely fastening it to the bed when doing heavy work.

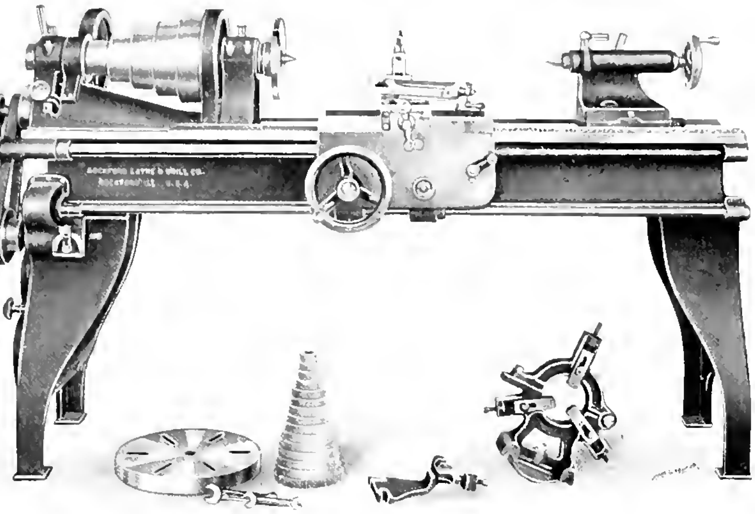
One of the striking features of this machine is the addition of a third bearing in the center of the bed which forms a rigid support for the carriage and insures a steady cut and the elimination of all chatter. This support is provided with a taper block which makes it possible to compensate for wear. The carriage is of a heavy pattern and the carriage-slide is dust-proof, as well as chip-proof, protection being afforded by means of a cover.

All shafts in the apron have double bearings so that the

strains are well taken care of, and the worm runs in oil. The cross-slide has a specially designed locking nut which makes it possible to quickly lock the compound rest or tool-slide at any point along the screw. This is a desirable feature in connection with the use of a taper attachment, as it is only necessary to loosen this nut, and there is no danger of dirt getting down into the screw.

The feed is by belt drive to a gear-box by means of which three changes, controlled instantly by a lever, are obtained. As two-step cones are provided, this number is doubled, making six feeds in all. The width of the feed belt is 1¼ inch, which, combined with the ratio of gearing in the box, gives a powerful drive.

The bed is of the heavy box pattern and it is so arranged that a taper attachment can be applied at any time. The legs supporting the headstock end of the bed contain a cabinet which has shelves enough to accommodate all the change



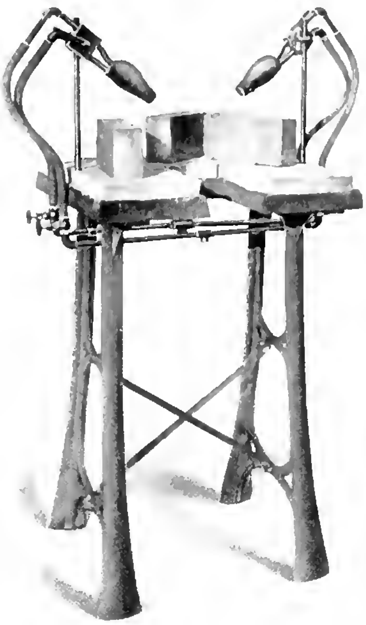
Fourteen-inch Engine Lathe built by the Rockford Lathe and Drill Co.

gears, thus keeping them free from dust and dirt. The central hole of the faceplate furnished with this machine is made just large enough to admit the center thus making it possible to use this extra surface when boring small jigs and similar work, which could not be held on the conventional faceplate owing to the diameter of the central hole.

This lathe is particularly adapted to tool-room work, as it has a thread-cutting capacity ranging from 1 to 92 threads per inch. So far as we know, this is the largest range of threads that can be cut on any lathe. This machine swings 16 inches over the bed and 9¼ inches over the carriage. The diameter and lengths of the front and rear headstock bearings are, respectively, 2½ by 4 and 2⅛ by 3 inches. The length of the bed is 6 feet 6 inches and the maximum distance between the centers, 36 inches. The net weight of the machine is 1900 pounds.

SCOTT BRAZING FURNACE

The brazing furnace shown in the accompanying engraving is a recent design brought out by C. U. Scott, Davenport, Iowa. This furnace may be operated by city gas or gasoline, and it is provided with two burners which are mounted on standards located at each side of the table. The blocks by which the burners are attached to the standards may be adjusted (by loosening a handle nut) in either a vertical or horizontal plane or vertically on the standards, so that the flame from the burners can be brought to bear on any part of the top of the furnace. Connection with the air and gas pipes is made by flexible hose, and valves at the side of the table provide convenient means for proportioning the mixture admitted to the burners. As the engraving shows, the top of the furnace is supported on well-braced legs, and it has a rectangular opening in the center through which long parts can extend. Two important features claimed for this furnace are, that the heat can be taken without scaling work and the burners will not blow out while in operation. As soon as the burners are lighted, a temperature of 1872 degrees is available.



Scott Brazing Furnace with Two Adjustable Burners

HOEFER CONNECTING-ROD DRILLING AND FACING MACHINE

The manufacturers of automobile engines have realized the necessity of performing the various operations on the motors with machines especially adapted to work of this class. Heretofore, considerable motor work has been done on standard machines which required many changes, in order to adapt them to certain operations, which of course affected the output. One of the expensive operations in the manufacture of automobile engines is the connecting-rod, which requires accuracy and perfect alignment, both in drilling the holes and facing the ends. After studying the problem, the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill., has designed a special machine for this purpose, which drills and faces accurately both ends of the engine connecting-rod without the necessity of changing the rod in the jig, or changing the tools or drills.

The principle of the machine, front and rear views of which are shown in Figs. 1 and 2, is extremely simple and its operation can be readily mastered by comparatively inexperienced men. The attachment and operating devices are so arranged

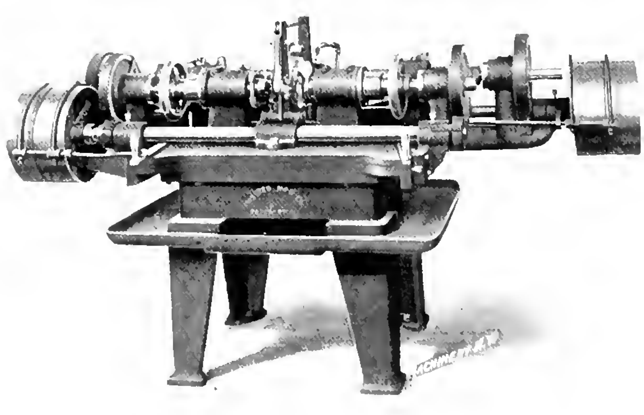


Fig. 1. Front View of Hoefer Connecting-rod Drilling and Facing Machine

that it is almost impossible for the operator to produce defective work. The machine consists principally of two heads, which are adjustable and gibbed to a solid bed. One of these heads carries the drilling spindles for both the large and the small ends of the connecting-rod, and the other head has two spindles in which are placed the facing tools for the ends of the rods. The connecting-rods are placed in a trunnion jig which has hardened steel jaws operated by a quick-releasing screw. The jaws clamp the rod firmly during the operations of both drilling and facing, as but one setting of the rod in the jig is necessary to complete it, which gives the best possible results.

After the rod has been set, an eccentric lever on the two

projecting arms is locked, thus giving additional support to the rod for high-speed drilling. The small end of the connecting-rod is drilled first by throwing in a power feed lever. While the drill is removing the stock, the operator, by means of two handwheels shown in Fig. 1, faces the sides of the large end, and as the cutters face concentric with the holes, a very

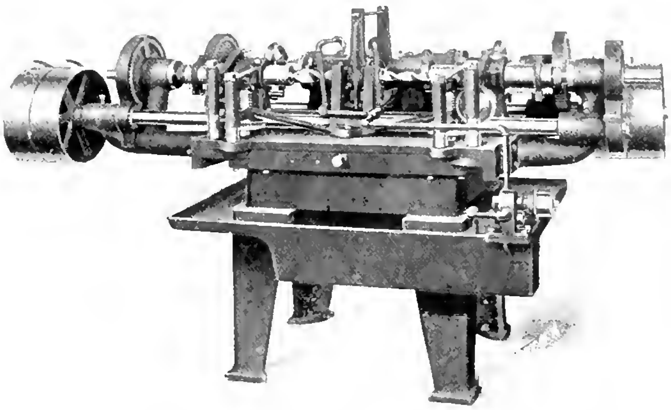


Fig 2. Rear View of Connecting-rod Drilling and Facing Machine

good finish is secured. When these operations are completed, the eccentric lever is opened and the trunnion jig is swung 180 degrees against an adjustable positive stop. After clamping the ends of the rod again by means of the eccentric lever, the power feed of the large drill spindle is thrown in and the large end is drilled while the operator faces the small end. As the spindles are in perfect alignment with the trunnion jig which carries the connecting-rod, absolute accuracy is assured. In each end of the trunnion is placed an adjustable positive stop (steel hardened) for the facing tools, and each end of the rod, as it is swung from one position to another, carries with it its own stops so that when once set, all dimensions are duplicated.

The spindles are made of a crucible steel, carefully ground and run in bronze bushed bearings. They are driven through gearing by wide-faced pulleys which rotate at a high speed, thus insuring ample power. The two drilling spindles are driven by one driving shaft, but the gearing is proportioned to give the proper speeds for the large and the small drills. The two heads carrying the drill and facing spindles are gibbed to a heavy bed and are adjustable for connecting-rods varying in length from 10 to 14 inches.

With ordinary connecting-rods, it requires about five minutes to drill and face both ends; this time includes picking up the rod, fastening it in the trunnion jig, and taking it out of the jig. Even better time than this has been made on a day's run.

As there is but slight variation in the holes of ordinary connecting-rods, the machine was designed for but one speed. The feed also has but one speed, so in neither case can the operator change the speed or feed.

ELECTRICALLY CONTROLLED REVERSING DRIVE FOR POND PLANERS

An electrically controlled reversing mechanism for direct motor-driven planers, characterized by its remarkable simplicity, has recently been applied by the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J., to the regular line of heavy planers brought out by this company. Some of the advantages of this reversing drive are that the overload on the motor at the time of reversal is reduced to a minimum; that it is possible to obtain very short strokes of the platen without any perceptible shock, and without injury or abnormal wear to the mechanism; and that the platen motion becomes practically positive, the platen stopping at the end of every stroke within a limit of variation of less than one-eighth inch.

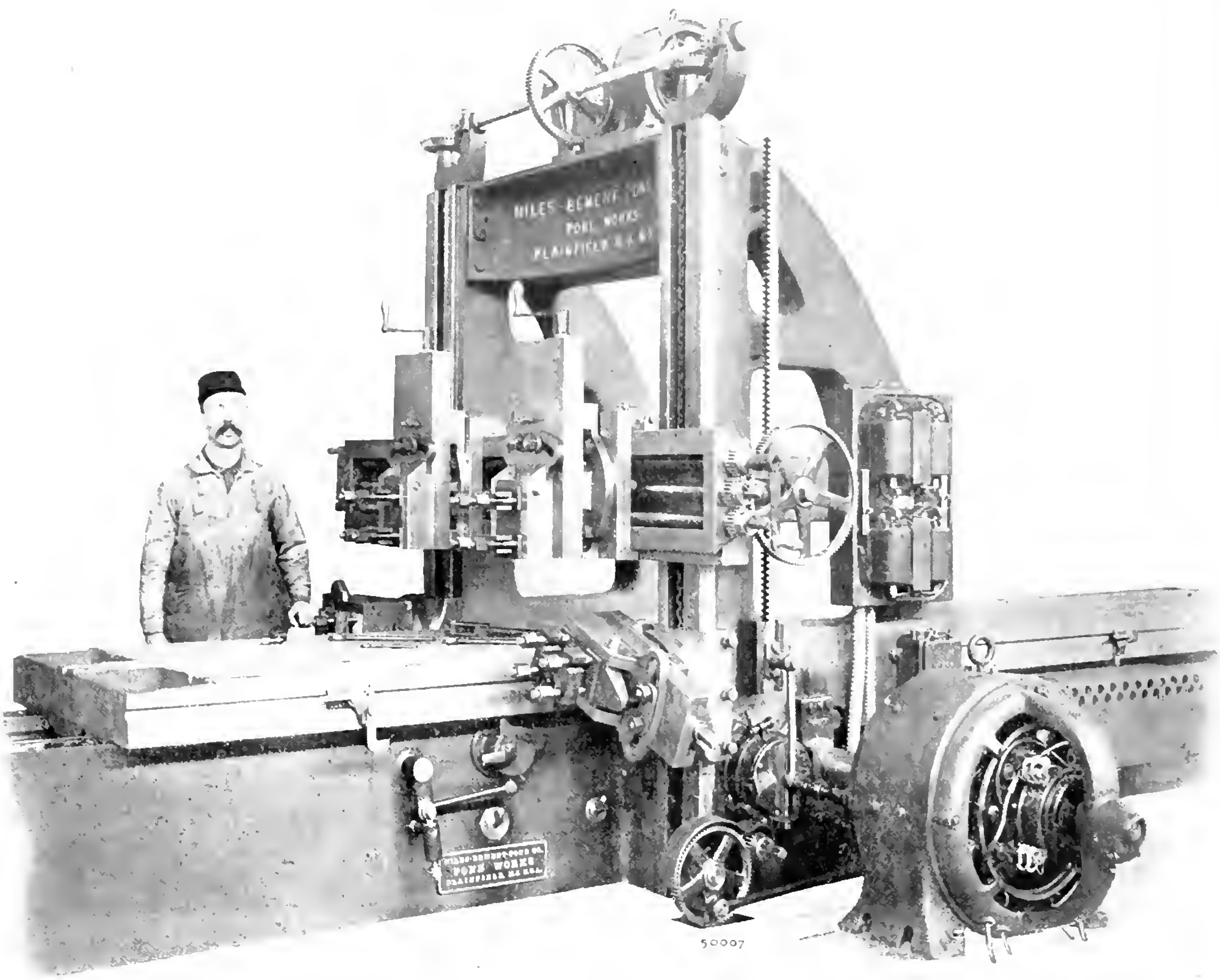


Fig 1 Pond Planer with Electrically Controlled Reversing Mechanism

A planer provided with direct motor-drive and reversing mechanism of this type is shown in Fig. 1. The whole driving and reversing mechanism consists of a motor mounted directly on the pinion shaft, a controller mounted on a marble panel on the side of the planer housing, as shown, and a pilot switch placed in the same position on the planer bed as the hand lever control or rocker lever of the ordinary belt driven machine. This pilot switch is tipped by adjustable dogs on the side of the platen in the same way as is the ordinary rocker lever, and by its movement it electrically operates the controller. It is entirely enclosed and is but six inches in outside diameter.

The controllers are made in two sizes, according to the size of motor for which they are to be used. The controller for motors from 7½ to 30 horsepower is provided with three magnets, while the controller for motors of 35 horsepower and up consists of four magnets or solenoids, on the plungers of which are mounted the electrical contacts. This latter type is the one shown in Fig. 1. The only parts susceptible to wear and replacement in the mechanism are the contacts, but these are all simple in shape, being made of sheet copper or bar stock such as would be found in any average shop. The replacement can be made by any mechanic.

On the controller are mounted two index scales or dials, one controlling the range of cutting speeds and the other the return speeds. These scales will be seen in Fig. 1, one on each side of the magnets. Each scale is provided with thirteen graduations or divisions by means of which the same number of different motor speeds are obtainable by simply sliding a knob on the scale. The cutting speeds obtainable on the standard type of planers vary from 25 to 40 feet, and the return speeds from 60 to 100 feet; but these speeds can, of course, be changed to suit individual requirements. The cutting and return speeds are entirely independent of each other, so that it is, for example, possible to use the slowest cutting speed and the highest return speed, or *vice versa* should this for any reason be deemed desirable. The reversible electric motor used is built by special specifications and it is shunt wound with a speed range of 4 to 1, the revolutions per minute varying from about 250 to 1000.

As will be seen from the illustration Fig. 1, the pilot switch is provided with a handle so that it may be operated by hand instead of by the reversing dogs, thus giving the operator immediate control of the machine. By a slight movement of the switch it may be placed in a neutral position which will immediately stop the platen. A valuable feature of the planer is that, owing to this direct hand control, it is possible for the operator to control the speed at any time during the cutting or return strokes. For example, in working castings with hard spots, thin walls, etc., or working a line of castings mounted on the platen, when one or more castings are harder than the others, the operator would set his index for the cutting speed most suitable for the average of the softer castings, and when the tool is about to enter the harder metal or the thin walls, he can, by simply moving the pilot switch by hand, obtain a reduction of cutting speed which will be maintained until the pilot switch is returned to its former position. Thus the platen is under the absolute control of the operator, even when in motion, and it is possible to stop the table within a limit of ⅛ inch by throwing the pilot switch to the neutral or "off" position.

On account of the controller's automatic action it is impossible to reverse the motor's direction of rotation until its speed is very low. This feature not only reduces the power required for reversal by nearly 100 per cent at the instant the direction of motion changes, but it also saves the feed line from any voltage surge or pumping action. At the moment of reversal the motor acts as a generator and tends to stop itself. The length of time of this action is automatically taken care of by the ingenious design of the controller. The variable speed of the motor is dependent entirely on shunt field regulation, and no armature resistance is used. Another important feature is that at the instant of starting, the motor has full field strength, giving it the maximum torque at a time when it is most required.

In Figs. 2 and 3 are shown two charts giving the load curves of a planer operated by this reversing drive, and showing that even at the time of reversal the motor is not subjected to excessive load, and hence in no way to excessive heating; it can, therefore, stand up to the requirements of modern service for any length of time.

The most noteworthy of the advantages of this drive may be briefly summarized as follows: The elimination of any frictional drive mechanism, such as is introduced by belts, friction clutches, etc., tends to give a more positive stroke and eliminates the shocks incident to reversal. There are no replacements necessary on account of the wear of friction surfaces, the only wearing parts being the contacts, as mentioned,

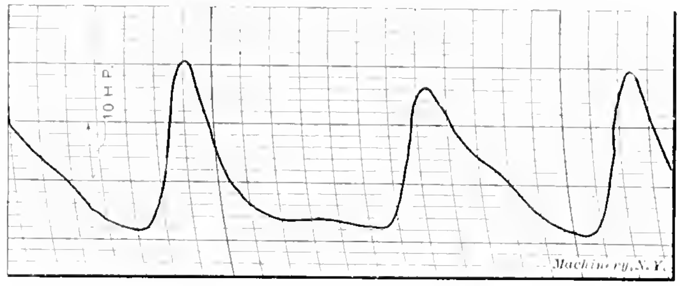


Fig. 2. Curves for Power Consumption, 84-inch Pond Planer with 35-horsepower Motor, Stroke of Table 71.2 inches, Cutting Speed 30 feet, Return Speed 65 feet

which may be easily and quickly replaced. The speed range is greater than that possible with any other drive, and cutting and return speeds are independent of each other. The shock at the time of reversal is almost entirely eliminated, due to the elimination of the rapidly revolving belt driving pulleys. It has been ascertained by experiments that 85 per cent of the momentum of a planer at the time of reversal is due to the rapidly revolving driving pulleys. The possibility of obtaining a short stroke—from 3 to 4½ inches on 36- to 96-inch planers—is also a feature well worth mentioning; and the ease of operation, the platen being at all times under the absolute control of the operator; the possibility of changing the cutting speed during any part of the stroke; and the elimination of a great number of driving members liable to wear and damage are features of high importance. The small space occupied by the controller is also an advantage. The controller used for motors up to 30 horsepower occupies a space of only 17½ by 19¼ inches, and is 4½ inches thick. Considerable economy is also obtained by the method of absorbing the inertia of the motor, due to the fact that at the instant of reversal the motor acts as a generator and produces the power which stops it.

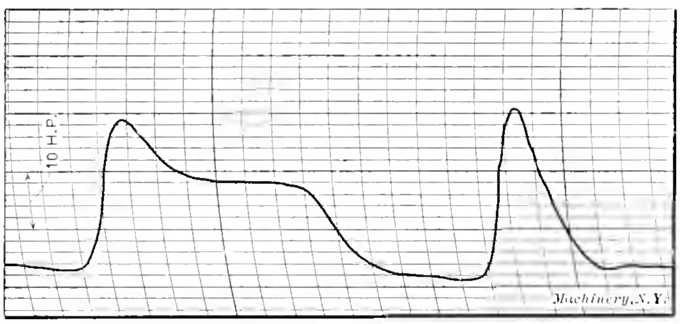


Fig. 3. Curves for Power Consumption, 84-inch Pond Planer, with 35-horsepower Motor, Stroke of Table 12 inches, Cutting Speed 30 feet, Return Speed 110 feet

The builders are prepared to equip their full regular line of planers with this drive, and will also attach it to their belt-driven type of planers in which case the motor is connected directly to the driving shafts on which the belt pulleys ordinarily are mounted.

* * *

The following is from a paper by J. B. Doan of the American Tool Works Company on the tariff, read at the Rochester meeting of the National Machine Tool Builders' Association: "As an example of the varying import duties upon machine tools when shipped into some of the leading countries, I quote the following approximate figures, applying to the shipment of a 14-inch or 16-inch lathe, weighing approximately 1,800 pounds: Into Germany, $15.61; France, $38.02; Denmark, $24.10; Austria-Hungary, $40; Italy, $14.28; Russia, $107.84."

NEW MACHINERY AND TOOLS NOTES

Engine Lathe: South Bend Machine Tool Co., South Bend, Ind. Lathe that may be operated by the foot or with power as desired. It swings 13 inches over the bed and has a maximum distance of 33 inches between the centers.

Tumbling Barrel: E. C. Bliss Mfg. Co., 91 Sabin St., Providence, R. I. Small double tumbler designed for bench use. The finishing and burnishing is accomplished by the use of steel balls which have proved efficient for this work.

Oilless Roller Bearing: Troy Roller Bearing Co., Troy, N. Y. Bearing that is designed to run without oil, a small amount of dry graphite being the only lubricant used. Bearings of this type are made for practically all purposes.

Pipe Die Stock: Borden Co., Warren, O. Die stock equipped with narrow dies which recede to form the pipe taper. The dies may be adjusted by simply shifting a cam, so that pipe from 1 to 2 inches in diameter may be threaded. The dies cut easily, and it is stated that a 2-inch pipe may be threaded by one man without difficulty.

Shop Truck: Gannett Electrical Co., 55 Pine St., Providence, R. I. Small, heavily-constructed two-wheeled truck for moving heavy machinery or parts. By connecting two of these trucks in line with a heavy timber, a narrow truck of any length can be made, and by attaching two such trucks with cross-pieces, the width can be extended as required. Each of these trucks weighs about 30 pounds.

Lathe Tool-holder: Kearney Foundry, Machine & Automobile Co., Kearney, Neb. Tool-holder in which the blade is clamped between two wedge-shaped washers by a slotted bolt through which the blade passes. This method of clamping and holding the tool permits adjusting it vertically or swinging it to the right or left. It is also possible to tilt a thread-tool to the angle of either a left- or right-hand thread.

Core Machine: Falls Rivet & Machine Co., Cuyahoga Falls, O. Vertical jar-ramming core machine, which forms the core in a vertical shell or core-box, that is given a jarring motion by two ratchets which alternately lift and drop the core-box in order to compact the sand. For making ordinary straight cores, the core tube itself may be used, but for irregular work, special dies or core-boxes are inserted in this vertical tube.

Low Knife Bar Shear: Thomas Carlin's Sons Co., Henry W. Oliver Building, Pittsburg, Pa. A shear designed for cutting muck bars or other material within its capacity. It will sever soft steel stock up to 1¾ inch square. As the shear arm is connected directly with the crankshaft by a pitman, it has a speed of from 60 to 80 working strokes per minute, thus making it possible to handle large quantities of material in a given time.

"Changeezy" I-Beam Trolley: New Jersey Foundry & Machine Co., 90 West St., New York City. Trolley that is so constructed that it may be converted from a plain to a geared one or *vice versa*, thus making it possible to rack the trolley along the track when handling heavy loads or to pull it along at comparatively high speed when light, by disengaging the gears. This change is made by the hand-chain, which is also used to move the trolley by the rack and pinion.

Right-angle Drilling Attachment: Lowndes & Butler, Norristown, Pa. Compact attachment intended for drilling in places where lack of room precludes the use of an ordinary power drill. The driving shank has a Morse taper and is connected with the drill socket by hardened steel spiral gears provided with ball thrust bearings. This attachment is made in four sizes with drill capacities ranging from 9/16 to 2 inches, and corresponding weight variations of from 2¼ to 10 pounds.

Pneumatic Chuck: Bashlin Tool Works, Grove City, Pa. Pneumatically-operated chuck for small lathes that is intended for the rapid handling of castings of irregular shapes These chucks are made with jaws of two styles, the alligator and the four-hinged, either of which may be attached to the master collet used. The four-hinged chuck is intended for round or hexagonal work, etc., while the alligator jaws are for holding irregular parts, such as valve bodies, air and gas cocks, and similar pieces.

Friction Clutch: F. C. Sanford Mfg. Co., Bridgeport, Conn. Clutch that transmits power by friction alone until the speed and resulting centrifugal force is great enough to swing out pivoted locking dogs, which engage with pins and form a positive drive. The design is such that the work of the friction surface is confined to starting and accelerating to normal speed, thus lengthening the life of the clutch. The locking dogs and the pins with which they engage, are of hardened nickel steel and the clutch itself is bronze-bushed.

Double-Head Traverse Drill: National Machine Co., Hartford, Conn. Two-spindle drill which differs from previous designs in having a hand feed instead of an automatic feed, both spindles being fed simultaneously by a pilot wheel at the front of the machine. The heads are adjustable along the bed giving a maximum distance of 20 inches between the spindles. The spindles have a travel of 5⅜ inches, and the distance from the spindle centers to the bed is 7 inches. The machine will drill holes up to 9/16 inch in diameter.

Pipe Wrench: Brosnihan Wrench Co., 31 Hermon St., Worcester, Mass. Pipe wrench designed along the lines of an ordinary monkey wrench and equipped with hardened and tempered tool steel jaw faces which are serrated for gripping pipe or other round parts. The face of the sliding jaw is wedge shaped and it is free to slide on a correspondingly inclined surface on the jaw so that work is gripped tightly by the wedge action when pressure is applied to the handle. Extra jaw faces can be furnished when desired. These wrenches are made in four sizes, ranging from 8 to 18 inches.

Special Drilling Machine: Buckeye Machine Co., 2617 East 76 St., Cleveland, O. Special machine for drilling cross holes in bolts, etc., for cotter pins or other retaining devices. The machine has five drilling spindles and the work is clamped by quickly operated levers so that the holes are drilled centrally and the correct distance from the bolt ends. Each spindle with its drill is automatically fed by cams which are mounted on a horizontal shaft extending across the machine. The drive is through a single pulley mounted on the central spindle which transmits the movement to the remaining spindles by spur gears.

Mono-rail Trolley Hoist: Heyl & Patterson, Inc., Pittsburg, Pa. Mono-rail trolley hoist, the frame of which is hung from two cast-steel trucks by steel straps which rest on ball bearings. With this construction, the trucks are independent of each other so that they will operate on comparatively small curves. Each truck has four 10-inch cast-steel wheels, which are set at such an angle as to be perpendicular to the slope of the I-beam flange on which they run, thus reducing the wear on both the flange and wheels. This trolley is provided with an operator's cab and is driven by an 11 horsepower Westinghouse motor.

Auxiliary Planing Head: Cincinnati Planer Co., Cincinnati, O. An auxiliary floor planing head intended to handle work usually done on the open side planer. It consists of a column with a swiveling head which has a vertical travel above the planer table of 42 inches. The face of the column is pivoted in the center so that by swinging it around, the planing head may be used on either side of the planer. Power feed is taken from the double combination friction on the planer itself, connection being made to the feeding mechanism of the column by a suitable rod. The feeds are controlled by a small lever at the top of the tool-head, and the amount of feed may be varied by means of a slotted crank.

Improvements in Surface Grinder: Walker Grinder Co., Worcester, Mass. The Walker "single-stroke" rotary surface grinder, which was illustrated and described in the February, 1910, number of MACHINERY, has recently been equipped with a number of improvements. The spindle is now driven with an independent belt drive, the belt transmitting the power direct from the countershaft at the rear to the spindle by a quarter-turn belt, thus giving a more powerful drive than formerly obtained. The quarter-turn belt in the column which transmits power from the countershaft to the table speed-change mechanism, has been provided with an improved take-up device for varying the belt tension. This design is also equipped with a new belt shifter, which may be easily operated and which is conveniently located.

Heavily Designed Radial Drills: Mueller Machine Tool Co., Cincinnati, O. Heavily designed 4- and 4½-foot radial drills brought out to meet the requirements of modern practice. The column is heavily constructed, and the arm is of hollow rectangular section and has been increased considerably in weight. The arm can be locked to the column by one handle and it can be lowered at twice the elevating speed. The back-gears are located in the head and they may be engaged or disengaged without shock and while the machine is in motion, by a conveniently located lever. A tapping mechanism is provided, and the spindle is equipped with a depth gage and automatic stop. A speed box of the geared friction type gives twelve changes of speed, which is doubled by the back-gears, making twenty-four speeds in all available for the spindle. By means of a combination positive and friction feed, eight changes to each change of spindle speed may be obtained without stopping the machine.

Electric Controllers: General Electric Co., Schenectady, N. Y. Controllers for use on electrically-driven machine tools and wherever the starting service is frequent or of a severe nature. They are of the drum type and have embodied in their construction a number of special features to adapt them to the conditions of modern practice. Among these may be mentioned substantial removable barriers between the fingers wherever required; magnetic blow-outs for all equipments for 500-volt service or for large currents at lower voltages; special screws to hold the segments with heads slightly countersunk below the surface so as to prevent their wearing with the segments, and tapered at such an angle as to prevent their loosening; sheet iron covers lined with asbestos to protect live parts from dust and mechanical injury, and eliminate the danger of shock from accidental contact; terminals and other parts readily accessible; and field control with adjustable fingers similar in design to the fingers for the armature circuit.

Fourteen-inch Engine Lathe: Young Machine & Tool Co., Worcester, Mass. Engine lathe of the plain type that is intended for repair and general machine shop work. The feed-rod of this machine is so arranged that either a belt or direct gear drive may be obtained. This positive drive for the feed-rod, makes possible the taking of heavy cuts for rapid reduction. The construction of the apron is such that it is impossible to throw in both feeds at once, thus eliminating the danger of stripped gears and spoiled work. All the bearings of this lathe are cast iron and like those on the bed, they are hand-scraped. This lathe is built with either a 6- or 8-foot bed It will swing 16 inches over the bed and 11 inches over the carriage. A four-step cone pulley is provided, thus giving, by means of the back-gears which have a ratio of 10 to 1, eight speed changes. Change gears are provided for cutting any pitch of thread, ranging from 4 to 36 per inch, inclusive. The maximum distance between the centers with the 6-foot bed is 36 inches. The net weight of the machine is 1470 pounds.

Improved Upright and Radial Drills: Prentice Bros. Co., Worcester, Mass. The radial drills manufactured by this company have been re-designed to adapt them more thoroughly to modern needs. The base has been made more massive beneath the column and the arm is heavily ribbed to resist torsional strains. A feed dial has been conveniently located on the head, which, by the movement of a crank, gives four speed changes, which number may be doubled by a second adjustment. A dial depth gage is also provided which is so arranged that it can be set to zero for any position of the drill. The spindle, through the quick speed change box, has sixteen changes. The machine is equipped with a tapping attachment, a quick return mechanism and an automatic stop motion. The upright machine also contains a number of important changes. The back gears are so arranged that the spindle may be changed from high to low speed or *vice versa* without stopping the machine and simply by the operation of a back-gear lever. Eight spindle speeds are available, and the machine is equipped with the Prentice quick-return and stop motions.

Automatic Nut Tapper: Acme Machinery Co., Cleveland, Ohio. Automatic non-reversing nut tapping machine which taps the nuts straight through as with hand tapping, thus insuring an accurate thread. The nuts to be tapped are placed in a hopper at the top of the machine from which they are fed automatically to a chute that leads down to the tap. At the bottom of this chute there is a reciprocating mechanism that feeds the nuts onto the revolving tap. The machine is provided with three taps which are indexed successively to the tapping position. When the shank of one of these taps is filled with tapped nuts, the tap-carrying mechanism revolves automatically, thus bringing another tap into position, which is then filled as before. The number of nuts that are fed onto the tap is automatically regulated by their thickness. After a tap is filled with nuts, it is indexed from the working position; it then stops automatically, thus enabling the operator to remove it and the tapped nuts. These machines are made in three sizes, designated as Nos. 1, 2 and 3. The first has a capacity for nuts up to ¼ inch, the second to ½ inch, and the third up to 1 inch in diameter. The machine is very rapid as two or three nuts are tapped at a time, and the mechanism is simple and durable.

Four-head Drilling and Facing Machine: Garvin Machine Co., Spring and Varick Sts., New York City. Machine with four heads that is particularly adapted for drilling or reaming four holes simultaneously in such parts as universal joint rings, bevel gear differential spiders, etc. The four heads are located 90 degrees apart on a cross-shaped bed, and the drive is taken from a four-way, right-angle countershaft, there being a separate belt for each spindle. In the center of the bed, and coincident with the axes of the four-spindles, there is a plate to which fixtures may be clamped The heads have a power feed of 4 inches and a tripping mechanism is provided. The heads are returned to their outward position by a handwheel, and the feeding mechanism is so arranged that they may be adjusted independently if desired. The spindles have threaded ends to permit the use of round box tools, and each has on the inside a drill spindle provided with a Morse taper hole for receiving drills or reamers. The machine is provided with a lubricating system for the cutters, oil being contained in a reservoir in the base. The maximum distance between the ends of the spindles is 10 inches, and the largest size drill that can be used in steel is 7/8 inch. The machine weighs 2800 pounds.

Pipe Threading Machine: Stoever Foundry & Mfg. Co., Myerstown, Pa. Pipe threading machine with capacity for threading pipe from 4 to 12 inches in diameter. By means of a gear-box, in conjunction with a double train of outside gears, ten speeds may be obtained. All the gears are made of carbon-steel castings fitted with bronze bushings, and they run in oil. The speed changes can be made without stopping the machine, and the control of the latter is by means of a clutch operated from the working side of the tool. The headstock is made in one casting similar to that of the lathe, and contains all the principal bearings, thus insuring permanent alignment. The diameter of the spindle on the inside is such that the largest fittings within the machine's capacity can be passed through. The pipe is held by powerful chucks equipped with three independent steel jaws faced with hardened plates. The die-head is of the sliding or floating type that allows for any eccentricity in the pipe. By moving the die-head to one side, the pipe can be cut off within 3 inches of the face of the chuck. The machine is provided with an oil pump for supplying lubricant to the dies, and all bearings have deep receptacles for holding lubricating wool and oil for insuring good lubrication.

All-wrought Steel Pulley: American Pulley Co., Philadelphia, Pa. Improved design of all-wrought steel pulley which is now being manufactured in large sizes ranging from 44 to 60 inches in diameter. These pulleys have eight arms which are built up of two steel plates that are riveted to an annular rim flange and to the flange of an annular hub ring, the rivets passing through both sections of the arm. The hub shell is riveted to a horizontal leg of the same ring, thus giving a very strong construction. The bore of the hubs is standard while the lengths vary. One bushing is furnished with each pulley and extra sizes are carried in stock so that the pulleys may be fitted to shafting of ordinary dimensions. These pulleys are of the parting type which enables them to be put on the shaft without taking it down. The faces are either flat or crowned and pulleys of considerable width are equipped with a double set of arms. A groove is cut in the center of the pulley face, which allows the air to escape from under the belt as the pulley revolves, which results, it is stated, in increasing the horsepower transmitted by at least one-third over that transmitted by a pulley with a plain face. Tests made with this type of pulley show that one 30 inches in diameter with an 8-inch face, will stand a pull of 250 pounds per inch of belt width without slipping.

* * *

BRISTOL-DURAND RADII AVERAGING INSTRUMENT FOR CIRCULAR CHART RECORDS

The extensive use of automatic instruments for recording pressures, temperatures, and electrical units has created a demand for a simple device to quickly determine the average of the records made on such charts, and the integral value for the whole twenty-four hours or whatever time is covered by the record. This demand has been filled by the instrument illustrated herewith, the operation of which is based upon a fundamental plan worked out and patented by Professor W. F. Durand of Stanford University, and constructed in accordance with a novel design developed by William H. Bristol, president of the Bristol Co., Waterbury, Conn.

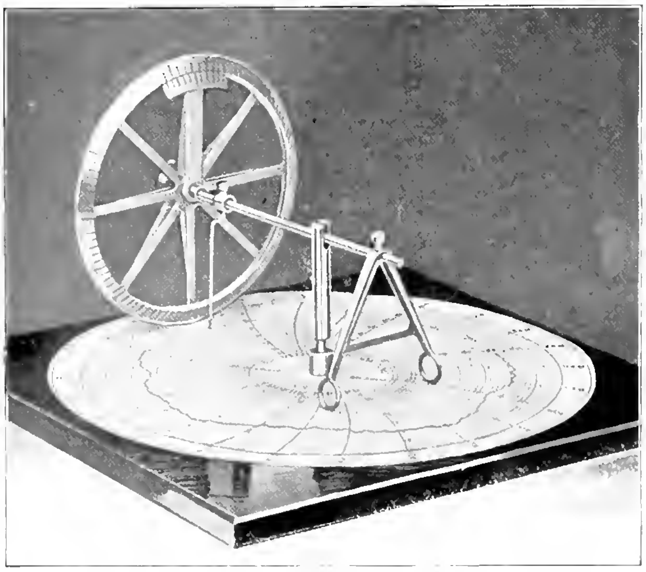
The instrument can be applied for averaging records of any kind on circular charts having uniform graduations, as, for instance, records of watts, amperes, temperature, pressure, etc. Recording instruments equipped with circular charts are therefore made available for a number of applications for which it was previously thought necessary to use the instruments recording on straight lines, or strip record charts. Recording differential pressure gages are coming into use for measuring velocities and volumes of liquids, air or gas flowing in mains, and this integrating device will prove of value for quickly obtaining total volumes of flow for any given period of time.

The simple construction of the instrument is shown by the accompanying illustration. A wooden base with a metal socket is provided for supporting and centering the chart. This socket holds a rotatable pin with a vertical slot at the top to receive the bar which carries the integrating tracer point and triangular support. The vertical groove in the rotatable pin allows the integrating wheel to roll on the chart with uniform pressure due to its own weight. The integrating wheel is six inches in diameter and the rim is graduated into one hundred numbered equal spaces and is fitted with a vernier which makes it possible to easily read with the naked eye to one-tenth of one division on the integrating wheel. The wheel is of such large size it is not necessary to supply any counting device for the number of revolutions. In fact the number of complete revolutions cannot be more than two, even for a record of maximum size on large 12-inch charts.

To operate the instrument, the thumb and forefinger of one hand are applied to the base of the triangular support, which is moved radially, so as to cause the tracer point to continually follow the record curve, while the chart is turned with the other hand. By referring to a line plotted on a sheet of cross-section paper furnished with the instrument, for the par-

ticular record curve that is to be measured, the total reading for the entire twenty-four hours may be taken off directly.

A full explanation of the theory upon which the operation of the instrument depends has been given by Professor Durand, in a paper presented at the New York meeting of the American Society of Mechanical Engineers in 1908. This may be briefly summarized as follows: In applying the instrument, it is necessary to have a uniform radial scale, from which it follows that equal increments in the length of the radius correspond to equal increments in the watts, amperes, temperature or whatever quantity is measured. The integrating wheel, being carried at right angles to the shaft passing through the center, does not turn and give a reading when the tracing point is moved on a straight radial line, but if the tracing point is made to follow a record, the integrating wheel will revolve and the amount of the revolution will correspond to the total of the circumferential elemental components of the record curve, the radial elemental components of the record having no turning effect on the integrating wheel. As the lengths



Instrument for determining the Average Record on Charts of Automatic Recording Gages

of the arcs of concentric circles for given angles or for the entire circumference are proportional to their radii, it is evident that the amount of turning of the integrating wheel, and the reading obtained thereon, will be proportional to the average radius of the record traced.

The instrument is adapted for integrating charts with either straight or curved radial time arcs. The correction necessary for radial time arcs which are curved, may be made after completely tracing the record, by returning the tracing point to a point on the chart having the same radius as the starting point, the movement of the tracing point being along an arc corresponding to the curved radial time arcs.

* * *

SEMI-ANNUAL CONVENTION NATIONAL GAS AND GASOLINE ENGINE TRADES ASSOCIATION

The most successful semi-annual convention in the history of the National Gas and Gasoline Engine Trades Association, was held at the Sinton Hotel, Cincinnati, Ohio, June 13-16 inclusive. About two hundred members and visitors registered and over thirty dealers and manufacturers had products on exhibition. Racine, Wisconsin, was chosen for the next meeting, which will be held some time in December. Several interesting papers were read by prominent authorities, and a number of social events were features of the evenings.

Election does not occur until the next meeting, and the officers whose terms do not expire until then are: President, M. A. Loeb, Cincinnati, Ohio; vice-president, C. D. Hamilton, Elyria, Ohio; treasurer, Otto M. Knoblock, South Bend, Indiana, and secretary, Albert Stritmatter, Cincinnati, Ohio.

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According to statistics quoted by *Page's Weekly*, there are at present about 85,000 private automobiles in use in Great Britain, about 15,000 motor cars used for industrial purposes, and nearly 9000 public service cars.

DON'TS FOR DRAFTSMEN

By H. E. WOOD

Don't use a loose-jointed T-square.

Don't use a triangle that is too thick.

Don't use instruments with dull points.

Don't make unnecessary lines on a drawing.

Don't use an extremely soft drawing board.

Don't draw with the sun shining on your work.

Don't push a pen or pencil when you can draw them.

Don't design odd or special sized bolts or screws.

Don't use ink that is thick and stringy; new ink is cheaper.

Don't forget that a comprehensive drawing is a valuable asset.

Don't make fancy flourishes and leave off necessary information.

Don't keep a watch lying on your board, open and face toward you.

Don't refuse to listen to what a "jackleg" machinist wants to say.

Don't put perspective drawings and plan drawings on the same sheet.

Don't turn in a drawing until you are sure there are no mistakes on it.

Don't let scales and triangles get dirty, as they will soil your paper.

Don't miss an opportunity to do a little job of machine or bench work.

Don't keep any more instruments lying on the board than you are using.

Don't forget that bicarbonate of soda and water will bleach blue-prints.

Don't put all the patternmaker's dimensions on the machine shop drawings.

Don't use different T-squares and triangles on a complicated drawing.

Don't use too much pounce on tracing cloth, and clear off what you do put on.

Don't leave blue-prints when you are printing them, as they are easily spoiled.

Don't fail to sign all drawings which you make, as it often saves controversy.

Don't forget to backline letters and figures when they are pasted on a tracing.

Don't think that it is always necessary to make machine shop drawings right up to scale.

Don't design curves in machinery when you can make straight flat surfaces answer as well.

Don't forget that oxalate of potash dissolved in water will make a white ink for blue-prints.

Don't let a tracing stand in the sun between the time you start tracing it and the time you finish it.

Don't indicate an oil hole and channel in such a manner that the oil will form an air trap for itself.

Don't fail to mark very distinctly the bearings that should be tight, from the ones that should be loose.

Don't forget that the draftsman can save his employer more money with less exertion, than a machinist can.

Don't let the chief measure anything for you, but if he gives you a measurement, then work faithfully to it.

Don't forget that in some cases a loose bearing is better and much more economical than a tight one.

Don't fail to indicate where oil holes and channels should go, as they are vital points in the design of a machine.

Don't forget that washing soda, gum arabic and water makes a good writing fluid for fine lines on blue-prints.

Don't be reluctant about consulting with both the patternmaker and molder sometimes regarding framework and large castings.

Don't forget that very often a little note of explanation in the corner of a drawing will save the foreman many annoyances.

Don't forget that bread crumbs rubbed thoroughly over a drawing after it is completed will take off the majority of the dirt, and will not disturb the pencil lines perceptibly.

* Address: 182 North 4th St., Newark, N. J.

WELDING A LARGE CRANKSHAFT WITH THERMIT

A large three-throw engine crankshaft with a broken web was recently successfully repaired at the plant of the Goldschmidt Thermit Co., in Jersey City, N. J., by the thermit welding process. Owing to the large size of the shaft, which was 9 inches in diameter and 16 feet in length, and the accuracy of alignment necessary after the broken parts had been welded,

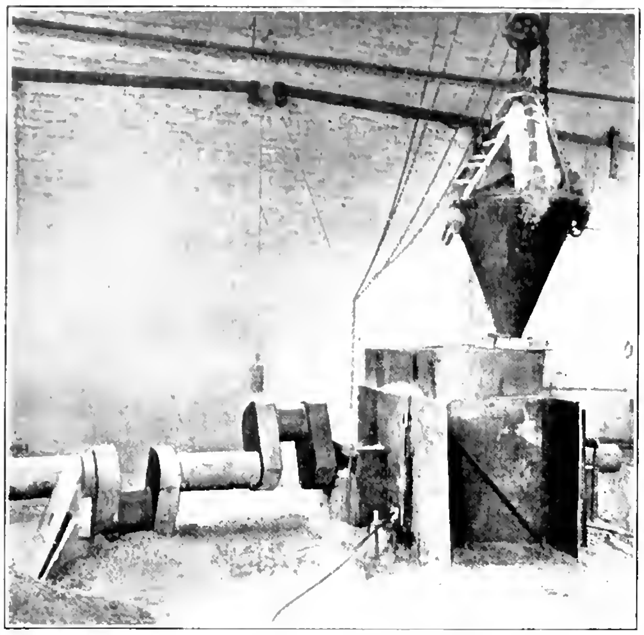

Fig. 1. Large Crankshaft ready to be welded by the Thermit Process

this job is of unusual interest and shows in a rather forcible way the possibilities of the thermit process.

As those familiar with the use of thermit know, it is necessary when making a weld to provide room between the broken ends for the thermit steel. In this instance, an oxy-gas torch was used very effectively for this purpose, and a space two inches wide was quickly cut in the web which had a section of 5 by 15 inches. The crack which made the weld necessary, extended clear across the web between the shaft and crankpin, and penetrated to a depth of 4 inches. The two shaft sections were aligned, prior to welding, by mounting them in V-blocks of the same height that rested on a large surface-plate,

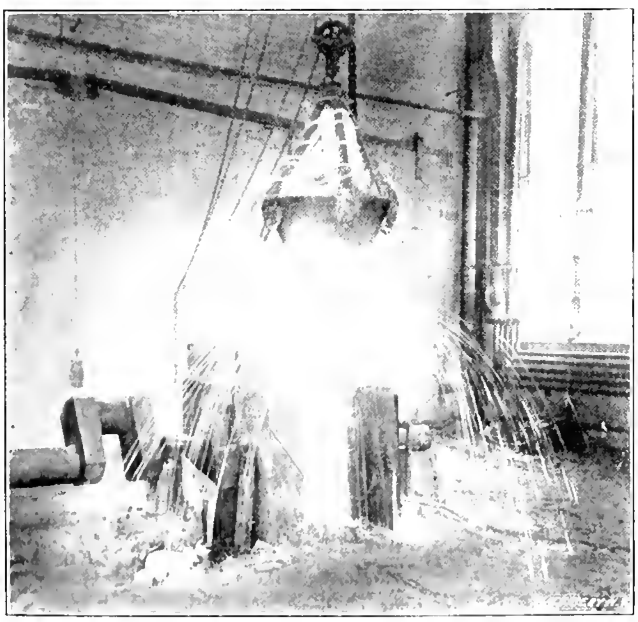

Fig 2 View showing the Thermit Steel running from the Crucible into the Mold built around the Fractured Web

two blocks being used for each section. After the webs of the broken crank had been set in the proper relation with each other, and the sections were securely clamped, the opening at the break was filled in with a yellow wax matrix after which the mold was built up around the crank. This mold was formed of a sheet iron shell, containing a mixture composed of one-third fire sand, one-third fire clay, and one-third ground fire brick. This mixture forms a very refractory material, which is absolutely necessary owing to the intense heat of the thermit steel. Openings were, of course, left in the mold for a gate and riser, and as parts to be welded by thermit must be pre-heated to prevent them from exerting a chilling effect on the steel, additional openings were made at the bottom of the mold for the insertion of gasoline blow torches. The solid web was pre-heated, as well as the broken one, in order that the expansion on both sides of the crank would be equalized. After the parts had been sufficiently pre-heated, which, of course, also melted the wax previously inserted, thus forming a pocket in the mold, the space surrounding the solid web was filled in with dry sand to prevent any possibility of the molten steel breaking through, and the openings for the torches were also closed. A large inverted cone-shaped crucible, containing 450 pounds of thermit, was then swung by a crane over the gate of the mold as illustrated in Fig. 1. The thermit, which is a mixture of ground aluminum and iron-oxide, was then ignited by means of a special powder which generates the intense heat necessary to start the thermit reaction. In forty-five seconds after a match had been applied to the starting powder, the pre-heated thermit steel was tapped into the mold. Owing to the large amount of thermit used, the chemical reaction was unusually violent

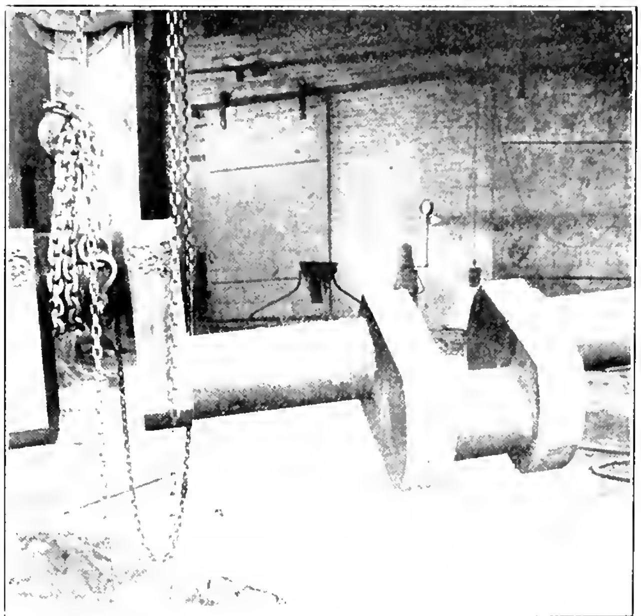

Fig 3 The Shaft after the Fractured Web (seen to the extreme right) had been welded

and produced showers of brilliant and scintillating sparks which formed a very spectacular pyrotechnical display.

During this reaction, the oxygen of the iron is taken up by the aluminum, which has a strong affinity for it, producing aluminum-oxide (or slag) and superheated thermit steel. Immediately after the reaction ceases, the steel which sinks to the bottom of the crucible is tapped into the mold where it comes into contact with the broken sections and because of its intense heat, which is as high as 5400 degrees Fahrenheit, amalgamates with them to form a homogeneous weld. Fig. 2 shows the steel running from the crucible into the mold, while Fig. 3 is a view showing the welded part of the web.

Of course, thermit has been used on larger and more difficult jobs than the one illustrated, but nevertheless, the successful welding of a section of this size in the comparatively short time required, is an interesting mechanical achievement

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ADDITIONS TO MEMBERSHIP OF NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

In addition to the list given in the June number, the following concerns have acquired membership in the National Machine Tool Builders' Association: Fay Machine Tool Co., Philadelphia, Pa.; Ohio Machine Tool Co., Kenton, Ohio; Superior Machine Tool Co., Kokomo, Ind. These make 24 new members, and a total of 119.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The attendance of the spring meeting of the American Society of Mechanical Engineers, held at Atlantic City, N. J., May 31 to June 3 was not as large as that of some of the meetings held heretofore, the registration of members and guests being about 250. The coming joint meeting of the society with the Institution of Mechanical Engineers in England, no doubt caused many who will attend that meeting to forego attending the regular spring session.

A good program was presented, some of the papers being of unusual interest to the engineering profession. A case in point was the paper of Mr. H. J. Freyn, "Some Operating Experiences With Blast Furnace Gas Power Plants." It was conceded to be by far the best exposition of modern gas power practice from the operating standpoint that has been made public. About twenty members took part in the discussion.

The paper by Prof. Walter Rautenstrauch, "A Comparison of Lathe Headstock Characteristics" was a masterly analysis of lathe headstock construction, its object being to show a rational means of working out speed torque combinations and avoiding those combinations which are found in many lathes to be of no practical value. The paper is one that should have the careful attention of machine tool designers generally. In the discussion of the paper, Mr. Carl G. Barth said that certain fundamental formulas deduced on this side of the Atlantic were better than those derived by Dr. Nicholson. For example, the formula $V = \frac{1}{a} + 15$ was valueless for slow cutting speeds as it contained the constant 15. The paper was highly commended by Mr. Taylor, who was disposed to overlook what he considered were comparatively minor faults pointed out by Mr. Barth, and gave the author much credit for the constructive work so valuable to the designers and users of machine tools.

The paper on "Stresses in Curved Machine Members," by Prof. A. L. Jenkins, was followed by a spirited discussion in which conflicting ideas were set forth with more or less convincing force. The thought was expressed that small models freshly cast, containing severe shrinkage stresses, were not safely comparable with full-sized shear frames. Mr. Henry Hess pointed out that the determination of the yield point was all important, and stated that an instrument consisting of a delicate pyrometer and gold-leaf electroscope galvanometer had been developed abroad by which it was possible to test the stresses existing in any part of a machine frame.

The paper by Mr. Wilfred Lewis, "A Shockless Jarring Machine," described a type of molding machine built by the Tabor Manufacturing Company, Philadelphia, Pa., in which the anvil and platen are spring supported. The advantages of the construction claimed are freedom from shocks so destructive to other molds on the molding floor, and the production of homogeneous molds because of avoiding the common causes of flaws and rifts in the sand. The discussion of the paper was characterized by an attack by a competitor which led Mr. F. W. Taylor to deprecate the admission of commercial papers in general. He expressed the thought that unless discussion could be fair and free from trade jealousies, all papers describing commercial machines should be barred from the society's proceedings.

The paper by Prof. Edward C. Schmidt "The Resistance of Freight Trains" dealt with the results of tests made upon the Illinios Central by the railway engineering department of the University of Illinois. The trains tested varied in weight up to 3000 tons. The tests were made on tracks laid with 85-pound rails.

Space will not permit the giving of a full review of the discussion of these or other papers presented. An addition to the list of papers published in the program in the June number was that by Mr. C. K. Lassiter, entitled: "Improved Methods of Finishing Staybolts and Straight and Taper Bolts for Locomotives."

The social event of the meeting was the reception Thursday evening at which honorary membership was conferred on Rear Admiral Melville, U. S. N., retired. Rear-Admiral Melville delivered an address, "The Engineer's Duty as a Citizen."

M. C. B. AND A. R. M. M. ASSOCIATIONS CONVENTIONS

The forty-fourth annual convention of the Master Car Builders' Association and the forty-third annual convention of the American Railway Master Mechanics' Association were held at Atlantic City, N. J., June 15-22, inclusive. Following the custom of alternating the conventions in the matter of priority the Master Car Builders' Association convention was held June 15, 16 and 17, and the Master Mechanics' Association convention June 20, 21 and 22. The Railway Supply Manufacturers' Association held an exposition of railway supplies and apparatus, machine tools, etc., on Young's New Pier simultaneously, as has been the custom for many years. This exhibition of railway supplies is one of the most important annually held in the United States and is growing in importance. Last year the exhibit space was about 65,000 square feet and the year before about 58,000 square feet. This year it was over 71,000 square feet, and still more space would have been used had it been available. Between thirty and forty concerns were turned away that desired to exhibit but could not be accommodated because space was lacking.

The general technical program of the Master Car Builders' Association convention was made up in the usual manner, consisting of topical discussions and papers as follows:

June 15.—Discussion of reports on: "Revision of Standard and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe Tests"; "Rules for Loading Materials."

June 16.—Discussion of reports on: "Rules of Interchange"; "Coupler and Draft Equipment"; "Car Wheels"; "Safety Appliances"; "Freight Car Trucks"; "Splicing Underframes"; "Car Framing, Roofs and Doors"; "Tank Cars"; "Train Pipe and Connections for Steam Heat."

June 17.—Discussion of reports on: "Consolidation of Master Car Builders and Master Mechanics' Associations"; "Classes of Cars"; "Salt Water Drippings from Refrigerator Cars"; "Mounting Pressures on Wheels and Axles."

Individual paper: "Design of Axle to Carry 50,000 Pounds," by E. D. Nelson, Engineer of Tests, Pennsylvania Railroad.

Discussion: "Springs for Freight Car Trucks."

Discussion of reports on: "Train Lighting and Equipment"; "Lumber Specifications."

The following officers were elected for the M. C. B. Association:

President, T. H. Curtis, L. & N. R. R.
First vice-president, A. Stewart, Southern Ry.
Second vice-president, C. E. Fuller, Union Pacific Ry.
Third vice-president, D. F. Crawford, Pennsylvania Lines.
Treasurer, John S. Lentz, Lehigh Valley R. R.
Executive Committee: J. D. Harris, B. & O. R. R.; C. E. Fuller, U. P. Ry.; and C. A. Seley, C. R. I. & P. Ry.

The technical program of the Master Mechanics' Association was as follows:

June 20.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards."

Individual paper by W. S. Hayes, Supt. Loco. Operation, Erie R. R.: "Fuel Economies."

Topical Discussions: 1—"Self-dumping Ash Cans," by H. T. Bentley, A. S. M. P., C. & N. W. 2—"Apprenticeship Education," by F. W. Thomas, Supervisor of Apprentices, A., T. & S. F.

Discussion of report on: "Motive Power Development."

June 21.—Discussion of reports on: "Widening Gage on Curves"; "Steel Tires"; "Safety Appliances"; "Superheaters."

Individual paper: "Locomotive Performance under Different Degrees of Superheat," by Prof. C. H. Benjamin, Purdue University.

Individual paper: "Locomotive Frame Construction," by H. T. Bentley, A. S. M. P., C. & N. W. Ry.

Report of Committee on Safety Valves.

Report of Committee on Lumber Specifications.

June 22.—Discussion of report on: "Train Brake and Signal Equipment."

Individual paper: "Freight Train Resistance," by Prof. E. C. Schmidt, University of Illinois.

Discussion of reports on: "Locomotive and Shop Operating Costs"; "Design, Construction and Inspection of Locomotive Boilers"; "Consolidation of Master Mechanics' and Master Car Builders' Associations."

The following officers were elected for the A. R. M. M. Association:

President, C. E. Fuller, Union Pacific Ry.
First vice-president, H. T. Bentley, Chicago & Northwestern.
Second vice-president, D. F. Crawford, Pennsylvania Lines.
Third vice-president, T. Rumney, Erie R. R.
Treasurer, Dr. Angus Sinclair.
Executive Committee members: T. H. Curtis, L. & N. R. R.; F. F. Gaines, Central of Georgia; and G. W. Wildin, N. Y., N. H. & H. R. R.

For several years consolidation of the Master Car Builders' Association and the American Railway Master Mechanics' Association has been discussed without arriving at definite action, but now consolidation seems practically assured. The committee on consolidation presented a report in which it recommended that in view of the fact that neither association would agree to be absorbed by the other, an amalgamated association be formed under the name "The American Railway Mechanical Association." The object of the association shall be the advancement of knowledge concerning the construction and maintenance of cars, locomotives and other railway mechanical appliances by investigation through committees and discussion at conventions. There shall be four classes of members, *i. e.*, active, representative, associate and life. The motion to consolidate has been deferred until another year when investigation of the legal and other aspects of necessary consideration will have been made.

The proportion of machine tool builders exhibiting was not as large as last year. Then out of a total of 228 exhibitors about 50 concerns building machine tools, machinists hand tools and other accessories of the machine shop exhibited. This year there were 42 concerns exhibiting machine tools, accessories and closely allied products out of a total of 255, which number included all exhibitors listed.

Exhibitors of Metal-Working Machines, Accessories and Allied Products

American Vanadium Co., Pittsburg, Pa. Vanadium alloy locomotive parts, including 9-inch locomotive axle bent double under 14,000-ton press pressure to show its remarkable homogeneity and elasticity; 2 x 14-inch vanadium steel eye-bar for new Quebec bridge, the largest eye-bar ever made.

Armstrong-Blum Mfg. Co., Chicago, Ill. Portable grinders for lathes and planers; hand lever punches and shears; "Marvel" power hack-saw machine.

Armstrong Bros. Tool Co., Chicago, Ill. Drop forged lathe and planer tool-holders and other machine shop specialties.

Besly & Co., Charles H., Chicago, Ill. Besly spiral disk grinders (see MACHINERY, May, 1910, for description); spiral circles; forged taps, etc.

Buck Boring Bar Co., Huntington, W. Va. Roughing and finishing expansible cutter boring bar for car wheels.

Celfor Tool Co., Chicago, Ill. Celfor high-speed drills, three-lip drills, flat drills, reamers, countersinks, etc.; tests of Celfor drills on Colburn high-duty drill.

Chicago Pneumatic Tool Co., Chicago, Ill. Belt-driven air compressor for pneumatic drills.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Cyclone high-speed chain hoists from ½ ton to 30-ton capacity; I-beam trolleys, etc.

Colburn Machine Tool Co., Franklin, Pa. Motor-driven high-duty drilling machine in operation.

Cooper Hewitt Electric Co., New York. Mercury vapor lamps and mercury arc rectifiers for operating same with electric current.

Davis-Bournonville Co., New York. Repaired locomotive parts welded by the oxy-acetylene autogenous process.

Disston & Sons, Inc., Henry, Philadelphia, Pa. Hack saws; regular and superfine files; hand saws and other carpenter's tools.

Dixon Crucible Co., Joseph, Jersey City, N. J. Graphite products for locomotives and cars.

Duff Mfg. Co., Pittsburg, Pa. Hydraulic jacks, ball bearing jacks, etc.

Faessler Mfg. Co., J., Moberly, Mo. Improved sectional tube expanders, etc.

Fairbanks-Morse & Co., Chicago, Ill. Hydraulic and screw jacks; track drills, etc.

Foster, Walter H., New York. Lassiter locomotive bolt turning machine; staybolt threading and reducing machine; Potter & Johnston chucking lathe; staybolt threading machine; automatic nut tapping machine; die chaser grinder, etc.

General Electric Co., Schenectady, N. Y. Electric tool hardening furnace; motor-driven machine tools, Curtiss turbo-generator, etc.

Goldschmidt Thermit Co., New York. Apparatus illustrating the Thermit welding process; metals free from carbon produced by the Thermit process, etc.

Greene, Tweed & Co., New York. Reversible ratchet wrenches; packing.

Hammett, H. G., Troy, N. Y. Locomotive link grinder, etc.

Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa. Chain hoists; I-beam trolleys, etc.

Independent Pneumatic Tool Co., Chicago, Ill. Piston air drills; pneumatic chipping, riveting, calking and flue beading hammers, etc.

Keystone Drop Forge Works, Chester, Pa. Drop forgings, including machine handles, etc.

Landis Machine Co., Waynesboro, Pa. Self-opening Landis die for turret lathes; semi-automatic die head for pipe threading machines; and double-head motor-driven bolt threading machine; single spindle ½-inch bolt threading machine.

Landis Tool Co., Waynesboro, Pa. Cylindrical gap grinding machine, 16 x 72 inches, in operation, especially designed for railroad work; universal cylindrical grinder.

Manning, Maxwell & Moore, Inc., New York. 24-inch F. E. Reed motor-driven engine lathe; 24-inch high-duty Foote-Burt drill; 36-inch Foote-Burt high-duty drill; 26 by 8 by 8-foot single-head motor-driven shaper; 4½-inch Gridley single spindle motor-driven turret lathe; 1¼-inch Gridley four-spindle turret lathe; No. 4 Hendey motor-driven knee-type milling machine; 16-inch Hendey geared head engine lathe; Dreses motor-driven full universal radial drill; 1½-inch National wedge grip heading and forging machine; National motor-driven double head bolt cutter; National die chaser sharpener; Elmore (Dwight Slate Co.) high-duty ball bearing single-spindle sensitive drill press, etc.

National-Acme Mfg. Co., Cleveland, Ohio. Multiple-spindle automatic screw machine in operation.

Niles-Bement-Pond Co., New York. 20-inch LeBlond engine lathe with all-geared heads; three-step cone pulley; LeBlond double back-geared lathe head; LeBlond universal milling machine; pneumatic clamp tool-post for locomotive driving wheel lathes and car wheel lathes; Pratt & Whitney small tools, etc.

Norton Co., Worcester, Mass. Alundum grinding wheels and other alundum abrasive products.

Revolute Machine Co., New York. Continuous electric blue-printing machine.

Sellers, William, & Co., Inc., Philadelphia, Pa. Turret tool-post for 42-inch car wheel lathe; turret tool-post for high-duty locomotive driving wheel lathe; set of three drivers for 42-inch car wheel lathe, etc.

Stoever Foundry & Mfg. Co., Myerstown, Pa. Automatic pipe bending machine; pipe threading and cutting-off machine.

Taylor Mfg. Co., James L., Bloomfield, N. J. Machinists' patternmakers' and boilermakers' clamps.

Tindel-Morris Co., Eddystone, Pa. Cold sawing machine and inserted tooth cold saws; grinders, etc.

Toledo Pipe Threading Machine Co., Toledo, Ohio. Hand-operated pipe threading tools, etc.

Underwood & Co., H. B., Philadelphia, Pa. Portable cylinder boring bar; portable crank-pin turning machine; portable machine for facing off riveting on crank-pins; locomotive pedestal facing machine.

Union Mfg. Co., New Britain, Conn. Lathe, planer, drill, valve, boring mill and car-wheel chucks.

Walworth Mfg. Co., Boston, Mass. Stillson wrenches; Miller ratchet stocks and dies, etc.

Watson-Stillman Co., New York. Hydraulic jacks; centrifugal pumps, etc.

Westinghouse Air Brake Co., Pittsburg, Pa. Air brakes, seven-car passenger train rack equipped with PC equipment, etc.

Westinghouse Machine Co., Pittsburg, Pa. LeBlanc steam condenser and LeBlanc vacuum pump, turbine driven.

Yale & Towne Mfg. Co., New York. Electric hoists, I-beam trolleys, chain blocks, etc.

* * *

DRY HIGH-SPEED TOOL GRINDING

Fine surface cracks are often found on high-speed steel tools after grinding, especially when grinding with a wet wheel. A class of work that is particularly troublesome in this respect is hardened disks such as slitting saws, washers, etc., ground on the side. The cracks develop radially, and although of microscopic depth and really not injurious in most work, they give it a defective appearance and cause rejections and losses. It is pretty well settled now that these cracks are caused by momentary overheating of the steel which results in local expansion sufficient to exceed the elastic limit of the metal. The cracks grow with each revolution of the work, radially to the edge of the disk. The remedy is to use a soft wheel and grind *dry*. When work is ground dry with a soft wheel the pressure is reduced as compared with wet grinding, and thus local overheating is also reduced. Many have the idea that if tools are ground wet there is no danger of overheating. This is a mistake; water cannot be forced to the exact point of contact of the wheel and work, and its local cooling effect is comparatively slight. The effect of the water in wet grinding is to keep down the temperature of the wheel and work generally, but not locally.

On account of the tendency to exceed the safe pressure and ruin tools by overheating when grinding with a wet wheel, some tool experts now recommend dry wheels for all high-speed steel tool grinding. If water is used, it should be used only with the idea of keeping down dust and washing the wheel and tool, and not as a cooling medium of much efficiency.

PERSONALS

Robert S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, was married June 25 to Margaret Carel Maury.

George S. De Laney, superintendent of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has been promoted to the position of manager.

Alex. Luchars, publisher of MACHINERY, sailed with his family on the *Oceanic* June 15 for a three month's tour in Europe, principally by automobile.

R. D. Reed, for several years with the H. B. Smith Co., Westfield, Mass., has been made manager of the Springfield Foundry Co.'s new plant in Springfield, Mass.

Wilson P. Hunt, of the Moline Tool Co., Moline Ill., recently took an extended eastern trip, including Toronto, Buffalo, National Machine Tool Builders' Association convention at Rochester, Pittsburg and Cincinnati.

F. H. Wilder has been promoted from the position of foreman of the "J and L" department to the position of foreman of the chassis assembling department of the automobile section of the New Departure Mfg. Co., Bristol, Conn.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., is now on his annual trip to Germany visiting his company's allied German companies, manufacturing balls and ball bearings, and arranging for the coming year's contracts. Mr. Rogers expects to attend the meeting of the American Society of Mechanical Engineers in joint convention with the British Institute of Mechanical Engineers in Manchester and London in July.

C. H. Kingsbury, for the past twelve years manager of the Niles-Bement-Pond Co.'s Boston office, will take a vacation of several months on account of ill-health. Previous to his departure the managers and heads of departments of the Hill-Clarke & Co., Inc., Chandler & Farquhar Co., Prentiss Tool & Supply Co., and Manning, Maxwell & Moore called upon Mr. Kingsbury and extended their best wishes for rapid return of health. They presented him with a Masonic charm, suitably engraved as a token of friendship. Mr. M. Estabrook of the New York office will have charge of the Boston office during Mr. Kingsbury's absence.

Louis I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Co., 11 Broadway, New York, has resigned his position, the resignation taking effect August 1, and will open an office in New York City as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. Mr. Wightman is well fitted for this line of work by his wide experience in managing one of the largest advertising departments in the machinery field, which was preceded by some years' experience in practical mechanical and electrical engineering, construction work, machine design and manufacture and machinery selling. Mr. Wightman is a graduate engineer, the author of a text-book on compressed air, and an authority on compressed air subjects.

* * *

OBITUARIES

James Wilson, master mechanic of No. 5 machine shop, Ludlow Mfg. Associates, Ludlow, Mass., died at his home in Ludlow, June 5, aged forty-four years.

W. P. Bettendorf, president of the Bettendorf Steel Car Co., Davenport, Iowa, died at his home in Davenport, June 3, in the fifty-third year of his age. Mr. Bettendorf organized the company of which he was president and built the works which cover thirty acres of ground. A recent addition is 2100 feet long. He was the inventor of several improvements in agricultural machinery and railway cars.

John H. Whittemore, a pioneer in the malleable iron industry, died at his home in Naugatuck, Conn., May 28 after a short illness. Mr. Whittemore began in the malleable iron business in 1858, the firm name being Tuttle & Whittemore. After several years the concern was reorganized and the name changed to the Naugatuck Malleable Iron Co. Mr. Whittemore was interested in the malleable iron industry in Cleveland, Chicago, Indianapolis, Toledo, Bridgeport and New Britain.

Charles E. Bailey, a veteran armorer, who retired fifteen years ago after thirty-one years of service as foreman in the Water Shops, United States Armory, Springfield, Mass., and a total of forty-five years in the government shops, died at his home in Springfield, Mass., May 10, aged eighty-three years. Mr. Bailey devised and perfected many valuable fixtures and tools. Col. Benton during his term as commandant recommended to the government that Mr. Bailey receive liberal extra pay for valuable service, but the grant was never made. At the time the Rock Island, Ill. shops were being planned, Mr. Bailey was sent there to prepare plans for the lay-out of machinery. He had charge of the armory exhibit at the Chicago World's Fair in 1903. He was a native of South Berwick, Me.

William P. Davis

D. Wheeler Swift, inventor of printing and automatic machinery used in the manufacture of envelopes, died of paralysis at his home in Worcester, Mass., June 14, aged seventy years. Mr. Swift went to Worcester in 1864 and entered the employ of David Whitcomb who was just starting in the envelope business. He worked twenty years as superintendent for the Whitcomb Envelope Co., during which period he and his brother produced and perfected new machinery which would successfully fold and gum envelopes. In 1884 the Logan, Swift & Brigham Envelope Co. was organized and Mr. Swift was made president. His inventions of new machinery were largely responsible for the success of the company. The United States Envelope Co. was founded in 1898 and Mr. Swift was elected director and mechanical superintendent, which position he filled during the remainder of his life.

John M. Rogers, of the John M. Rogers Works, Inc., Gloucester City, N. J., died in the Cooper Hospital, Camden, N. J., June 4, following an operation, aged sixty-eight years. He was born in Key West, Fla., and his early life was spent as purser on the side-wheel steamer *Golden Rule*, running between New York and the Isthmus of Panama. After the wreck of this vessel off Roncador Reef, he spent a few years in the employ of his uncle, the late Francis Morris. After his marriage he resided in Wilmington, Del., where he entered the printing business, having full charge of the John M. Rogers Press for several years. In later years he became actively engaged in the machine business, being one of the pioneers in the manufacture of measuring tools. Mr. Rogers developed the John M. Rogers Works, Inc., Gloucester City, N. J., of which he was president at the time of his death. He leaves a widow and two sons, J. Morris Rogers and Francis C. Rogers.

William P. Davis, president of the W. P. Davis Machine Co., Rochester, N. Y., died at his home in that city May 30, aged sixty years. Mr. Davis was born in Lima, N. Y., in 1850 and was educated in the public schools of Honeoye Falls. Early in life he manifested a strong mechanical bent, and entered a machine shop at Auburn when only fourteen years old. Eight years later Mr. Davis started a machine shop of his own in North Bloomfield, N. Y., and later removed to Canandaigua, N. Y., where he remained three years. In 1890 he moved to Rochester, where quarters were occupied in the Borseline building at the foot of Commercial St. In 1894 he organized the W. P. Davis Machine Co., and in 1897 the present large brick plant in which about 200 men are employed was erected on St. Paul St. near the New York Central station. Mr. Davis was a charter member of the National Machine Tool Builders' Association and was prominently identified with it from the time of its organization, having always filled an official position. He was treasurer of the association at the time of his death, which office he had held since 1906. It was largely through his efforts that the last meeting of the association was held in Rochester but his last illness prevented him taking part. He leaves a widow, one daughter, an aged father and brother, Charles F. Davis, secretary and treasurer of the W. P. Davis Machine Co.

* * *

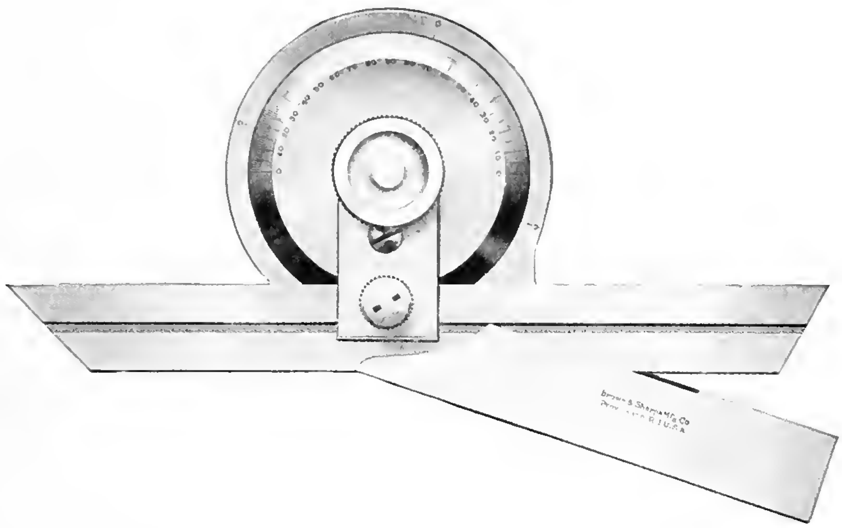
There have been many attempts to formulate an explanation of a steam turbine's operation which will be understandable by the non-technical man. One of the simplest we have seen is given by the *Daily Star* of Lincoln, Neb.:

"The turbine stands about 6 feet high and is about 6 feet through. It is cylindrical. The turbine wheels inside are used to keep the acids and zinc stirred so as to generate electricity rapidly."

This was contained in a comment on an accident to a turbo-generator. No wonder it blew up!—*Engineering News.*

Here is a new tool, accurate and inexpensive, for laying out or establishing angles.

B. & S. IMPROVED BEVEL PROTRACTOR



The protractor is made with one side flat so that it can be laid flat on the work or paper—a feature that adds greatly to the utility of the tool.

The blade can be moved separately from the dial and can be moved back and forth its entire length. It is clamped independently of the dial and this adapts the tool for work where other protractors cannot be used.

DIAL GRADUATED TO DEGREES

All graduations on the dial are accurately made, the graduations reading to degrees. These graduations extend over an arc of 180°, reading from 0 to 90° from each extremity of the arc. The tool is intended for work that does not require a Vernier, a point wherein it differs from the Universal Bevel Protractor. The dial turns on a large central stud which is hardened to prevent wear. When the dial is set, this clamp nut holds it rigidly in place, doing away with all danger of slipping and consequent inaccuracies in the measurements.

The Protractors are made in two sizes, with 6" or 12" blades.

Send for new folder.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

COMING EVENTS

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

July 28-30.—Convention of the Society of Automobile Engineers, Detroit, Mich. Subjects for discussion: "Gears," "Commercial Vehicles," "The Electric Vehicle," "Gasoline Motors," "Metals and Treatment," "Wheel Rims, Tires, etc.," "Bearings," "Driver's Seat on Left-hand or Right-hand," "Final Drive," "Factory Systems," "Contests," etc. Howard E. Coffin, president, 1451 Broadway, New York.

August 16-19.—Annual convention of Traveling Engineers' Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. A. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Bulletin of Syracuse University, April, 1910.
General catalogue and catalogue of the summer session which is held July 5 to August 16. Address the University of Syracuse, Syracuse, N. Y.

Society of Automobile Engineers, 1451 Broadway, New York, has taken over the work of the Association of Licensed Automobile Manufacturers' mechanical branch and will broaden the activity of the association in its relation to the motor car industry. Its object is to collect, scientifically arrange, and disseminate motor car engineering data and information.

NEW BOOKS AND PAMPHLETS

Concrete from Sand Molds, by A. A. Houghton. 145 pages, 5½ by 7½ inches, 12 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.

This interesting book describes the processes of molding concrete, especially ornamental forms, in sand molds, the practice being similar to molding for metal castings. It is a revived art, there being evidence to show that it was practiced by the Romans. The work describes the process of preparing and mixing the sand for hardened sand molds, how to make sand molds from wood and metal patterns, construction of sand molds from clay, plaster, concrete, or other patterns, method of making cores, how to combine molds to mold large monolithic work, molding concrete brick with sand molds, facing molds with crushed granite, marble flour or any other material, etc.

The Polytechnic Engineer. 144 pages, 6 x 9 inches. Illustrated. Published by the Polytechnic Institute of Brooklyn, New York.

This work is published annually by the undergraduates of the Polytechnic Institute. Volume X contains the roster of the corporation, officers, officers of instruction, Polytechnic Institute engineering societies, board of editors, and among others the following technical articles: "Negative Track-Feeders," by Samuel Sheldon; "Some Experiments on the Casehardening of Steel by Gases," by John C. Olsen, John R. Brierley, and John S. Weiffenback; "Train Resistance Formulas and Speed-Time Relations," by William D. Ennis; "Deflections of Beams with Variable Moments of Inertia," by C. W. Hudson; "Gyration Stresses in Shafts," by D. D. Barlow; "Automobile Transmissions," by Edward O. Ericson; "Continuous Indicator Diagrams," by M. G. Farrell.

CATALOGUES AND CIRCULARS

Sprague Electric Co., 527 West 34th St., New York. Catalogue of electric hoists.

General Electric Co., Schenectady, N. Y. 18th Annual report to the stock-holders.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 3017 on gas compressors.

Sprague Electric Co., 527 West 34th St., New York. Catalogue of flexible steel armored hose for compressed air or steam.

Emerson Electric & Mfg. Co., St. Louis, Mo. Bulletin No. 3707 of electric buffing lathes for alternating and direct currents.

Graton & Knight Mfg. Co., Worcester, Mass. Circular entitled "What Mr. Denniston Says," advertising G. & K. leather belting.

National Brake & Electric Co., Milwaukee, Wis. Bulletin No. 389 on types of National emergency and variable release brake valves.

Turner-Fricke Mfg. Co., Sharon, Pa. Catalogue of Turner-Fricke gas engines, illustrating and describing the construction in detail.

Westinghouse Machine Co., East Pittsburg, Pa. Circular W-M 501 on the Westinghouse-Le Blanc condensers for steam power plants.

Reynolds Machinery Co., Moline, Ill. Circular of Reynolds gear hobbing machine illustrated and described in the April, 1909, issue of Machinery.

Ingersoll-Rand Co., 111 Broadway, New York. Bulletins Nos. 306 and 3023 on Class O duplex steam-driven air compressors, and Class OC duplex Corliss driven air compressors.

Miami Valley Machine Tool Co., Dayton, Ohio. Blotter advertising 13-inch and 16-inch lathes; plain, cutter and reamer grinders; universal tool and cutter grinders; 12-inch and 14-inch drills, etc.

General Electric Co., Schenectady, N. Y. Bulletin No. 4737, illustrating and describing electric hardening furnaces designed for the hardening and tempering of tool steel. (See Machinery, November, 1909.)

Union Mfg. Co., New Britain, Conn. Circular advertising economical iron castings which in quality and net cost should give the highest satisfaction. The company has specialized on the work for forty years.

Carb-Ox Co., Rogers Park, Chicago, Ill. Catalogue of gas analysis instruments and allied specialties, used in the determination of boiler efficiencies, gas producers, etc., whether the fuel be coal, oil, gas or refuse.

National Brake & Electric Co., Milwaukee, Wis., Bulletin No. 388, "Types of National Motorman's Air Brake Valves." These air brake valves are designed for street railway urban and interurban service.

Chicago Bearing Metal Co., Chicago, Ill. *The Graphose Age* being the second number of a publication devoted to graphose-bronze, white brass, brass castings, babbitt metals, solder and other products of the company.

Crescent Machine Co., Leetonia, Ohio. Catalogue of Crescent wood-working machinery comprising band saws, universal saw tables, shapers, jointers, variety wood-workers, planers, planers and matchers, swing cut-off saw, disk grinders, etc.

Aerial Navigation Co. of America, Girard, Kans. Circular illustrating and describing the Call aviation engine built in two sizes—45 horsepower and 90 horsepower, weight 135 and 225 pounds respectively, price $700 and $1,200.

Negretti & Zambra, 38 Holborn Viaduct, London, E. C., England. Revised price list and instructions for acrometer, an instrument giving direct readings of the maximum cylinder pressure of internal combustion engines, compression, vacuum, etc.

Risdon Tool & Machine Co., 63 Canal St., Waterbury, Conn. Circular giving official organization and statement of its activities. The company designs and makes dies, models, tools, sub-press dies, light machinery, and does all kinds of light manufacturing.

Union Mfg. Co., New Britain, Conn. Catalogue of combination, universal, independent, geared scroll, scroll combination, planer, boring mill, car wheel, grinding machine, box body, round body and drill chucks. The company also builds special chucks of every description to order.

General Electric Co., Schenectady, N. Y. Bulletin No. 4732, containing upwards of fifty illustrations of installations of Curtiss steam turbine generators of various classes. The bulletin should interest central station managers and others concerned with the production of large powers.

W. F. & John Barnes Co., Rockford, Ill. Catalogue of the various styles and sizes of Barnes upright drills, horizontal radial drills, gang drills, drill press attachments and other machine tools. This catalogue is attractively arranged, and contains much that is of interest relating to drilling machinery.

Pawling & Harnischfeger, Milwaukee, Wis. Bulletin No. 18, illustrating and describing traveling electric hoists. Besides showing the various types of hoists made, the bulletin illustrates a number of interesting installations. It will interest the plant engineer, superintendent and other responsible men desirous of saving costs in handling material.

Cling-Surface Co., Buffalo, N. Y. Report of an interesting experience in the treating of a painted ten-inch heavy canvas belt which had been treated with "Cling-Surface" after having been condemned as being no good. After being treated with the "Cling-Surface," the belt ran at 850 R. P. M. and transmitted 85 H. P. without sign of slip, although the sag was 23 inches between pulleys.

Tate Jones & Co., Inc., Pittsburg, Pa. Circular No. 129 on fuel oil burning equipment for open-hearth furnaces. The Kirkwood oil burner is illustrated and described; also reversing valve stand, pumping, heating and regulating systems, etc. Views are shown of installations of the apparatus in foundries and steel works, and a piping diagram of oil fuel installation in an open-hearth steel plant is included.

L. A. Williamson Co., 79 Milk St., Boston, Mass. Booklet describing Williamson's electric "Flexilyte," which is a portable electric light extension containing a cord that can be unwound to any desired length and which is held fast by a sliding catch. The fixture is neat in appearance and convenient to use, there being no extra length of cord hanging in loops, the excess length being coiled within the fixture.

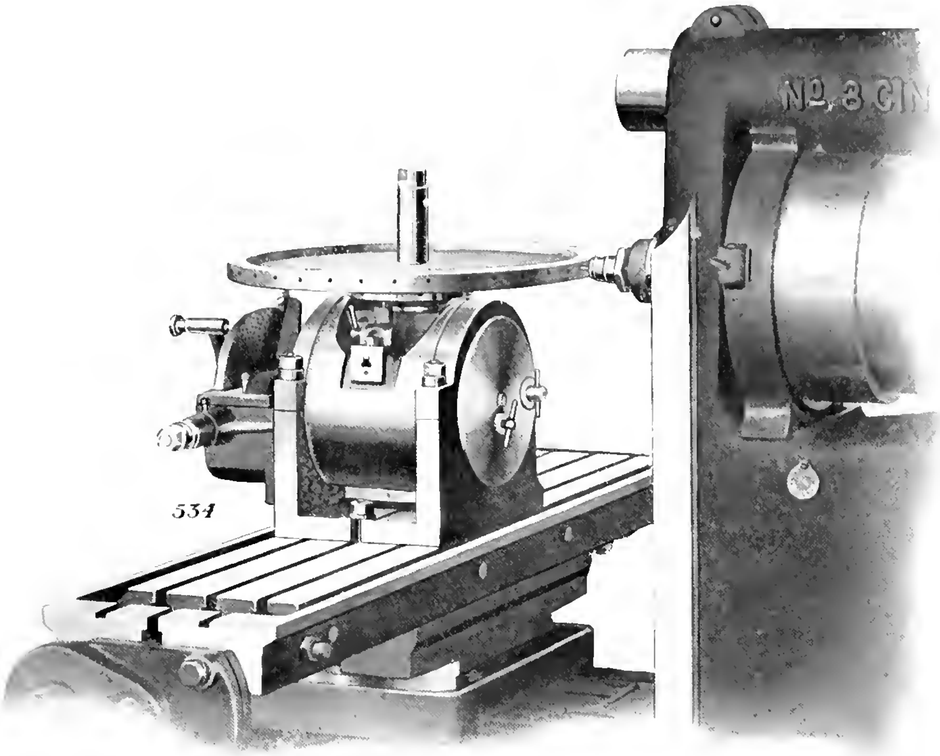
De Laval Steam Turbine Co., Trenton, N. J. Treatise on De Laval centrifugal pumps, giving the results of tests and illustrations and descriptions of various types of centrifugal pumps for all classes of service. The characteristic curves of several sizes of pumps designed to meet the requirements of representative classes of service are reproduced, and testing apparatus illustrated. The construction of pumps is shown disassembled, and much matter of engineering interest is included. The treatise is recommended to the attention of all interested in the possible use and operation of centrifugal pumps.

National-Acme Mfg. Co., Cleveland, Ohio. Parts and tools catalogue for the Acme automatic multiple-spindle screw machine. It illustrates the component parts of head, spindles in head, spindles in slide, main slide, cut-off and forming cross-slides, top slides, feed mechanism, spindle stopping mechanism, power transmission—drive, power transmission—control, power transmission—back gears, power transmission—housing, countershaft, frame, oil system, stock carriage, cams, chucks, box-tools, tools for top slides, tools for cross-slides, dies and drill-holders, etc. The book is intended particularly for men in charge of automatics and automatic screw machine departments. Copies are sent free upon request.

Green Fuel Economizer Co., Matteawan, N. Y. Pamphlet entitled "Foundry Heating System," containing detailed descriptions of two novel installations recently made by the company. In one of these installations, a foundry of 515,000 cubic feet capacity and having walls made up entirely of glass was successfully heated by a small four-section "Positivflo" heater. The pamphlet also describes a novel arrangement of ducts whereby the heat is supplied just where needed by the workmen, at the same time furnishing them with fresh air, and forcing the smoke and gases out of the building through the skylight. By using the right number of heater sections, and regulating the volume of air delivered, it is also possible to maintain the foundry at such temperature at night that cores and molds will be prevented from freezing.

Ward Leonard Electric Co., Bronxville, N. Y., recently published a pamphlet describing a new generator and storage battery outfit for automobile lighting. The ingenious feature of the device is the provision of an electrically controlled magnetic clutch between the engine and the generator. This control connects the generator with the power whenever the gear shifting lever is moved from the neutral position. When the engine and generator have speeded up so that the voltage induced becomes slightly greater than that of the storage battery, an automatic electric switch connection is closed between them, charging the battery. Whenever the voltage of the generator falls below that of the cells, this switch automatically opens, preventing an improper discharge of the battery. When the engine and generator speeds become so high that the charging amperes reach a predetermined amount, an automatic electric switch breaks the circuit to the clutch, thus slowing down the dynamo armature. When this again has been reduced below the critical point, the clutch circuit is thrown in again, accelerating the dynamo. It will thus be seen that the dynamo speed is kept within predetermined speed limits, no matter how high the engine speed attained. Two storage batteries are provided, either of which may be used for the lighting service, and the other for ignition. The storage feature provides for both light and ignition over periods when the engine has been stopped for some time.

CINCINNATI UNIVERSAL TOOL ROOM MILLERS



Thirty-six holes ¼″ diameter are spaced on the periphery of a 19″ disk rigidly held on a 12″ Index Head. They are first drilled, then bored a trifle under size, and finally reamed to a plug gauge fit with a specially ground ¼″ end mill. The error between holes is less than one thousandth (—.001″). To get such results requires a miller that is accurate all over.

This is a good illustration of the best method of handling work of larger diameter than the index centers will swing. The swivel trunnions on our Dividing Head are large in diameter and fully protected in all positions, insuring permanency of alignment at any angle to which the spindle may be set.

Cincinnati Millers are as famous for their accuracy as for their productive capacity.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg and Copenhagen. Alfred H. Schutte, Cologne, Brussels, Milan, Paris, Barcelona and Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

Canadian Agent—H. W. Petrie, Limited, Toronto, Montreal and Vancouver.

Australian Agents—Thos. McPherson & Son, Melbourne.

CONTENTS FOR JULY

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition

This whole mechanism would seem to be as well adapted for development into a railroad car lighting apparatus, as for automobile use.

International Harvester Co., Chicago, Ill. Circular describing plan of industrial accident department of the International Harvester Co. and associated companies, comprising International Harvester Co. of Canada, Ltd., International Flax & Twine Co., Wisconsin Steel Co., Illinois Northern Ry., Chicago & West Pullman & Southern Ry., Owasco River Ry., and Deering Southwestern Ry. The scale of compensation provided is as follows: In case of death there will be paid three years' average wages, but not less than $1,500 nor more than $4,000. In case of the loss of a hand or foot, one and one-half years' wages, but in no event less than $500 nor more than $2,000. For the loss of both hands or both feet, or one hand and one foot, four years' wages, but in no event less than $2,000. In case of other injuries, one-fourth wages during the first thirty days of disability; if disability continues beyond thirty days, one-half wages during the continuance thereof, but not for more than two years from the date of the accident. Thereafter, if total disability continues, a pension will be paid. Provision is made so that the employes may increase the benefits to be paid during the first thirty days of disability to an amount equal to half-wages. This is accomplished by the creation of a benefit fund, to be paid by the company, be sufficient to provide half-pay for all injured which employes earning $50 per month or less will contribute 6 cents a month, employes earning more than $50 and less than $100, 8 cents These small contributions will, together with the one-fourth wages a month, and employes earning more than $100, 10 cents per month. employes during the first thirty days of disability.

TRADE NOTES

Bausch Machine Tool Co., 200 Wason Ave., Springfield, Mass., has made plans for building a three-story addition, 50 by 100 feet.

Lees-Bradner Co., Cleveland, Ohio, manufacturer of gear generating machines, is building an addition, 30 x 50 feet, to its factory.

Deane Steam Pump Co., Holyoke, Mass., branch of the International Steam Pump Co., will build a new foundry plant 290 feet long, 150 feet wide.

C. W. Hunt Co., New York, builder of coal handling, conveying and hoisting machinery, has appointed C. T. Anderson manager of the Chicago office, 1616 Fisher Bldg.

Sebastian Lathe Co., Covington, Ky., has just completed a 45 x 80 foot single story, concrete floor, trussed roof addition to its shop, and reports orders ahead for the next three months.

Knox Automobile Co., Springfield, Mass., is building an addition to its plant, 66 x 125 feet, six stories and basement. The addition will increase the company's manufacturing space about 25 per cent.

Wisconsin Engine Co., Corliss, Wis., has appointed George B. Foster its Chicago sales manager. His office will be located in the Fisher Building, Chicago. Mr. Foster represents the company in the Chicago district.

Springfield Foundry Co., Springfield, Mass., has bought a large tract of land on the main line of the Boston & Albany R. R. and will at once build a large plant to meet the requirements of its increasing business.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., maker of electric controlling devices will hereafter manufacture the Kohler system automatic push button control for printing presses, motor-driven tools, etc. This system was developed by Kohler Bros. of Chicago.

Globe Stove & Range Co., Kokomo, Ind., has largely increased its plant. It has installed a Newten cupola of 14 tons hourly capacity and an outfit of ladles and trucks for an industrial railway, all furnished by the Northern Engineering Works, of Detroit, Mich.

Ready Tool Co., Bridgeport, Conn., has engaged Mr. G. C. Parker to act as its sales manager. Mr. Parker has been for the past three years connected with the William J. Smith Co., New Haven, Conn., and has had successful experience marketing machine shop accessories.

Westinghouse Machine Co., East Pittsburg, Pa., held its annual meeting of stockholders June 21. The orders received for shop products during the fiscal year ending March 31 aggregated $5,123,612.23, an increase of $2,322,536.88 as compared with the previous fiscal year.

C. W. Hunt Co., New York, builder of coal handling, conveying and hoisting machinery, has opened offices in State Bank Bldg., Richmond, Va., and also at 607 Rhodes Building, Atlanta, Ga., with Mr. W. F. Lee, for several years preliminary engineer to the company, in supervision.

Peerless Automatic Machine Co., Cleveland, Ohio, manufacturer of automatic screw machines, was recently burned out, the loss being $15,000, partly insured. The company will erect a new plant immediately, and expects to be ready to handle business again in about ninety days.

Penberthy Injector Co., Detroit, Mich., numbered its 600,000 Penberthy automatic injector on March 29, 1910. It is estimated that 600,000 size G G injectors would handle about one-third the amount of water flowing over Niagara Falls, or approximately 2,520,000,000 gallons per hour.

Crocker-Wheeler Co., Ampere, N. J., at a recent meeting of directors, elected the following officers: President, Schuyler Skaats Wheeler; first vice-president, Gano Dunn; third vice-president, Arthur L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell.

LaSalle Machine & Tool Co., LaSalle, Ill., manufacturer of surface grinders and foot presses, has contracted for an addition to its plant, 48 x 95 feet, which will practically double the capacity of its shop built only a little more than two years ago. The construction calls for the completion of the new addition August 1.

G. M. Yost Mfg. Co., Meadville, Pa., has purchased the plant and equipment of the Williamson Vise Co., Bradford, Pa. The entire outfit of the Williamson Vise Co. will be moved to Meadville and the G. M. Yost Mfg. Co. will make a complete line of vises for machinists, patternmakers, wood-workers, jewelers, blacksmiths, and toolmakers.

M. L. Andrew & Co., Cincinnati, Ohio, manufacturer of wood-working machinery and multiple-spindle drills for metal drilling is now located in its new factory, corner of Colerain Ave. and Alabama St. The new location gives the company excellent facilities. The plant has been thoroughly equipped with modern tools and the output will be greatly increased.

Jacobs Mfg. Co., Hartford, Conn., chuck maker, has posted a notice to the effect that its factory will be closed the first week in August, and its employes who have worked nearly as full time as possible up to August 1 will be given a vacation for a week with full pay, paid in advance. In order to fill orders, it will be necessary for the plant to run Saturday afternoons until August 1.

Cooper-Hewitt Electric Co., New York, has recently purchased the substantial structure located on the corner of Grand and 8th Sts., Hoboken, N. J., for the manufacture of Cooper-Hewitt electric lamps. The new factory will be fully equipped with modern machinery and devices for the manufacture of the lamps. The plant is four-story and basement, the total space being 60,000 square feet.

Reliance Electric & Engineering Co., Cleveland, Ohio, announces that its armature shifting type of variable speed motor will be known as the Reliance adjustable speed motor instead of the Lincoln variable speed motor as formerly. This change is made necessary in order to better describe the type of motor in accordance with the present standard terms adopted by the American Association of Electric Motor Manufacturers.

International Acheson Graphite Co., Niagara Falls, N. Y., has adopted the name "Gredag" for its graphite grease in order to distinguish it from other grease products which contain impure natural graphite. The graphite blended with high-grade grease is an electric furnace product, exceedingly pure. The graphite is soft and unctuous and is a perfect lubricant in itself. It is claimed that in "Gredag" all the merits of graphite and grease are combined, making a lubricant of high quality and value.

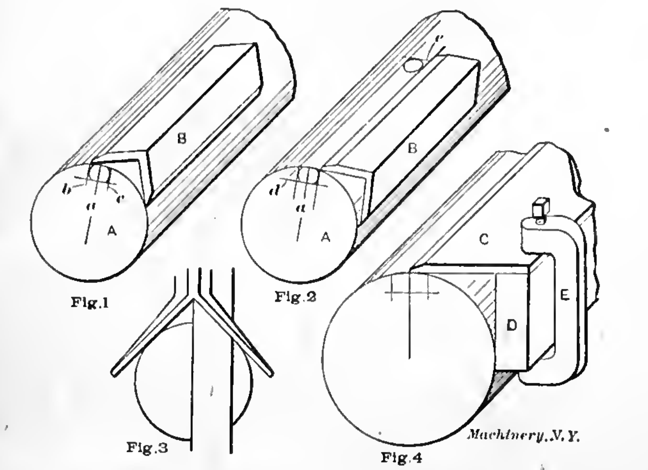
Cincinnati Planer Co., Cincinnati, Ohio, has completed the removal of machinery to its new building at Oakley, a suburb of Cincinnati.

Supplement to MACHINERY, August, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Key Fitting"

SHOP OPERATION SHEET NO. 142.

Oscar E. Perrigo MACHINERY, August, 1910



Laying Out a Shaft Keyway

NOTE.—It is assumed that it is necessary to keyseat the shape *A* by hand, either because of its size or position which makes the use of a planer or milling machine impracticable.

1. Rub moistened sulphate of copper, (blue stone) over the outer surface and end of the shaft where the keyway is to be laid out.

2. Scribe a center line *a* from the center of the shaft to the point where the center of the keyway is to be. This line may be quickly drawn by the use of a center square as illustrated in Fig. 3, or the center of the shaft may be located and a line drawn through it and the keyway center.

3. Lay off arcs on either side of the center line, by the use of dividers set to one-half of the width of the keyway, and scribe lines *b* and *c* tangent to these arcs and parallel to the center line *a*.

4. Apply the keyseat rule *B* to the shaft, as shown in Fig. 1, with its upper edge set to coincide with the line *b* which represents one side of the keyway. Hold both blades of the keyseat rule firmly against the shaft and with a scriber, draw a line as long, or somewhat longer than the keyway to be cut.

5. Shift the keyseat rule to the position shown in Fig. 2; that is so that its edge coincides with line *c*, and scribe a second line.

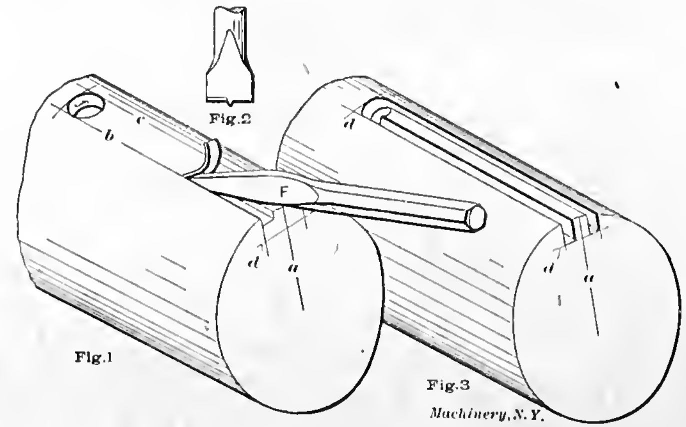
6. Across these lines, draw a line *e* indicating the end of the keyway. Just within this line and tangent to the side lines, scribe a circle with dividers.

7. Upon the end of the shaft, draw the depth line *d* at right angles to the center line.

NOTE.—Should the shaft be so large in diameter that the keyseat rule shown in Figs. 1 and 2, will not embrace it sufficiently to insure parallel lines, a practical device for the purpose may be improvised as shown in Fig. 4, by using a broad straightedge or plate *C*, and a parallel strip *D*, attached to each other by two screw clamps at the ends.

SHOP OPERATION SHEET NO. 143.

Oscar E. Perrigo MACHINERY August, 1910



To Chip a Keyway in a Shaft

NOTE.—The keyway to be cut is supposed to have been laid out with lines on the curved surface indicating the width and length of the cut, and on the end indicating the width and depth.

1. Make a deep punch mark in the center of the circle previously laid out at the end of the keyway, and with this mark as a starting point, drill a hole *f* slightly deeper than the depth of the keyway, using a teat drill such as is illustrated in Fig. 2. This type of drill, as its shape indicates, leaves the bottom of the hole flat. A hole at the end of the keyseat is not, of course, absolutely necessary when the latter is to be cut by hand, but when the work is done by planing, such a hole provides clearance for the tool at the end of the stroke.

2. With a stout cape chisel *F*, somewhat less than one-third the width of the keyway, and held in the position shown, begin a light cut at the end of the shaft and slightly inside of the side line. Carry it steadily and at an even depth, back to the end hole *f*. Repeat the cut as many times as is necessary to cut nearly down to the depth line *d*.

NOTE.—There is no fixed rule for determining the depth or width of a keyway, but a good general rule which corresponds closely to average practice is to make the width equal to one-fifth the diameter of the bore and the depth to one-half the width, measuring at the side.

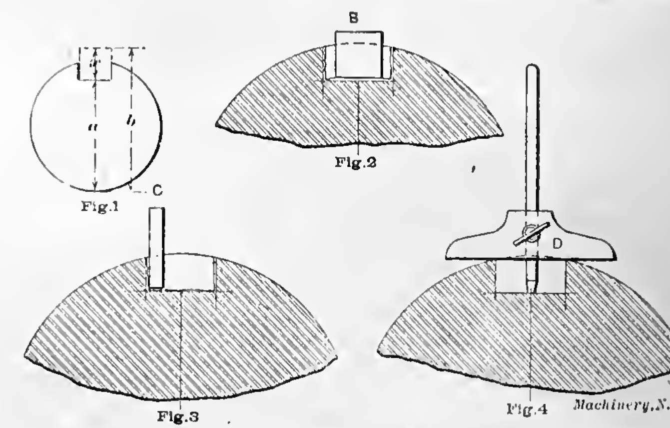
3. Proceed in the manner described in Step 2, to chip another channel at the opposite side of the keyway and slightly inside the scribed line. When this channel has also been cut to depth, the work will appear as shown in Fig. 3.

4. With a wider chisel, proceed to cut out the central rib between the two channels, making as many cuts as necessary and carrying them down nearly to the depth line *d*.

NOTE.—In chipping a long groove, it is necessary that an equal depth be maintained through its entire length, otherwise the proper depth will be more difficult to hold with each successive chip. There will also be more difficulty in keeping the cut straight laterally. The chisel should be slightly wider at the cutting edge than farther back, to provide clearance.

SHOP OPERATION SHEET NO. 144.

Oscar E. Perrigo MACHINERY, August, 1910



To Finish a Keyway by Filing

NOTE.—After the keyway has been cut as close to the line as is practicable by chipping, as described on the preceding sheet, it is finished to the correct width and depth by filing.

1. Select a second-cut square file of the blunt type, if possible; that is one whose sides are parallel throughout its length. Use this as at *B*, Fig. 2, to file the bottom of the keyway and straighten, somewhat, any unevenness there may be at the sides. Hold the point down firmly with the left hand to prevent any rocking motion, and be careful not to mar or misshape the corners of the keyway at the end of the shaft.

2. Set the depth gage *D*, Fig. 4, to the required depth and apply this in the position shown, and at different points to insure a uniform depth throughout the length of the keyway. Before using this gage, all burrs should be carefully removed from the edges on each side.

3. There will be a short portion of the keyway next to the end hole that is not conveniently reached with the file. Chip this out carefully with a light, thin cold chisel and square out the end of the keyway in the same manner.

4. Select a second-cut "hand file" with one "safe edge," and holding the file as indicated at *C*, Fig. 3, with the safe edge down, file the left side of the keyway exactly to the line. With the end of a scale, test the angle to see that the side is square with the bottom.

NOTE.—The edge or side of a file is said to be "safe" when it is without teeth and finished smooth. The advantage in having one of the sides smooth is that it can be placed next to a finished surface, which would be spoiled or marred if subjected to additional filing.

5. File the right side as described in Step 4. Test the width of the keyway with the key to be used. It should crowd tightly down to the bottom of the keyway at all points in its length.

NOTE.—When keyseats are being machined in a number of shafts and hubs, much keyfitting can be eliminated by taking measurements as indicated at *a* and *b*, Fig. 1, as then slight variations in the diameter of the shaft or hub will not affect the dimensions *x*.

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—I

Method of Using the Accompanying Charts.

The diameters of high-pressure cylinders for compound air compressors are found instantly from the accompanying charts for varying pressures and altitudes, when the low-pressure cylinder diameter and the stroke have first been computed with reference to the required piston displacement. The dotted lines and arrows in the diagrams indicate the procedure when the diameter of the low-pressure cylinder is 20 inches and the air compressed to 200 pounds gage pressure. The ratio between the cylinder diameters so found divides the load equally between the two stages, provided the intercooler abstracts all the heat due to compression in the first stage.

The ratios of cylinder areas in the charts are obtained from the absolute ratio of compression.

Example: Compression of 150 pounds gage pressure required.

Absolute pressure = 150 + 14.7 = 164.7 pounds.

Absolute ratio of compression = 164.7 ÷ 14.7 = 11.2.

The square root of this ratio is the ratio of the low-pressure piston area to the high-pressure piston area, or

$$\sqrt{11.2} = 3.35 = \text{ratio of cylinder areas.}$$

A table of absolute ratios of compression for various pressures and altitudes is given below:

Table of Absolute Ratios of Compression.

Gage Pressure, Pounds	Absolute Ratio of Compression		
	Sea Level	5000 feet	10000 feet
80	6.44	7.55	8.92
100	7.80	9.20	10.90
125	9.50	11.25	13.40
150	11.20	13.30	15.90
200	14.60	17.40	20.80
250	18.00	21.50	25.80
300	21.40	25.60	30.70

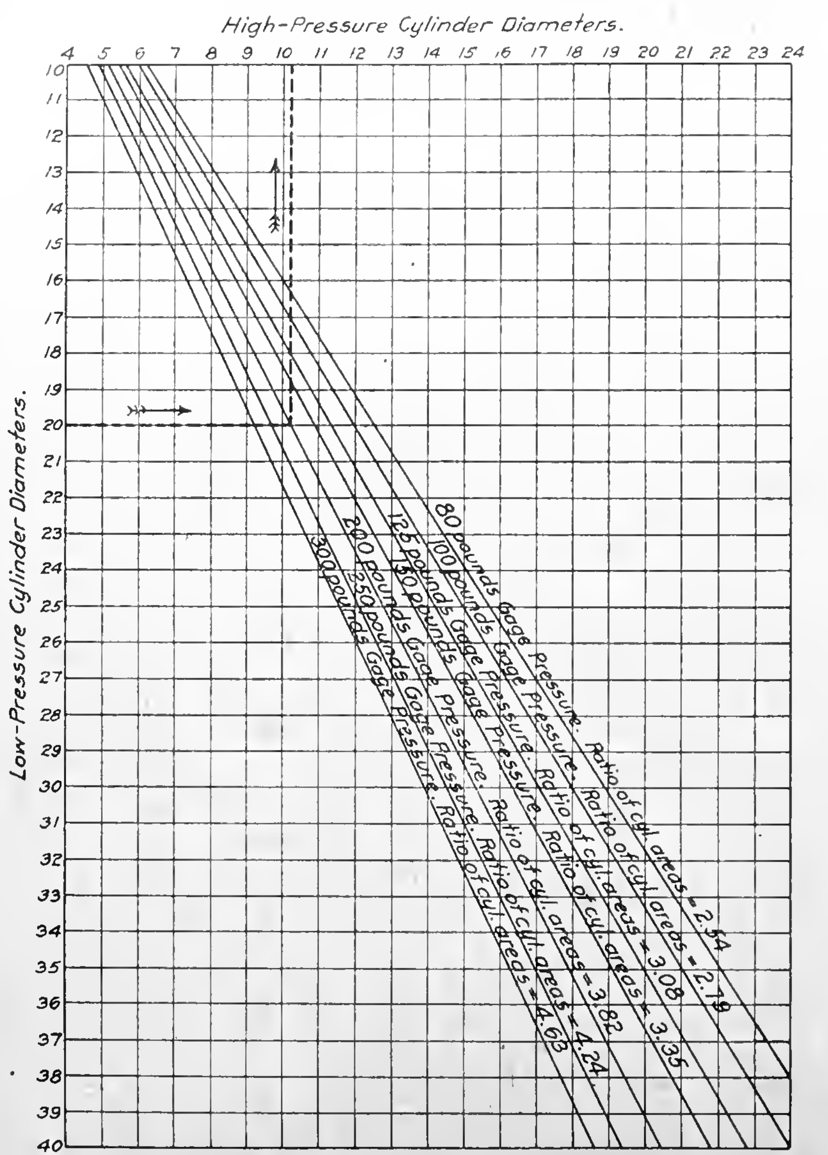
The general formula for determining the high-pressure cylinder diameter is:

$$d = \sqrt{\frac{D^2}{\sqrt{\frac{P_1 + P_2}{P_1}}}}$$

in which d = *diameter of high-pressure cylinder,*
D = *diameter of low-pressure cylinder,*
P_1 = *initial pressure,*
P_2 = *terminal gage pressure.*

Contributed by J. William Jones

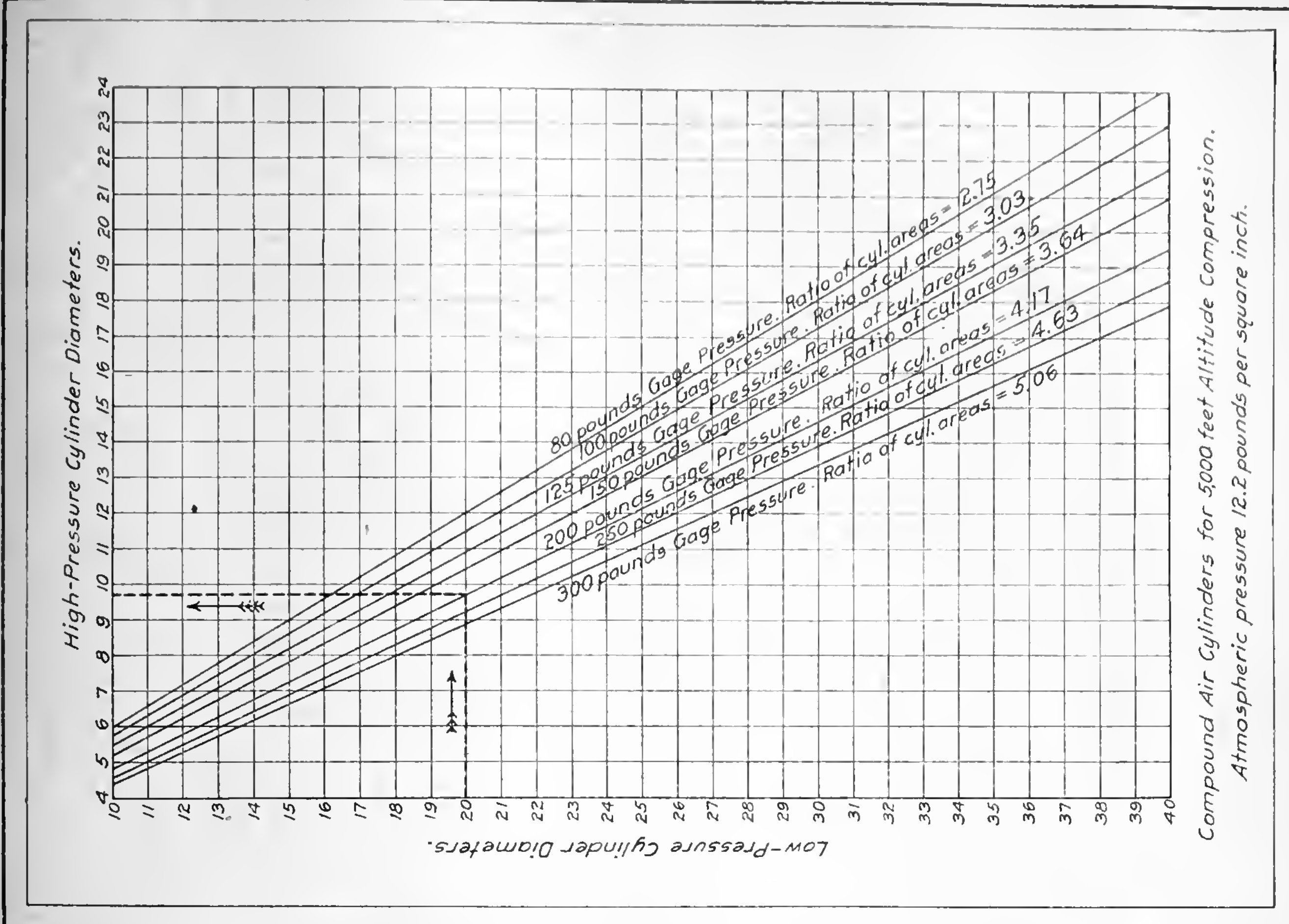
HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—II



Compound Air Cylinders for Sea Level Compression.
Atmospheric pressure 14.7 pounds per square inch.

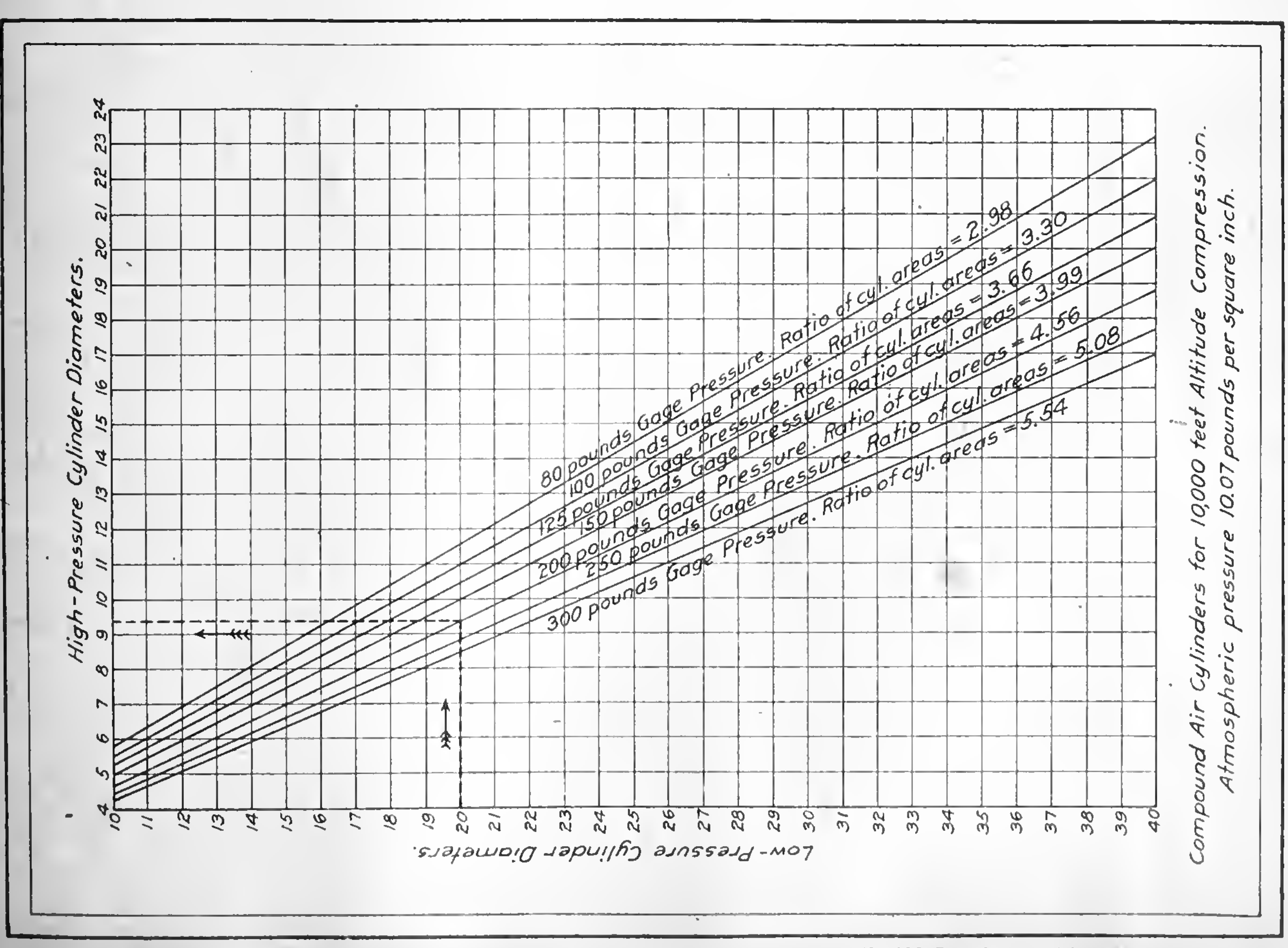
Contributed by J. William Jones

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—III



Contributed by J. William Jones

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—IV



Contributed by J. William Jones

MACHINERY

August, 1910

THE ELLIS ADDING TYPEWRITER

THE PRINCIPLE OF THE ADDING MECHANISM, AND ITS APPLICATION TO A NEW TYPE OF MACHINE

By RALPH E. FLANDERS

THE commercial adding machine is so fearfully and wonderfully made, that it might well seem a reckless undertaking to describe it in a general way for the general mechanical reader. The temptation is strong, however, in the case of the machine here illustrated, for three reasons. The first of these is the courtesy of the makers, the Ellis Adding Typewriter Co. of Newark, N. J., who went beyond the usual bounds in giving explanations and offering facilities for investigation. The second is the fact that the machine, while very highly developed, is yet so arranged that the principles involved can be easily and clearly illustrated. The third reason is the fact that the whole mechanism is full of suggestion to the designer of automatic machines in other lines, on the score of the particular movements employed, as well as on the score of the general orderliness of the design.

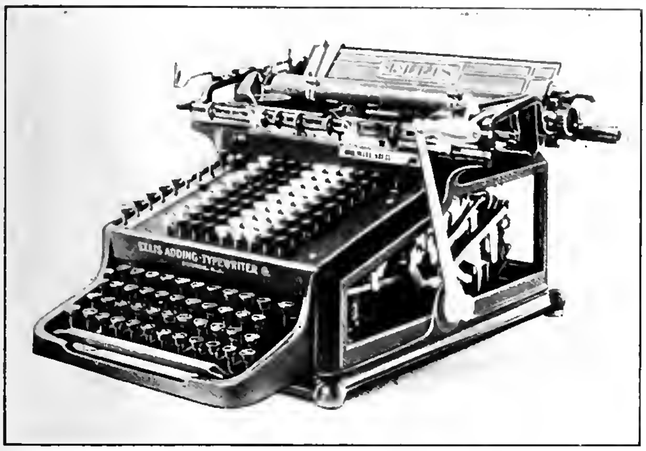
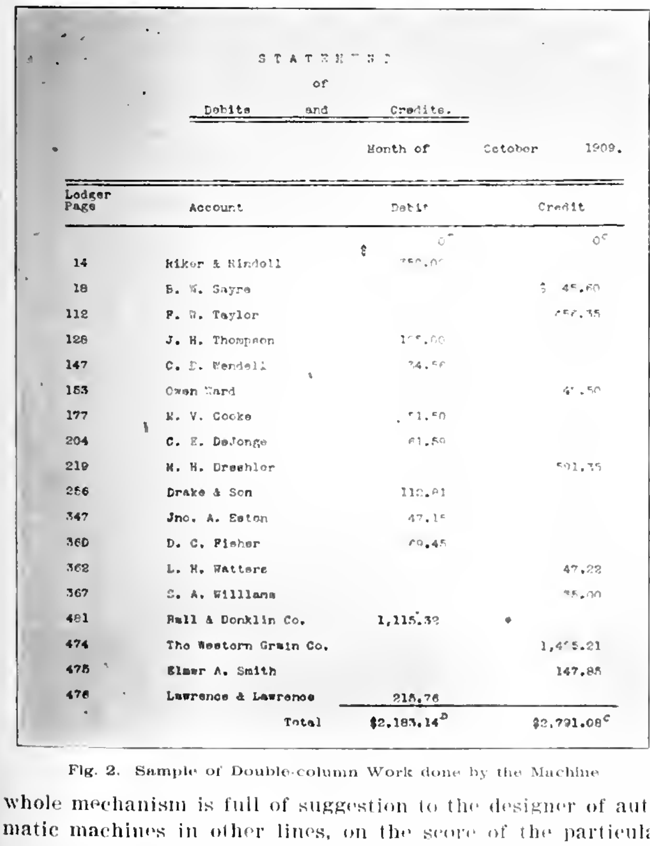


Fig. 1. The Ellis Adding Typewriter



STATEMENT

of

Debits and Credits.

Month of October 1909.

Ledger Page	Account	Debit	Credit
14	Riker & Rindell	$ 750.00	
18	B. W. Sayre		$ 45.60
112	F. W. Taylor		456.35
128	J. H. Thompson	105.00	
147	C. D. Wendell	34.56	
153	Owen Ward		41.50
177	M. V. Cooke	51.50	
204	C. E. DeJonge	61.50	
219	M. H. Dreehler		591.35
256	Drake & Son	112.81	
347	Jno. A. Eaton	47.15	
360	D. C. Fisher	69.45	
362	L. H. Watters		47.22
367	S. A. Williams		35.00
481	Ball & Donklin Co.	1,115.32	
474	The Western Grain Co.		1,405.21
475	Elmer A. Smith		147.85
476	Lawrence & Lawrence	218.76	
	Total	$2,183.14 D	$2,791.08 C

Fig. 2. Sample of Double-column Work done by the Machine

With this preamble, and with the assurance that the mechanism will be described in its larger features only, it is hoped that the reader will have the courage to follow the explanation through.

The Work of the Adding Typewriter

First let it be briefly stated what this machine is and what it will do; we can then pass on to a discussion of the way in which it performs its work. It is a combination of two completely developed machines—a visible typewriter and an adding machine, both writing on the same line on the same piece of paper, in plain sight of the operator, and each designed to possess all the advantages with which the best separate machines of its class are provided.

An example of the work of which the machine is capable is shown in Fig. 2, which illustrates a statement, including both debit and credit accounts written down indiscriminately, with each set of items added up and printed in a total at the bottom. The writing is done with the typewriter in regular typewriter fashion, and the figures are set up and printed in regular adding-machine fashion, on the same line and at the same time that the reading matter is written. This evidently requires two adding mechanisms, or two "accumulators" as they are called, one for the debit and the other for the credit column. This provision of two accumulators with the accompanying adjustments for their convenient use in relation to each other, is a novel feature in adding-machine construction.

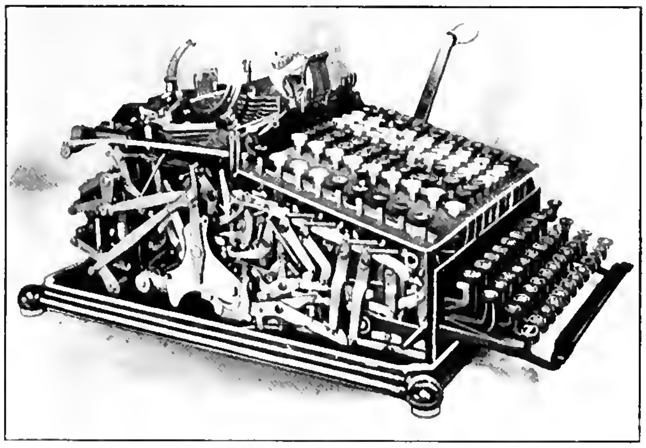


Fig. 3. Front and Left-hand View of the Machine with the Case Removed

Besides this, the machine is adapted to perform numerous other "stunts" such as the printing of items in a series of vertical columns, and the adding of these columns into totals both horizontally and vertically. Finally these totals, both horizontal and vertical, may be added together in a grand total. This operation is useful for such work as cost sheets, etc. Discounts may also be reckoned, amounts may be subtracted from each other, and so on, enabling the machine to do a wide range of commercial work.

Perhaps this recital of the intricate processes of which the machine is capable sounds rather confusing, but it will be made plain by the following description of the action of the adding mechanism.

The Principle of Action of the Adding Machine

Figs. 5, 6, 7 and 8 illustrate the principle on which the machine works. Figs. 1 and 10 show that the adding keyboard is composed of nine vertical rows of nine keys each. The lower key of each row is numbered 1, the next 2, and so on up to 9. Of the nine vertical rows the first one on the right is for

units and the next for tens, etc.; or, since the punctuation is usually set for reckoning in dollars and cents, the first is for cents, the next for dimes, and the succeeding rows for dollars.

Figs. 5 and 6 show digrammatic sections through the machine along the line of any one of these vertical rows of adding keys, say the first or cents column for instance. The keys are shown at *G*. Other important parts of the mechanism are the rack *A*, the type sector *F* by means of which the

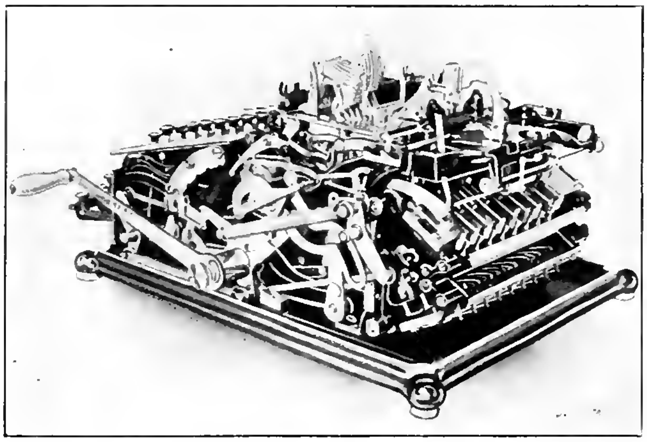


Fig 4 Rear and Right-hand View with Case Removed, showing Operating Mechanism and Accumulators

numbers are printed on paper carried by roller *K* and the accumulator wheels *B*, by which the addition is performed. All these, as well as the other moving mechanism shown in Figs. 5 and 6 are duplicated for each one of the nine rows of keys, there being nine racks, nine type bars, nine sets of accumulator wheels, etc., in all.

The adding mechanism is operated by the movement of rack *A*. This movement takes place under the influence of spring *O* whenever stop *N* is swung back as shown in Fig. 6 by the operation of the handle of the machine. The length of the movement which spring *O* thus gives to rack *A* is determined by keys *G*. If the figure $476.34 is set up on the keyboard, for instance, key "4" will be depressed in the cents column, and when the movement of the rack takes place, the rack teeth beneath the accumulator wheel will have moved four spaces.

This is more clearly seen in Fig. 5 where each of the keys *G* is shown to be mounted on a stem which carries a stop *H* at the lower end. When the keys are depressed, these stops come into line with corresponding steps formed at the left-hand end of the rack *A*. These steps are so proportioned that when key 1 is depressed, for instance, the rack is allowed to move one tooth before striking its abutment. When key 2 is depressed it moves two teeth and so on as shown by the dimensions at the bottom of Fig. 5. When no key is depressed, indicating zero, then a stop is interposed which prevents any movement of the rack. When key 9 is depressed, the rack takes the full movement of nine teeth allowed by the striking of the lips on the under side of the rack against supporting bar *J*.

Each rack *A* has cut in it a slot engaging pin *C* in sector *D*. Each sector is in turn connected by link *E* with the type bar *F*, carrying characters from 0 to 9. Whenever, as shown in Fig. 6, a key (key 4, for instance,) is depressed and the rack is allowed to move four teeth backward under the influence of spring *O*, the type bar *F* is thereby set at the corresponding figure. The throwing forward of lever *L* to which the type bar is pivoted then prints this figure "4" on paper wrapped about roll *K* as shown in Fig. 6. It is important to remember that rack *A* and type bar *F* are positively connected under all conditions. It should, perhaps, be mentioned that the teeth in sector *D* simply provide for more accurate alignment of the type in printing than would otherwise be possible. Just before the printing stroke takes place arm *W* swings up, carrying a plate which enters the corresponding tooth space in each one of the nine sectors *D*, aligning all the figures on type bars *F* and giving a good, evenly printed number on paper.

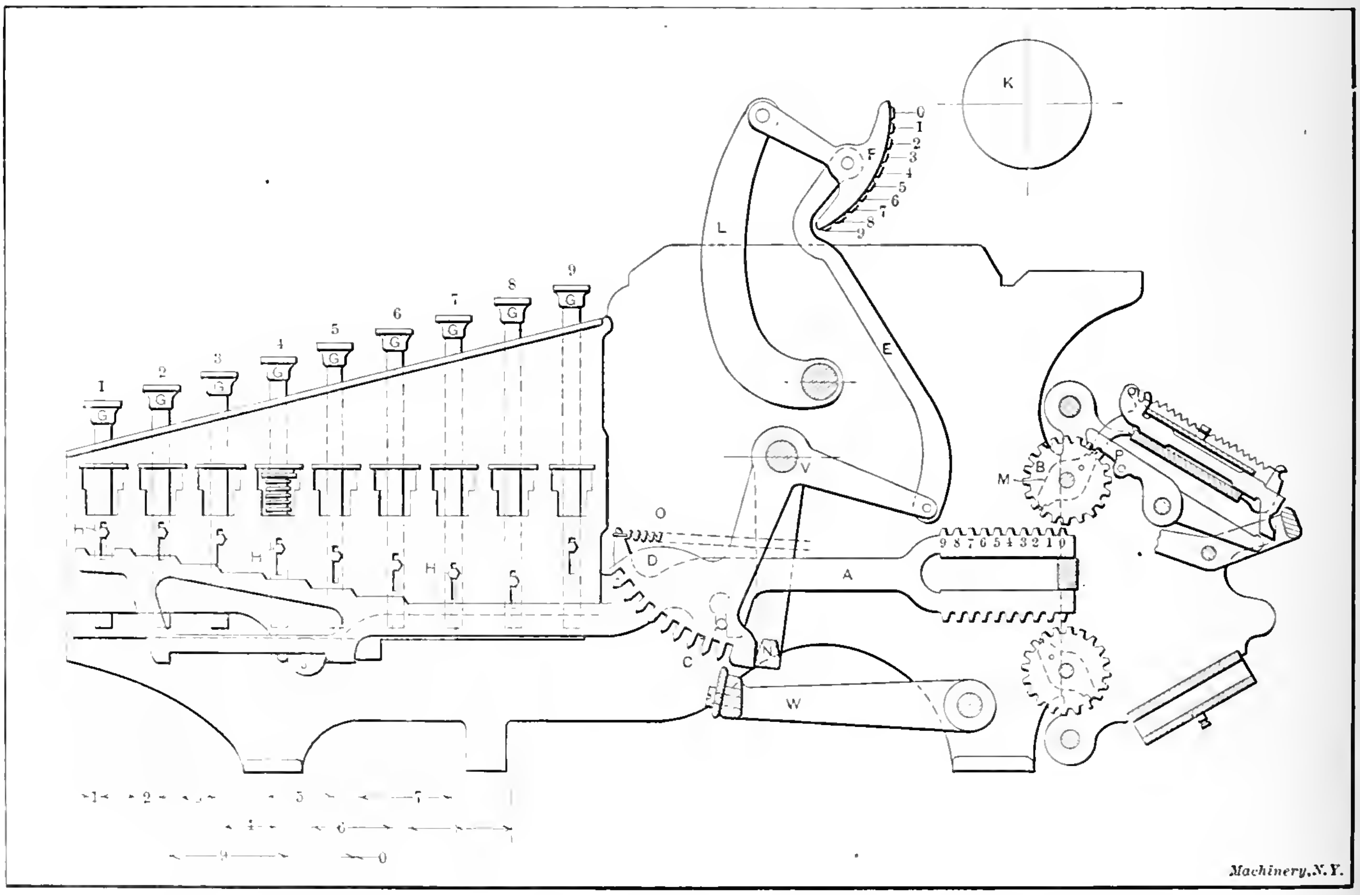


Fig 5 Diagrammatic Cross-section of the Machine showing Relation of Keys, Racks, Accumulators and Printing Mechanism

Now we come to the accumulator mechanism in which the adding is done. There are ordinarily, as explained, nine accumulator wheels for each of the nine racks. Here, however, there are two sets of these nine wheels, one above rack *A* and the other below. The upper one is the debit accumulator for addition in the debit column and the other is the credit accumulator for the credit column. A general view of the

mechanism is shown later in Fig. 9. We will, for the time being, consider only the upper or debit accumulator.

This set of nine accumulator wheels, of which only one is shown at *B* in Figs. 5 and 6, may be swung into and out of engagement with the teeth of racks *A* at will. These accumulator wheels have 20 teeth each. They might as well have ten, except for the fact that it would make them inconveniently small. Each wheel is provided with a two-tooth ratchet *M* positively pinned to it. This ratchet therefore spans ten of the wheel teeth between its points. Pawl *P* is adapted to engage the teeth of ratchet *M*, and is connected with mechanism by means of which the tens are carried from one column to another (that is, from one accumulator wheel to another) as will be later described. With this rapid review of the mechanism, we can turn to Fig. 7, which shows in diagrammatic form the method of procedure followed in the simple problem of adding 4 to 9, and getting the sum 13.

The Order of Operations for Adding

At *A* in Fig. 7 the machine is shown "clear," that is with the accumulator wheels at zero, which means that one tooth of the two-tooth ratchet is up against the hook of the pawl. Key 4, corresponding to the number we wish to add into the accumulator wheel, is now depressed and the operating handle of the machine is pulled over. The first thing that takes place is that the rack is allowed to move four teeth to the right as shown at *B* (see also Fig. 6). In this position the number "4" is printed. Next (as shown at *C* in Fig. 7) the mechanism automatically throws the accumulator wheel down into engagement with the rack. Then as the operator allows the handle to return, the next thing that takes place is the return of the rack to the zero position again as shown at *D*, carrying the accumulator wheel with it a space of 4 teeth from its zero position. The mechanism then disengages the accumulator wheel, leaving the machine ready for the next operation with the 4 added into the accumulator, as shown at *E*.

We now wish to add 9 to the 4. Key 9 is depressed and the operator pulls the handle. This results in a movement of nine teeth of the rack as shown at *F* in Fig. 7. The figure "9" is then printed. The accumulator wheel is next engaged, as at *G*. Then the rack is returned to the zero position as at *H*, and the accumulator wheel is disengaged as at *I*. This evidently moves the accumulator wheel 9 + 4 = 13 teeth as shown at *H*. In doing this, one of the teeth of the two-tooth ratchet as it passes under the pawl raises it, as shown by the full and dotted lines at *H*. This raising of the pawl operates a spring-loaded mechanism, which shifts the next accumulator wheel (that for the tens column) one tooth, when the wheels are returned from engagement in operation *I*. This operation exactly corresponds to that of "carrying" when adding with pencil and paper. This is here done automatically. It is not thought advisable to describe this carrying mechanism in detail as the parts are small and rather complicated, though the action is simple enough.

(The mechanism may be understood a little more clearly, however, if the reader follows the actions of the wheels when every one of them in the accumulator, from cents up to the millions of dollars is set at 9—that is to say, when they are set up for 9,999,999.99. Now suppose that one cent is added in, so that the first wheel is moved beyond 9—that is, to 0. The tooth of the ratchet *M* will then pass under the first pawl, raising it. Now when the accumulator wheels return from engagement, this raising of the first pawl releases a spring-loaded mechanism which moves the next wheel from 9 to 0. This, in turn, moves the next wheel from 9 to 0 and so on until each one of the row has been advanced one tooth, setting the whole row at 0,000,000.00. This operation, of course, takes place in a flash. It is done so rapidly that neither the eye nor the ear can take in the successive operations, but each one is dependent on the preceding one. So much for the carrying mechanism.)

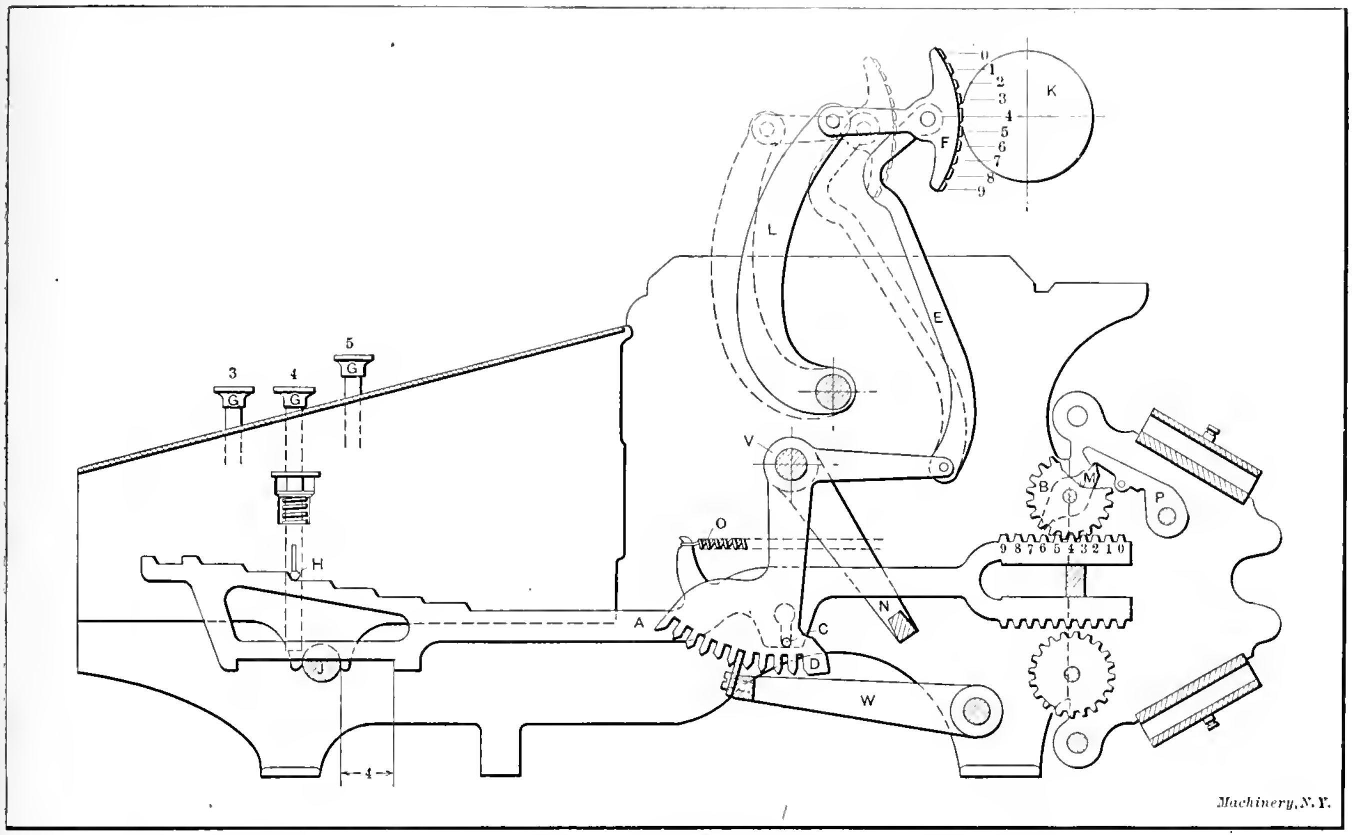


Fig. 6. Diagrammatic Cross-section showing the Machine set up for Printing the Number 4 and Adding it into the Accumulator

We have now added 9 and 4 into the accumulator wheel. Of course, this process can be carried on indefinitely, adding in any number of different numbers. Suppose that we now are through with the addition and wish to take a total. How is this done? The operations required are shown at *J*, *K*, *L*, and *M* in Fig. 7.

Finding the Total

The first thing the operator does is to depress the "credit total" key at the left of the key-board, the sum having been added into the upper or credit accumulator. He then pulls the operating handle, and the next thing that takes place, as shown at *J*, is the throwing of the accumulator wheels into engagement with the racks. The next operation is the release of the racks so that the springs move them toward the right. There are in this case no keys depressed in the keyboard, so that the racks would move the full distance of nine

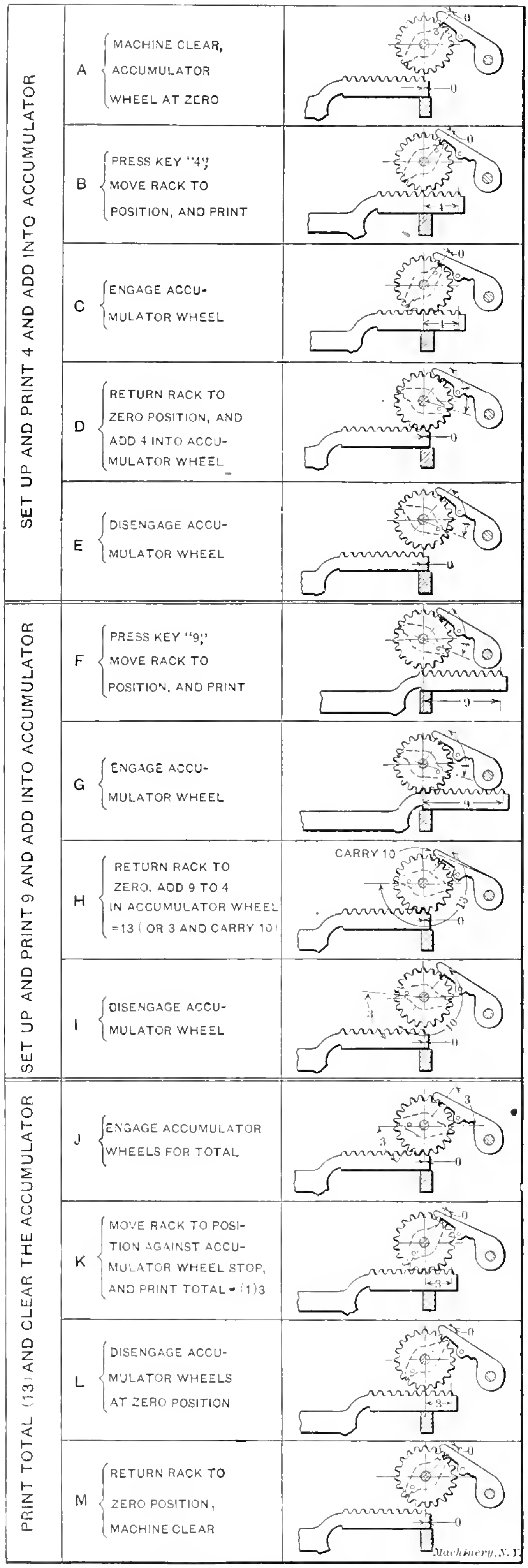


Fig. 7. Diagram Illustrating the Principle of Action of the Ellis Adding Typewriter

teeth, were it not for the fact that they have to carry the accumulator wheels with them, and the ratchets on these wheels come in contact with the pawls, thus arresting their movement and stopping the movement of the racks.

Now in the operation *I*, adding 9 into the 4 already in the wheel had set the units wheel 3 teeth beyond the point of the ratchet, and the tens wheel 1 tooth beyond the point of the ratchet. It is evident, then, that in operation *K* the units rack will be allowed to move 3 teeth and the tens rack 1 tooth. This, as shown in Fig. 6, will evidently set up the unit type bar at "3" and the tens type bar at "1." On the return of the handle the printing mechanism is operated, transferring the total "13" to the paper. The accumulator wheel will then be released, and the rack will be allowed to return to the zero position as shown at *M*. This leaves all the accumulator wheels back in the zero position, with the teeth of the ratchets back against the pawls, leaving the machine "clear" as at *A*, ready for the next operation.

Taking Sub-totals, etc.

It might have been desired to print a sub-total instead of a total. That is to say, it might have been desired to print a total for the addition as far as it had proceeded, but not to clear the machine, thus permitting more figures to be set up and printed and added into the same sum. Sub-totals can be printed at any point in the adding up of a line of figures, as required, by a simple change in the operation shown at *J*, *K*, *L* and *M* in Fig. 7. This consists simply in allowing the wheels to remain in engagement at *L*, so that the racks, when they return in operation *M*, will bring the wheels to the same position as they had in *J*, thus leaving the totals still set up in the accumulator.

Since there are two independent accumulators, it is evident that a number can be added into either one or both of them; or a total or sub-total can be taken from one of them and added into the other—all depending on the manipulation of the keys and the time of throwing the accumulator wheels into and out of action.

The order of the operations followed in printing without adding, in printing and adding, taking sub-totals, and taking totals to clear the machine, are all given in tabular form in Fig. 8. A study of Figs. 5, 6, 7 and 8, should serve to give a clear idea of the principle underlying the operation of the mechanism. It should be stated that this principle is not original with this particular machine, but was invented many years ago and has been adopted by all commercial adding machines of this type. It is worked out differently here, however, than in other machines, and in a way that offers a number of advantages.

The Various Sections of the Machine in Detail—The Accumulator

One of the fundamental features in the design of this machine is the fact that it is arranged to be built in sections. There are fourteen of these sections, each of which takes care of some particular function of the whole machine. The first of these to be described is the double accumulator, two views of which are shown in Fig. 9. This forms a self-contained unit. The accumulator wheels and the two-tooth ratchets shown in the previous diagrams will be readily seen in the engraving. The springs seen on the accumulator at the left, actuate the device for carrying the tens from one wheel to the next, to which reference has already been made. The upper accumulator is for the debit totals and the lower for the credit totals. Either set of wheels may be thrown in by the operation of the levers (marked *Q*), shown at the end of the accumulator at the right of the engraving. These levers, one of which is shown in Fig. 17, are operated by a mechanism at the left-hand side of the machine, to be explained later. The only connections this compact mechanism has with the rest of the machine are through the racks, as already described, and through the action of these levers *Q*.

The Flexible Keyboard

The keyboard section of the adding machine is shown in two views in Fig. 10. It is built up entirely of screw machine and presswork parts, showing much ingenuity in its design. It forms a rigid, self-contained unit, which may be inserted in

the complete machine without difficulty. Although it is comparatively simple in construction, it has a wide variety of duties to perform. One of the most interesting points of the construction relates to the method by which the "flexible keyboard" effect is produced. A "flexible keyboard" is one so arranged that when a key has been depressed, it will stay down; but the pressing down of another in the same vertical column

Operation	No	Rack	Accumulator Wheel	Type
To Print without Adding	1	Back to Key		
	2			Print
	3	Forward to Zero		
To Print and Add	1	Back to Key		
	2		Engage	
	3			Print
	4	Forward to Zero		
	5		Disengage	
To take Sub-total and Retain in Accumulator	1		Engage	
	2	Back to Wheel Stop		
	3			
	4	Forward to Zero		Print
	5		Disengage	
To take Total and Clear the Accumulator	1		Engage	
	2	Back to Wheel Stop		
	3			Print
	4		Disengage	
	5	Forward to Zero		

Fig. 8. Table showing Order of Movements for Different Operations on the Adding Machine

will release the first one. That is to say, but one key in a column can be depressed at a time, thus avoiding possible error. As a further advantage, when the wrong key has been pressed, the operator simply presses the right one and the wrong one is restored to normal position.

This effect is secured by means which are ridiculously simple. The principle is illustrated in Fig. 11. When the key 1, for instance, is depressed, the lower hooked end of the stem on which it is mounted springs past the end of a long pivoted strip *R*, which extends for the whole length of the vertical row of keys. Here the key is held by its hooked end. Supposing now the operator presses down on key 2. This also

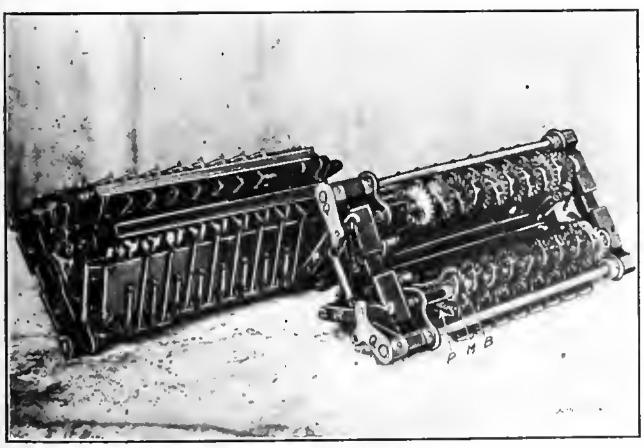


Fig. 9. Front and Rear Views of the Accumulator Section into which the Numbers are added

will open out the pivoted strip *R* to allow the hooked end of the stem to pass, and in so doing it will, of course, release the hooked end of key 1, which will immediately fly back in its normal position under the influence of spring *S*. Any key which may be pressed down will throw back strip *R*, and release any key which may be at the time depressed. One key *H*, the third from the left in the first row on the accumulator at the right, is shown depressed in Fig. 10, with its end hooked over the retaining strip in the same position as for key 1 in Fig. 11.

The keyboard is provided with interlocking mechanism connected with the controlling keys of the machine and with the operating lever. This mechanism, among other things, prevents the keys from being pressed down or changed after the operating lever movement is started. The keyboard also has a connection with an error key, the pressing of which releases all the keys that may be depressed at the time. This is operated by the strip shown extending across the base of the mechanism in the keyboard at the left of Fig. 10. It has also means for automatically releasing and returning the keys after each operation.

The Printing Section

The printing section is shown in Fig. 12, where it will be seen to be very much more complicated than is indicated by the simple diagrams shown in Figs. 5 and 6. The same parts, however, have been given the same reference letters, so that it will be possible to compare the engravings. This section, like that in Fig. 10, is built up entirely of screw machine and presswork parts, and is a very fine example of the combination of compactness and rigidity which is only attainable with such construction, in mechanism of this kind.

The added complication in Fig. 12 is due to a number of requirements. One of the most important of these is the "non-zero printing" action, which holds back all the zeros to the left of the last integer to be printed. By means of this mechanism, when we set up, for instance, "111.11" on the keyboard, the type will print that number instead of printing it 0,000,-111.11. Another provision is that of the rebound mechanism for the type, which allows it to strike the paper a hard blow and then quickly return. This gives clear printing without smearing or blurring the ink. Still another function that has to be taken care of is that of punctuating the numbers.

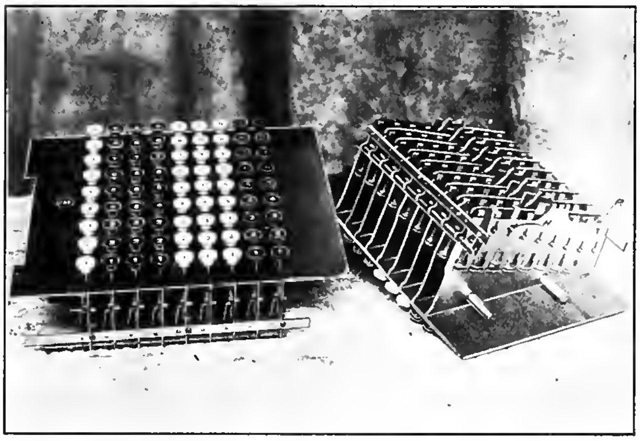


Fig. 10. Top and Bottom Views of Keyboard Section

This is controlled by the graduated slide shown just over the adding keyboard at the right of the machine in Fig. 1. By setting this slide, the numbers may be punctuated for units, for dollars and cents, and so on. When set to the graduation marked "X," the machine will add without printing at all. One of the punctuation characters is shown at *U* in Fig. 12.

It should be noted in Fig. 6 that there is enough mass to the parts of the printing mechanism to give a sharp blow of the type on the paper. This gives unusually good results in manifolding, this machine being equal in that respect to the best makes of typewriters. The ability to manifold through ten or a dozen thicknesses of typewriter and carbon paper is a new feature in adding machine construction.

The Reducing and Rack Section

In Fig. 13 is shown a top view of a machine partially dismantled. This view is given to show the arrangement of the typewriter mechanism for one thing, but more particularly to call attention to the "reducer" mechanism shown at *V*. In Figs. 5 and 6 it was shown that the racks *A* are connected with the type sectors *F* through a positive mechanism. Racks *A*, however, spread over the whole width of the machine while sectors *F*, as shown in Fig. 12, are concentrated in a small space. It is the office of these parts *V*, therefore, to effect this positive connection between the two differently spaced mechanisms. These levers correspond to the same part

marked V in the simplified diagrams Figs. 5 and 6, though, of course, the construction shown is different. At their lower ends they carry the arms making connections with the racks A, and also the tooth sectors shown at D, for registering the line of figures.

The Operating Mechanism

The best view of the operating section that can be obtained is shown in Fig. 14, where the right-hand side of the dismantled mechanism is illustrated. The principal provision

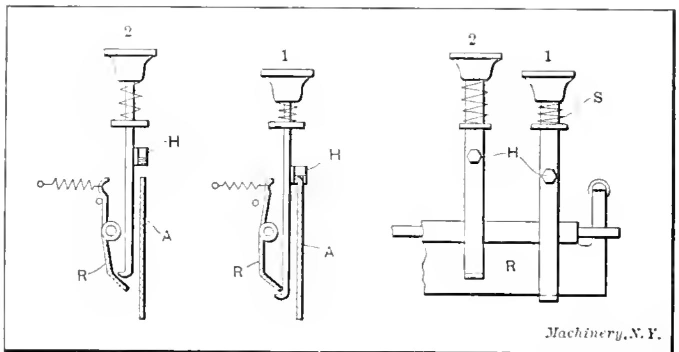


Fig. 11. The Principle of Operation of the Flexible Keyboard

which this mechanism has to take care of is that of safeguarding the more delicate parts of the machine from rough handling on the part of the operator. It causes the operation of the machine to take place under spring action at a certain known rate and with a known driving force. All the operator is allowed to do is to supply the power for stretching certain springs and releasing their action. He cannot directly apply his strength to the mechanism.

Fig. 15 shows this device. In position No. 1 the operator has just pulled the handle forward to commence operating the machine. This handle revolves freely on its shaft, the operat-

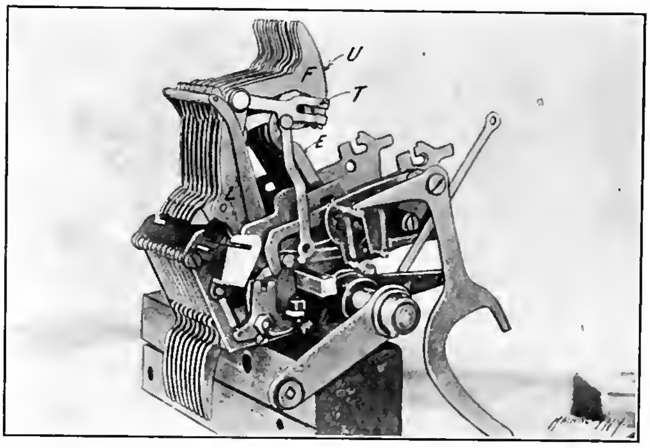


Fig. 12. The Printing Section

ing parts being driven by member E_1. As Y is pulled forward, catch C_1 releases pawl Z allowing member E_1 to fly forward by the contraction of springs A_1, through levers D_1 and links B_1. This free movement of member E_1 operates the forward stroke of the machine, and it is held to the proper rate of action by an oil by-pass governor, (shown best at G_1 in Fig. 13). Abutment F_1 stops this movement, in position No. 2.

The operating handle Y, which is now free of the mechanism, continues its forward movement under the hand of the operator until position No. 3 is reached. Here the tail of pawl Z, striking pin H_1, is thrown back into engagement again with the catch of member E_1. In moving the handle from position No. 2 to No. 3, spring A_1 has been extended, and it now acts through levers D_1 and links B_1 to return handle Y to the starting position, carrying with it member E_1 and the mechanism of the machine. This reverse movement is also under the control of the governor. Latch C_1 rises to permit pawl Z to pass, and the springs bring the whole back to position, all ready for a new stroke.

The double action of springs A_1 is very interesting. It will be seen that they operate the mechanism for both the forward and back strokes. This is made possible by the fact that they are connected to movable members at each end—in one case to levers D_1, and in the other case to operating handle Y. Their contraction to length X between positions No. 1 and No. 2, operates the forward motion, while their contraction from position No. 3 to position No. 1 operates the backward motion. The provision of two each of springs A_1, links B_1 and levers D_1, is simply for the purpose of balancing the strains in the mechanism.

Another interesting point to be noticed in connection with Fig. 14, is the double-acting pawl J. This makes it impossible for the operator to start a movement of the handle and not complete it. Handle Y is shown here at the commencement of the forward movement. Pawl J locks into successive notches on sector K, preventing its return until it has reached the final notch at the lower end. This is large enough to permit pawl J to reverse and turn in the other direction. This compels the handle to return to the vertical position, since it would lock again in the notches in sector K if any further forward action were undertaken. At the completion of this

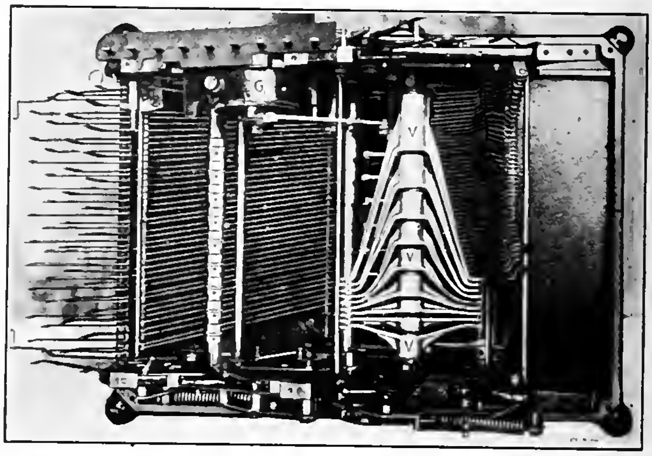


Fig. 13. Top View of Machine showing particularly the Reducer and Typewriter Sections

return stroke, J drops off the end of the sector, where it can again turn around for the forward stroke.

The Controlling Mechanism

Fig. 16 shows the most complex, and also one of the most useful sections of the machine. The stems shown projecting above the top of the keyboard at the right of the engraving are for the controlling keys shown at the left of the keyboard in Fig. 1. These are named, beginning at the top: "non-add," "debit add," "debit sub-total," "debit total," "credit add," "credit sub-total," "credit total," "repeat" and "error."

The pressing down of the non-adding key permits the print-

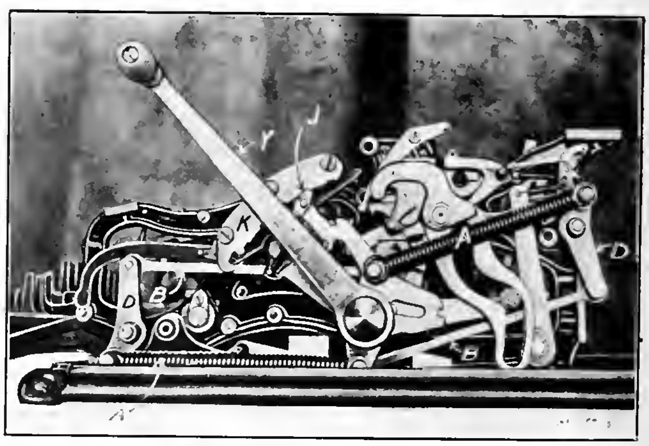


Fig. 14. Side View of Machine showing Operating Mechanism

ing of a number without adding, as explained in the first operation of the table in Fig. 8. In other words, this keeps the accumulators permanently out of engagement with the racks. The debit and credit add keys permit a number to be printed and added into the corresponding accumulator, even though the carriage is not set in the proper position for that accumulator. The use of these keys, therefore, gives a flexibility to the machine which is necessary for special operations such as horizontal adding. The debit and credit sub-total

keys take and print a total from either the debit or credit accumulators without clearing the accumulators, as illustrated and explained in Fig. 8. The debit and credit total keys, on the other hand, take the total from either the debit or credit accumulators, as the case may be, and clear the accumulator after the total is printed, as also explained in Figs. 7 and 8. The pressing down of the repeat key holds in the downward position whichever of the number keys have been depressed, allowing the same number to be repeatedly printed and added as many times as the operating handle is pulled. This is useful in multiplying by repeated additions, and for other similar uses. The pressing of the error key, as has been explained, will release every other key on the keyboard, both of the number keys and of the operating keys as well.

Now, the complexity shown in Fig. 16 is required for making the machine incapable of falsifying itself; that is to say, through it all the various functions of these keys so interlock with each other and with the operating parts of the machine, that it is impossible for an ignorant or careless operator to

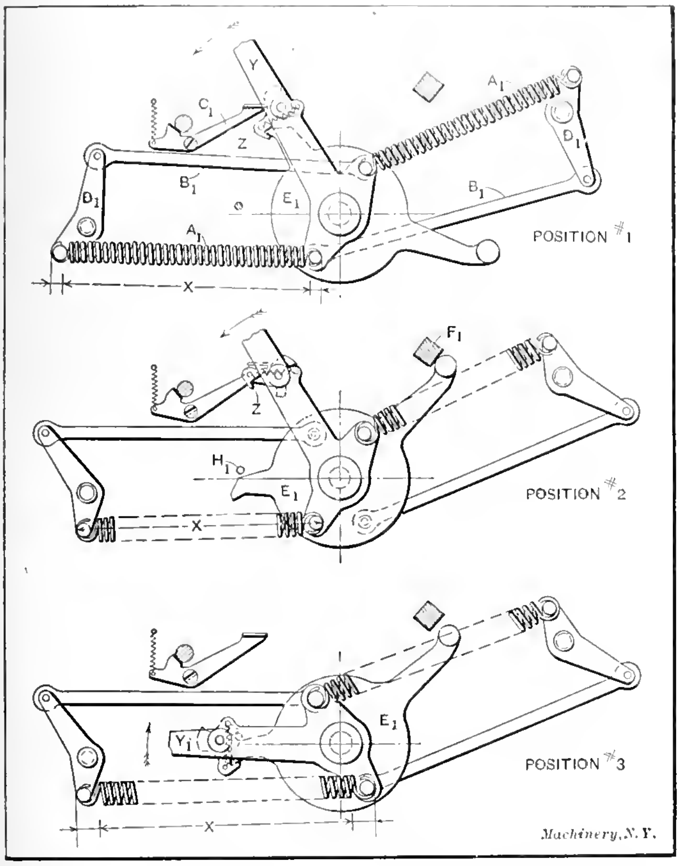


Fig. 15. Spring Control Device which safeguards the Delicate Mechanism from Rough Handling by the Operator

give wrong orders to the machine. The arrangement of the parts in this section required continuous concentrated thought on the part of the inventor, Mr. Ellis, and his assistant, Mr. Perkins, for nearly two years. The number of contingencies that had to be provided for seemed almost endless, and the amount of mechanism required seemed almost hopeless. By close study, however, the various functions were grouped, single parts were made to perform a variety of functions, and the whole range of connections was simplified so that this section has been reduced to the compact form shown herewith. It is hopeless, however, for a migratory editor or a casual reader to attempt to do more than get a vague notion of the work this section is called on to perform.

The Accumulator Controlling Mechanism

It may be worth while, perhaps, to get a notion of just how the controlling mechanism determines when the accumulators shall be thrown into engagement with the racks, and when they shall be released. In Fig. 17 sector K_1 is directly connected with the operating shaft L_1, controlled by the operating handle. It is provided with connections with both accumulators. Fig. 17 for convenience shows only the connections with the debit accumulator. Flying lever M_1 is connected with the debit accumulator by means of links O_1 and bell crank Q. Member P_1 is simply a spring detent to locate Q for either the engaged or disengaged position of the accumulator wheels.

As sector K_1 starts on its stroke toward the dotted position, it carries flying lever M_1 with it, owing to the resistance which the tail of the latter meets with against abutment R_1. When K_1 has gone far enough so that the tail has dropped off

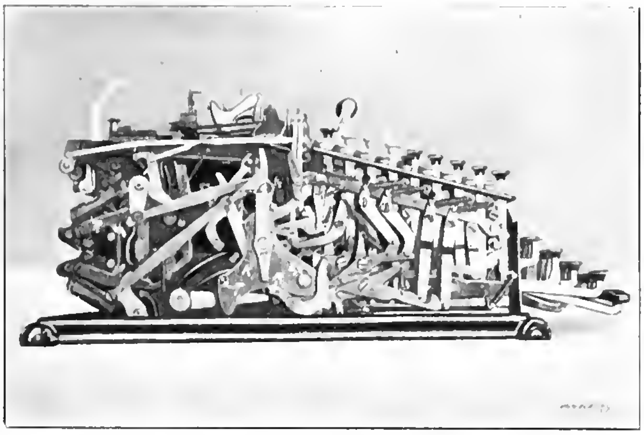


Fig. 16. Left-hand Side Frame Section for Controlling and Directing the Movements

R_1, flying lever M_1 becomes free. The movement has been sufficient, however, to move accumulator lever Q to position Q_1, which throws the wheels into engagement. If it had been desired to throw the wheels into engagement at the end of the stroke instead of at the beginning, detent R_1 would have been withdrawn from the position shown, leaving flying lever M_1 free. Near the end of the stroke of K_1, however, the end of the pawl S_1 would have struck stud T_1, making M_1 and K_1 solid, for all practical purposes, and moving Q to the position Q_1 at the end of the stroke.

If it had been desired to keep the accumulator wheels out of engagement altogether, R_1 would have been lowered out of the position shown, and S_1 would have been moved to a position clear of stud T_1. Then flying lever M_1 would have been entirely free of K_1, and no movement of Q would have taken place. The provisions for throwing the accumulator out of engagement at either the commencement or end of the return

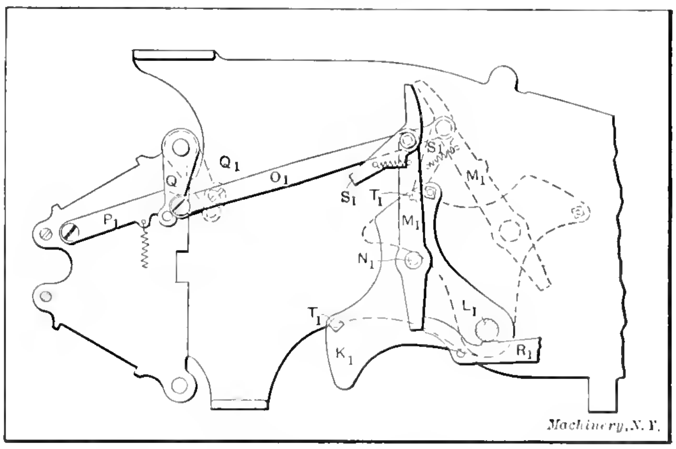


Fig. 17. Diagram showing Flying Lever Connection between Operating Shaft and Accumulators

stroke are similar to those just described, so need not be particularly referred to. This surely goes far enough into the mechanism of this controlling scheme for the average reader.

The Typewriter Mechanism

The various sections of the machine which relate to the typewriter mechanism are similar in principle to the corresponding parts on standard typewriters, though there are some added complications required for connections with the adding machines. The tabular, for instance, is provided with two kinds of stops, one of which is operated with the ordinary typewriter tabulator key. The other is located by latches on the tabulator scale, for setting the carriage at the proper position for the debit and credit columns, as determined by the

tabulator key on the adding machine keyboard. The white tabulator stop is for the debit column and corresponds with the white control keys at the left of the machine. The black stop corresponds to the black debit control keys. Except as previously described in connection with the controlling keys, the machine is locked to prevent debit adding unless the carriage is set for the debit accumulator, and the same is true for the credit accumulator.

The typewriter mechanism is best understood from the views shown in Fig. 13. The chief peculiarity of the machine as a typewriter is the compactness of the basket of keys, and the extreme length of the key levers necessitated by the interposition of the adding keyboard between the keys and the type. In spite of the handicap thus apparently placed on the typewriter mechanism, it appeared to the writer that the action of the machine was exceedingly agreeable—equal to that, in fact, of any machine with which he had ever had anything to do. This is in line with the inventor's express purpose to make the machine a good typewriter as well as a good adding machine. Diagrams showing the arrangement of the levers will be given in a subsequent article dealing with manufacturing operations.

Points in the General Design of the Machine

It is posible that, in reading the foregoing description, the reader may have been more impressed by the complexity of the mechanism than with the orderly arrangement which the inventor and designer have given to the parts. Without this orderly arrangement the machine would have been far more complex—so much so as to have been prohibitive. A rapid review may serve to make the orderliness of the arrangement a little clearer.

Looking at the machine from the front, the mechanism at the right, on the outside of the right-hand side frame, is entirely given up to the operating movements—that is, it is composed of parts whose movement is invariable. The parts on the left-hand side of the machine, on the other hand, are devoted entirely to such movements as are variable in their action at the option of the operator—that is to say, these are the parts which determine whether the machine shall print, add, or take sub-totals, totals, etc. All the space between the frames is filled with mechanism which does the actual work of calculating, as directed by the left-hand side mechanism, and as operated by the right-hand side mechanism.

To put it in another way, the machine may be considered as a manufacturing organization with the executive offices at the right-hand side, the sales or order-taking department on the left-hand side, and the shop itself—which delivers the goods—in the main part of the structure. This segregation of the different functions results in shorter connections throughout between the various moving members, reducing the number of parts to a remarkable degree.

The designer of an adding machine has to do much more than make a machine that shall add correctly. He has to make a "fool-proof" machine, one that the operator cannot put out of business by roughness or carelessness. We have shown some of the features of the machine which render it proof against error from this cause. But the designer has to do still more than this. He has to make it what might be termed "villain-proof," as well as fool-proof. The necessity for this is due to the peculiar conditions under which the adding machine works.

When an adding machine is used, implicit confidence is placed in it. It may be permissible for a bookkeeper to make a mistake once in a while in adding a column of figures, but no excuse is ever listened to if an adding machine makes a similar error. The adding machine salesman knows this, of course, and it is part of the stock in trade of some of them, when the opportunity offers, to show how a rival machine may make a mistake. Now in all probability, in order to force the machine to make a mistake, he will have to do something that the operator would not by any possibility think of doing, unless he actually set out to do it, and knew exactly how to go about it. This, however, the intending purchaser may not stop to think of. He sees that the machine may be made to make a mistake and so he loses confidence in it.

The designer of an adding machine, then, has to provide all sorts of safeguards to prevent willful misoperation of the mechanism. Without explaining in detail the precautions of this kind taken in the machine we are considering, it may be well to make note of one of them. In some machines it is possible, by pressing a key part way down, to get an undesired result; the pressing of the key part way down may affect part of the change in the control of the mechanism desired, while it may require the full movement to produce the whole result desired. In order to avoid this difficulty, particularly in the matter of the left-hand row of operating keys, the action of these keys has been made "permissive" only; that is to say, when these keys are pressed down, as best seen in Fig. 16, they allow the bent ends of certain levers to snap into place in notches cut in the sides of the stems. Now the ends of these levers have either snapped into place in the notches, or they have not. There is no halfway position, and there is no possibility of fooling the machine on that account. A good deal of the mechanism provided in Fig. 16 is required to prevent the possibility of willful mismanagement of the machine.

The writer asked Mr. Ellis, the inventor, the reason for the plate-glass windows which the adding machine builder is accustomed to place in the sides of the frame of his product. The explanation offered was that the customer was thereby enabled to see that he had gotten his "money's worth" in mechanism. With the detailed views of the machine here given, there should be no further doubt on this matter in the mind of the reader. In fact, he might well wonder how the manufacturer can afford to sell so much complication for the paltry hundreds of dollars he asks for it. Articles on manufacturing operations in succeeding numbers of MACHINERY, will, perhaps, let a little light into this dark mystery.

* * *

SAG AND STRENGTH OF MANILA POWER-TRANSMISSION ROPE

The sag and strength of manila rope cannot be determined exactly, as it varies with the load carried, the speed run, and the initial tension in the rope. In the multiple system, when the slack comes on top, the rope is allowed to sag until parts running in opposite directions would nearly touch. It then has to be shortened. The sag on the tight side may be determined quite closely if the exact power to be carried is known. Likewise, in the continuous system, where it is possible to keep a uniform tension on the rope, the sag may be closely approximated. In general, a rope should be allowed to run as slack as possible without slipping.

The sag of ropes takes nearly the form of a parabola. The amount may be approximated by multiplying the weight of one foot of rope by the square of the distance from sheave to sheave where the rope leaves, and dividing by eight times the tension on the rope. For example, the sag of Plymouth two-inch diameter rope supported ninety feet apart, running at four thousand two hundred feet per minute is $\frac{1.34 \text{ pounds} \times 8100}{8 \times 800}$ = 1.7 feet on the driving side, which would be the same at all speeds. The slack side sag may be determined after the same method, by adding to the initial tension the tension from centrifugal force. Thus, with the same rope as before

$$\frac{1.34 \times 8100}{8 \times 199 \text{ pounds initial} + 205 \text{ centrifugal tension}} = 3.3 \text{ feet.}$$

A new rope will stretch considerably for a short time, but after the parts of the rope are firmly bedded together further stretch is slow. The total stretch should not exceed five per cent under reasonable conditions. In cutting the slack out of continuous drives, it must be borne in mind that some movement of the tightener sheave must be allowed for shrinkage caused by atmospheric conditions and future resplicing.

* * *

It is stated by the United States Consul at Rio de Janeiro that the president of the Central Railroad of Brazil proposes to send to the United States groups of four mechanics each, every six months, to work in a large locomotive-building plant in this country which is furnishing locomotives to this railway. In this way it is proposed to educate a number of men in American locomotive-building methods.

MULTIPLE CUTTER TOOLS

By W. S. GIELE*

The writer has, in conversation with many practical men, encountered such widely differing opinions on the relative advantages of boring and turning tools made with single and with multiple cutting edges, that he offers his own experiences with such tools. Many men seem to hold to the belief that far more accurate work is produced by the single cutting edge than can be produced by tools having multiple cutting edges, and they are usually able to support their position by showing work of the highest excellence made with single cutters, and probably plenty of work which is decidedly not of the highest excellence made with multiple cutters.

Some experience in the manufacture of machines which required multiple cutters and the design and purchase of a number of cutting tools used in the manufacturing processes, has led the writer to analyze some of the problems involved, with the very commonplace conclusion that in this, as in everything else, there are situations where one type of construction is best adapted, and other situations where a different type of construction is best adapted. Neither is it particularly original to say that in the final analysis, the terms of the problem must be reduced to dollars and cents.

The most ardent advocate of multiple cutters will probably continue to turn up his occasional lathe job with a single tool in the tool-post, and to bore out his jig holes with a single pointed boring tool, because that is really the best way; not that it might not be done just as accurately and as well some other way, but because that is generally accepted as the most *economical* way to do the job sufficiently well. On the other hand, the man who firmly believes in the single cutting edge, will probably continue to use twist drills with more than one lip, taps and reamers with more than one flute, threading dies with more than one cutting edge, hollow mills with more than one tooth, and very likely more than one cutting edge in his cutting-off machine. And his reason for doing all these things is, again, not because he has no choice, but because he is following what has been accepted as the most economical way.

Whenever multiple cutter tools have failed, it is reasonable to inquire whether each of the cutting edges has been ground with the same care and precision as a single cutting edge would have been, and whether the drive, the feed, the support, and the piece on which the work was being done all had the same relative rigidity in proportion to the amount of metal being removed in the case of the multiple cutter, as in the case of the single cutter. The problem is not what can be done, but what will it pay to do.

As a concrete illustration, let us suppose a line of headstocks in which the spindle bearings are to be bored, varying, in a case which the writer has in mind, from 4½ to 17 inches in diameter of bore, each headstock having two bearings of the same diameter and in line with each other. The material is cast iron, and the bearings have caps of the usual form with liners varying in thickness from 1/16 to ⅛ inch according to the bore. Boring-bars or arbors are made for each size of headstock. These bars are made as short and as large in diameter as the clearances will allow, to gain the maximum stiffness in proportion to the amount of work to be done. On each bar are mounted two roughing, and two finishing heads so spaced that the two bearings will be rough bored simultaneously, and finish bored simultaneously. The roughing and finishing heads are so spaced, relatively, that the finishing tools do not come into action until the roughing tools have completed their cut.

Without discussing here the relative advantages of an odd number of cutters and an even number, it is evident that this is a job for an odd number, as with an even number, equally spaced, there would be two cutters jumping a liner gap at the same instant.

In this case, the roughing heads have three tools each, all standing in the same plane perpendicular to the axis of rotation and with equal angular spacing. The tools have ample clearance and rake, being shaped much like a round-nosed roughing tool for a lathe. These tools are jig ground and abut against wedges or taper keys, which are graduated so that it is possible to set the tools with ample exactness for rough boring, without calipering. They do the cutting on the leading side and not on the circumference. The finishing heads have a varying number of inserted cutters according to size of hole. The largest has nineteen cutters. These tools cut on the leading corner and also take a slight shearing cut on the circumference. They vary in length parallel to the axis of rotation in the different heads, but are all set at such an angle that the are embraced between the radii to the front and back corners is equal to about three times the liner gap. They are, in fact, equivalent to the teeth of a left-hand helically (commonly called spirally) fluted reamer. They are ground to size in place and gaged to limits. The holes they produce are sufficiently accurate, both as to size and finish, to run as bearings without scraping.

In feeding any boring tool through the work, a point on the cutting edge passes through the hole in a helical path and its trace as marked on the work appears as a shallow screw thread. The apparent roughness of the finish left by the tools depends on the depth and pitch of this thread; that is, the finer the pitch, the smoother the finish appears. The time for cutting a given length of hole, however, depends on the lead of the thread, other things being equal. To increase the lead without increasing the pitch, it is necessary to produce a multiple thread. In other words, for any given pitch or width of tool marks on the work, it is possible to increase the lead or feed in direct proportion to the number of cutting edges and cut down the time required to feed a given length in inverse proportion. Thus a feed of 3/16 inch per revolution with a three-cutter head, gives a pitch of 1/16 inch to the tool marks, whereas the same feed applied to a single cutter would result in a 3/16-inch pitch in the tool marks, and if the depth of metal removed is the same, the single cutting edge would have to remove three times as much stock as each cutter in the multiple tool head, and would leave a rougher finish.

It is important to remember, when making multiple cutter heads, that the clearance and rake angles on the leading or cutting side are determined by the lead or feed and not by the pitch. These angles depend on the angle between the helical path of a point on the cutter and a plane perpendicular to the axis of rotation which is easily found, being the angle whose tangent equals the feed per revolution divided by the circumference of the hole.

As far as the matter of design is concerned, the number of cutters in a head is limited only by the chip clearance which will be left between cutters and the space required between cutters for the means which holds them in place. The design of the head itself is, however, not the only factor to be considered, as the limit may be set by the rigidity of the machine it will be used on, or the strength of the drive and feed, or the strength and stiffness of the piece being worked on. The ultimate limit which governs all others must, however, always be the economic one.

The larger the number of cutters in a head, the shorter will be the cutting time for any given length of hole; and also the higher will be the initial cost. Offsetting the higher initial cost is the fact that with a multiple cutter head each individual cutter does an amount of work inversely proportional to the number of cutters, and the head as a unit will therefore have an endurance, in number of holes bored between grindings and total number of holes bored during its life, proportional to the number of its cutters. Even where the total number of holes to be bored is very large, the higher initial cost of the multiple cutter head may not be easily justified if the distance to be bored is very short or the setting-up time is a very large proportion of the total time, because in such cases a saving of two-thirds or four-fifths, or a larger proportion of the boring time, may still represent a very small proportion of the total time.

To sum up: The number of cutting edges in a boring or turning tool (which may also be made to include tools for internal or external threading) is governed principally by the following considerations:

1. Number of pieces to be machined.
2. Proportion of cutting time to total time of operation.
3. Rigidity of pieces worked on.
4. Capacity of drive and feed.
5. Chip clearance between cutters.
6. Space required for means to hold the cutter.

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ECCENTRICALLY LOADED BOLT AND RIVET GROUPS

By M. TERRY*

The eccentrically loaded rivet group problem discussed by Mr. Gwinner in the May issue of MACHINERY is one of the cantilever class. As a mathematical proposition the cantilever problem is analyzed as follows: In Fig. 1, O is the point of support of any object, A is any point outside of it to which a force $(+W)$ is applied. R is the perpendicular distance from O to the line representing the direction of the applied force. Now, if two forces $(+W)$ and $(-W)$, each equal to the force W at A, and parallel to it, are introduced at O, the situation remains unchanged; but the forces $(+W)$ at A and $(-W)$ at O can be combined into a couple whose numerical value is

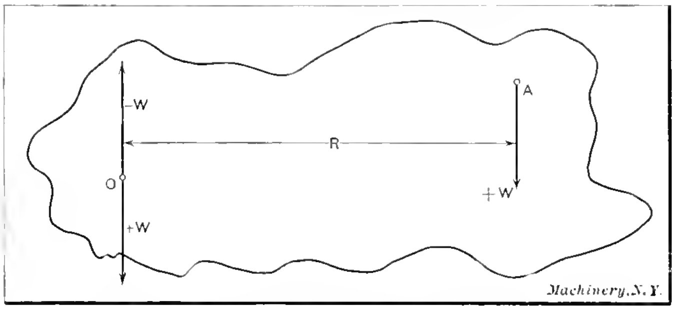

Fig 1. Diagram for Mathematical Analysis of Cantilever Problem

$W \times R$. Thus a single force W applied to a body at a distance R from its center of support is equivalent to the same force W applied in the same direction at the point of support, and a couple or moment WR.

In every practical problem of this nature the direct force W is usually considered equally distributed among the various bolts or rivets that make up the group. The bending moment WR is balanced by the resisting moment of the rivets, and only those rivets play an active part in resisting the bending moment that are placed outside the geometrical center of the group, *i. e.*, those that are "possessed of an arm."

In the following, let

M = bending moment produced by the eccentric load,

f = actual shear per rivet due to the eccentricity of the load,

R = radius of the bolt or rivet circle,

n = number of rivets located on the same circle,

Then

$$n \times f \times R = M$$

$$f = \frac{M}{n \times R}.$$

If n and M remain constant, f varies inversely as R. Hence

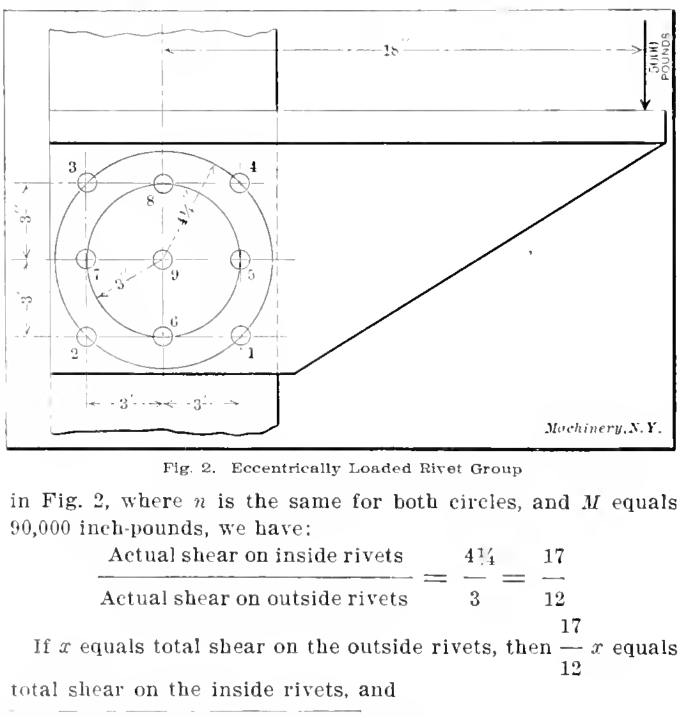

Fig. 2. Eccentrically Loaded Rivet Group

in Fig. 2, where n is the same for both circles, and M equals 90,000 inch-pounds, we have:

$$\frac{\text{Actual shear on inside rivets}}{\text{Actual shear on outside rivets}} = \frac{4\frac{1}{4}}{3} = \frac{17}{12}$$

If x equals total shear on the outside rivets, then $\frac{17}{12}x$ equals total shear on the inside rivets, and

$4\frac{1}{4}\,x$ = resisting moment of outside rivets,

$\frac{17}{12}x \times 3 = 4\frac{1}{4}\,x$ = resisting moment of inside rivets.

The total resisting moment = bending moment = $8\frac{1}{2}\,x$ = 90,000 inch-pounds. Hence,

$$x = \frac{90{,}000}{8\frac{1}{2}} = 10{,}588 \text{ pounds},$$

$$\frac{10{,}588}{4} = 2647 \text{ pounds} = \text{shear per outside rivet},$$

$$2647 \times \frac{17}{12} = 3750 \text{ pounds} = \text{shear per inside rivet}.$$

The direct load of 5000 pounds is equally distributed among the 9 rivets, producing a shear of 555 pounds per rivet.

The total shear on any rivet is the geometrical sum of direct and tangential shear. Referring to Fig. 3, it is clear that rivet No. 5 is in greater stress than any of the rest, having a total shear of 4305 pounds. Taking, as Mr. Gwinner did, 10,000 pounds per square inch as the safe shear, a ¾-

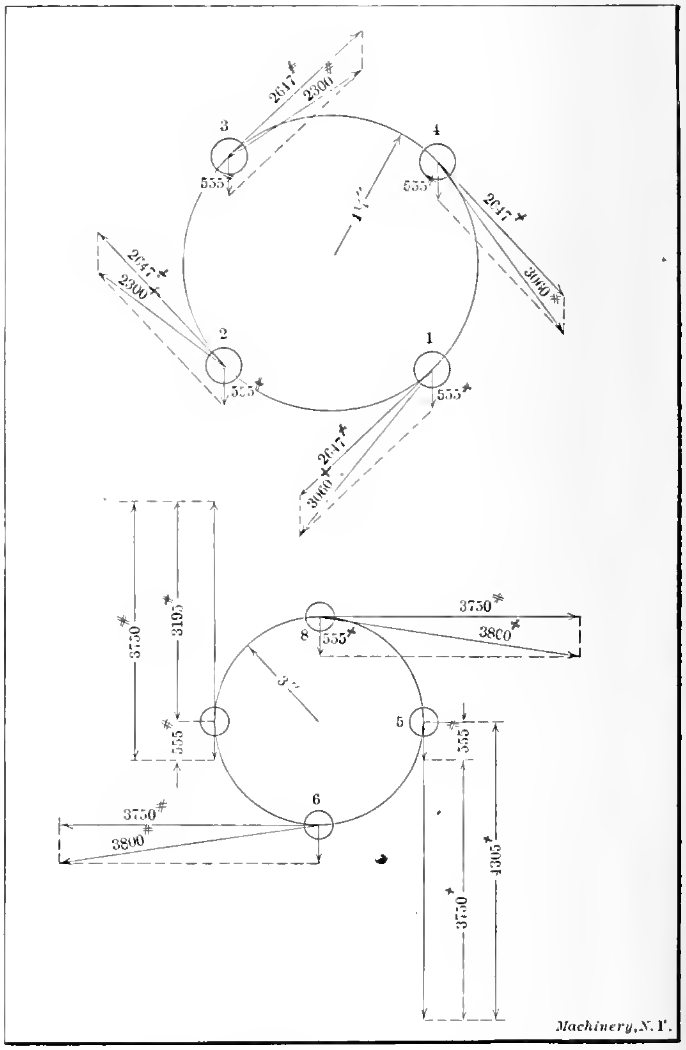

Fig. 3. Stress Diagrams for Eccentrically Loaded Rivet Group

inch rivet can be safely stressed to 4400 pounds. The shear on rivet No. 5 then is just within the safe limit. Since a ⅝-inch rivet has a safe shear of about 3060 pounds, a set of four ⅝-inch rivets can be safely used on the outside circle, if desired.

Let us now take the simple case shown in Fig. 4, and deduce the principles involved in designing a well-proportioned joint. The joint in question is likely to fail in any or all of the following three ways:

1. Rivets may fail by shearing.
2. The plate A may be too thin, making the bearing value too high, and causing the metal in the plate to "flow" at the rivets.
3. The plate A might fail at its weakest section, which is in the plane of the rivets.

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"No chain is stronger than its weakest link," and if the weakest link is strong and safe enough for its load, there is no necessity for making other links stronger. An ideal joint is one designed in accordance with this principle, but like many other ideal things it is seldom carried out in practice. Usually, the width and thickness of plate are assumed, rivets calculated, and then the plate examined for safety in bearing and bending. This method might give us, say, a factor of safety of 7 for shear, 9 for bearing and 11 for bending. Sometimes this is the best that can be done even when considerable time is spent in calculations. For instance, if we try to reduce the too high factors of safety in bearing and bending, by making the plate thinner, we may arrive at some

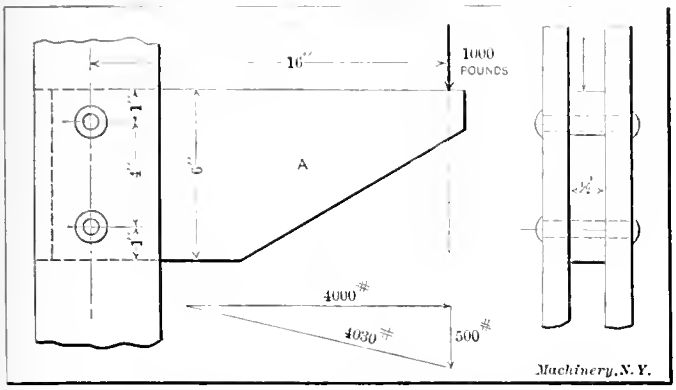


Fig. 4. Another Example of Eccentrically Loaded Rivet Group

odd-size plate which, as a manufacturing proposition, is out of the question.

In Fig. 4:

M = bending moment = $1000 \times 16 = 16{,}000$ inch-pounds,

F = tangential shear per rivet,

r = distance between rivets = 4 inches,

Resisting moment = bending moment.

$$F \times r = M,$$

$$F = \frac{M}{r} = \frac{16{,}000}{4} = 4000 \text{ pounds.}$$

Assuming that the direct load is equally supported by the two rivets, the total shear per rivet = $\sqrt{4000^2 + 500^2} = 4030$ pounds, which is also evident from the graphical solution in the lower part of Fig. 4.

Taking 10,000 pounds per square inch as the safe shear, and remembering that the rivets are in double shear, we have

$$\frac{\pi D^2}{4} \times 2 \times 10{,}000 = 4030,$$

$D = 0.51$ inch = diameter of the rivets.

One-half-inch rivets would be used in practice. This apparently exceeds the safe limit by about 2 per cent. Such slight excess is permissible, and even if the excess amounts to from 7 to 10 per cent, we need only remember that holes are drilled 1/32 inch larger, and the rivet after being driven in place will be 17/32 inch in diameter.

The bearing pressure is calculated on the projected area of the hole, and the safe unit stress for good structural steel can be taken at 20,000 pounds per square inch. The projected area of the hole = $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ square inch. $20{,}000 \times \frac{1}{4} = 5000$ pounds = safe pressure.

The actual pressure amounts to 4030 pounds.

Next and last comes the question of the strength of the plate.

M = bending moment = 16,000 inch-pounds,

y = distance from neutral axis to the top fiber = 3 inches,

I = moment of inertia of the section in the plane of rivets = 7,

f = actual tension per square inch in extreme fiber =

$$\frac{My}{I} = \frac{16{,}000 \times 3}{7} = 6857 \text{ pounds per square inch,}$$

which is well within the safe limit for structural steel.

There is one more manner in which this joint may collapse; this would be due to cutting off the plate too close to the edge of the rivet holes. The plate would then collapse at the upper rivet. By locating the rivets at from 2 to 3 times their diameter from the edge of the plate, one need not fear any trouble from that source.

* * *

TO DIVIDE A TRAPEZOID INTO EQUAL AREAS

By M. F. JACKSON

While in the pattern shop the other day I noticed several of the men in a heated argument over something and paused to discover what the bone of contention might be. It was an old problem about a tapered plank and where to cut it in order to have two parts of equal areas. Joe proposed to draw lines diagonally across the plank from one corner to the other, and cut the plank in two at the intersection of these lines, while George thought it best to balance the plank on the edge of a steel square, thus finding the center of gravity; for, said George: "There must be as much material on one side of the center of gravity as on the other." As a matter of fact, a student in geometry would know that Joe was wrong, as would also a student of mechanics who understood the principles of moments, know that George was also wrong; nevertheless, each had his adherents, and as the discussion was likely to be prolonged, I volunteered to work it out for them. The statement, solution and proof follow:

A patternmaker has a plank of mahogany in the form of a trapezoid (see Fig. 1) 12 feet long, 12 inches wide at one end and 9 inches at the other. He wishes to cut it into two parts of equal areas. How far from the small end must the center of the saw-cut be to effect an equal division; that is, what is the value of x?

Solution: The total area of the plank $= \dfrac{9 + 12}{2} \times 144 =$

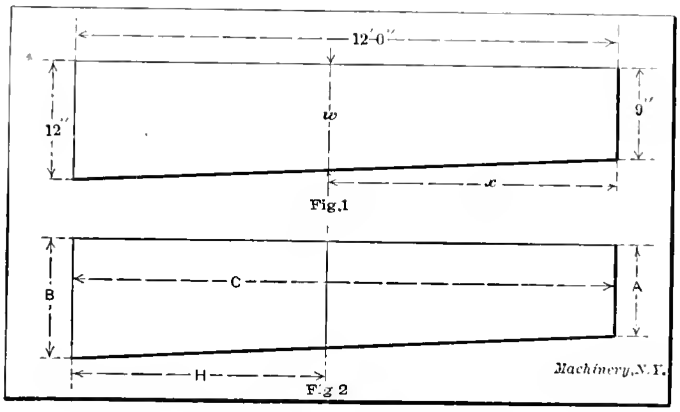


Fig. 1. Plank to be cut into Two Parts of Equal Areas. Fig. 2. Trapezoid giving Notation used in Formula

1,512 square inches and one-half of the area equals 756 square inches.

The taper per inch is $(12 - 9) \div 144 = \dfrac{1}{48}$ (1)

The width of the plank at the saw-cut is $w = 9 + \dfrac{x}{48}$ (2)

The area of the narrow end is $\dfrac{9 + w}{2} x$; but this must equal 756 square inches. Therefore $\dfrac{9 + w}{2} x = 756.$ (3)

Inserting in (3) the value of w as given by (2), we have

$$756 = \frac{9 + 9 + \frac{x}{48}}{2} x = 9x + \frac{x^2}{96} \quad (4)$$

Multiplying both sides by 96 gives

$$96 \times 756 = 96 \times 9x + x^2 \text{ or } 72{,}576 = x^2 + 864x \quad (5)$$

adding $\left(\dfrac{864}{2}\right)^2 = 186{,}624$, to both sides to complete the square gives

$$72{,}576 + 186{,}624 = x^2 + 864x + 186{,}624 \quad (6)$$

Extracting the square root

$\sqrt{259,200} = x \pm \sqrt{186,624}$ or

$x = \sqrt{259,200} \pm \sqrt{186,624} \pm 509.177 \pm 432$ or

$x \cong 941.117$ or $x \cong 77.117$ inches, the latter being the value sought.

Proof: Inserting this value of x in (2), we have $w = 9 + \frac{77.117}{48} = 10.6066$, and area of end $= \frac{10.6066 + 9}{2} \times 77.117 =$ 756.001086, the slight excess being due to the decimals.

[The formula $H = \frac{C}{B - A}\left(B - \sqrt{\frac{A^2 + B^2}{2}}\right)$ the notation of which is indicated in Fig. 2. may be used for dividing a trapezoid into equal areas.—EDITOR.]

* * *

REPAIRING AND IMPREGNATING COILS

By RALPH W. DAVIS

To a person who is not familiar with the methods used in electrical construction, the question of insulation appears to be complex and difficult, so a short account of the modern procedure may be of interest.

The coil shown in Fig. 1 happened to be a repair job, but new work follows the same line of treatment. The great size of this coil, which is one of a set for a 4000 volt, series arc transformer, can be judged by a comparison with the 3-foot rule that is suspended before it. The cost of repairing the coil by the method to be described was only about one-seventh the cost of a new one. Of course, when repairing, the largest item of first cost, which is that of the copper, is eliminated, and there is, practically speaking, only the labor cost, which depends largely on the extent of the injury.

The process of repairing this coil was as follows: The coil, when received, was carefully measured, after which it was torn apart or "unwound," and all injured wires repaired. It was then formed up again by winding over a wooden form made to the recorded dimensions. The winding is usually done in a worm-driven winding lathe. The re-formed coil was then removed from the form and wound with cotton tape and the terminals put in place and insulated. After all metal parts were carefully covered with adhesive tape, the coil was ready for the bath in the impregnating compound.

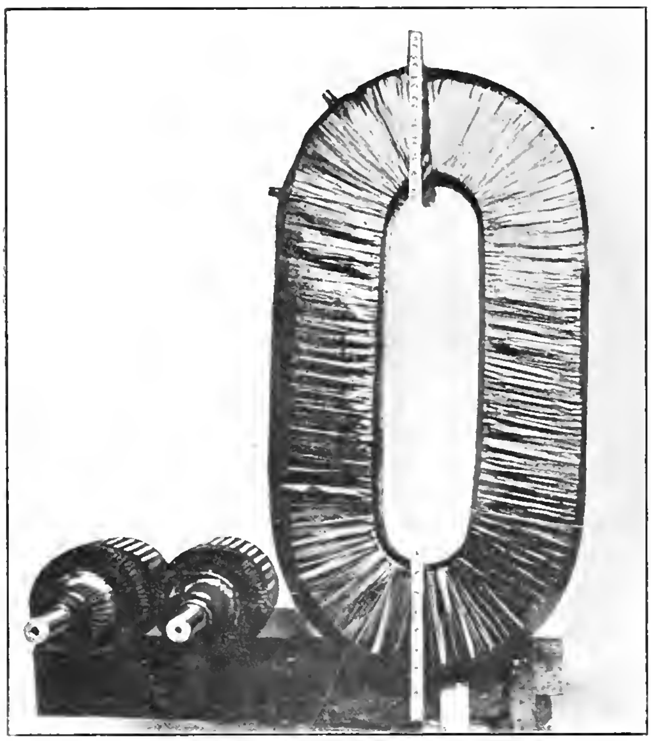


Fig. 1. Large Transformer Coil

It is necessary that the coil be subjected to a high drying heat for about six hours, the temperature being kept at 335 degrees F. It is then placed in a vacuum chamber, where a 29½-inch vacuum is maintained by means of a pump having a water-cooled condensing chamber. All moisture is thus expelled and the coil is absolutely dry and ready for the liquid portion of the bath. This liquid is a combination of several good insulating and moisture resisting elements. In Fig. 2, the cylinder at the left is the liquor chamber where the compound is mixed and heated until it reaches the proper constituency. At the right, and connected to the liquor chamber, is the impregnating chamber, in which the coils are suspended by means of a specially designed rack that keeps each coil separate from the other. The compound, at a temperature of 340 degrees F., is "run over" from the liquor chamber, and a pressure of 70 pounds per square inch is applied to the impregnating chamber by means of a small combination vacuum pump and compressor.

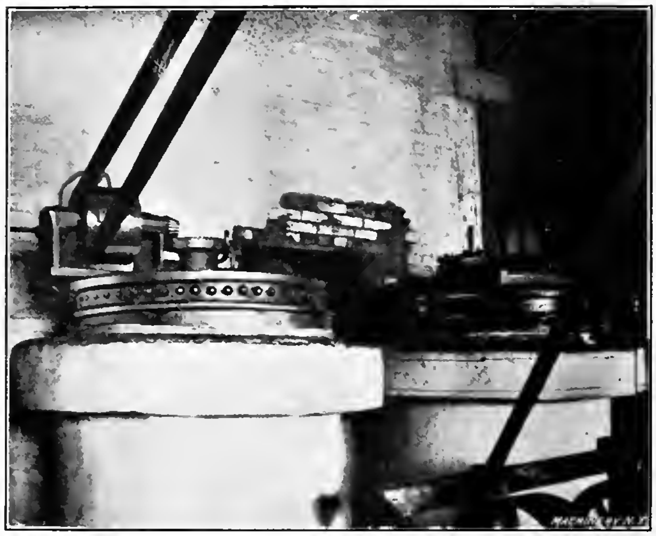


Fig 2. Tanks in which Coils are impregnated with Insulating and Moisture-resisting Compound

Under this condition the coil is kept for eight hours, allowing the compound to penetrate to every portion of the winding, and by reason of its high insulating quality, it places additional insulation between the winding. Actual tests show an increase of 100 per cent. The compound also acts as a preservative on the tape and cotton insulation, and the coil is firm and solid. After being removed from the bath and drained, the coil is jet black, but a covering of a more pleasing color may be added if desired.

This treatment is especially useful for armatures and field windings that are subject to moisture or hand usage, such as would be received in steel mills, coal or iron mines and outside construction. The small armatures are impregnated after the windings are in place, while large armatures have each coil treated before being placed in position.

A complete impregnating outfit for ordinary work can be bought and installed for $700, while larger sizes, of course, are more costly. An outfit which will handle 2500 pounds of railway field coils at one time will cost about $1,350. Fig. 2 shows the liquor and vacuum chambers of a plant of this size. Note the heavy asbestos heat insulation and also the massive covers. The mechanism on top of the liquor chamber (at the left) operates the mixing blades. The combination vacuum pump and compressor, previously referred to, first obtains the vacuum needed, and then by an arrangement of bypasses and piping, the same pump provides the required pressure. The chambers are usually heated by steam, which is admitted to the jacket about the chambers, but where steam is not available, the jacket is filled with high flash oil heated by a gas burner, and kept in circulation about the chambers.

The impregnating compound is a commercial article made by several companies, and it is in several grades. The point at which it will soften and begin to drip determines the particular grade to be used, as some coils are subject to greater heat than others, but with all grades the action of the vacuum to take out all air pockets, followed at once by the immersion in the heated compound under pressure, insures every portion of the coil's receiving its portion of the compound, which rarely happens with the old method of dipping in varnish.

* Address: 227 Columbia Ave., Rochester, N. Y.

COMPRESSED AIR RECEIVERS

By O. J. MacFADDEN*

An air receiver plays an important part in obtaining the highest efficiency and most economical operation of any compressed air installation. It is essential that the cubic capacity of the receiver be in the right proportion to the capacity of the compressor. For all practical purposes the receiver should have a capacity of from 15 to 20 per cent of the free air capacity of the compressor (per minute), but in large installations the percentage is sometimes lower, running down to about 10 per cent. To obtain good results the receiver should be placed as near as possible to the compressor, and in any case not more than 50 feet distant.

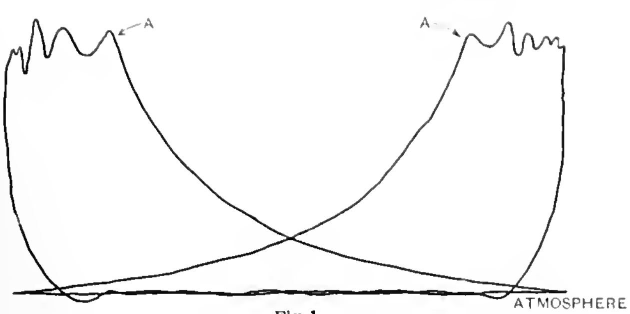


Fig. 1

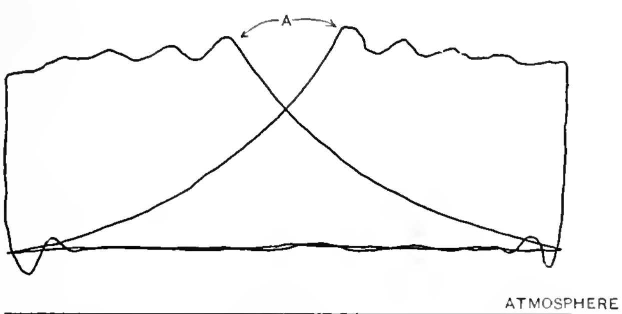


Fig. 2

Figs. 1 and 2. Typical Indicator Diagrams from Single-stage and Two-stage Air Compressors

Receivers may be placed in either a vertical or horizontal position, the vertical being preferred in most cases owing to the economy in floor space thus obtained. In many cramped installations the receiver is suspended from the ceiling by means of hangers or on the wall by means of brackets.

On entering the receiver, the discharge air from the compressor is reduced in velocity, and cooled to a certain extent, a large percentage of the oil and moisture held in suspension being deposited thereby, giving a relatively dry and clean air at the machines and tools using same. The inlet and outlet openings should not lie in a straight line opposite each other, as a through current would result which would interfere with efficient cooling and depositing of the moisture; the usual practice is to take the air in at the top and discharge it at the side near the bottom where the air is cooler, thus causing a change in the direction of flow and allowing of more efficient cooling and depositing of the moisture. Atmospheric conditions affect the amount of moisture deposited, and the receiver should be drained often in warm weather.

If the air from a compressor were discharged directly into the main, a loss of power would result, due to the piston of the compressor forcing a cylinder full of air into the main against a pressure momentarily higher than the normal. In other words, the effect of the strokes of the compressor piston would be to set up pulsations and cause fluctuations in pressure. This action would also have a tendency to increase the friction in the discharge pipe.

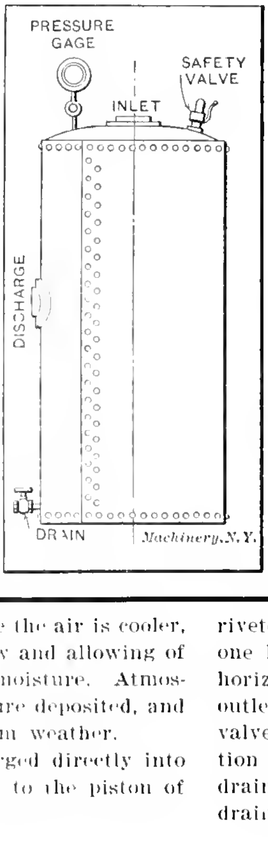
In comparing the pulsations caused by the discharge on a single-cylinder and a multiple-cylinder stage compressor it will be noticed that the latter has less pulsation to a marked degree, on account of the discharge valves opening sooner in the stroke and producing a longer duration of discharge. Fig. 2 illustrates this to good advantage, being an indicator card from a two-stage compressor, the card being taken from the high-pressure cylinder, 10 inches bore, compressing to 100 pounds per square inch gage. The points marked *A* show the commencement of discharge, and it will be noted that about one-half the stroke is utilized for it. The discharge valves of a single-cylinder compressor working at the same pressure open much later in the stroke, causing the total discharge to occur during a shorter part of the stroke, thus setting up a violence of discharge pulsations.

Fig. 1 shows a card from a 10-inch bore single-cylinder compressor, compressing to 100 pounds gage. The points marked *A* show the opening of discharge valves, and by comparing with Fig. 2, it will be seen that the duration of discharge is very much less in Fig. 1.

The receiver, if the capacity is sufficient, prevents any appreciable rise or fall of pressure due to the discharge of air and absorbs all pulsations. In regard to the receiver acting as a reservoir of power, this is true only to a certain limited extent; the storage feature can be of much value only in certain cases, such as in small plants where an exceptionally large receiver is employed in connection with a small compressor, the compressor being operated only long enough to raise the air to the desired pressure in the receiver, then being shut down, and the air used from the receiver to operate pneumatic tools or machinery which would allow a variation in working pressure of from 20 to 40 pounds, permitting the pressure to drop to that extent in the receiver before the compressor is put into operation again.

In the common form of receiver construction, steel of 60,000 pounds per square inch tensile strength is used; all circular seams are single-riveted and the longitudinal seams double-riveted. The heads of vertical receivers are usually dished, one being concave and the other convex, and in the case of horizontal receivers both heads being convex. Air inlet and outlet flanges, tapped holes for the pressure gage, pop safety valve and drain cock should be provided in the right proportion to suit the capacity of the receiver, always placing the drain cock at the lowest possible point to allow complete drainage of all moisture and lubricating oil deposited by the

DIMENSIONS OF VERTICAL AIR RECEIVERS



Diameter of Receiver in Inches	Height in Feet	Thickness of Shell	Thickness of Head	Inlet and Outlet	Diameter of Safety Valve	Cubic Contents in Feet	Weight	Compressor Capacity for which Receiver is best adapted
24	5	1/4	3/8	2	1	16	510	75 — 100
24	6	1/4	3/8	2 1/2	1	19	580	100 — 120
30	5	1/4	3/8	3	1 1/4	25	630	110 — 140
30	6	1/4	3/8	3	1 1/4	30	720	120 — 150
36	6	1/4	3/8	3	1 1/4	42	950	150 — 200
36	7	1/4	3/8	3	1 1/2	50	1050	160 — 210
36	8	1/4	3/8	3 1/2	1 1/4	57	1150	200 — 300
42	7	1/4	3/8	3 1/2	1 1/4	67	1280	270 — 450
42	8	1/4	3/8	4	2	77	1400	300 — 500
42	10	1/4	3/8	5	2	96	1650	500 — 700
44	8	1/4	3/8	5	2	85	1480	400 — 600
44	10	1/4	3/8	5	2	106	1740	600 — 800
48	8	1/4	3/8	5	2	101	1650	500 — 750
48	10	1/4	3/8	6	2 1/2	126	1930	850 — 1100
48	12	1/4	3/8	6	2 1/2	150	2210	1100 — 1400
54	10	6/16	7/16	6	2 1/2	159	2725	1200 — 1500
54	12	5/16	7/16	7	2 1/2	191	3000	1400 — 1800
60	12	5/16	7/16	7	2 1/2	236	3520	1600 — 2000
60	14	5/16	7/16	7	2 1/2	275	3950	2600 — 3000

* Address: 3038 Diamond St., Philadelphia, Pa

air. For ordinary pressures from 80 to 125 pounds per square inch, receivers are designed to stand a cold-water test of from 150 to 165 pounds pressure. In receivers of 36-inch diameter and larger a manhole is usually provided in the lower part of the shell. The accompanying table contains a list of standard-size receivers, together with data as to capacity, weight, etc.

* * *

DETERMINING COMPARATIVE VALUES OF LEATHER BELTING

Large buyers of leather belting, particularly purchasing agents of corporations who get estimates for supplies from a number of manufacturers, naturally feel the need of uniform specifications, so that they may have a basis upon which to compare prices. The result has been a great variety of specifications with some of which it is impossible for any belt manufacturer to comply, while others frequently exclude the purchase of some of the best brands of belting.

Old Idea Exploded

The truth is that the old idea that only certain materials for tanning and rules for currying and stuffing leather as well as for fixing certain lengths for pieces could be used, is exploded. It was claimed a few years ago by a large belt concern (not now in business), that a steer hide whether taken

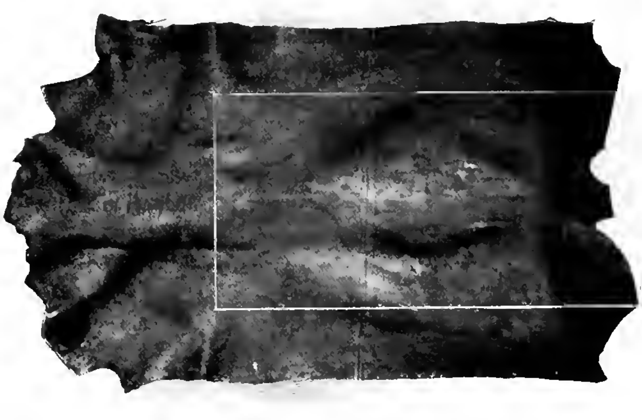


Diagram showing Portion of Hide used in Making Belting

from a small or a large, a young or an old animal would cut pieces of exactly the same length, suitable for belting—no longer, no shorter. But now any man familiar with hides knows that this is absurd. We could as well claim that there is no more cloth in the coat of a giant than in that of a dwarf, as to suppose that the good portion of the hide is of the same size, whether the steer from which it is taken weighs 1000 pounds or 1500 pounds. This being the case, it is evident that to cut the pieces taken from a large hide to the same length as those taken from a medium-sized one must waste good leather in the large hide and consequently increase the cost of production and the price to the buyer. If all hides were of the same size, thickness and consistency throughout, like a plate of steel, it would be a simple matter to make good belts, but they are not; hence no hard and fast rule can be laid down for their construction.

Making a Good Belt—Improvement in Methods of Currying and Tanning

The best leather was at one time supposed to be cut from directly over the back of the animal, but very careful tests have proved that the strongest leather is not there, nor toward the butt end of the hide, but just back of the shoulder and about one-third of the distance from the backbone to the belly.

Again the old ways of currying and tanning have given way to improved scientific methods which were scoffed at and condemned in their infancy as innovations and fakes. Our grandfathers did not know how strong their tanning liquors were; they guessed at the amounts of materials used, applied the greases to the outside of the leather, and got but little into the center fibers. To-day we have our laboratories and appliances, which insure vastly more uniform results than were then obtained. Then "pure oak tanned leather" was considered the only stock from which to make the "best belts," but now there are belts which have never seen "pure oak bark" or any "oak bark" at all, which command highest prices. Thus it is evident that it is not alone a question of rule-of-thumb tannage, of currying, or of the length of pieces, but one of the use of brains—the employment of the best talent and machinery in all the processes of the work combined with the strictest supervision.

What Constitutes a Good Belt

It naturally will be asked what then constitutes a good belt and how the buyer is to compare values without specifications. Replying to the first part of this question and granting that good leather is provided (which by the way may or may not be oak tanned), *uniformity of material is of the first importance.* By the term uniformity we do not mean exact uniformity of thickness, but uniformity of working efficiency; *i. e.*, a belt in which all the pieces rigidly class in the same grade, not one piece of first grade and perhaps the next piece to it of third, as is not infrequently the case. A belt composed of ten pieces of leather may have in it one piece of poor stock which will put the whole belt out of commission. The determination of a belt's working efficiency requires expert knowledge. Mere piping or wrinkling of the grain or hair side of the leather is not necessarily a serious matter, as some hides will pipe comparatively near the backbone while others maintain their solidity almost to the flank.

Probably the next most important thing to the user is a thoroughly stretched belt, one that does not have to be taken up every few days.

How a Buyer Can Determine Cooperative Values of Belts

As to how a buyer can determine comparative values of different makes, this cannot certainly be decided by weight, thickness or length of pieces. "The proof of the pudding is in the eating," and the proof of leather belting is in the result obtained from its use. It does not take an expert to tell which is cheaper, a belt that costs $50 and lasts six years and stretches but little, or one which costs $45, lasts four years and stretches much. To determine what makes of belting to use, keep a record of the service of each belt and it will not take long to determine which is the cheapest. The results obtained will very likely surprise the average belt user.

* * *

RECORD HEAT FOR A SMALL CUPOLA

The following is the record kept of a heat which was taken for a small cupola 36 inches in diameter in the works of E. Leonard & Sons, London, Ontario, Canada. Coke was used as a fuel, and the composition was agricultural scrap, broken small and mixed with 40 per cent pig iron, each pig being broken into four pieces. The blast engine was 9 inches cylinder diameter by 8-inch stroke, working at 120 pounds steam pressure with atmospheric exhaust and making 290 revolutions per minute. The fan was a No. 5 Sturtevant, making about 3500 revolutions per minute. The piston pressure as noted on the water gage was 16 ounces per square inch, but the pressure occasionally dropped to 12 ounces. The pressure was on for 3 hours 35 minutes, and the amount of metal poured was 45,000 pounds. One large casting was made of about 41,000 pounds and the balance of 4000 pounds was made into small castings. The fan belt was shortened about 2 inches each time the cupola was tapped, and 15 pounds of rosin was used on the belt during the heat. C. Cariss

London, Ontario.

* * *

A SOFT SNAP

"Say, Bill, I've got a fine job now in the office of the *Lallapaloosa;* we don't have *your* cast iron rules and regulations. We can go to lunch when we *feel* like it—none of that foolish stuff with our Old Man about staying in till 12 and getting back at 1."

"That's fine, but do you mean to say that anyone can go and come when he feels like it?"

"Sure, Bill. Oh, of course, we have to punch a time clock, but *every one there* has to do that!"

DONKIN'S DIVIDING ENGINE—EARLY MACHINE TOOLS*

By W. S. DAVENPORT†

There is an old and well-known saying, "The Ancients stole many of our best ideas," and many an inventor after working hard and long on some device which he considered original and valuable, has found to his sorrow that someone else, months, years, or centuries before had conceived the same idea and carried it out with more or less success.

Recently, while on a Transatlantic voyage, our ship received a wireless telegraph message from a disabled sister ship of the same line, and sailed back over her course 150 miles, found the vessel, and towed her safely into port. Naturally our conversation turned to the wonders of wireless telegraphy, when a worthy Scotchman, now a professor in a Canadian university, stated that messages had been sent by electricity from one mountain to another in Scotland without wires a hundred years ago, more or less, but the people believed it to be witchcraft, so the inventor and discoverer was obliged to drop the work. We cannot vouch for the accuracy of this statement, but it illustrates the old adage.

There is, however, an authentic illustration of this saying, which we recently saw, that will be interesting to the readers of MACHINERY, no doubt, and that is a device for correcting the pitch of a lead-screw. It has been thought by most of those acquainted with this device, that it was a comparatively recent invention, but it is not so. In the science department of the South Kensington Museum in London is a very fine machine, constructed in 1826, with the principle carried out in an admirable manner. It is known as Donkin's dividing engine, and is illustrated in Fig. 1 at A. The illustration shows the machine fitted to cut an accurate screw, but it was also used for graduating accurate scales, from which the above name was taken. Even at that date, the principle was old, but Mr. Donkin carried it out to a highly perfected state.

The lead-screw of the machine is between the two guides for the carriage, and is revolved by the large gear shown on the right-hand end. The nut, instead of being rigidly attached to the carriage, as is the usual practice, is fitted closely between bosses so there is no looseness longitudinally, but it is free to rotate slightly with the screw or in the opposite direction. It is obvious that if the nut rotates with the screw a fraction of a turn, the carriage will travel less than the lead of the screw, and if the nut is rotated in the opposite direction, the carriage will move a proportionally greater distance than the lead. To make the compensating rotation of the nut just the desired amount to correct the inaccuracies of the original screw, the nut has an arm fifty times as long as the radius of the screw. This long arm has a knob on one side which is held, by a suitable spring, in contact with a series of adjustable blocks half an inch wide, each block having its own adjusting and clamping screws. These blocks can be seen with their screws, below

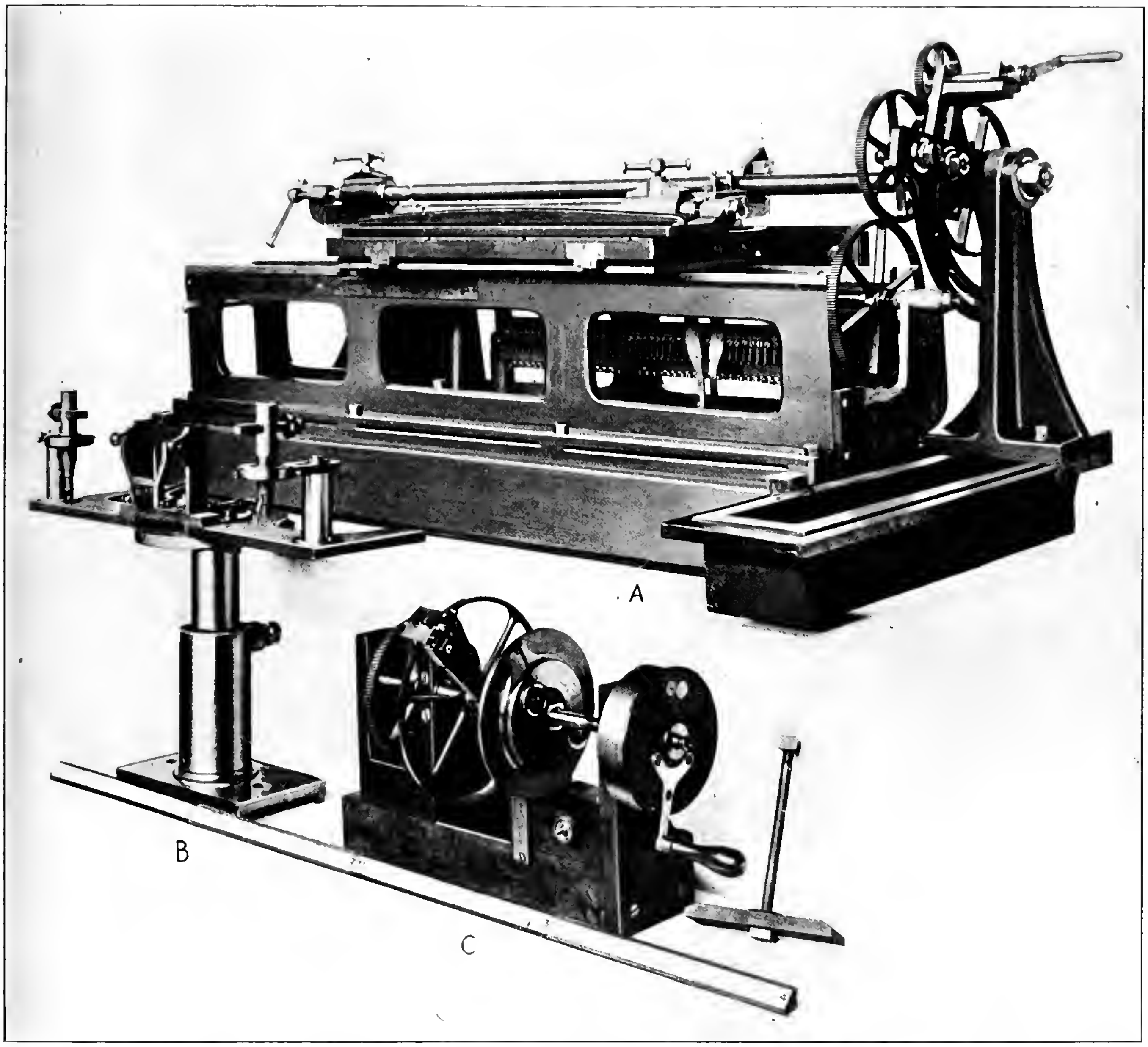


Fig. 1. Donkin's Dividing Engine and Accurate Screw Cutting Lathe. A Compensating Device is provided for Correcting Local Inaccuracies of Lead-screw

* For previous articles published on early machine tools, see MACHINERY, September, 1909, "Chapters in the Early History of Machine Tools," by Joseph Horner, and articles there referred to.

† Address: Davenport Machine Tool Co., 90 Sixth St., New Bedford, Mass.

the lead-screw. The lead-screw is 24 inches long, so there are 48 adjustable blocks. After the inaccuracies of the screw were found, the blocks were adjusted up or down as necessary, till the movement was uniform throughout the whole length. The corners of the blocks were rounded off, so the knob would ride easily over them.

At *A* in the illustration Fig. 1 the machine is shown from the back side, as this view best illustrates the principle of the compensating arrangement. The small view *B* shows the graduating device and two microscopes mounted on a table, and all supported by a post in a bracket. This device was placed on the front of the machine, and used in finding the errors of the original screws, testing the lead-screw until it was correct. The testing was accomplished by graduating very fine lines on a polished strip of brass—first 24 inches apart, then bisected, then both these divisions bisected, and so on till there were 24 lines, the microscopes being used to compare the divisions, and finally, after repeated adjustments of the blocks, the nut with the long arm traveling on the blocks moved the carriage uniformly the whole length so graduations could be made perfectly uniform. The second small view *C* shows the ratchet wheel with 500 teeth which was geared to the lead-screw when the machine was used for graduating.

In the illustration, the machine is shown arranged to thread the screw at the top, which is 36 inches long, necessitating two settings of the carriage with relation to the work; the tool carriage is attached to the nut carriage by the clamps on the rod. The lead-screw is of very fine pitch, being 50 threads to the inch. In threading, the screws were both turned by the crank shown at the top of the machine.

So far as known, this was the first accurate dividing engine made, and the first really accurate screws were cut on this machine. The principle, however, was old at that time, as it had been used in a crude way by Maudslay, who made a correction of 1/16 of an inch in 7 feet by an inclined guide for the nut, but did not correct the local inaccuracies.

In the same department is the original Maudslay engine lathe, made late in the eighteenth century, and a notice in the case with it states that this is the first lathe ever made with a self-acting tool carriage and a lead-screw for use in threading other screws. [See illustration of this lathe in MACHINERY, September, 1909, page 1, engineering edition.] Previous to the building of this lathe, slide rests had been used which could turn short lengths only, and screws were cut only with dies or toothed chasers in hand tools, which at best would produce only inaccurate leads. The head- and foot-stocks are attached to only one of the inverted V's, but the carriage slides on both, and has a cross-slide with a graduated collar on its feed-screw. This is an illustration of the original conception's being correct, although not copied on the thousands of lathes built during the greater part of a century. It has been provided, however, on the best class of tools during the last twenty-five years. Provision is made in the tool-post for three tools, but probably not for roughing and finishing tools. Doubtless two were used as supports for slender work, and one for the cutting tool. The shape of the cross-section of the inverted V's has been closely followed in American practice. The dovetailed fit of the cross-slide at the start, seems to have differed but little from our present practice.

It seems that in making screws, Maudslay had tried many devices before he succeeded in making one good enough for this lathe. He first tried to wind a metal wire or tape around a bar, but could not get as even pitch as desired. He then constructed a machine, also exhibited, which he made about the year 1800, in which round bars of hard or soft wood or metal were rotated in a long hole, and a chisel or cutting tool set at an angle and held by a graduated device, cut into the work at an angle and caused the work to travel longitudinally as it was rotated, the lead produced being controlled by the inclination in the cutting tool. [For illustration see MACHINERY, November, 1909, page 189, engineering edition.] The best of these were taken as lead-screws and from one of these the screw was made which is now in the lathe. Think of the struggles these pioneers had to originate the methods and first tools, making our present machines possible.

Near by is a "planing machine" made by Richard Roberts in 1817 and said to be the first machine made for planing metal. [For illustration see MACHINERY, October, 1909, page 91, engineering edition.] It is evident from the marks of chipping chisel and file that this was made without other tools than these. At this early date, the correct principle of grinding a slide was used, one side being a V (long and narrow), and the other a flat surface.

The table has bolt holes for securing the work. The cross-rail is supported by a standard each side of the bed with screws for adjusting for height, and has a screw for feeding

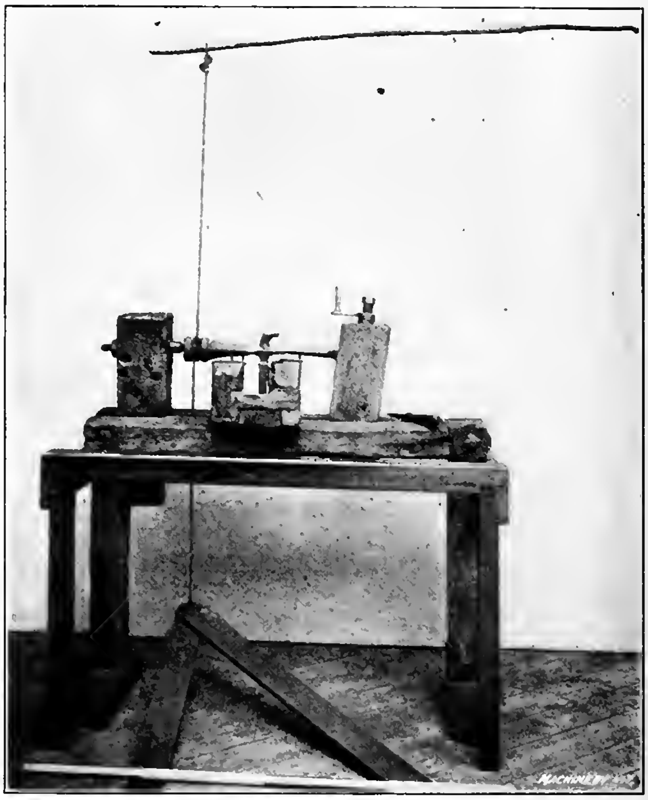


Fig. 2. Pole Lathe in South Kensington Museum, the Oldest Form of Lathe Known. This Lathe was in Active Use until about 35 years ago

the tool across the work. The tool is held in a hinged clapper arranged to lift on the return stroke, and a screw is provided for feeding the tool down to the work, which also can be adjusted to feed at an angle. With the exception of the traversing of the table, which is done by hand and chain, and the absence of automatic feed, the metal planer seems to have come into existence in a remarkably perfect form.*

Going still further back, Fig. 2 illustrates a "pole lathe" which is the earliest form of lathe made. This particular lathe was made in about 1800 by Thos. Nokes & Sons, and was in use as late as 1879 by them for turning parts of stop-cocks, etc. The work does not revolve continuously in one direction, but oscillates in each direction perhaps a dozen revolutions each way. The strap connected with the treadle is wrapped around the wooden arbor of the lathe and leads up to the spring pole. As the operator pushes the treadle down with his foot, the work rotates forward and the cutting is done; the hand tool is then drawn away from the work and the spring pole draws the treadle up again, the spindle, of course, rotating backwards. This seems very slow and crude, but is in daily use in many small shops on the shores of Lake Como, where fancy novelties are made of olive wood to sell to the many tourists who flock there every year.

Compare this very crude lathe of 1800 and the beautifully wrought Donkin's dividing engine, and it is obvious that great strides were made in the early part of the last century, and that the improvements made then were even more marvelous, relatively, than those of which we are wont to boast of at present. Maudslay, Donkin and others had the field all to themselves, it is true, but they were men of great minds and made great improvements, laying the foundation for our present progress and prosperity.

* Comparatively little is known of the early development of metal planers and of the various schemes tried for producing planed surfaces beyond that many inventors worked on the problem with indifferent success. Most of them worked secretly and what they individually accomplished is for the most part unknown. See "Industrial Biography," by Samuel Smiles.—EDITOR.

NEW FACTORY OF THE FRANK MOSSBERG CO.

By CHESTER L. LUCAS

The location of the Frank Mossberg Co.'s new factory at Attleboro, Mass., is ideal. Directly on the main line of the New York, New Haven & Hartford Railroad and but a short distance from the station at Attleboro, the two-story brick factory is situated on high, level ground. Apart from the factory district proper, the light and surroundings of the building are superior and the view of green fields from its windows is a refreshing change from the outlook upon the cinder yards and busy streets that the average factory windows afford.

The building itself faces the east. This position was necessary on account of the north and south direction of the railroad. It being impracticable to employ the usual type of mill construction with saw-tooth roof, a roof with the saw-teeth placed lengthwise of the building was used so as to supply the best light.

At the front end of the building and on the second floor are the business offices, the private offices for the officials of the company and the drafting-room. These various offices are finished in Flemish oak and are of ample size for the purposes intended. Fig. 2 shows the general appearance of one of the offices.

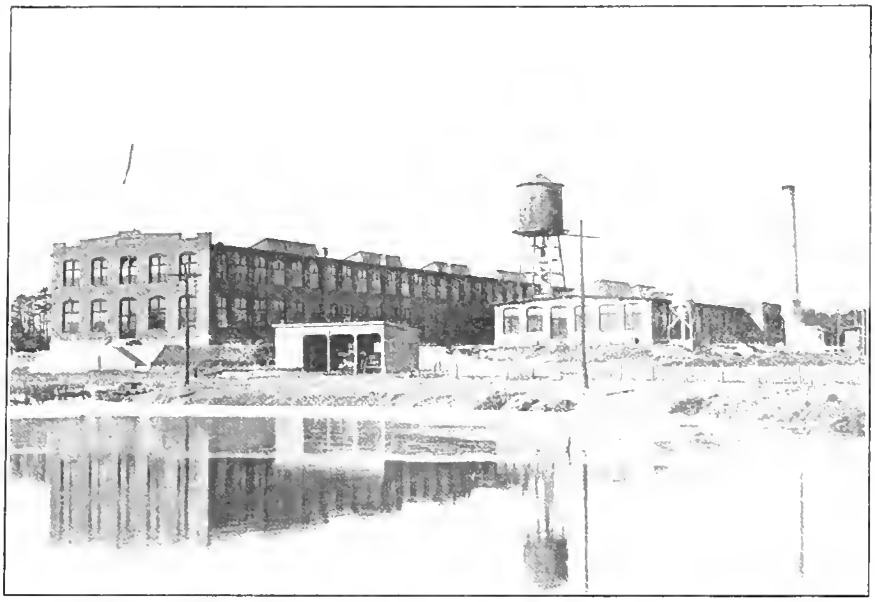


Fig. 1. Factory of the Frank Mossberg Co., Attleboro, Mass.

On the south side of the second floor is the toolroom. Here the dies and tools for the factory work are turned out. The punch and die shown in Fig. 4 are fair specimens of the tool work. The remainder of the floor is given up to light machine work, screw machines, shapers and lathes, milling machines and the like. At one part of this floor is maintained an apprentice department where the boys are started at their trade. By keeping the younger apprentices on these machines until they are accustomed to the proper use of machine tools, the machines in the toolroom are saved much abuse. The view of the screw machine department, Fig. 3, illustrates the well-lighted condition of the rooms, and throughout the factory the same good lighting is noticeable.

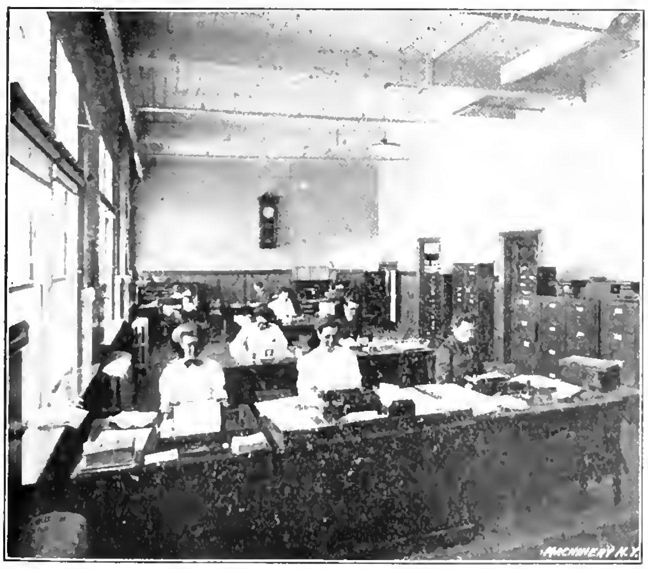


Fig. 2. Interior of one of the Offices

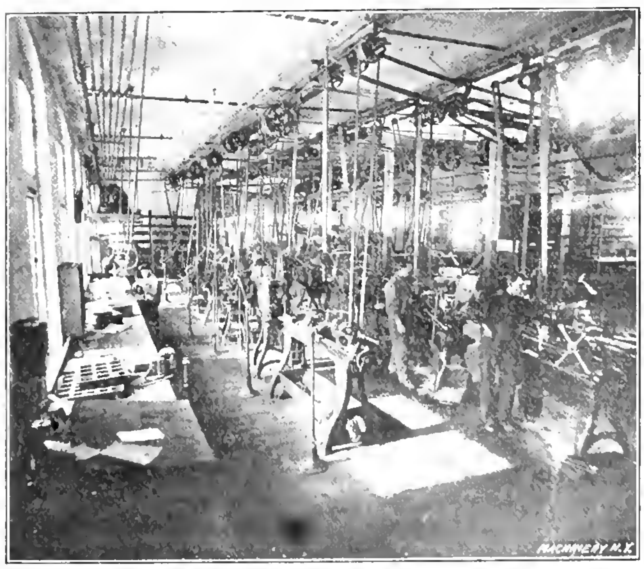


Fig. 3. Screw Machine Department

The polishing and plating departments and also the hardening department are located in the building at the right of the main factory as it appears in Fig. 1. The plating room is shown in Fig. 5. The arrangement of the tanks and various baths is most convenient. The wiring of the work is all done at the corner of the room where the work enters from the factory. At the center of the room are the various dips, potash and hot water tanks and the cleaning benches. On both sides of the room are the nickel solutions, easy of access from the central row of cleaning tanks and dips.

The current for the plating tanks is furnished by two direct-connected dynamos, one of 1500 ampere capacity and one of 500 ampere capacity. In order to avoid the expense that would be necessary for wiring the smaller work, a rotary plater has been installed that effectually cares for this item. Instead of the usual boxes of sawdust for drying the parts, this company places the plated work in a large basket and forces a strong current of hot air through them, a method that is both quicker and cleaner. The cleaning of much of the work is done in a tank with a special solution. The process employed is just the reverse of the nickel plating operations, for the current passes through the solution in the opposite direction from the one taken while plating, and this process removes the grease and dirt rapidly.

The polishing department, in which from 50 to 75 men are employed is kept exceptionally clean by means of a powerful exhaust fan driven by a direct-connected electric motor. Friction is eliminated as far as possible by the use of ball bearings mounted on the main shaft, and each shaft length is driven by an independent motor. A great deal of the brass goods manufactured receives a high polish and consequently must be lacquered to protect the finish. Instead of applying the lacquer with a brush or dipping the articles in the lacquer, a spraying process is used. Compressed air is forced through the lacquer tank and by means of a nozzle

* Address: 1 Bailey Ave., East Saugus, Mass.

from this tank the lacquer is sprayed onto the work, a better result being obtained in this way than by dipping—the process is also quicker than brushing.

The hardening room is well equipped with furnaces, most of which are operated by crude oil. The problem of storing the oil supply has been taken care of by means of a large

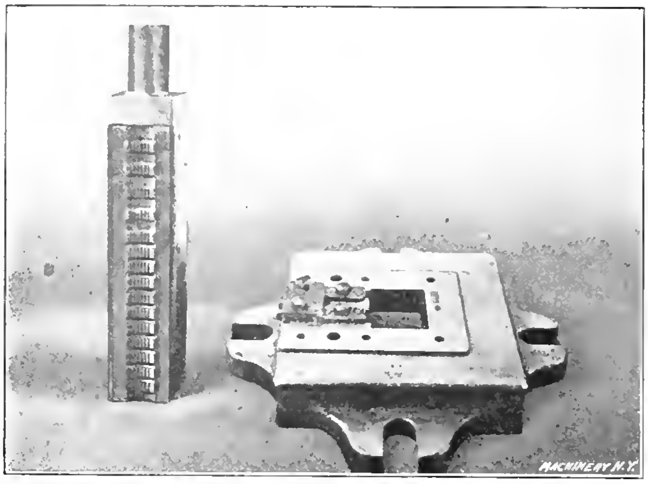


Fig 4 Broaching Tools for Gear Teeth

underground oil tank that is placed under the car tracks outside of the building so that the oil cars may be quickly emptied; at the same time the oil is not exposed to fire risks. As required, the oil is pumped into the factory and fed to the furnaces. The hardening furnaces are equipped with recording pyrometers that enable the hardeners to put the work through at the proper heat and, of course, the results are uniform. In addition to the crude oil burning system used for the larger furnaces, a gas plant is installed for making gas from gasoline. This gas is made with the proper proportion of air and is piped to the different departments where it is to be used.

At the rear of the building, on the second floor, are the inspecting, packing and shipping departments. The wrenches,

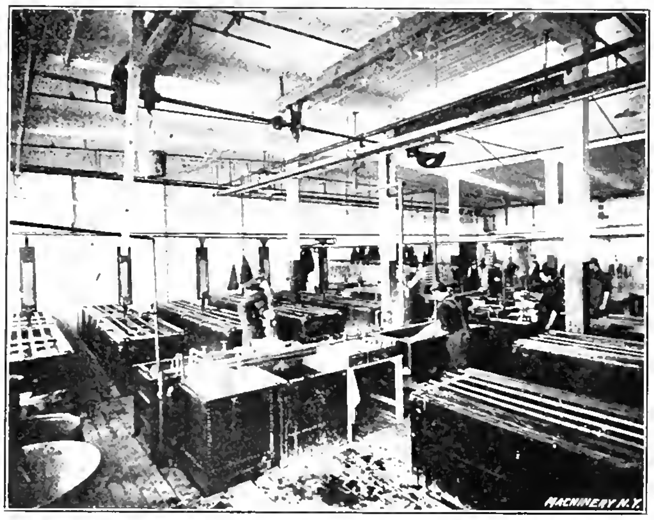


Fig 5. Nickel Plating Department

bells and other specialties pass through these departments successively to their final destination on the freight cars in the yard.

The lower floor of the factory is given over entirely to punch-press work. Fig. 6 shows a section of the department that is used for heavy press work. The press shown in the illustration is powerfully geared and the heavy frame is supplemented by four three-inch steel rods that strengthen it beyond danger of breaking. The press is motor-driven and is shown set up for piercing the sides of large wire reels. These reels are made in a large variety of sizes, from 2 to 72 inches diameter, and are for holding wire of all kinds as sent out by the wire manufacturers. A group of these spools may be seen in Fig. 7, the large spool being made of iron and the smaller ones of brass.

Wrenches, both adjustable and socket, form a considerable part of the firm's output. The group shown in Fig. 8 illustrates a few of the 75 styles and sizes of the adjustable wrenches and most of the styles of socket wrenches. At the center is shown a socket wrench complete, applied to a pipe joint. Mounted on the board shown in Fig. 9, is a set of shells that illustrates the evolution of a socket wrench from the round blank to the finished wrench. After blanking, the piece receives eight draws, each drawing the shell a little deeper and narrower. After the eighth draw, the process is divided into two groups, one for the wrench for hexagon, and one for the wrench for square-head nuts. From this dividing point, in the case of either style of wrench, the first two or three operations are to draw out the narrow part of the shell and the final two operations are the shaping of the hexagon and square sections. These latter operations are done in the drop press by placing within the shell a mandrel of the correct shape and then striking the shell sideways between dies that give it the finished shape. The other pieces in this illustration are specimens of the drawn work done in the Mossberg factory.

The adjustable wrenches for bicycle, automobile and gen-

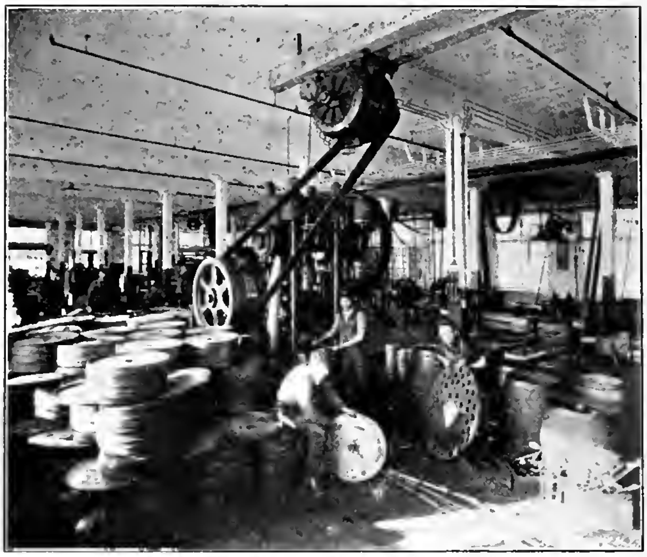


Fig. 6. Heavy Press Work Department

eral use are made in larger quantities than the socket wrenches and consequently there are more interesting operations employed in their making. One of these operations is the broaching of the wrench teeth, which is done in a punch press as shown in Fig. 12. As the position of the press did not admit of taking a detail photograph, a set of broaching

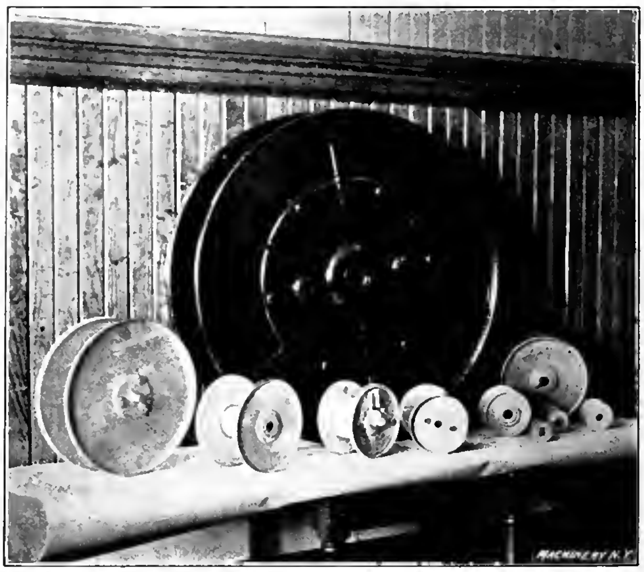


Fig. 7. Wire Spools and other Drawn Work

tools was photographed showing the construction of the punch and die, which, although not for wrench work, illustrates the principle of the broaching dies. In this illustra-

tion, Fig. 4, the die consists, primarily, of four pieces set into a cast-iron bolster. The pieces at the top, bottom and right-hand side of the rectangular opening, are of machine steel, casehardened 1/16 inch deep, and the left-hand section is of high-speed steel and is the broaching die proper. These four pieces are each a driving fit in the bolster and are doweled and screwed in place. On the top of the die section are screwed the hardened locating gages that confine the blank while being broached. The broaching punch is built up of casehardened machine steel sides. The side that does the actual broaching is of high-speed steel and consists of a number of steps as in the ordinary broach. As may be seen, the steps at the bottom do but little cutting and hence are closely spaced. Each successive step removes a little more of the stock, except the last three or four steps, which do little more than to smooth the surface and size the teeth. As the sides

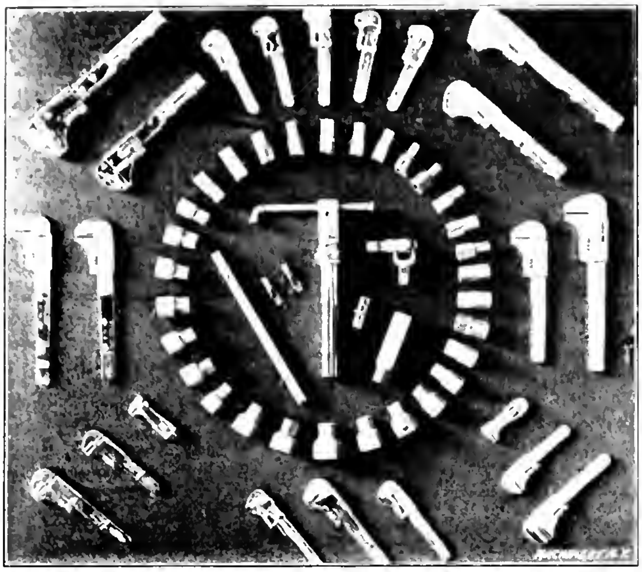


Fig. 8. Various Styles of Socket and Adjustable Wrenches

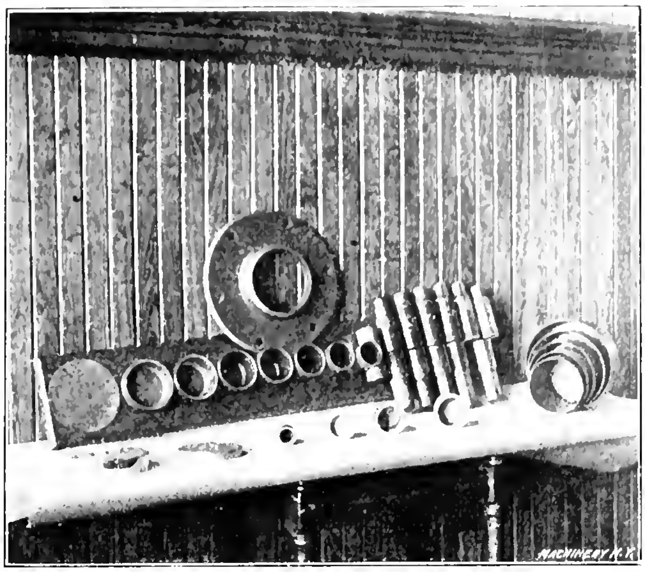


Fig. 9. Evolution of a Socket Wrench

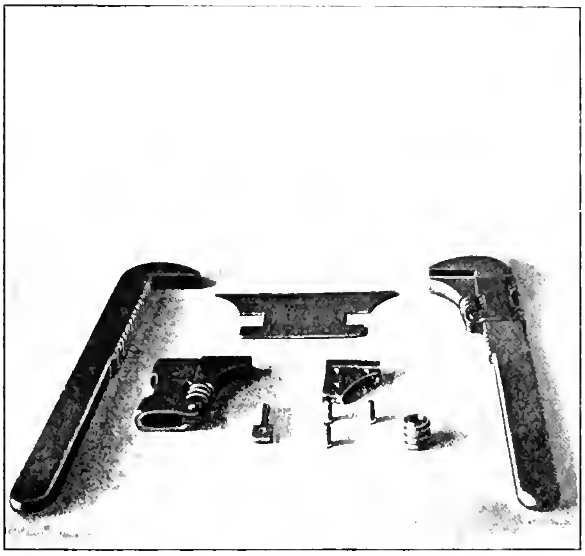


Fig. 10. Component Parts of a Wrench

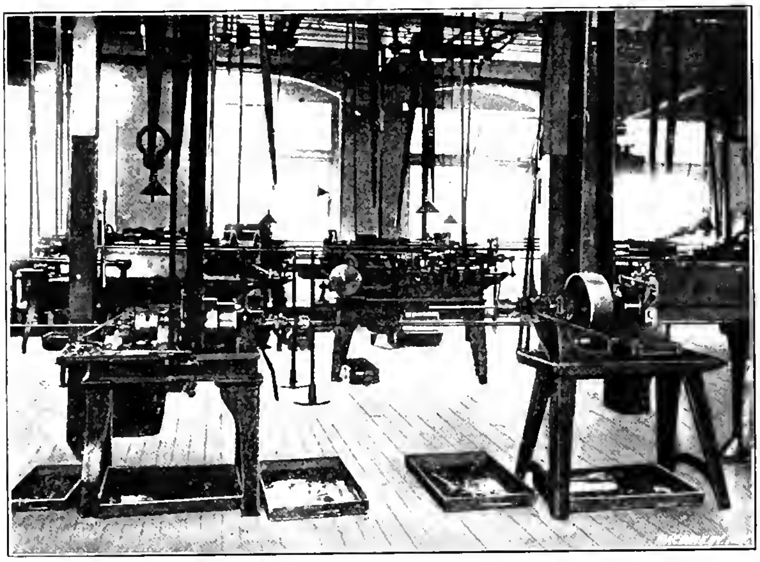


Fig. 11. Threading the Stock for Wrench Nuts

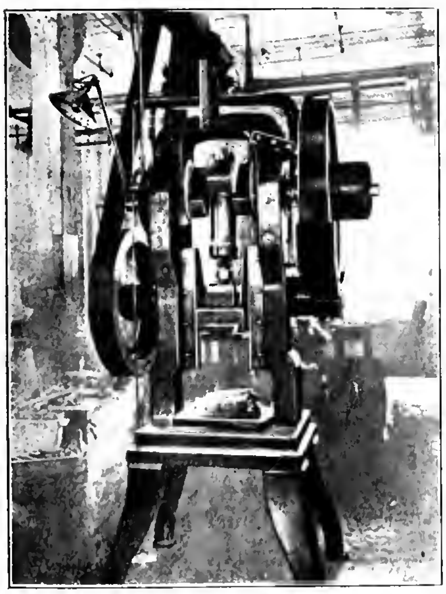


Fig. 12. Broaching Wrench Teeth

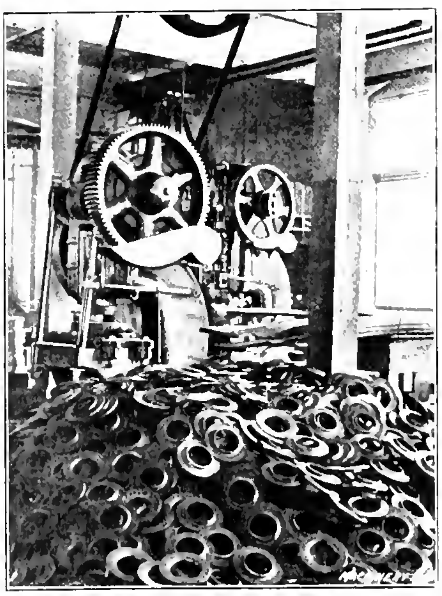


Fig. 13. Making Automobile Hub Flanges

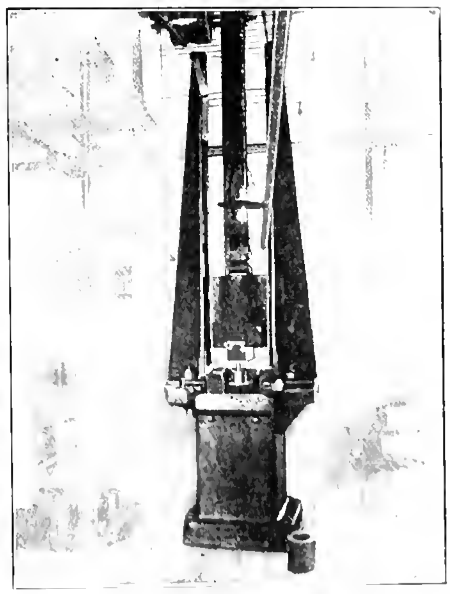


Fig. 14. Novel Drop Press Foundation

of the punch fit the opening in the die closely, the broaching teeth are kept perfectly aligned and there can be no springing away of the punch. By the use of this type of die, all the advantages of the sub-press are gained at about one-third the cost. The Mossberg people have made a special study of broaching problems and some of the work done on wrenches, typewriter, clock and adding machine parts, is indeed creditable. The inclining of the broaching die in Fig. 12 is, of course, to give the proper pitch to the wrench teeth and incidentally enables the broaching to be more easily done.

Electric lighting for presses and other tools where the light must be at close quarters, is taken care of by fixtures like that at the left of the press in the illustration. The general lighting of the shop is by tungsten lamps of the 250-ampere size. These lights with shades are suspended from the ceiling by means of spring fixtures.

After the teeth are broached, the company's name, the size and trade name of the wrench, are stamped upon the shank. As this is a simple punch-press job, no further description is necessary. The stamping operation completes this part of the wrench and it is now ready for the polishing and plating department. The sliding jaw is first punched out as a flat

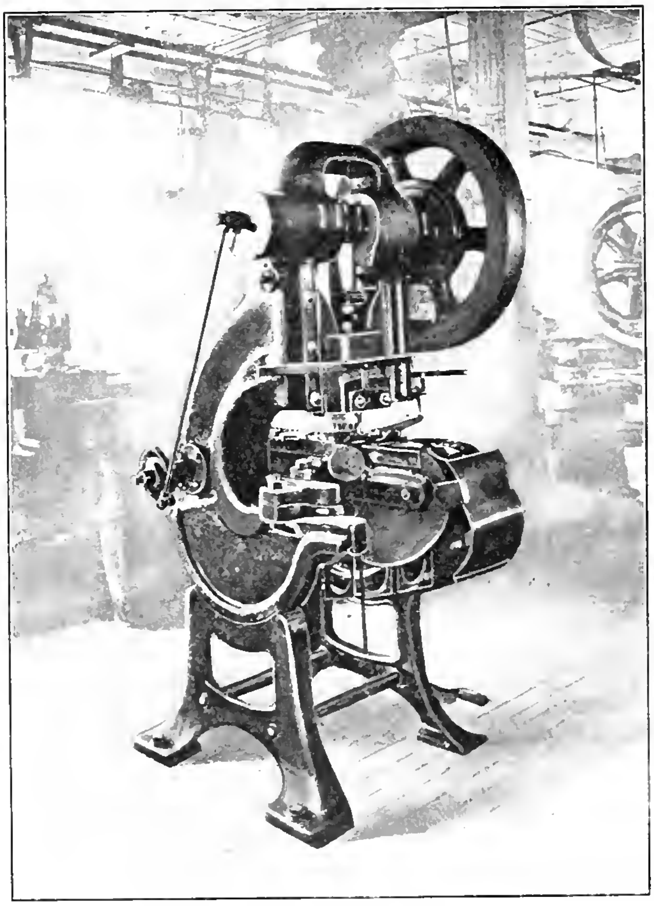


Fig 15. Endless Belt Feed for Press Work

punching and then bent to shape. Fig. 10 shows this and the other parts that compose the wrench.

Making the wrench nuts is an interesting series of operations. Fig. 11 shows the machines used in the nut department. The two machines in the foreground thread the stock automatically. All they require is the putting in of fresh bars, after which they literally eat it up at the rate of about two feet a minute, the speed varying with the size of the stock. A feature of the machine is the construction of the feed rolls that advance the bars. These rolls are grooved *lengthwise* so the bars cannot turn laterally and spoil the thread or break the die. After the bars leave the threading machines they are taken to the Acme automatics and knurled and the center hole drilled. Each of the Acmes turns out 4000 pieces per day when on a run of the wrench nuts.

Drilling the solid part of the sliding jaws and the pin upon which the nut turns come next, and then the assembling. The latter operation is done upon riveting machines and the sliding jaw is then ready for grinding, polishing and plating. While the polishing and grinding department is a large one, there is little of mechanical interest there. Casehardening in the big oil furnaces imparts a beautiful dark blue color to the steel as well as hardening it to a depth sufficient to withstand ordinary wear. Those wrenches that are to be highly finished go to the polishing and plating department for a coat of nickel. Each wrench is then inspected, wrapped and sent to the stock room as one of the 75 varieties.

While wrenches are the standard production of this factory,

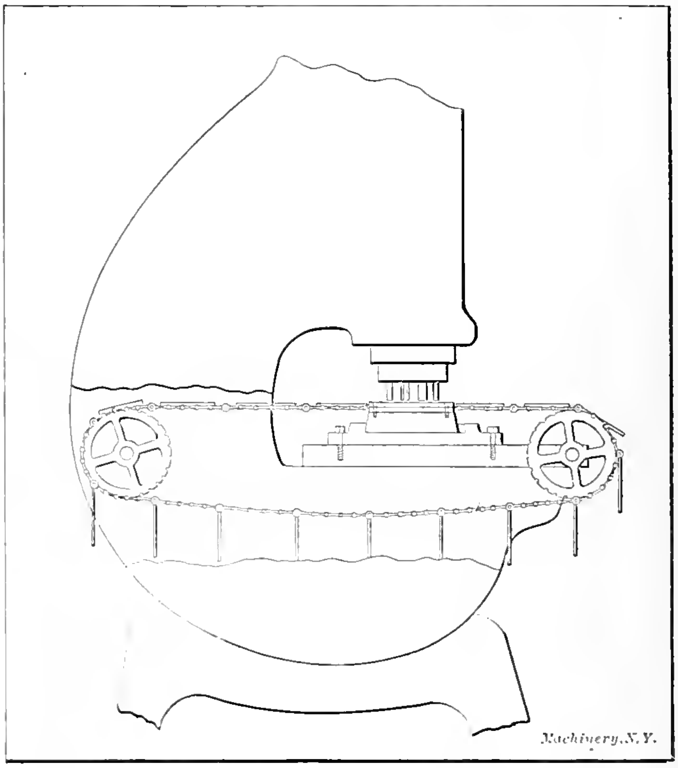


Fig. 16. Details of Endless Belt Feed

there are other branches of work done that are of more than passing interest. Fig. 13 is a striking view of the press-working of heavy steel which is being made into automobile wheel hub flanges. The material is $\frac{1}{2}$ inch thick and the punching is $8\frac{3}{4}$ inches diameter with a 3-inch hole, the stock being drawn to a depth of $\frac{1}{2}$ inch at the center. The press tools consist of a compound blanking and drawing die. The die works successfully and the pile of punchings at the right of the press in Fig. 12 backs up this statement.

That blessing in disguise, the "tattoo" alarm clock, furnishes a good deal of press work for this factory in the making of the gongs. The press work itself is comparatively simple, consisting of compound dies for blanking and drawing, and dies for piercing the holes and stamping the lettering, but the endless-belt style of feed on the piercing and stamping operation is interesting. At the front and rear of the press are two pairs of sprocket wheels connected by chains. Be-

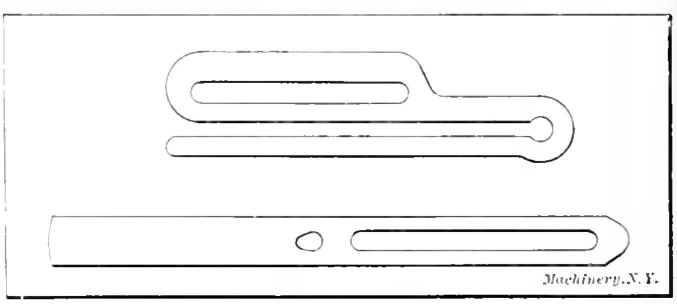


Fig 17. Punching used in Textile Work

tween these two chains are hinged at intervals, thin steel plates, each with a circular opening, large enough to admit one of the gongs to be pierced. At the front of the press the operator places the blanks in the openings as they rise with the chain, and after feeding under the die they drop out of the openings of their own weight when the hinged plates "flop" over by gravity at the rear of the press. In the photograph, Fig. 15, some of the hinged plates may be seen under the press as they are on their way up to the dies. On the

press bed is one of the blanks showing the pierced holes. Fig. 16 shows this style of feed in detail, and it should be applicable to many other press jobs. The endless chain is operated by a crank on the driving shaft of the press, as shown in the illustration Fig. 15.

It was necessary to locate a 200-pound drop-press on the second floor of the factory and just how to mount it in the best way was a puzzling question. At length a piece of 8-inch iron pipe was set up from the ground to the level of the second floor. A cement foundation was put in and the pipe itself filled with cement. At the top of the column a casting was fitted, whose top face spread out to fit the base of the press. The press was bolted to this head and it has proved to be an excellent foundation. The press and base casting are shown in Fig. 14.

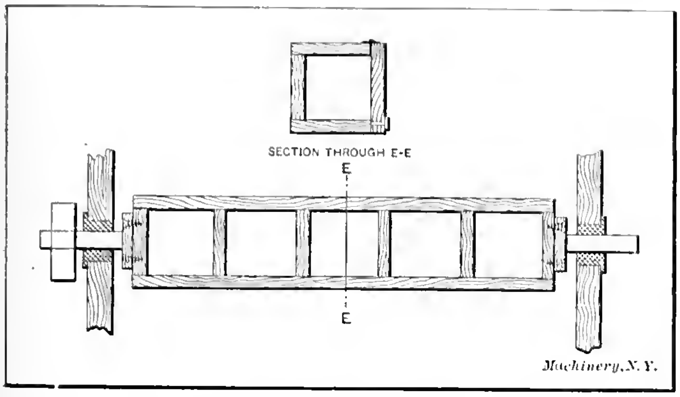


Fig. 18. Arrangement of Tumbling Boxes

Fig. 17 shows two thin sheet-metal blanks that are used in large numbers in the textile industry. They are made of both brass and steel, 0.010 inch thick, and it is very necessary that they be straight and free from sharp edges. Difficulty was experienced in getting rid of the sharp edges because ordinary tumbling methods could not be used on account of bending the blanks. To overcome this difficulty a series of tumbling boxes (Fig. 18) was devised that made the operation quick and successful. These boxes are four inches square and four feet long and are divided into partitions just long enough to take a handful of the punchings when they are all laid the same way. The boxes are not deep enough to allow the pieces to get tangled up and, in fact, they can only roll over and over. About thirty of these boxes were set up and belted together and enclosed in a little room, and the tumbling of these textile pieces was well taken care of.

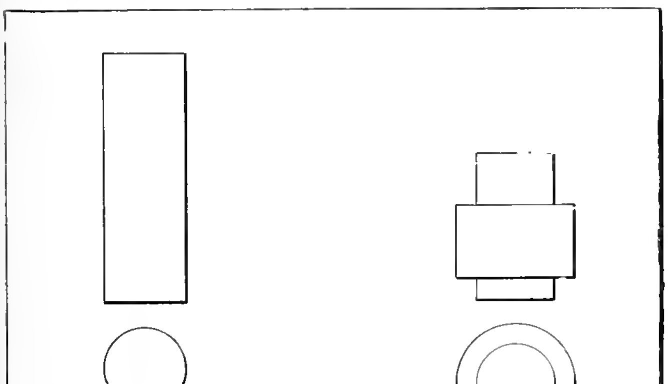


Fig. 19. A Header Job Done in a Punch Press

A somewhat unusual piece of press work is illustrated in Fig. 19 and while it is really a job for a header it was accomplished in good shape in a heavy press similar to that shown in Fig. 6. One view in Fig. 19 shows the blank, which is soft steel 1/2 inch diameter and 1 9/16 inch long, before upsetting. The other view shows the piece after upsetting; the length has been shortened to 1 inch and a ring thrown out 3/4 inch in diameter and 3/8 inch wide. Needless to say, the dies are made of high-speed steel. They last for about 10,000 pieces before giving out.

Fig. 20 shows the interior of one of the many wash-rooms which are at different locations throughout the factory, and they are equipped with wash-bowls of a new and sanitary design. The bowls are of iron with porcelain facing and each is entirely separate from the others in the line. They are supported by two pins cast integral with the bowl and can be lifted from the rack and cleaned easily. By the use of this system, each man is assured of a clean bowl of water for washing up without having to race for the wash-room at the sound of the closing whistle.

Aside from such conveniences as the wash-room just described, the Mossberg Co. does many things to make its factory conditions congenial to the men and by so doing it is able to get skilled employes and to keep them. No effort is spared to insure the most harmonious feeling throughout the different departments. During the winter months the company maintains a lunch room where food is supplied at cost to those who do not go home to dinner or bring their lunch. They have a base-ball team, and a mutual benefit association; the foremen have meetings each month to talk over the shop work and have a social hour together, and each year the shop outing is an attractive feature that includes them all, from the management down to the sweeper.

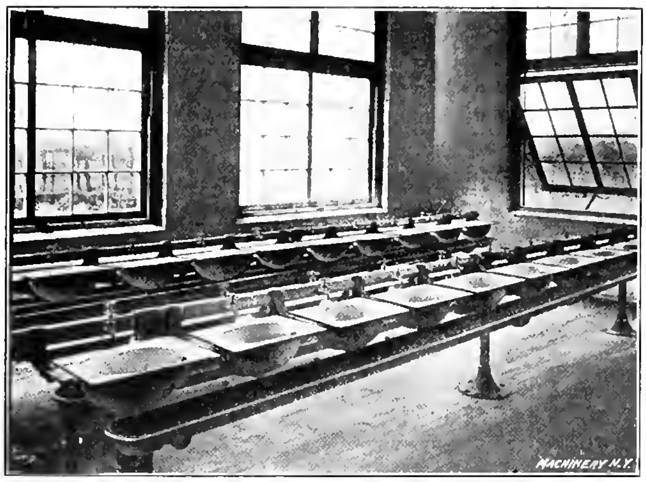


Fig. 20. One of the Wash-rooms

The officers of the company are: Frank Mossberg, president and general manager; Silas Tuttle, vice-president; Walter I. Tuttle, secretary and treasurer; E. L. Ford, superintendent, and Conrad Luttropp, mechanical engineer.

* * *

PERSISTENCY NECESSARY FOR SUCCESS

"The best laid plans of mice and men gang aft agley" is true of the affairs of the great as well as of the mean and obscure as the proverb really means. It is a common idea entertained no doubt by many of our readers that successful men meet few disappointments—that practically everything they "back" wins, but the truth is they meet many reverses that the world never hears of. The faculty that makes many if not most men successful is the try-try-again spirit. Genius has been defined as unlimited capacity for hard work, and it is largely so.

We recently heard a mechanical engineer of international fame say, when congratulated on the rosy prospects of his latest invention: "You never can tell; I've been disappointed so many times with things that worked out well on paper but which turned out rank failures when put to practical test that I never feel sure of success until it *is* sure."

* * *

The best gas engines, says Prof. Franklin in an article on the second law of thermodynamics, convert about 30 per cent of the heat of the fuel into mechanical work. The best steam engines convert about 10 or 12 per cent of the heat of the fuel into mechanical work. The ordinary run of steam engines, however, convert only 4 or 5 per cent of the heat into work.

HOW A MACHINE SHOP SYSTEM WAS IMPROVED

By M. H. WESTBROOK*

My friend Bob has been a foreman of a machine shop in C——, a neighboring city, for a few years, and the following is part of a letter I received from him about six months ago:

Things are so busy at the shop I must either ask for a few more machines, work longer hours or "go after" my men harder. Now, while I am sure they are just as fast a bunch, if not faster, than the average, and my speeds and feeds up to the limit of the best high-speed steel, I feel that if an entire stranger were to spend a few days in the shop and give me his candid opinion of what he thought should be done to increase the output, he might be able to put me next to things that, through familiarity with them, have passed unnoticed by myself. I wish you would try and come over and spend a week with me. We will have a good time in the evenings trying my new Ford, but in the daytime you get busy in the shop and don't spare my feelings in the least. If you see room for improvement just tell me where. Let me know when to expect you.

Yours as ever,

BOB

Now, as Bob and I used to be shopmates together and as he has done me many a favor, I arranged my affairs and went over to C—— and spent a week in his shop. Following are the conditions as they appeared to me:

Speeds and feeds.—The speeds and feeds, as Bob said, were all that could be desired; his men were above the average in ability and willingness, and his machinery the best and well kept up. At first I thought that conditions were O. K. and that he required more machinery to increase his output, but I was soon able by investigation to find a little slackness here and there.

Belts.—I noticed that when a belt broke the operator of the machine had to repair it himself, wire lacing being kept in the toolroom for the purpose. This resulted in a general run-down condition of the belting throughout. Some very poor lacing was in evidence and much greater time was spent lacing than should have been. A good belt-man can lace a four-inch belt with wire and pliers in four minutes. The average stoppage for belt repair took eleven minutes. I recommended that Bob put on a special belt man whose whole duty would be to repair and keep all the belting in good condition. I also recommended that every noon hour, when machinery was at rest, be spent in examining a certain section of the belting, dressing it where necessary with a good dressing made by a reliable belt manufacturer and not with one of the many forms of belt dope which are supposed only to keep a belt from slipping off the pulley. I recommended that this man be paid sufficient to insure his keeping on the job, and that belt literature be put in his hands occasionally, and that he be frequently questioned about the subject; also that he be fully informed on the value of the material in his charge.

High-speed steel.—While all the machines were using high-speed steel, no high-speed drills were in use. Now my own experience with drills is that for any but cored work we cannot afford to use common twist drills even if supplied free. I advised Bob to procure a Celfor high-speed twist drill for some work of which he had a great deal, and we made a demonstration, with the following results: The common twist drill drilling 1-inch holes in steel plate 1¾ inch thick, running at 35 feet peripheral speed per minute, feed 0.018 inch per revolution, required grinding about every ten holes. The high-speed drill running at 90 feet per minute, feed 0.025 inch per revolution, drilled 53 holes before requiring grinding. On reducing the feed to 0.018 inch per revolution several hundred holes were drilled without grinding. Bob took special interest in this as the drill work was always behind and he had been sure that he required two new drilling machines up to this point.

Drill work done on lathes.—I also found many jobs being done on lathes with boring bars and threading tools by machinists, at 34 cents an hour, that could be done equally well on drilling machines by the use of special cutters and taps at a much less cost per hour in wages and in some cases in one-half the time. The only change necessary was altering the patterns so that instead of coring the holes out to nearly the proper size in cast iron, the cores were discarded and the castings made solid; by using high-speed drills and counterbores, in addition, the best results were obtained. I have seen this weakness in many places I visit, real good drilling machine jobs being done on lathes and boring mills for no other reason than that the casting had been cored out.

Non-productive periods of machines.—I noticed that when a change of jobs was to be made on the larger machines, boring mills and planers particularly, much time was lost, owing to the machinist doing this work alone, the machine standing idle while many bolts were being removed, cuttings pulled out of the slots and swept away, and work set up and clamped. The work is progressing only when the chips are flying. I advised Bob to hire a few machinists' helpers for just this work, men trained to be "Johnnie on the spot" when machines were to be loaded or unloaded. From personal experience I know this is a paying proposition.

Tool-grinding.—This was being done by the machinists themselves, Bob stating that he did not want to stir up any discontent among them by having, as he termed it, "some dub" do the grinding for good machinists. Now, here is where I expect some readers will say Bob was wrong, that he should have put in a tool grinding system whether the men liked it or not, and that it was Bob who was running the shop, etc. It must be borne in mind, however, that the business was paying well. Bob's employers were not complaining on that score but were pleased with the results. Having surrounded himself with a number of excellent mechanics he could hardly be blamed for not wishing to create any discontent.

Inasmuch as some of Bob's men on special work had their own good ideas regarding the best form of tools to use, I advised that, instead of adopting, all at once, one of the various standard tool grinding systems, he have the patternmaker make wooden samples of each kind of tool that had proved satisfactory, number them, have some of each forged and have the special man for grinding keep them on hand ready for instant exchange when necessary. By doing this gradually he would soon have his system installed and everybody satisfied. This was done and I have since learned that in less than two months the system was extended to cover almost every class of work done with tools; each sample was numbered and a framed blueprint in the grinding department showed just what each tool was for. The men all liked it, in fact a good many took credit for aiding by suggestions as to which form of tool was the best, etc., and for having brought this system into its present condition. Among the men themselves one tool is known as Bill's tool or Jack's tool. This does no harm to the system and lets the men enjoy what honor they can extract from it. Of course, I expect that some reader will criticize and say this is no system at all, but at any rate it was a decided improvement, as the output has shown.

Bad castings.—I found the brass department handicapped owing to the castings having so much coarse sand burned into them that the tools were not standing up as they should. On tracing this up to the source, after much inquiry it transpired that the purchasing department got in a consignment of molding sand entirely unsuitable for the work and not at all what was ordered. The brass foundry foreman rather than make any trouble by refusing to accept it on account of having had the car unloaded before he discovered it, put it into use with the foregoing result. It was found that this car of sand was purchased 20 per cent cheaper than the kind ordered. I find instances similar to this occurring in many establishments to the detriment of the output. I have found also that high-speed steel is not the most suitable for brass work but prefer a good grade of carbon steel having a special temper, as the cutting edge will last longer. Bob took note of this also.

Although Bob was not able to advise me six months later that he had doubled his output, he did write to the effect that after adopting the changes suggested with a few others all of mere detail, he had kept the good will of his men and increased his output nine per cent which was sufficient to take care of the extra work without working overtime, "going after" his men, or putting in new machinery.

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MAKING OPEN-SIDE PLANERS

By ETHAN VIALL*

Owing to the limited demand for open-side planers, that branch of the machine tool industry greatly resembles the manufacture of special machinery. I was informed by the manager of the Cleveland Planer Works, that in their eight years' experience they never had orders on their books for

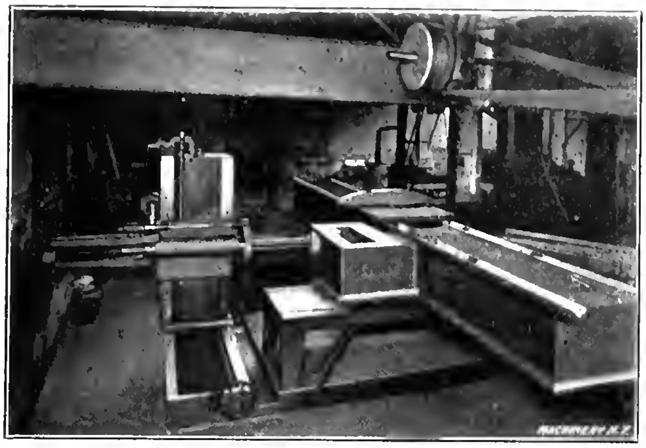

Fig 1. Large Boring Mill with 8- x 30-foot Open-side Planer Bed in Position

two planers of the same size at one time. It is owing to the varied sizes and character of their machines, that Mr. Dornbirer has been compelled to design and build most of the machinery in use in their shop, in order to profitably handle

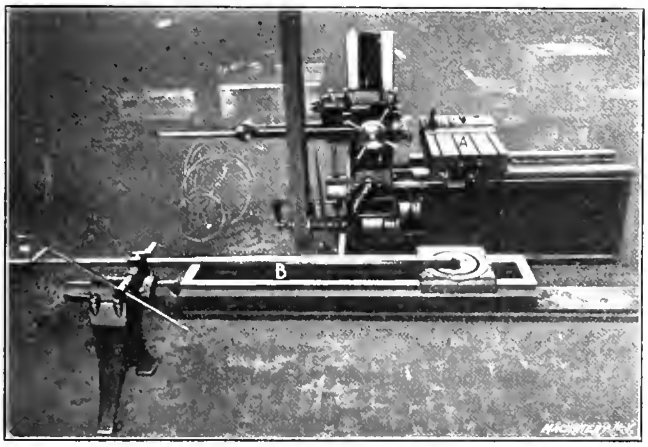

Fig 3. Cross-rail Scraping Bench with specially designed Boring Mill in Background

their work. For instance, Fig. 1 is a floor boring mill with a very long planer bed placed upon its tables for the purpose of boring out the bearings. An idea of its size can be obtained when it is known that the bed being bored is 8 feet in width at

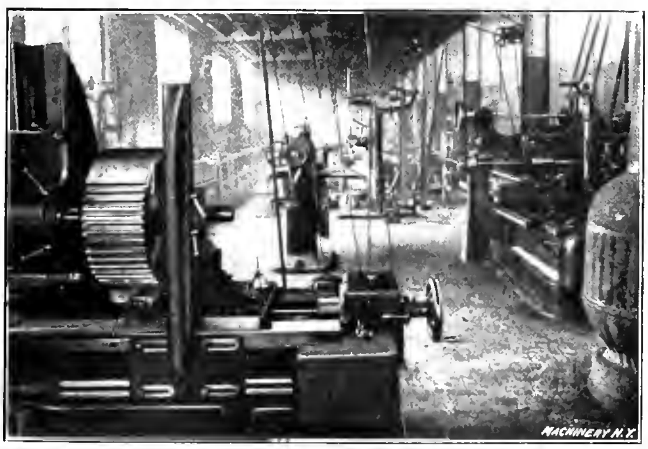

Fig 5. View of Shop under East Balcony with Walcott & Wood Automatic Rack Cutter at the Right and a Brown & Sharpe Gear Cutter at the Left

the point lying on the table nearest to the front of the photograph, and 11 feet back to the other table. All the beds for their open-side planers are planed on the bottom, which enables the operator to set a bed in position on the boring mill in a remarkably short time.

Some of the simple and efficient details are shown in Fig. 2. The alternating current motor is mounted on brackets fastened to the saddle and is raised or lowered with it. Three speeds are provided by means of cone pulleys. The feeding mechanism is in position for drilling, when the tumbler is in mesh with the center gear on the cone of gears, as shown in Fig. 2.

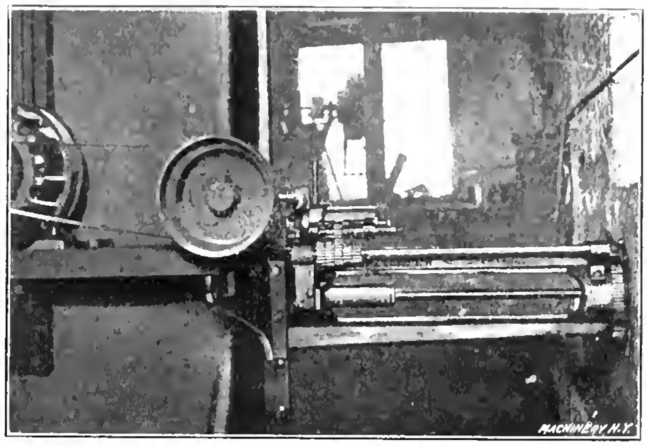

Fig. 2. Geared Bar-feeding Head of Boring Mill

Moving the tumbler to the left of this center gear gives two forward feeds, and moving it to the right gives two backward feeds. In one case the screw that feeds the bar is rotated faster than the spindle, and in the other case, slower.

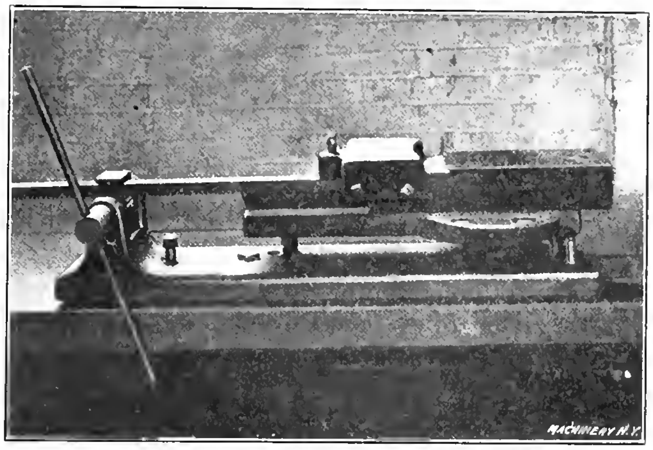

Fig. 4. Bench Scraping Block for Planer Heads

When the screw is locked so as to stand still, a quick return for the bar is obtained in whichever direction the motor is turning.

At *A*, Fig. 3, is shown another boring mill designed by Mr

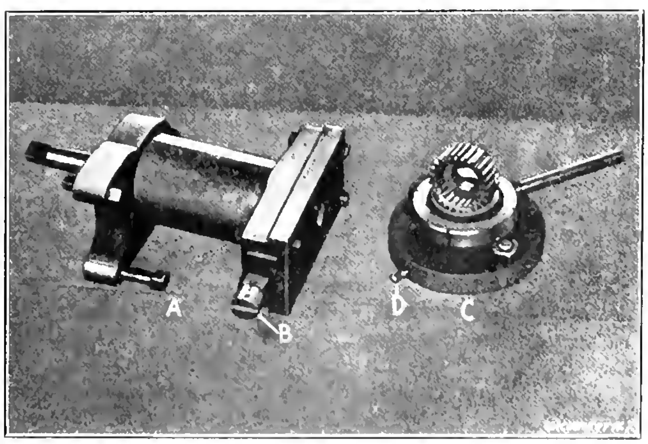

Fig 6. Milling Machine Attachment for Slotting inside of Ratchet Gears and Chuck for holding them

Dornbirer, but when they built it they embodied so many features to facilitate their work that it will be impossible to go into details in this article. At *B* is a scraping bench that is a marvel of simplicity and convenience, since the cross-rail

*Associate Editor of MACHINERY.

may be placed in any desired position simply by rotating the bench on the trunnions, thus making a hard and tedious job a comparatively easy one. It will be noted that the rack and pinion mechanism is fastened to the bench trunnion so that it always has the same position relative to the top of the scraping bench.

Fig. 4 shows a small scraping bench for the heads, which may be rotated in a plane parallel to the top of the workbench, enabling the fitter to scrape on either side with no heavy lifting or pulling.

Fig. 5 is a view of the shop under the east balcony, showing a Walcott & Wood full automatic rack cutter at the right, and a Brown & Sharpe gear cutter at the left.

At *A*, Fig. 6, is shown a vertical slotting attachment for a milling machine, used for slotting the inside of ratchet feed gears. The cutting tool is shown at *B* and the method of attaching the device to the milling machine spindle is plainly indicated. At *C* is the universal chuck used to hold the ratchet feed gears while slotting them on the inside, the indexing being accomplished by means of the pin *D*, which engages in accurately spaced holes in the base flange of the collet holder.

The saddles are graduated on the machine shown in Fig. 7. Under rotating base-plate *A* is a worm gear having a projecting hub *B* over which various sized bushings, to suit the different sized saddles may be placed. The worm gear has 180 teeth and the slack or lost motion between it and the worm, is taken up by rotating an eccentric bushing which forms the bearing for the worm spindle. Two notches are provided in the periphery of the index plate exactly opposite each other so that the handle may be easily moved half a turn, which moves the worm gear plate one degree. The marking head is clamped to the spindle around which the worm gear and its hub rotates. The marking is done by pulling the small hand lever *C* once for each indexing of the saddle, and, by the automatic turning of a small ratchet-cam, a latch is lifted at every fifth stroke of the lever so that the fifth mark is three times as long as the other four.

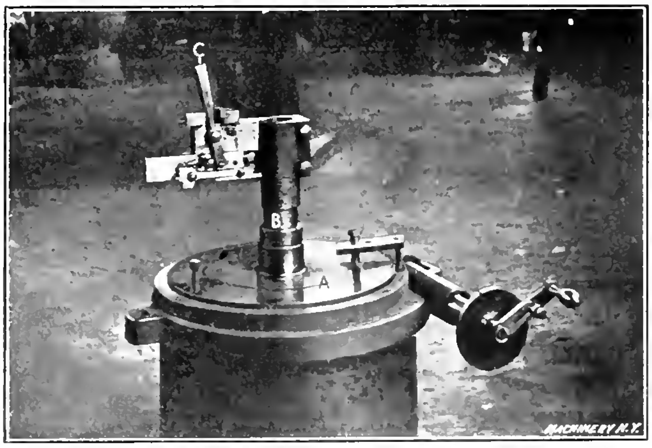

Fig. 7. Indexing Machine for Planer Saddles

One of the interesting points to be noticed in this shop, is the unusual use of draw-in collets for all sorts of work. A milling machine with only a twelve-inch index center has been fitted with draw-in collets up to 2 inches, and a set of collets for another machine runs up to 5 inches in diameter by 16 inches in length.

* * *

POSTING REGULATIONS IN SHOPS

In some shops we see a variety of posted rules and regulations forbidding workmen to do this and that under penalty of discharge. In other plants apparently as well organized and disciplined there is a noticeable absence of posted regulations. The question is: Which is the preferable practice? It is our opinion that the posting of rules and regulations is generally resented and that it is best to avoid insulting the intelligence of the workmen by forbidding them to do things common sense tells them they must not do if they expect to retain employment. The most rigid rules governing the affairs of life are largely the unwritten laws. Let the rules of the shop be unwritten but fully understood.

PERTINENT POINTS ON JIG AND FIXTURE DESIGN*

By C. NOSRAC

There are several points of vital importance in the design of jigs and fixtures for the production of interchangeable parts that are often overlooked by the designer, and also in many cases by the toolmaker, yet which, if they had been given the proper attention at the proper time, would have resulted in a marked increase of accuracy and efficiency in the jig. It is practically conceded that the ideal jig should be so designed that it will do a maximum amount of work in the minimum amount of time with the least possible amount of labor on the part of the operator, and with the smallest initial cost. The attainment of any such condition in practice, however, is very rare. Nevertheless, the designer has it in his power to save many dollars for his employers by giving attention to the few most essential points when originating the fixture. A mistake frequently made in the design of jigs for small work is that of making the jig too small. It must be remembered that the vertical alignment of the holes in the jig depends on the accuracy with which the jig rests upon its feet on the drill-press platen, and it must also be remembered that drill-press platens are usually covered with drill chips which get under the feet of the jig, serving to throw it out of the horizontal plane and make it rest unevenly. It follows then that if one leg of the jig is elevated from the platen a fraction of an inch, the drill bushing will stand at a certain angle out of the perpendicular, and also that the larger the base area of the jig is made, the less the angular inaccuracy will become. Furthermore, if the jig is made small and provided, as they often are, with a handle, in order that the operator may have something to take hold of, the chances of inaccuracy of the holes are increased by the possibility of his tilting the jig during its operation by what may even be an unconscious pressure on the handle. Handles on jigs are as a rule unsatisfactory in many cases and they will be found especially so by the operator if the jig to which one of them is attached suddenly "takes charge," and the handle strikes him on wrist or chest.

Material for Jigs

There has been a great deal of discussion among designers, and also among manufacturing firms throughout the country, about the relative merits of cast iron and steel as materials from which to construct the jig and fixture bodies. In the writer's opinion the decision on this point should depend to a great extent upon the usage to which the fixture is to be put and the character of the work which it is to handle. For small and medium sized work, such as typewriter, sewing machine, gun, adding machine, cash register, phonograph and similar parts, the steel jig offers decided advantages, but for larger work such as that encountered in automobile, engine, and machine tool fixtures, the cast iron jig is undoubtedly the cheaper, and more efficient to use. The steel jig should be left soft in order that at any future time additional holes may be added or the existing bushings changed as required. With a cast-iron jig this is a difficult matter, as the frame is usually bossed and "spot finished" at the point where the bushings are located. This, of course, makes it very difficult to build up on the jig frame in order to locate or change the bushings. When designing the jig, these points should be remembered and provision made for them, where possible.

Drill Bushings

The drill bushings should be made of tool steel, hardened and lapped, and where convenient should be ground inside and out. They should also be long enough to support the drill on each side regardless of the fluting, and they should be so located that the lower end of the bushings will stop about the same distance above the work as the diameter of the drill, so that chips will clear the bushings readily. Of course, where holes are drilled on the side of a convex or a concave surface, the end of the bushing must be cut on a bevel and also come a little closer to the part being drilled, to insure

* For information previously published on jig and fixture design, see "Defects in Jig Design," November, 1909, and "Standard Designs of Jigs and Fixtures for the Manufacture of Small Interchangeable Parts," with accompanying references, July, 1909.

the drill having adequate support while starting into the work. The bushings should also have heads of sufficient diameter to prevent the operator starting the point of the drill all around the hole instead of in it, thus mutilating the jig body. Long bushings should be relieved by increasing the hole diameter at the upper end in order to give the drill freedom from its bearing portion. The length of the bearing portion in the bushing should be equal to the length of the lead of the spiral on the drill. The lower end of the bushing should have its edges rounded in order to permit some of the chips being shed from the drill easily, instead of all of them being forced up through the bushing. It is also good practice to cut a groove under the head so that when grinding the bushing on the outside, the wheel will not have to "corner." Correct designs for short and long bushings are shown in Figs. 1 and 2. Clearance holes should be provided below the work. The drill bushings should not be driven

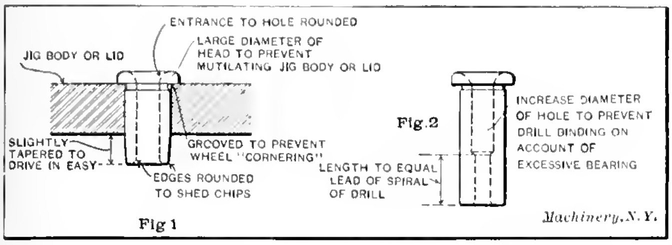

Fig. 1. Correct Design for Short Bushings

Fig. 2. Correct Design for Long Bushings

through hardened steel blocks as these parts will naturally change to a certain extent during the hardening process and the hole locations will consequently be inaccurate when the bushing is driven through. The length of the bushing should be limited so that special drills will not be required to reach the work when getting into difficult corners. When designing the jig, provision should be made for this by building the fixture closer around the work.

Clamping Devices

When designing the clamping device, as few operating screws or handles should be used as will accomplish the desired result, for it takes considerable time to turn a screw one or two revolutions four or five thousand times a day, which is nearly an average number of operations for many jigs. Making the screw with a double or triple thread is sometimes used to advantage in decreasing the number of turns necessary to release the piece. Jig lids should be hung on taper pins in order that wear in the hinge may be compensated for and the resulting inaccuracy due to the lost motion in the hinge prevented. The included angle of taper on hinge pins should be only one or two degrees and the pins should be spirally grooved to within 3/8 inch of each end, in order to hold oil for lubricating the hinge after the pin is driven in. The hinge pin should be a tight fit in the central portion of the hinge, which is usually the jig body, and a bearing fit in the ears of the lid. In this manner the greatest wearing surface possible is obtained. (The foregoing points are clearly illustrated in Fig. 3). All clamping screws and similar parts should be long enough and so located as to be conveniently taken hold of to operate, and of sufficient size to prevent hurting the operator's hands on account of the pressure necessary to manipulate them. The screws should be located so that they will resist the tilting action of the block, and the dowel pins should be fairly close to the screws and of liberal dimensions in order to resist the shearing strains to which they will be subjected. When clamping or locating the work in the jig it is essential to have the clamping pressure exerted in a direct line against some solid point of support to prevent the tilting tendency, and the thrust should also come on such a point of the work that it will be resisted by solid metal, as the power of a screw is frequently underestimated by both the designer and the operator of the jig, with the result that the work will frequently be sprung by the clamping device, and drilled in this position, which would naturally spoil the accuracy of the location of the hole after the work was released from the jig and had expanded back to its normal shape. It should be further borne in mind that when clamping rough castings in a fixture they can be supported only on three points, and "tickler studs" or adjustable stops should be placed on the fourth point of the support and also under any weak portions of the piece through which holes are to be drilled or machining operations are to be performed, in order to resist the springing action of the cutter. Posts in which clamping and locating screws operate should be of liberal proportions and should not project above the fixture body any further than is necessary in order to keep down the tilting action to a minimum; and all handles for clamping devices should be so located that they will not be awkward to operate.

Equalizing bars are frequently used to divide the strain of clamping between two points, or to place the pressure upon three points in case it is so needed.

Resting Studs

Resting studs for supporting the work in the jig are usually made of tool steel, and hardened and ground, and should be of such a length that the piece which the jig is to hold will be held up above the jig body far enough to clear the chips which soon accumulate during the drilling operation. In this connection it is advisable to give a generous amount of room around the piece being operated on in order that the jig may be easily cleaned, and that there may be plenty of room for the chips to fall out. Resting studs should also be provided under all points where drill pressure or reamer pressure will come and also under other points where it is necessary to absorb the strains. Jigs and fixtures should also be made to stand as low as possible above the machine platen as the higher up they stand, the more angular error will occur when drilling long holes as chips get under the rest and feet.

It is also customary to equip jigs with suitable lid stops of such a shape and so located that they will not interfere with the manipulation of the various functional parts of the

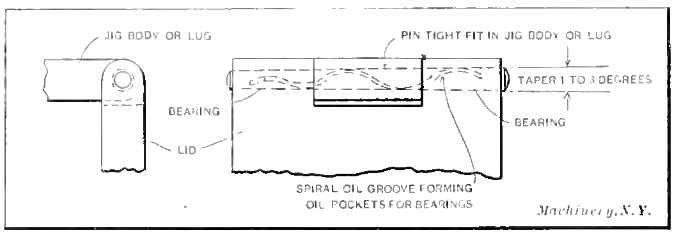

Fig. 3. Improved Hinge-pin Construction

jig. It is usually unnecessary to swing the jig lid entirely back. Therefore, the lid stop may be so placed as to support it after it is swung past the perpendicular, thus saving the extra time required to reach back the extreme distance for the lid every time the jig is closed.

Locating Blocks

Locating blocks and similar parts should be of very solid construction and especially where pressure due to the action of the clamping device will exist, and should be fastened with heavy screws and large dowel pins. It seems queer that designers will persistently screw a locating block onto a jig, with medium size screws or often with large screws, and yet locate the block with ridiculously small dowel pins, entirely losing sight of the fact that the screws do not take the side thrust, nor hold the block in its true location, and that the greater part of the strain actually comes on the pins, with the result that they are either partly or wholly sheared off, and a great deal of work is frequently spoiled before this condition is discovered. When selecting proper locating points on a piece of work, choose the most important one, which must be determined by careful examination of the piece, and consideration of how it is to be assembled in the machine. This locating point should be used throughout the succeeding jigs and fixtures.

If proper attention is given to the above points on jig and fixture design it will undoubtedly result in increased production and greater efficiency of operation.

* * *

The fans of the hot blast heating system in the H. H. Franklin Mfg. Co.'s plant, Syracuse, N. Y., are kept running in summer to circulate fresh air throughout the factory.

DESIGNING SCREW MACHINE TOOLS AND CAMS*

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The object of the present article is to give the average mechanic and draftsman a clear idea of the methods employed when designing special tools and cams for the Brown & Sharpe automatic screw machine. One of the first things which the writer considers necessary is a thorough understanding of the change-gear mechanism, as on this are based the fundamental principles used in the construction of the tables for

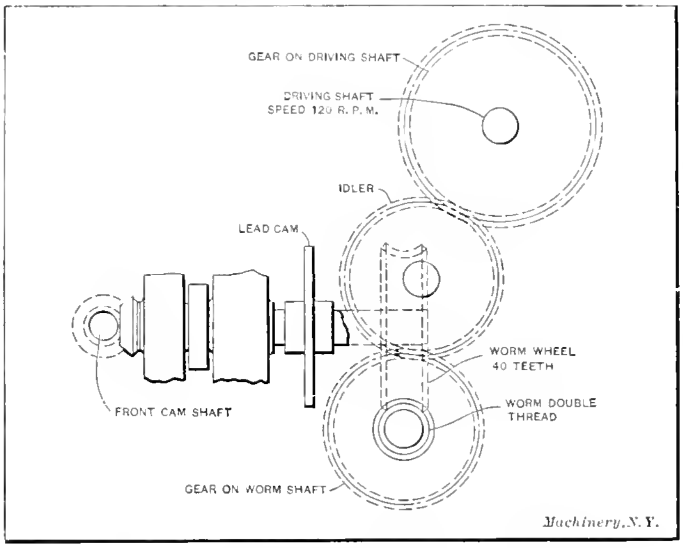

Fig. 1. Diagram of Gearing on the No. 00 Brown & Sharpe Automatic Screw Machine

laying out cams. Following this is the construction of the rise and drop on the cams, this governing the amount of clearance necessary for one tool to pass another. Then a number of general points which should be of value, especially to those who are not experienced in this class of work, are given.

Change-gear Mechanism

A system of simple gearing is used on the No. 00 Brown & Sharpe automatic screw machine, as can be clearly seen in Fig. 1, in which one driving and one driven gear is used. The worm has a double thread, so for every revolution that the worm makes the worm-wheel will travel through a dis-

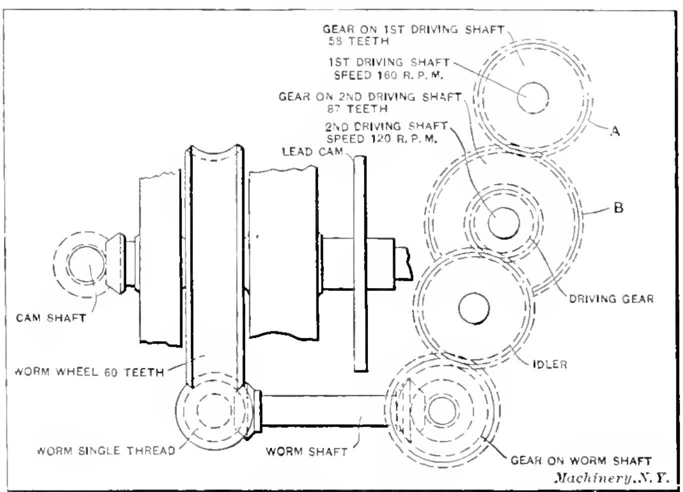

Fig. 2. Diagram of Gearing on the No. 0 Brown & Sharpe Automatic Screw Machine

tance of two teeth. To find the change gears, assume that it is required to make one piece in 12 seconds. This necessitates that the worm-wheel make one revolution in 12 seconds. As there are 40 teeth in the worm-wheel and the worm has a double thread, the worm shaft will make $\frac{40}{2}$ or 20 revolutions in 12 seconds. The driving shaft runs constantly at 120 R. P. M. or 2 revolutions per second. Then the driving shaft will make 12×2 or 24 revolutions in 12 seconds. Considering, in this case, that the driving shaft is required to run the faster, we will put the gear with the larger number of teeth on the worm shaft. Now if we have gears having 20 and 24 teeth respectively they will "do the trick," but after referring to the gears as supplied with the machine, we find that a gear with 24 teeth is not available, so multiplying each by two (which does not change their value) the gears will be: 40 gear on driving shaft; 48 gear on worm shaft.

On the No. 0 Brown & Sharpe automatic screw machine there is also one driving and one driven gear, but on this machine the gear which is called the driver is placed on the second driving shaft as shown in Fig. 2. Then, before finding the change gears it is necessary to find the speed of the gear on this second driving shaft. The first driving shaft runs constantly at a speed of 180 R. P. M. Then the speed of the second driving shaft $= \frac{180 \times 58}{87} = 120$ R. P. M. To find the change gears, assume that it is required to make one piece in 36 seconds. (To obviate confusion, we will call the second driving shaft the main driving shaft which runs at 120 R. P. M.). Since the cam shaft is to make one revolution in 36 seconds and as there are 60 teeth in the worm-wheel and the worm has a single thread, the worm shaft will make 60 revolutions in 36 seconds. The driving shaft which runs at 120

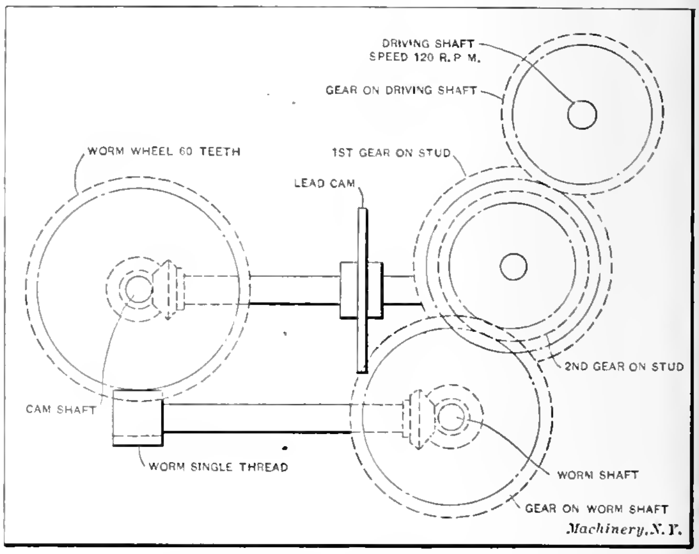

Fig. 3. Diagram of Gearing on the No 2 Brown & Sharpe Automatic Screw Machine

R. P. M. or 2 revolutions per second will make 72 revolutions in 36 seconds. Now as the worm shaft is required to run the faster, we will put the larger gear on the driving shaft. Then the gears can be found by the following formula:

$$\frac{120 \times D}{W} = \frac{3600}{S}$$

where D = gear on driving shaft, W = gear on worm shaft, and S = time in seconds to make one piece. Then, $\frac{120 \times D}{W} = \frac{3600}{36}$ or $120\ D = 100\ W$. Then $W = \frac{120}{100} = 1.2\ D$. Let $D = 30$. Then $W = 30 \times 1.2 = 36$. If the speed of the driving shaft is less than the speed of the worm shaft the result will be just the opposite. For example, let $100\ D = 120\ W$. Then $D = \frac{100}{120} = \frac{10}{12}\ W$. Let $W = 36$. Then, $D = \frac{10}{12} \times 36 = 30$.

A system of compound gearing is used on the No. 2 Brown & Sharpe automatic screw machine making it necessary to

* For additional information on Brown & Sharpe automatic screw machine practice see "Threading Operations," MACHINERY, June and July, 1910, and other articles there referred to.
† Associate Editor of MACHINERY.

find the various gears by factoring. To explain the method of finding the gears we will take a practical example. Let it be required to find the gears to make one piece in 28 seconds. Referring to Fig. 3 we find that the speed of the driving shaft is 120 R. P. M. There are 60 teeth in the worm-wheel and the worm shaft has a single thread. Then we require the cam shaft to make one revolution in 28 seconds. The worm shaft will make 60 revolutions in 28 seconds as the worm has a single thread. The driving shaft makes 2 revolutions per second or 56 revolutions in 28 seconds. It can be seen that

TABLE I. SHOWING HOW TABLE FOR LAYING OUT CAMS IS CONSTRUCTED

Time in Seconds to Make One Piece	Gross Product in (10) Hours	Net Product in (10) Hours Gross Less 10 Per Cent	Gear on Driving Shaft	1st Gear on Stud	2nd Gear on Stud	Gear on Worm Shaft	Hundredths of Cam Surface to Feed Stock	Spindle Speeds: A Diagram of the Pulleys on the Counter Shafts, and the Position of the Belts to Give the Various Speeds Can be Given in This Space											
							Min. Sec. Pulleys *b*	2	2 47	3 03	3 75	4 62	5 70	7 02	8 65	10 67	13 15	16 22	20
							a	120	148	182	225	277	342	421	519	640	789	975	1200
							Number of Revolutions to Make One Piece												
10	3600	3200	80	52	72	60	10	20	25	30	37	46	57	70	86	107	131	162	200

the worm shaft is required to run the faster. Therefore the multiple of the two gears which are placed one on the driving shaft and the other, the second gear, on the stud should be greater than the multiple of the two gears one placed on the worm shaft and the other, the first gear, on the stud. It will also be noted that the number of teeth in the gear on the driving shaft should be greater than the number of teeth in the gear on the second stud, and the number of teeth in the gear on the first stud should be less than the number of teeth in the gear on the worm shaft. The ratio equals $\frac{56}{60}$. By dividing the numerator and denominator into factors and multiplying each pair of factors by the same number we find the gears.

$$\frac{10 \times 6}{4 \times 14} = \frac{(10 \times 8) \times (6 \times 6)}{(4 \times 8) \times (14 \times 6)} = \frac{80 \times 36}{32 \times 84}.$$

Then the gears are as follows:

80 gear on driving shaft, 36 second gear on stud, 32 first gear on stud, 84 gear on worm shaft.

How Tables for Laying out Cams are Constructed

Before a table can be constructed, it is necessary to know the range of spindle speeds obtainable and also the speed of

TABLE II. DIMENSIONS FOR LAYING OUT CAM RISE FOR NO. 00 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make one Piece	Lead	Front and Back Cams
	D	R
From 3 to 5 seconds	$\frac{29}{32}$	$1\frac{1}{8}$
From 6 to 12 seconds	$\frac{3}{4}$	$1\frac{1}{4}$
From 13 to 30 seconds	$\frac{5}{8}$	$1\frac{1}{4}$

the driving shaft. Then the number of seconds to make one piece is placed in the first column of the table, and the number of revolutions to complete one piece is placed under the various spindle speeds as shown in Table I. The total number of revolutions to make one piece is found by the following formula: $r = \frac{R \times S}{60}$ where R = revolutions of spindle or (R. P. M.), S = time in seconds to make one piece and r = total number of revolutions to make one piece. The total number of revolutions to complete one piece can also be found by adding together the number of revolutions required for each operation plus the revolutions required for clearance, feeding the stock, and revolving the turret. The seconds to make one piece are found by the following formula:

$$S = \frac{r \times 60}{R}.$$

To feed stock and revolve the turret requires one revolution of the driving shaft, but it is always advisable to add one hundredth for revolving the turret so that it will be securely locked in position before the tools advance on the work. Owing to the large diameter of the roll there should never be less than 3 hundredths for revolving the turret, irrespective of the speed at which the cam shaft is running. To illustrate clearly the method employed in constructing the table, take a practical example. Let it be required to construct a table for laying out cams for a No. 2 Brown & Sharpe automatic screw machine. Let the spindle speeds be as given in column *a* Table I. To show clearly the method, we will take a spindle speed of 182 R. P. M. Assume that it takes 10 seconds to make one piece. The revolutions required to complete one piece $= \frac{182}{10 \times 60} = 30.03$ or approximately 30 revolutions. We will then put 30 revolutions under the spindle speed 182

TABLE III. DIMENSIONS FOR LAYING OUT CAM RISE FOR NO. 0 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make one Piece	Lead		Front and Back Cams	
	D	R	D	R
From 5 to 12 seconds	$1\frac{1}{8}$	$\frac{15}{16}$	$\frac{7}{8}$	$1\frac{1}{2}$
From 13 to 30 seconds	$1\frac{1}{8}$	$2\frac{3}{8}$	$\frac{7}{8}$	2
From 32 to 60 seconds	1	$3\frac{1}{4}$	$\frac{13}{16}$	3

as shown in the table. Then to feed stock $= \frac{182 \times 2}{120} = 3.03$ revolutions. As shown in column *b*, the hundredths to feed stock $= \frac{30.03}{3.03} = 9.9$ or approximately 10 hundredths, and as it requires 10 hundredths of the cam shaft to feed stock, by adding one hundredth to this we get 11 hundredths for revolving the turret. The change gears are found by the methods previously described, and are placed in their respective columns in the table.

Constructing the Rise on Cams

The rise on the cam should be such that the tools will gradually slow up as they approach the work. It is not necessary

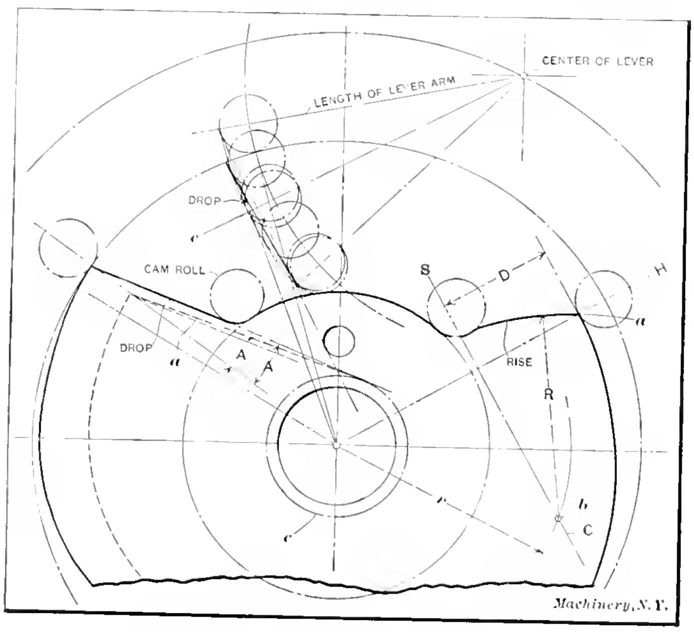

Fig. 4. Method of Laying out Rise and Fall on Cams

to lay out a uniform curve for the rise, as in most cases the cam rotates slowly, but when the cam is required to make one revolution in less than 5 seconds on the No. 0 or No. 2 screw machine, a curve of a more uniform speed should be constructed.

Generally the rise can be abrupt for about three-quarters of the way up and then gradually slow down as the tool approaches the work. An efficient method of laying out a curve of this form is shown in Fig. 4. The reason for making a curve of this form is that less time is necessary for

one tool to clear another which sometimes makes quite a considerable difference in the time required to produce one piece, this, of course, totaling up in the day's work. To construct the rise, refer to Fig. 4 and proceed as follows: Lay off on line H a distance D from the point a. Then through the point where an arc having a radius equal to D would cut the line H, draw the line BC at right angles to it. With a as a center, and a radius R describe an arc cutting the line BC at the point b; again with R as a radius and a center b describe the rise. Join the rise and the smallest diameter of the cam with a circle equal to the diameter of the roll. The distance r should then be measured off and recorded on the drawing to be used by the toolmaker when laying off the cams. The various values for the reference letters as given in Fig. 4 for the rise have been found suitable for the seconds to make one piece, and are specified in Tables II, III and IV.

Constructing Drop on Cams

The drop on the cams should be such that the cross-slides will drop back without shock. The turret slide drops back on a cushion spring, thus allowing the drop on the lead cam to be more abrupt, on the No. 0 and No. 2 screw machines, than it is on the front and rear cams. This is also true of the No. 00 machine, but as the drop is not great very little time would be saved by using a smaller angle of drop for the lead than for the cross-slide cams. Referring to Fig. 4 it can be seen that the lever arm swings in an arc so that to have a

TABLE IV. DIMENSIONS FOR LAYING OUT CAM RISE FOR NO. 2 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make one Piece	Lead		Front and Back Cams	
	D	R	D	R
From 6 to 14 seconds..	1 7/8	2 7/16	1 1/2	1 3/4
From 15 to 40 seconds..	1 3/4	2 5/8	1 1/4	1 13/16
From 45 to 90 seconds..	1 1/2	2 1/2	1 1/16	1 15/16
From 100 to 180 seconds.	1 5/8	3 1/4	15/16	2 3/16

uniform drop a harmonic curve should be constructed. But, as this drop would be more difficult to make than a straight drop, a straight or angular drop is adopted. This gives the drop of the arm a variable motion, as can be seen by referring to Fig. 4; the roll will drop quickly to about the point c, then slow up and then increase in speed as it approaches the bottom. The cross-slides are forced back by a spring which serves to keep the roll in contact with the cam. The drop on the cam should not be laid off from a circle as shown by the dotted lines at c. This would mean that the roll would drop slower when dropping a short distance than when dropping a greater distance. The drop should be laid off from the hundredth line where the operation finishes as shown by the angle A. This assures the drop always being the same speed irrespective of the distance through which it has to drop. The following angles of drop have been found suitable for the number of seconds required to make one piece as specified in Tables V, VI and VII.

TABLE V DROP ON CAMS FOR NO 00 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make One Piece	Lead, Front and Back
From 3 to 5 seconds	$A = 20$ degrees
From 6 to 12 seconds	$A = 15$ degrees
From 13 to 30 seconds	$A = 10$ degrees

TABLE VI DROP ON CAMS FOR NO 0 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make One Piece	Lead	Front and Back
From 5 to 12 seconds	$A = 17$ degrees	16 degrees
From 13 to 30 seconds	$A = 14$ degrees	13 degrees
From 32 to 60 seconds	$A = 10$ degrees	9 degrees

TABLE VII. DROP ON CAMS FOR NO 2 BROWN & SHARPE AUTOMATIC SCREW MACHINE

Number of Seconds to make One Piece	Lead	Front and Back
From 6 to 14 seconds	$A = 16$ degrees	22 degrees
From 15 to 40 seconds	$A = 14$ degrees	19 degrees
From 45 to 90 seconds	$A = 12$ degrees	16 degrees
From 90 to 180 seconds	$A = 10$ degrees	13 degrees

Clearance for Tools

In laying out a set of cams it is sometimes found necessary to make allowance for one tool to clear another, the amount of clearance necessary being determined by the diameter or width of tool used in the turret and the position of the cross-slide tools relative to the work. When determining the amount of clearance necessary, the rise and drop on the lead cam is disregarded and the rises and drops on the front and rear

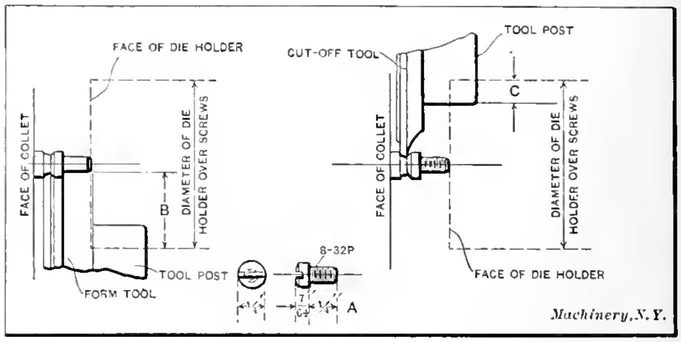

Fig. 5 Diagram Illustrating Method of Finding Clearance for Die Holder

cams are taken into consideration. To determine the rise and drop to use, make a rough lay-out of the various operations to be performed and also obtain the approximate number of revolutions to complete one piece. The revolutions are then converted into seconds as was previously explained and the rise and drop used as specified in a foregoing section. To explain clearly the method used, we will take a practical example. Assume that it is required to make a brass screw as shown in Fig. 5. This screw is made from 1/4-inch round brass rod, and can be made to advantage on the No. 00 Brown & Sharpe automatic screw machine using a spindle speed of 2400 R. P. M. backward and forward. Assume that it is required to find the amount of clearance necessary for the die holder to pass the circular form and cut-off tools. To proceed, draw in the form tool in position on the screw as shown to the left in Fig. 5, and also an outline of the tool-post. Then lay out the die holder in position to start on the screw as shown by the dotted lines. If a releasing die holder is used, take the diameter over the head of the screw, but if a "draw-out" type is used, the diameter of the cap is taken. In

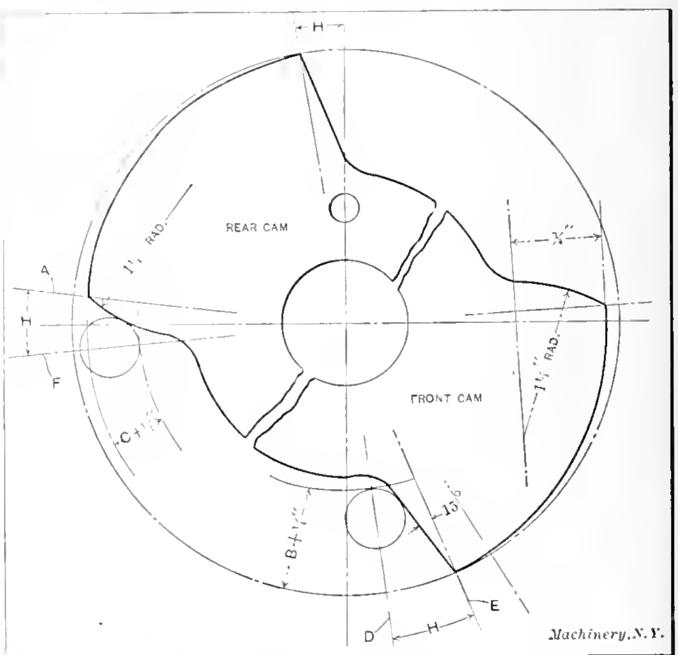

Fig 6 Method of Determining Clearance on Cross-slide Cams

this case, as the screw is threaded up to the shoulder, a releasing die holder will be used. Referring to Fig. 5, it can be seen that the die holder cannot advance on the screw until the form tool drops back equal to the distance B, but as B is the actual distance, it will be necessary to add an extra amount to insure the die holder's advancing without coming in contact with the circular form tool. The extra amount of

clearance necessary varies with the type of tool used. The following dimensions give the approximate amount which should be added to the actual clearance for the type of tools as specified:

Type of Tool	Extra Amount of Clearance
Drill holders	from 1/8 to 3/16 inch
Box-tools (with V-supports)	from 1/8 to 1/4 inch
Box-tools (with supporting bushing)	from 3/16 to 5/16 inch
Button die holders (draw-out type)	from 3/16 to 5/16 inch
Button die holders (releasing type)	from 1/4 to 1/2 inch

To find the amount necessary for clearance make a diagram as shown in Fig. 6, laying out the drop on the front cam as shown. Then add, say, 1/4 inch, to the dimension *B* and measure down from the point where the lobe finishes, as shown. Then with a radius equal to the radius of the cam roll, describe a circle touching the line as drawn and the drop on the cam. Join the center of the roll with the center of the cam circle by a straight line. The clearance is then measured off in hundredths as shown by dimension *H*. The starting point of the lobe on the lead cam for threading will be at the hundredth line *D* and the intervening space between the lines *D* and *E* will be the amount necessary for clearance.

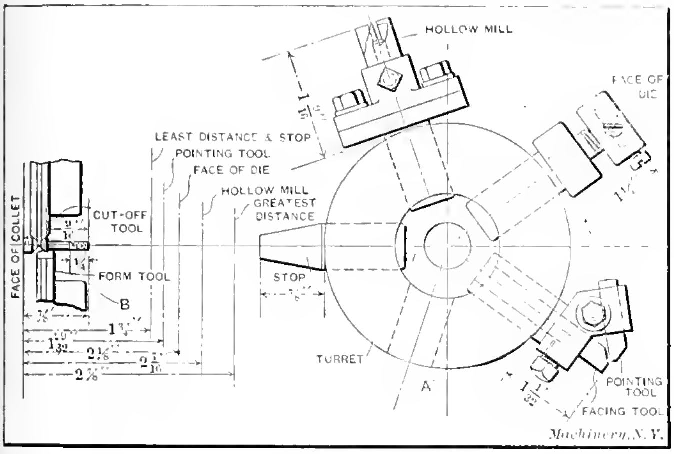

Fig 7. Position of Tools in Turret, and Forming Tools applied to Work

When the cutting-off operation follows the threading operation it will also be necessary to allow for clearance. To find the amount of clearance necessary for the die holder to clear the circular cut-off tool, proceed as follows: Make a lay-out as shown to the right in Fig. 5 and measure off the distance *C*. Add 1/4 inch to this and lay this dimension off from the starting point *A* of the rear cam as shown in Fig. 6. Then draw in a circle equal to the diameter of the roll touching the line drawn and the rise on the cam, and measure off the clearance *H* as was previously explained. The thread lobe would finish at the hundredth line *F* and the cut-off tool start at the line *A*. Clearance should also be allowed between the dropping back of the cut-off tool and the feeding of the stock. To find the amount of clearance necessary add 1/8 inch to the largest radius of the stock used and proceed as was previously explained.

To make this article more complete, the various steps followed when designing a set of cams will be given, starting at the first and covering each step until the drawings of the cams are completed.

Designing and Laying out Cams

When designing a set of cams the speed of the spindle best suited for the size of stock and nature of material should first be decided on. The formulas for finding surface speeds given in the July number of MACHINERY will be found convenient for this purpose. The quickest and best method of making the piece should next be considered and a diagram made of the tools to be used in the turret as shown at *A*, Fig. 7, leaving from 1/8 to 3/16 inch clearance between the rear face of the tool holder and the face of the turret. This amount, of course, varies to a considerable extent, depending on the length of the shank and body of the tool, and also on the distance that the work projects from the chuck. When the shank of the tool is short, care should be taken to see that the clamping devices in the turret have a good grip on the shank of the tool. The diagram of the circular tools applied to the work should also be made as shown at *B*, Fig. 7. The feeds for the various operations are then decided on and divided into the length of cut which will give the number of revolutions required for the various operations. The total number of revolutions to complete one piece is found by adding together the number of revolutions for each cut, for revolving the turret, feeding the stock and in some cases reversing the spindle; an approximate number of revolutions should also be added for clearance. When the approximate number of seconds to complete one piece has been obtained we then make a diagram of the rise and drop on the cam as shown in Fig. 6. To ascertain the exact number of revolutions required for clearance, if the approximate number of revolutions as allowed for clearance is not sufficient, the feed on some of the tools is increased, but if the maximum feed that the tools will stand has been used, the number of seconds to make one piece has to be increased. When the actual number of seconds has been obtained, we then convert the revolutions for each operation into hundredths and proportion the different lobes on the cam to the number of revolutions for each operation. To explain the method adopted in laying out the cams, we will take a practical example. Assume that it is required to make a screw as shown at *B*, Fig. 7. We first make the diagrams of the circular tools and the tools used in the turret as shown. Then to find the amount that the lead cam is to be cut down below the outer cam circle, measure the distance that the tools project out of the turret and add this amount to the distance that the piece projects from the face of the chuck. Then the least distance between the turret and the face of the chuck subtracted from this amount would give the distance down from the outer circle to where the lobe on the cam starts. For ex-

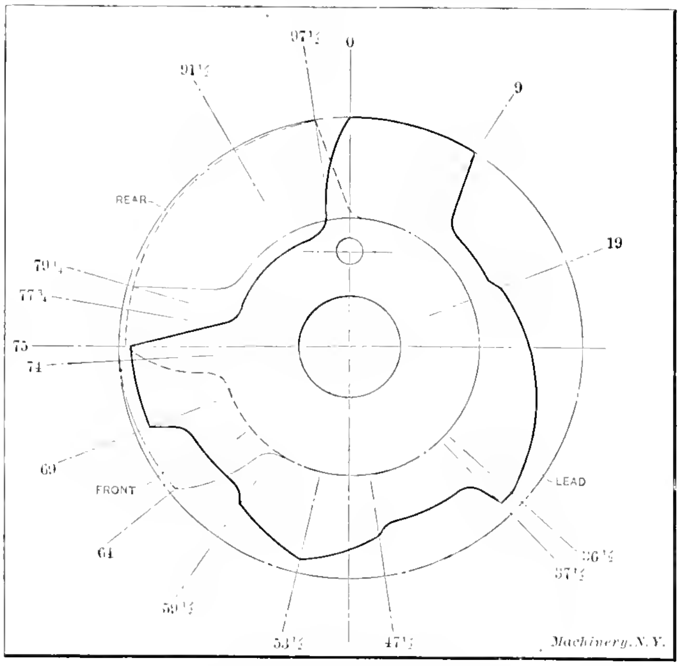

Fig 8 Commendable Method of Laying out Cams

ample, take the lobe for the hollow mill. 1 9/16 + 7/8 = 2 7/16 inch. 2 7/16 inch — 1 3/4 inch = 11/16 inch. In Fig. 8 is given a method of laying out the cams for the screw shown in Fig. 7. This method is commendable, as it can be seen whether the tools will clear one another better than if the cams were drawn separately instead of one on top of the other. If the foregoing suggestions are followed, the writer is confident that very little trouble will be encountered in designing a set of cams. The example as given is for making screws, but the same method can be followed in making any other class of work.

After the cams have been designed, a tracing should be made and kept for reference. In Fig. 9 is shown a cam drawing as adopted by the Northern Electric & Mfg. Co., Montreal. (The illustration here shown is about half size.) The cams for the No. 00 machine are drawn full size and the cams for the No. 0 and 2 machines are drawn half size, the same size of sheet being used for each. All the other neces-

sary information is put on this drawing, which has been found very convenient. It might be well to mention here that there are three prints made from this tracing. One print is kept in the designing department, one sent to the tool-room and the other is sent to the automatic screw machine department.

Practical Points in Designing Cams and Special Tools

1. Use the highest spindle speeds that the various tools will stand.

2. Use the arrangement of circular tools best suited for the class of work. (See MACHINERY, March, 1910.)

3. Decide on the quickest and best method of arranging operations before designing the cams.

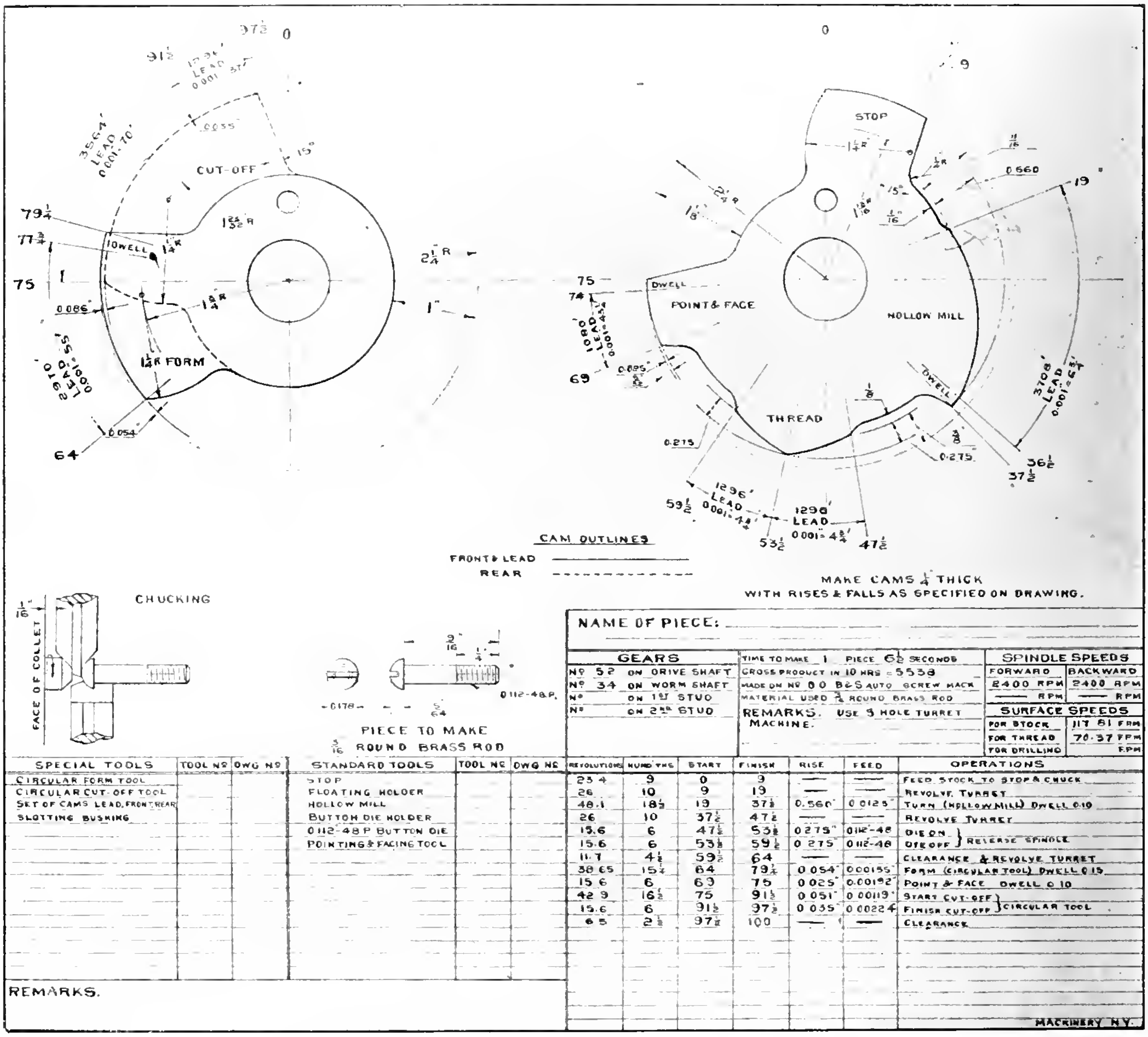

Fig. 9 Standard Cam Drawing adopted by the Northern Electric & Mfg. Co., Montreal

4. Do not use turret tools for forming when the cross-slide tools could be used to better advantage.

5. Do not use a circular cut-off tool without top rake when cutting Norway iron, machine steel, etc. (See MACHINERY, April, 1910.)

6. Make the shoulder on the circular cut-off tool large enough so that the clamping screw will grip firmly. (See MACHINERY, April, 1910.)

7. When chips clinging to the work are objectionable, the circular form tool should be turned up-side-down and placed on the rear cross-slide. (See MACHINERY, March, 1910.)

8. Do not use too narrow a cut-off blade. (See MACHINERY, March, 1910.)

9. Allow 0.005 to 0.010 inch for the circular tools to approach the work and 0.003 to 0.005 inch for the cut-off tool to pass the center.

10. When cutting off work large in diameter, the feed on the cut-off tool should be increased until near the end of the cut where the piece breaks off. After it breaks off, the feed should then be increased to pass the center.

11. When a thread is cut up to a shoulder, the piece should be grooved to make provision for the lead on the die. This requires an extra projection on the form tool and also an extra amount of rise on the cam.

12. Use circular form and cut-off tools made from high-speed steel when cutting Norway iron, machine steel, etc.

13. Use a fine feed and high spindle speed for all cutting tools.

14. Allow sufficient clearance for tools to pass one another.

15. Always make a diagram of the cross-slide tools in position on the work when difficult operations are to be performed; it is also necessary to make a diagram of the tools held in the turret.

16. Do not drill a hole more than 2½ times the diameter of the drill, but use two or more drills as required. If there are not sufficient holes in the turret, just drop the drill back clear of the hole.

17. Do not run a drill at a slow speed. Use a Brown & Sharpe drilling attachment.

18. When the turret tools operate in further than the face of the chuck, see that they will clear the chute when revolving the turret.

19. See that the body of all turret tools will clear the side of the chute when revolving the turret.

20. Do not use a box-tool for a roughing cut. Use a hollow mill.

21. Do not use a box-tool with soft supports.

22. The rise on the thread lobe should be reduced so that the spindle will reverse when the die or tap holder is drawn out. (See MACHINERY, June, 1910.)

23. When threading Norway iron, machine steel, etc., if the spindle speed used for the other tools is too high for threading, use the various threading attachments as described in MACHINERY, June, 1910.

24. When bringing another tool into position after a threading operation, allow clearance before revolving the turret.

25. Make provision to revolve the turret especially when pieces are being made in from three to five seconds and when only a few tools are used in the turret. It is sometimes convenient to use two sets of tools.

26. When using a belt-shifting attachment for threading, clearance should be allowed, as it requires extra time to shift the belt. (See MACHINERY, June, 1910.)

27. When laying out a set of cams for operating on a piece which requires to be slotted, cross drilled or burred, allowance should be made on the lead cam so that the transferring arm can descend and ascend to and from the work without coming in contact with any of the turret tools.

28. Always allow a vacant hole in the turret when it is necessary to use the transferring arm.

29. Use standard tools whenever possible.

30. When designing special tools allow as much clearance as possible. Do not make them so that they will just clear, as errors sometimes turn up causing trouble.

31. When designing special tools having intricate movements, avoid spring as much as possible and use positive actions.

* * *

LOCATING HIDDEN BOLT HOLES

By H E WOOD*

Occasionally it is necessary, particularly in connection with repair work, to locate and lay out bolt holes that come under brackets or in hidden places where they cannot be gotten at from the opposite side to lay them out with a scriber. There are several methods which can be successfully employed for work of this kind, some one of which will probably be applicable to almost any case that comes up in general shop work.

One approved method is to use studs *A* having projecting centers as shown in Fig. 1, there being a sufficient quantity of these studs to place one in each hole that is to be laid out. In this particular case the holes in the part *C* have been drilled and tapped, and it is required that corresponding holes be drilled in bracket *B* which must be attached to some other member of the machine; that is, it is necessary to lay out on bracket *B* holes which are completely covered by it. To do this the studs *A* are screwed in the holes in *C* just far enough to allow the sharp center points to project slightly beyond the surface *c*. Then when the bracket *B* is placed in position, evidently the points of the studs will hold it slightly above the surface of *C*. By giving bracket *B* a light blow with the hammer, it can easily be seen that the point of each stud will form an accurate center from which the bolt holes may be laid out. These studs should be made in the lathe so that the sharp points will be central, and a screw-driver slot should be cut across one side, as shown, to facilitate their insertion.

Another approved method would be to place the bracket (or other part) in the correct position and then with a scriber make a distinct line around the sides of it on the finished surface. When the bracket is removed, the location of the holes is transferred to it by measuring from the scribed lines to the holes and transferring these measurements to the bracket. The measurements in each case should be at right angles to the lines and edges of the bracket.

In case the corners of the part are rounded, as illustrated in Fig. 2, or the edges ragged or uneven, so that the method just referred to cannot be used with accuracy, the work may be laid out as follows: Scribe two lines *a* at right angles on the body or frame part, and two other lines *b* on the bracket, parallel to the first, the two sets of lines being any convenient distance from each other. The holes are now transferred to the bracket practically the same as described in the preceding paragraph, except that when the measurements are transferred to the bracket, the distances *x* between the parallel lines must, of course, be subtracted.

Another method that may be used (although not very accurate) is to fit plugs in the holes, letting the ends project slightly above the surface. The end of these plugs should be smeared with paint or chalk, after which the bracket is placed in position. If the bracket is rapped a few times with a hammer, it will be found upon removal that the paint or chalk will have made a mark, thus locating the hole. When this method is employed, it is best to first drill small holes, then place the work in position to see if these under-sized holes

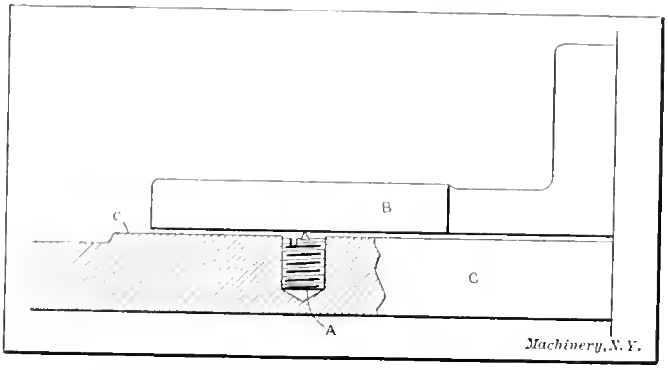

Fig. 1. Laying out Bolt Holes by the Use of Pointed Studs

are central. If they are not, there is still a chance to change their position before re-drilling to the correct size.

Still another method which is somewhat inaccurate, but which sometimes answers the purpose, is to lay the ball-peen of a hammer in each of the original holes and then strike the hammer face with another hammer which will raise a slight burr around the holes. If the underside of the bracket surface is then chalked and placed in position, the raised burrs will mark the chalked surface if the bracket is lightly tapped a few times with the hammer. The drill-and-try method mentioned should also be used when this method is employed.

Hidden bolt holes may also be laid out with a fair degree of accuracy by laying a small string, which has been saturated with paint, on the surface containing the holes so that

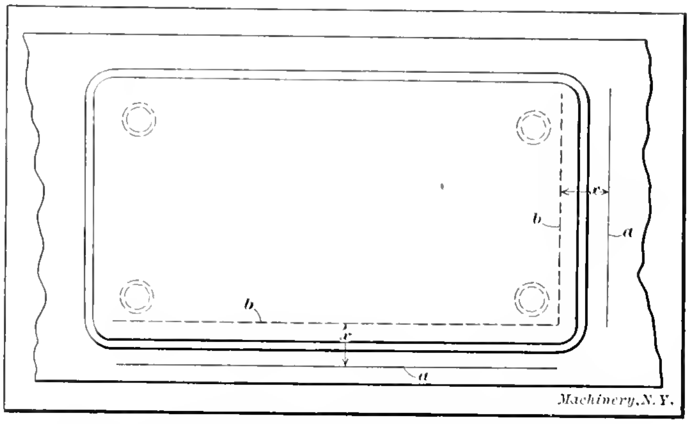

Fig. 2. Locating the Position of Hidden Holes from Scribed Lines

it forms a right angle as shown by the dotted lines *b* in Fig. 2. Now when the bracket is in position and hammered lightly or a heavy weight placed upon it, the paint on the string will make a mark on the bracket which may be used the same as lines, the holes being transferred as previously described.

Another way to locate centers by the use of lines is to first scribe lines at right angles across the centers of the holes. When the bracket is located, lines should be located on its edge to coincide with those previously scribed. The bracket is then removed and a straightedge is used to lay out lines at right angles on it. The intersection of these lines will indicate the centers of the holes.

Holes may often be transferred by the use of a paper templet. This is made by laying a sheet of heavy paper on the largest of the two surfaces. The sheet is then cut, by going around it with a hammer, to fit the edges exactly whether they are straight or ragged, and the holes are also cut by the use of the peen of the hammer. Next place the small piece or bracket on the paper, which is still in position, and mark around the edges with a pencil. These lines are then used for locating the paper templet when laying out the holes.

* Address: 182 North 11th St., Newark, N. J.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

DATING ADVERTISING MATTER

It is the custom for manufacturers purposely to omit from their catalogues and other printed matter the date of publication, because the date tells the age, which is undesirable in matter that is old. Where a manufacturer issues a catalogue only once in three or four years, this reason for omitting the date may be sufficient, but we hardly think it is. Of course it is true that the recipient of a catalogue bearing an old date might feel that an old edition had been sent to him instead of the latest issued. Aside from this, is there a good reason for not dating all advertising matter issued by a manufacturing concern?

All things considered, we believe it is preferable generally, no matter how infrequently a firm's catalogues are issued, to show the year and month of publication. The dating of advertising matter is of value to the manufacturer as well as to the prospective buyer. A date has historical significance, and often is of much value in a legal contest where it might otherwise be difficult to establish proof of the time when a product was put on the market. By all means date your advertising literature, and then issue it often enough so that you will not be ashamed to have the last dates known.

* * *

GETTING THE BEST RESULTS FROM EXHIBITIONS

Manufacturers in general seem to agree that exhibitions limited to one class of products are more effective than large industrial fairs which include many kinds. The specialized exhibition or show is becoming recognized as an effective means of advertising, and it is highly important that manufacturers who spend considerable sums of money exhibiting their products at these fairs should derive the greatest possible benefit from them. The same care should be given to all the details connected with such exhibitions as is given to the general advertising and selling of machinery, and the same principles should be observed. The exhibition should be necessarily of a character to attract the attention of the visitor, and when the attention has been attracted to demonstrate the value of the machines and devices shown. In order to do this, it is necessary to have a man of high ability in charge. Any young man from the sales department will not do. The man in attendance at an exhibition should be thoroughly familiar with the mechanical construction and operation of the machines exhibited. He should be able to explain their advantages in a simple and clear way to persons not familiar with the machines shown, and in a technical manner to the trained mechanical man. Besides, he should be a first-class salesman. If such men were always put in charge of exhibitions it is certain that the returns would be greater than otherwise, and the common complaint of manufacturers that exhibitions at fairs and shows do not pay, would be largely eliminated.

To sum up, it should be remembered that an attractive exhibition is not enough; advertising which merely attracts the eye but does not appeal to the intelligence of the prospective purchaser is not of the highest standard. The additional cost incident to improving the exhibition advertising so that it will be effective is much less, in proportion, than the initial cost. It is poor policy to spend a large amount of money on space rent, decorations, freight charges, installation, etc., and then to defeat the object in view by placing an incompetent man in charge.

* * *

DEFECTS IN MACHINERY DEVELOPED AFTER SHIPMENT

A thorough inspection system will disclose faults in machine construction and so provide for their correction that the product at time of shipment will be O. K., but no inspection could provide against defects that sometimes develop between the time of shipment and receipt by the buyer. A few cases in point will serve to illustrate:

Several years ago a machine tool builder shipped four engine lathes which had been thoroughly inspected, particularly as to truth of spindles. After the lathes were set up in the buyer's shop the spindles were found to be badly out of truth, and a hot letter of complaint was forthwith sent to the builder. The superintendent of the maker's shop who had personally witnessed the tests of the spindles could not believe the report, and went himself to find out the cause of the trouble. Sure enough the test-bar ran out several thousandths in every spindle!

The dumbfounded superintendent could not remedy the trouble nor give an explanation. He finally had the lathe heads removed and shipped back to the shop. There a careful investigation showed that the keys holding the head gears on the spindles had been fitted too tight, but the tight fit had not sprung the spindles appreciably until they had been subjected to the vibration and jar of the railroad trip. Reducing the keys slightly allowed the spindles to readjust themselves and run true.

Another case is that of a planer built by a well-known concern, which was received with the bed sprung so that at corners diagonally opposite the ways were one-sixteenth inch low. The buyer, fortunately a machine tool builder himself, set out to discover the cause of the fault. It was simple. The bed had been crated properly but badly placed on the car, the consequence being that one corner was unsupported. A long railroad trip with many delays had resulted in causing the corner to settle by its own weight and the metal had taken a permanent set. Instead of making the planer manufacturer trouble, the buyer simply set the bed on supports and loaded it so as to spring it back into shape. It required several days to accomplish this, but it was done with perfect satisfaction.

If users of accurate machinery fully appreciated that the heaviest machine members acting as a beam or cantilever can be deflected by the mere pressure of the hand and that the deflection of the beam is proportional to the stress up to a certain limit, the need for properly setting and handling machinery parts not intended to act as beams would be better understood. Nothing is so stiff that it does not bend under load. Lack of support or improperly placed supports will invariably cause trouble in machine tool use.

KEY-OPERATED DRAFTING MACHINE

We have often been impressed with the need of a simpler and more rapid means of making mechanical drawings, especially for inventors and designers. Ideas come quickly and sometimes vanish as suddenly as they come. They have to be brought down while on the wing, as it were, and the faster the pencil moves, the more accurately will the details be recorded.

Literary men know how laborious and unsatisfactory is the writing out of ideas with the pen, in long hand. A man thinks faster than he can write and some of the happiest phrases are lost before they can be written. The typewriter has made it possible to write almost as fast as one thinks, and it is a great conserver of ideas as well as a saver of time and labor. The expert operator becomes practically unconscious of his fingers which automatically strike the keys and write his thoughts.

Now, if some ingenious inventor would design an easily worked key-operating drafting machine with which his ideas could be graphically put on paper without the drudgery of measuring and using instruments, what a boon it would be to many. At the stroke of a key or combination of keys, a center line would be drawn and then in rapid succession would follow other lines in just the proportions the designer has fixed them in his mind, and in the correct relative positions. The drafting machine has greatly reduced the labor of making drawings but still leaves much to be desired. Is it too much to expect that something of the kind outlined, limited perhaps to drawings of small size, will be available in the not distant future?

* * *

OBSOLETE METHODS OF LARGE CORPORATIONS

Most mechanics whose duties or interests have led them to make visits to machine shops engaged in other lines than machine tool building, have doubtless been surprised to note the scarcity of some of the most highly developed forms of machine tools in the shops of the half dozen or so great manufacturing corporations, most of which were originally formed by the combination of smaller units. In such shops the standard design of engine lathe, for instance, still holds sway for large quantities of work which in smaller plants is profitably performed on turret lathes and chucking machines of the hand and automatic types. This condition can be described in no other way than as a tendency; but in some of the shops this tendency is very strongly marked.

The fundamental reason for it probably springs from the very conditions which make such corporations possible. Most of them have, to a greater or less extent, placed themselves beyond competition. The success of the concern may be built on a natural monopoly involving the supply of raw material, on an artificial monopoly in the form of patents, on financial connections which control important markets, on a superior selling organization made possible by the completeness of the line produced, on the careful cultivation of the territory, or on all these conditions combined. In few cases, probably, does such a concern attain and hold its position on account of superior ability in manufacturing. High development in this particular is naturally found in smaller shops, where the brightest minds of the concern are intimately in touch with the processes of manufacture, and constantly thinking out improved methods.

The significant feature of this condition is that very little pressure is brought to bear on such large companies to reduce the cost of production. In competition with smaller firms, more highly developed in this particular, the big concern possesses overwhelming advantages, like those enumerated above, which have produced its present preëminence. In what little competition there may be with other large corporations, similarly situated in respect to such advantages, the cost of production does not have to be carefully considered, because all the competitors are likely to be on the same footing.

This condition results in a tendency to cling to the older methods of manufacturing which do not call for such a high degree of administrative skill, or such close attention to details on the part of the manager. In completing a lot of machines, for instance, the old-fashioned way is to make up only a sufficient number of each of the parts to complete the lot, even though there is every probability that succeeding lots of the same machines will be required, and although many of the parts could be made cheaper in larger quantities. On machinery built in this way the selling cost is determined by keeping track of the cost of labor, material and overhead expense, and adding to them the desired profit. Economic conditions require nothing further, and this arrangement simplifies and makes possible the difficult task of managing a very large manufacturing enterprise.

But it should be possible, and it will become necessary, to avoid such economic waste. In time the smaller and better organized works will secure some of the commercial advantages of the larger organizations; and the latter, under the pressure of competition among themselves will be forced to adopt more economical methods.

* * *

THE VALUE OF BEING WELL INFORMED

An authority once said: "The best informed man does not always get the most money, but he usually holds his job the longest." There is a great deal of truth in this saying, and it would be well if young men, especially, could realize that the value of knowledge and experience is not measured by the temporary pecuniary returns only, but also by the advantage of being able to satisfactorily fill a secondary position until a greater opportunity offers. There are many men who are able to obtain good positions on the strength of their own representation of their ability, but who are not able to keep their jobs for any length of time, owing to the fact that the foundation of knowledge and experience on which they build is not substantial enough. In the long run those men are losers as compared with the man who does not attempt to obtain positions which he knows he cannot fill, and who perhaps for the time being seems to lag behind. Meanwhile, however, this man may be storing up knowledge and experience gained by faithful application to the kind of work for which he at the time is best fitted, and in due course he is likely to find himself called upon to fill a position which in responsiblity and compensation will amply repay him for the efforts and sacrifices he has made in acquiring a thorough training in his work.

The ambitious young man who tries to increase his usefulness by acquiring an education in his chosen trade should not be discouraged if he finds that his knowledge and labors are not immediately rewarded. The knowledge he acquires is sure to be appreciated some day, and when a specially trained man is needed, the one who has fitted himself for the work to be done is the most likely to be considered. Eliminating the cases where "pull" and personal favoritism have been responsible for the advancement of persons not actually fitted for the positions to be filled, it is safe to say that most of the responsible places in shops, drafting-rooms and business offices are filled by the men who ten, fifteen or twenty years ago most earnestly endeavored to acquire a greater and more comprehensive knowledge of the occupation in which they were engaged.

* * *

In the Eastman Kodak Co.'s plant on State St., Rochester, N. Y., is an ingenious device for measuring the area of hides. The company purchases large quantities of leather for covering cameras and the machine is used for determining the hide areas. It consists essentially of a wooden frame carrying several hundred metal pins, hinged at the back and suspended on a weighing scale having a pointer which indicates square feet area on its face, instead of pounds. The pins vary in weight, the lightest ones being at the back near the hinge of the frame and the heaviest ones in front. Their weight is proportional to their distance from the pivot. The pins two feet from the pivot, for example, weigh only one-half as much as those one foot away from the pivot, and so on. In operation the frame is raised and the hide is laid underneath the frame which is then let down. The weight of the pins resting on the hide is subtracted from the total weight, thus indicating on the scale the square feet in the hide.

MACHINING ACCURATE QUICK-PITCH SCREWS AND NUTS

By FRANCIS J. BOSTOCK*

Some time ago the writer had occasion to machine a considerable number of special quick-pitch screws and nuts having quintuple threads. The outside diameter of the screws was ¾ inch, with a lead of one inch. Fig. 1 shows the appearance of one of these screws and one of the nuts. (A quadruple threaded screw made in the same manner as the quintuple screw, is shown to the left.) The requirement was that all the screws and nuts should be absolutely interchangeable with each other. It is readily understood that this requirement presents considerable difficulties.

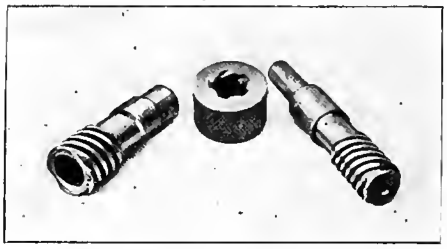

Fig. 1. Multiple-threaded Screws and Nuts made by Method Described

Several methods suggested themselves to the writer. One was the ordinary way of cutting the threads in the lathe, changing the gears around 1/5 of a revolution to give the requisite turn to the work so as to cut the next thread. Another method would have been to mill the screws in an ordinary milling machine and to arrange for some way of tapping the nuts by means of a master for giving the tap the correct turning effect while traversing the nut. This method, however, presents many difficulties, and would have caused the breaking of a considerable number of taps. The first method mentioned has the disadvantage of being slow, requiring the repeated starting and stopping of the machine, the thread being only about 2 inches long, and involving also the necessity of stopping the machine to change the gears. The use of a divisional driving plate would have introduced inaccuracies and loss of time. After careful consideration, therefore, the following method, which has proved itself to be quick and applicable alike to internal and external threads, was adopted. It insured all threads being cut exactly alike and the time of machining, as compared with the cutting of the threads in a lathe in the ordinary way, was reduced from 80 to 85 per cent.

The first step was to select a machine suitable for this work,

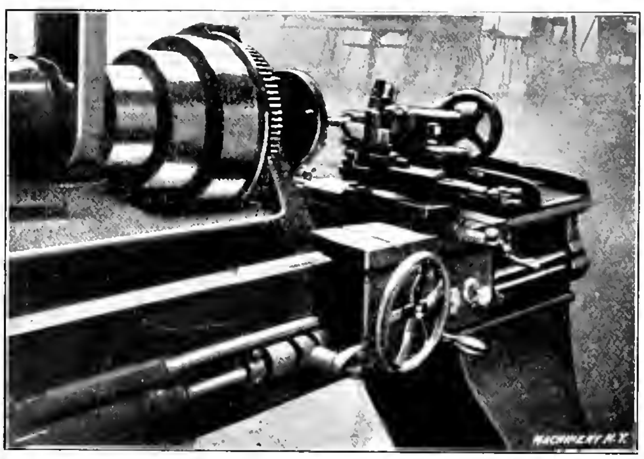

Fig. 2. Lathe Fitted with Master Cam for Cutting Multiple-threaded Screws

the feed shaft of which was driven directly from the feed screw, so as to enable this shaft to be driven at a predetermined ratio to the lathe spindle. On this feed shaft a cylindrical cam, capable of being adjusted to any desired position along the shaft, was fastened. This cam had a groove cut on its surface in which engaged a pin plunger extending from a bracket on the saddle or apron of the lathe. By this means the saddle could be moved forward or backward, as guided by the groove in the cam. The plunger could be let in or withdrawn from the groove as required. The groove in the cam was so arranged that the saddle would travel slowly while the thread was being cut, but return at an increased speed. The cam and work always revolved in the same direction, and it was only necessary to withdraw the tool on the completion of each cut and feed it in when beginning a new one. An adjustable stop was used for giving the requisite feed to the tool. The general arrangement is indicated in Fig. 2.

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The interesting feature about the method described is that it was not necessary to stop the lathe until the threads on each piece were completely finished, the device having a provision for giving automatically the travel from one thread to the next, thus insuring all the screws being cut absolutely alike and made interchangeable with each other. Another valuable feature is that the saddle travels only just far enough to clear the work, and that as little time as possible is occupied in returning. All motions are independent of the operator, whose sole duty it is to feed and withdraw the tool for each stroke.

The master cam was designed as follows: The length of the threaded part of the work was 1¼ inch, requiring a movement of the saddle of about 1¾ inch. As the ends of the grooves in the master cam were to be rounded, the travel in the grooves should be, initially, about 2 inches. Assuming, therefore, that the saddle travels forward 2 inches, then the work must make $\frac{\text{travel}}{\text{lead}}$ revolutions, or, in this case, $\frac{2}{1}$ or 2 revolutions. Assume now that we decide to reverse in say 1 1/5 revolution; then the total revolutions of the work to one

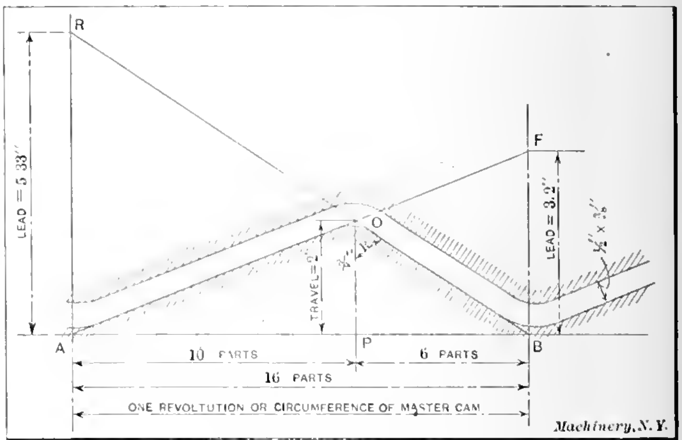


Fig. 3. Layout for Master Cam

revolution of the cam is 2 + 1 1/5 = 3 1/5. A little consideration will show that each time the tool returns, it catches the next thread to the one having just been caught, because the work has advanced 1/5 of a revolution for each time the tool returns. In the illustration in Fig. 2 it will be seen that the master cam has two grooves. One of these grooves is used for screws of different lead, and is not required for the work being described.

We will now proceed to find the requisite lead for the cutting of the cam, the lay-out of which is indicated in Fig. 3. The line AB represents the circumference or one revolution of the master cam. This must be divided into the forward and reverse periods. The forward travel is represented by 10 parts and the reverse by 6 parts, the point P being the point of reversal. From point P draw line OP equal to the travel of the saddle, *i. e.*, 2 inches. Draw from the points A and B through the point O lines AF and BR. Now AR and BF equal the leads to which the groove in a master cam must be cut, the lengths of these lines being easily found by proportion.

$$BF : 2 :: 16 : 10; \text{ hence } BF = 3.2 \text{ inches,}$$
$$AR : 2 :: 16 : 6; \text{ hence } AR = 5.33 \text{ inches.}$$

The master cam is now set up in an ordinary milling machine and grooves milled to the leads found. It is advisable, however, not to mill the grooves exactly to their meeting point, but to produce an easy radius at their junction so as to reduce the strain of reversing the direction of the saddle.

After the master cam was cut and attached to the machine, the correct gears to drive the feed shaft in the right relation to the lathe spindle were determined. The ratio of the number of revolutions made by the work to the revolutions of the

master cam is 16 to 5, and from this ratio the gears are easily found.

The measuring of the external threads was made by the wire method, but as the outside diameter was standard, only one wire was used, the size being taken from one wire and the outside diameter of the screw. The internal threads were measured by means of an ordinary screw plug gage.

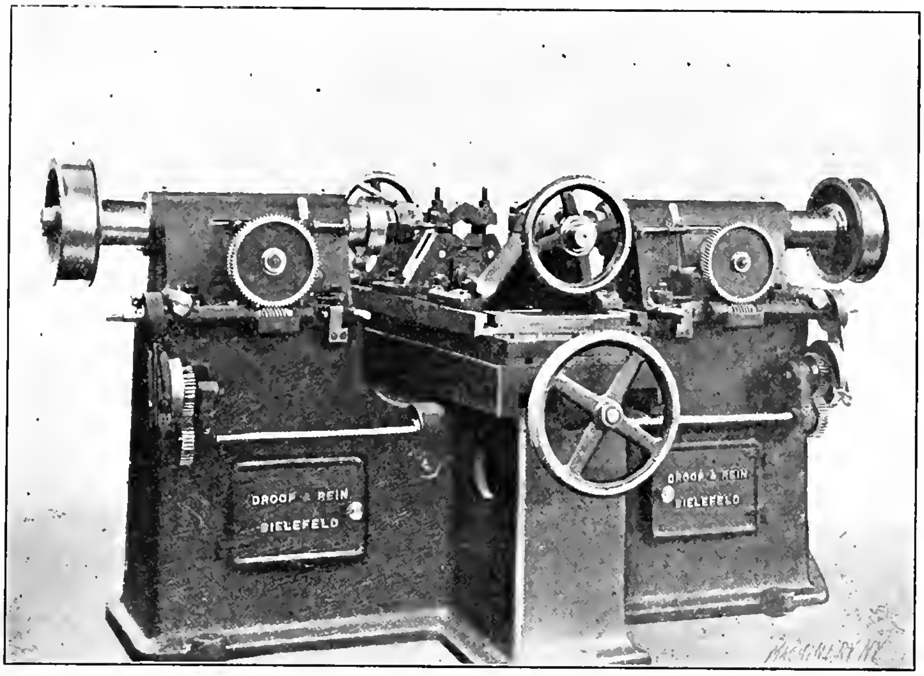
* * *

SPECIAL KEY-SLOT MILLING MACHINE

A special machine for milling slots and key-holes in shafts, bushings, cross-heads, piston-rods and similar pieces, is shown in the accompanying engraving. This machine has two horizontal spindles arranged on each side of the work-table so that the mills operate on both sides of the work simultaneously. The table is given a reciprocating motion by means of a slotted crank at the rear, and at the end of each stroke, the two spindles are fed in toward the center of the work. The stroke of the table is, of course, adjustable and it may be determined by a scale on the slotted crank.

The feeding movement for the spindles is transmitted from the drive at the rear through the bed, by shafts, which by means of spiral gearing, drive the horizontal shafts seen at the front of the machine. These shafts, through spur gears and a slotted crank and ratchet mechanism, actuate the worm and worm-wheels shown. The shafts on which the worms are mounted impart the movement to the spindles by a pinion that meshes with a rack cut in the spindle quills. This feeding movement, as before stated, takes place at the end of each table stroke. The feed can be varied by means of the slotted cranks, and it can be disengaged automatically at any predetermined point. The disengagement is brought about by a pin attached to the spindle quill striking an adjustable screw in a latch-lever which holds the worm into engagement with the wheel, the worm being mounted on a swiveling shaft as shown. As soon as the feed is thrown out, each spindle is automatically returned by a weight suspended from a pulley at the rear, mounted on the worm-wheel shaft.

When milling slots in solid pieces such as piston-rods, etc., the tools are prevented from touching each other at the center of the work, by adjusting the trip mechanism of one spindle so that it is withdrawn when within about 1/32 inch of the center. The other spindle is also automatically withdrawn after its milling cutter passes into the slot milled by the opposite tool.



Special Machine for Milling Slots in Shafts, Bushings, Piston-rods, etc.

Slots can be milled with either parallel or taper ends, though in the latter case a special swiveling table is used. The milling spindles are made of the best crucible steel and they are hardened and ground. The machine has a pump for supplying lubricant to the mills, which, after being used, drains to a reservoir in the lower part of the machine body.

The particular machine illustrated will mill slots up to 7⅞ inches in length, and it can cut a keyway 5⅝ inches long, 1 3/16 inch wide, and 3½ inches deep, in thirty minutes. The distance from the spindle centers to the main table is 11⅞ inches, and to the swiveling table 7⅞ inches, while the maximum distance between the spindle heads is 21 inches. This machine is the product of Droop & Rein, Bielefeld, Germany, who also manufacture two others of similar design. One of these is equipped with four spindles which adapts it to the milling of two slots simultaneously, while the other has two spindles, and is similar to the one illustrated, but is electrically-driven.

* * *

The legend "Patent Applied For" so often seen on manufactured machinery generally means that the inventor couldn't even get a combination claim patent which is usually not worth the paper it is written on.

LABOR CONDITIONS IN AMERICAN AND GERMAN MACHINE SHOPS AND FOUNDRIES

By W. H. DOOLEY*

The German government recognizes the duty and exercises the right of regulating the metal trades in the interest of the employed, but in doing so it is careful to keep in view the equal duty of fostering national metal and engineering industries, and consequently the German law is in many respects much less stringent than the English and American laws, which seem to have been enacted under spasmodic influences, without conscious recognition of any principle. This might be explained by the fact that the German government has been obliged to cultivate the great metal and engineering industries with much care. Consequently, the German legislature has been obliged to strike a happy medium between two claims, that of the employed for protection and that of the community at large for the promotion of industrial enterprises, whereas in both America and England the necessity for encouraging manufactures has not hitherto existed, and the legislatures have merely, from time to time, taken up the duty of protecting the employed with such drags upon their actions as the private interests of employers have been able to effect. The protection, in short, has been all on one side. The time when this line could be pursued with safety in this country and England has now passed.

The metal-working manufacturing industries have come to such a delicate balance that the possibility of their toppling over must be taken into account, and consequently the interest of the community is concerned in any course which is likely to have that effect. It is certain that if our metal industries do not need encouragement from the legislative branch of the government they certainly do require protection from serious shocks. It is, therefore, instructive to note the careful manner in which the German government has struck this happy medium, and the results.

The most stringent regulations passed by the government are those affecting children and women, and it is in this respect that the state has clearly in view the interests of the community as represented by the employed. The total number of children under fourteen years employed in the metal trades in Germany was 1087, and 543 in the machine trades. These children are between thirteen and fourteen, and the hours of employment are restricted to six with half an hour interval for meals. Between fourteen and sixteen they may work not more than ten hours, they must have an hour's pause at midday and half an hour both in the forenoon and afternoon, unless their working day is not more than eight hours and no continuous spell exceeds four hours. During the pauses any

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participation in the work of the factory or shop is forbidden, and even remaining in the rooms is allowed only when their own department of the work is brought to a complete standstill or it is impossible for them to go elsewhere.

When past eighteen they cease to be youthful workers and are under no special regulations except that all under twenty-one must be provided with a "work book" or register containing name, age, birthplace, nature of employment, date of engagement, discharge, and other particulars. All boys under eighteen are obliged to attend a continuation school for nine or ten hours during the week, where they receive instruction in the technical knowledge of their trade and religious instruction by their own clergyman. This time is taken out of the regular work-day without loss of pay. In a number of the larger engineering and machine shops no youthful workers were noticed by the writer.

Workmen may be fined to the extent of one-half their earnings except in cases of acts against fellow workmen, of offenses against morality, or against regulations, against maintenance of order and of security, etc., when the fines may be imposed to the full extent of the average earnings. All fines must be applied to the benefits of the factory workers, and generally go to the sick fund, but this does not affect the right of employers to obtain compensation for damage. Particulars of fines must be entered in a book, which is open to inspection by a government officer.

Every machine shop, foundry, or engineering establishment must have a set of rules hung up in an accessible place in each department stating the hours of work, with the regular intervals for meals, the time and manner of paying wages, the length of notice terminating employment and the conditions under which notice is unnecessary, and particulars of punishment, including fines and the objects to which they will be applied. Punishments which would wound self-respect or offend morality are inadmissible. These rules are equally binding on employer and employed, but before they are issued opportunity must be given to adult workers to express their views, and the rules with any objections must be submitted within three days of issue to the factory inspector, who may order amendments if the rules are not in accordance with the law or with special regulations. Punishments not in the rules cannot be imposed, nor can other grounds of dismissal be included in the contract.

It is a rare thing for a firm to have any differences with its workmen. Indeed, I was definitely informed by one firm that there had been only five cases of dispute in nine years, and these arose not from the workmen as a whole or any considerable number of them, but were cases of individual workmen making complaints. They have in Germany an institution corresponding to the Conseil des Prud'hommes in France, which they call in German "Gewerbe Gerichte," to which all cases of disputes of employes and employers of the metal industries are brought. The average number of cases tried by this bureau never exceeds 500 a year. The bureau consists of three or five people. The government appoints a chairman who is a lawyer and the representative of the employer and the employe. Sometimes two are selected instead of one. They try the case before them, but their decision is not final as is that of the arbitration board in this country. If a workman or employer does not like the decision it is only binding for two weeks. Then the workman may leave or the employer may discharge him. To illustrate a case: One of the workmen in an engineering firm thinks he should receive four marks more a week in wages. He goes to the firm and makes the demand. They refuse him. He appeals to the Gewerbe Gerichte. The Gewerbe Gerichte says, "No, do not pay it." The workman can leave at the end of a fortnight by giving a two week's notice, or if the decision is given in favor of the workman the firm is obliged to pay him the increase for two weeks at least and then they may give him a fortnight's notice by serving a legal notice.

Notice of termination of employment is usually a fortnight, but it may be dispensed with on the part of an employer on the following grounds: false representation, theft and other criminal acts; leaving work without permission or refusing to fulfill the contract; carrying fire or lights about contrary to orders; acts of violence or gross abuse directed against employer, his representative or family; willful damage; inducing members of employer's family or his representatives or fellow workmen to behave in a manner contrary to law or morality; inability to continue work; or an alarming disease. Similarly it may be dispensed with by the workers on corresponding grounds; and also for non-payment of wages in the prescribed manner; neglect to provide sufficient work for piece-workers; unprofitable prejudices; danger to life and health in the employment, which could not be inferred from the contract.

The provision of rules for the metal industries containing the foregoing and other particulars, legally binding on employers and employed, is a characteristically German method of doing business. It is in accordance with that respect for law and order which is such a marked feature of German life, and contributes materially, no doubt, to the smooth working of the metal and engineering industries. The rights and obligations of "work-giver" and "work-taker"—to use the excellent German terms—are publically defined and guaranteed by law. This conduces to tranquillity, and renders vague talk about "rights" palpably futile. The law cannot be changed by individual bullying on either side. The rate of wages is, of course, not included in the rules.

Before any foundry, machine shop or engineering establishment can be started it is necessary to give notice to the local authority. Similar permission is required for the erection of boilers, and especially noisy works. Apart from these particular provisions, the metal industries are subject to the following law:

Owners are bound to arrange and maintain workrooms, appliances, machinery and tools, and to regulate the working in such a way as to protect the workers from danger to life and health, so far as the nature of the business allows. Particular attention must be paid to the provision of sufficient light, ample air space and ventilation, and to the removal of dust arising from the work, of vapors and gases thereby developed, and of refuse incident to it.

Similarly, those arrangements must be provided which are necessary for the protection of workers against dangerous contact with machinery or parts of machinery or against other danger lying in the nature of the work, place of working, and particularly against the dangers which might arise from fire. This section is followed by one requiring the provision of arrangements for the preservation of morality and decency.

The proof of the pudding, however, is in the eating, and the test of a law is its execution. Do the German metal industries conform to the laws? They do—as regards health and comfort they are not to be excelled. The buildings are brick and in the larger plants, steel. The most striking feature of the metal and engineering plants is their clean, orderly and well-kept condition. These qualities are universal, and they extend to the dirtiest and the most untidy department of the trade—the foundry. The foundry in this country is usually a scene of dirt and disorder, unmitigated by any attempt to be tidy, and aggravated by an atmosphere heavy with smoke and gloom. The German foundries and machine shops were a revelation to me. They are as clean and well-kept and almost as light as any other shop. The remarkable order maintained is systematic, and in a large measure intended to promote the prevention of accidents. In the accident prevention rules of the Rhine Westphalian Engineering and Small Iron Industries Association, I find laid down in the first paragraph:

"The gangways in all workrooms must be broad enough to exclude as far as possible injury to persons using them by machinery or transmission parts in motion. They must be kept in good condition, and must not be blocked by the heaping of material or the transportation of articles."

Exactly the converse condition is what exists in most of our engineering shops. There is no room. The place is congested, and manufactured or half manufactured articles lie promiscuously about in all directions, blocking the passageway. The entire freedom from such disorder in German shops and work-rooms undoubtedly conduces to efficiency as well as to safety, and it is secured chiefly through the habits of order inculcated in all alike—workmen, managers and owners—by

the military discipline they have undergone. Fencing of machinery is required.

With regard to the installation of machinery and workshop appliances, I can only say that the Germans have our best machines installed. They make use of electric power, automatic tools, etc. Of course, there are small shops where one will find two men working on a lathe when it was intended to be run by a single man.

The shops are well provided with sanitary, washing and dressing accommodations. The workmen are clean and careful in their habits. They generally keep a working suit of clothes, and change before and after work. Consequently, lockers are provided. Baths are common, particularly shower baths. The practice of providing comfort and conveniences for workmen by employers is more common in Germany than in America.

The workmen are quiet and particularly intelligent. You might say they are no brighter than American workmen, but they seem to be because they do well what they are told to do. Mechanics working on an engineering order from England do not hesitate to use the original English blueprint with the English measurements. The foreman, on being asked if it would be necessary to turn them into the metric system, said, "Oh, no, the men will work from the English figures all right." Now, would or could our American mechanics do the same? The workmen are not in the least inventive; they never make suggestions as our American workmen are constantly doing, nor is there any system of encouraging them to do so, but they keep the rules and do not strike. In short, they do what they are told, and do it well. Herein is the second cause of the success of the metal industry in Germany.

Roughly speaking, the working hours are ten a day. The following schedule taken from the different metal industries in Germany, will show exactly the length and distribution of the day's work.

Hours in Engineering Works at Düsseldorf

Begin	6:30 A. M.
Breakfast	8:15 to 8:30 A. M.
Dinner	12 to 1:30 P. M.
Tea	4:15 to 4:30 P. M.
Close	6:30 P. M.

Total, 12 hours, minus 2 hours for meals, equals 10 hours, week 60 hours.

Hours in Machinery Works at Düsseldorf

Begin	7 A. M.
Dinner	12 to 1:30 P. M.
Close	6:30 P. M.

Total, $11\frac{1}{2}$ hours, minus $1\frac{1}{2}$ hour for meals, equals 10 hours, week 60 hours.

Hours in Engineering Works at Chemnitz

Begin	6 A. M. (winter 7 A. M.)
Breakfast	8 to 8:30 A. M.
Dinner	12 to 1 P. M.
Tea	4 to 4:15 P. M.
Close	6 P. M. (winter 7 P. M.)

Total, 12 hours minus $1\frac{3}{4}$ hour for meals, equals $10\frac{1}{4}$ hours, week $61\frac{1}{2}$ hours.

Hours in Steel Works at Essen (Krupp)

Begin	6 A. M.
Breakfast	8 to 8:15 A. M.
Dinner	12 to 1:30 P. M.
Tea	4 to 4:15 P. M.
Close	6 P. M.

Total, 12 hours, minus 2 hours for meals, equals 10 hours, week 60 hours.

The normal day is ten hours and the normal week is 60 hours. The great difference between the United States and Germany is the number and length of the meal intervals allowed in the latter. As a rule, in the United States the only interval allowed is for dinner and that is generally no more than three-quarters of an hour or half an hour. In some American shops when they are busy no interval is allowed at all; the men snatch their food as best they can. The machinery runs continuously and this is the secret of the great production of the American steel mills in particular and of the excessively high wages earned by them. Deliberateness and respect for meal times is as characteristic of Germans as hurry and indifference to them are of Americans.

BELL FOUNDING IN OLD FRANCE

By JOSEPH G. HORNER*

The accompanying illustrations of bell founding in France show the practice used previous to 1777, when the French encyclopedia, from which these illustrations are taken, was published.

Plate I shows in the upper part a bell foundry, with a pit in which the molds are contained, covered with a shed. The furnace, uncovered, is seen to the right. In Fig. 1 a molder is seen applying with his hands the tempered loam to form the model of a bell. He takes the loam from a cask by his side, seen to the right. In Fig. 2 the other workman pushes the loam board (the gage, or pattern) in order to unite or compress the loam, and to remove or scrape off the superfluous material. Fig. 3 shows the core of another bell; the cope is seen suspended by the tackle.

The lower part of this plate, Fig. 1, shows a detail of the

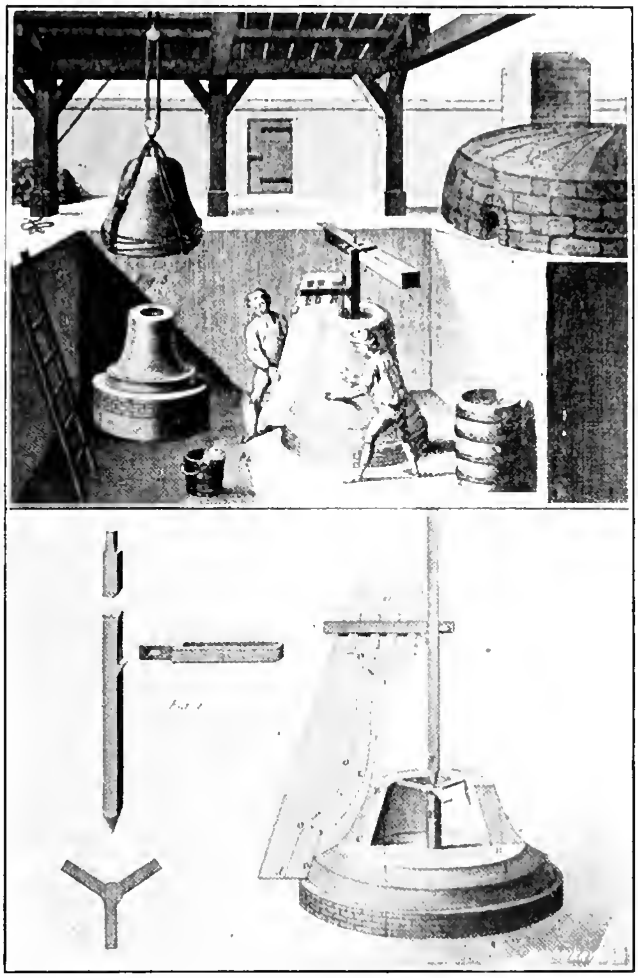

Plate I. Molding Pit and Methods used in a Bell Foundry 150 Years ago

striking bar or "compass" seen in Fig. 2 above, at *G*. Two pieces of iron compose the bar. The vertical arbor terminates at the bottom in a pivot, and at the top by a trunnion, and carries the "strong arm" mortised through it, on which the gage or striking board is fastened. Fig. 2 below shows the socket or step of iron, which is fixed by its three branches in the solid mass of the core, and the center of which carries the pivot of the arbor of the compass or striking bar. Fig. 3 shows the arrangement mounted with the striking board in place. The masonry of the core is broken away to leave visible stake *E* planted in the middle of the mold, on the head of which rests the three-branched footstep which supports the arbor and compass. The board is secured to the arm with wedges. The lines drawn on the board show the thickness of metal, just as the patternmaker puts them on to-day. Outside the metal the outer thickness of the loam cope is also drawn in.

Plate II illustrates the different portions of the mold in detail. The core is shown in Fig. 4. We are told that the edge of the pattern board in the previous plate has been cut

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with bill-hook and chisel to the form of the interior of the bell, and that the edge has been beveled so that it does not tear up the loam. On commencing to work the core, its mold or body is put together with bricks, partly entire and partly broken, and covered inside and outside by the loam. The exterior angles of the bricks are broken, in order to give the masonry a true circle. As each brick is placed, the striking board is presented for the purpose of setting or correction. At a certain stage of the building up, the wooden peg *E*, Fig. 3 in Plate I, is put in place to afford support to the triangular step.

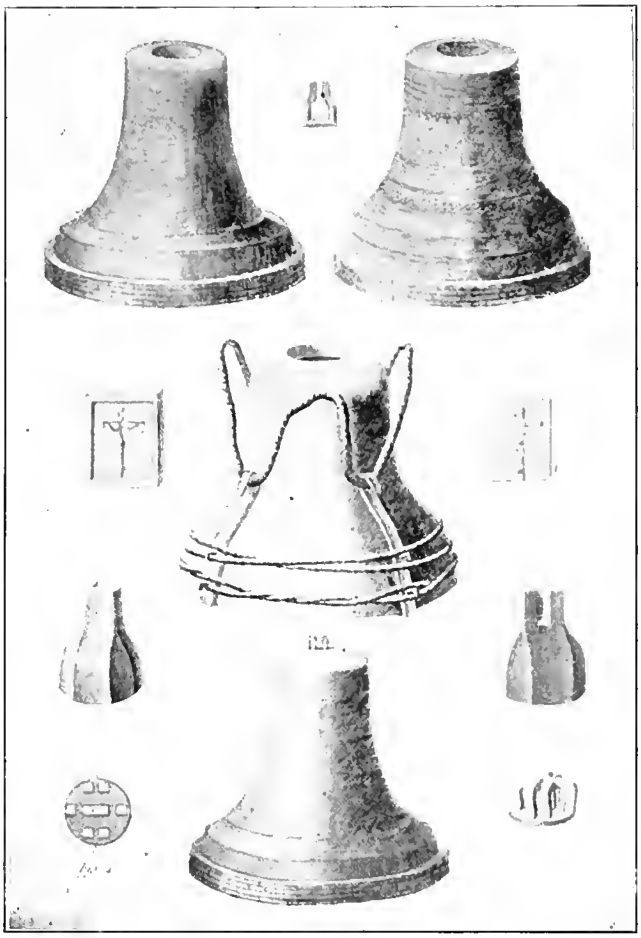
Plate II Steps in Making the Core and Mold

the arms of which are laid on the masonry. The work then proceeds to the full height. Then a bush of charcoal is let into the top of the core. All the brickwork is covered with a crust of cement made of clay, horse manure, and hair, well beaten and mixed together on a bench, with the head of a mattock. It is then put on with the hands, and the gage turned. A fire is lit to dry the first coat, which drying occupies from 12 to 24 hours. It is stated that during the drying, the molder must be careful to refresh the water parts of the mold that are dry, because uniformity of drying is necessary and some of the interior parts dry more slowly than others.

Two coats or applications of loam are made, each being dried. The second coat is finer and more liquid than the first. A third coat is then laid on, composed of cinders and soap; this greasy coat makes it easier to detach the mold yet to be built when it has to be lifted off. The final diameters and the circular truth are carefully checked before this last coat is put on, which is not dried. (It might have been a thin application of wax, though the word used is *savon.*) It is a parting thickness, serving the same function as a thick coat of blackwash, to effect a separation between the core and the mold to be built on it.

After the core is thus completed, the model or pattern of the false bell has to be struck. The board is removed from its bar and its edge cut back to the lines representing the pattern body, the edge beveled, and the bar and board replaced in its pivot.

The loam of which the model is formed is stated to be of clay, sieved and mixed with hair and horse manure; this is for the first coat. The workman takes his hands full of this, and applies it on the core in several thin applications which are amalgamated to form the thickness required. Each coat is gaged by the board and is dried by a fire. All these coats are covered with hemp to prevent the mold from cracking and splitting.

When the "false bell mold" or loam is thus finished, bordering lines are marked to indicate the positions for the fillets for the inscriptions, and proportions of the bell. Afterwards follows the building up of the cope or the last part of the mold, to prepare for which a composition of tallow, soap, and wax is used. The striking board is replaced, and a light or thin coat of this composition is swept on by the edge of the board to give an equal thickness. The board is then removed and the inscriptions are put on, and also other relief figures. Then all is ready for making up the cope. It must, according to the description, be extremely strong as it has to endure the heat due to casting, be buried in earth well trampled and beaten down, and carry the whole of the weight and force of the metal at the time of pouring. To strike this, the edge of the board is cut to the outline of the cope, the third line in Fig. 3 of Plate I. The first coat applied is of fine clay passed through the sieve and mixed with hair, horse manure, and water to the consistency of thin mortar. The molder takes the mixture in his hands and applies it softly to the surface of the model so as not to derange the letters and the figures. It covers all the parts in relief, filling and finishing the cavities of the figures and letters. This operation is continued to a certain thickness, which is allowed to dry without fire. It requires about 12 or 15 hours to form a crust. A second

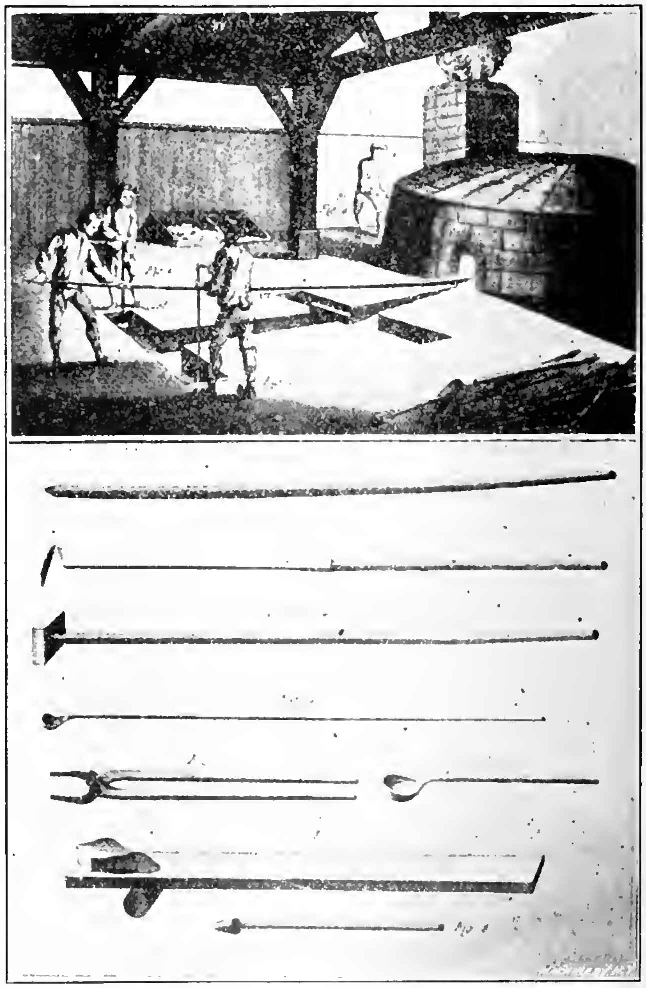
Plate III. Pouring the Metal, and Tools used in Bell Founding

coat of the same material is then laid over this coat, but not so thin, and when this second one has reached a certain consistency, the striking-board is replaced, and a fire put in the core to melt the wax in the inscriptions, and to impart, little by little, in the first coats the hollows of the letters and figures.

The next charge of loam is less thin, and each further application is more and more solid, and between these is placed plenty of hemp. Finally the cope is lifted by the hooks and

rope seen in Fig. 6. Cracks and defects are made good, if present, followed by drying with lighted straw. The model of the bell is broken away from the core, which is cleaned and dried before replacing the cope.

Fig. 7, Plate II, shows the core, which has a ring core for suspending the clapper, rammed in it. The eye is shown separately between Figs. 4 and 5. Fig. 8 is the model of a mold for the figures in wax. It is of copper, and drawn for a double section. It has a double edge that contains the wax which takes easily the imprint of the hollow portion. The letters are molded in the same manner. Fig. 9 shows the imprint in wax drawn from the mold, and in the state in which it is applied on the model of the bell.

Fig. 10 is the covering mold which contains the mold of the horns or handles, the casting, and the vents in the side opposite to the entry of the metal. Fig. 11 is the same taken from the side of the entry of the metal. Fig. 12 is a plan of the horns. Fig. 13 shows them in perspective on the upper part of the bell. These horns are made of loam cakes or cores.

The operation of pouring the metal for the molds is shown in Plate III. The furnace is of the reverberatory type. The fire, of wood, is built on a grating, fired from above, and the ashes are removed from a pit descended to by steps. These are on the other side of the view, out of sight. The master founder is seen in Fig. 1 tapping the furnace with a long pole to run the metal into the molds. He controls the flow by introducing more or less of the rod into the hole in the furnace. The molds are situated at the ends of the cross channels indicated. Two bells at the first cross channel are first cast, and the assistant founders (Figs. 2 and 3) are ready to lift the plugs of iron covered with clay at the set in the second channel as soon as the first two molds are filled. At Fig. 4 the workman pushes the metal with a rabble of wood towards the tapping hole.

When the time for pouring arrives, the canals are cleared and a charcoal fire is kept in them during the time of the melting of the metal. The ends of the rods are also heated. The tools are shown in the lower part of the plate. Of these Fig. 1 is the tapping pole, Fig. 2 is a rabble of iron with a handle of wood for skimming the metal, Fig. 3 is a rabble of wood handled with a rod of the same for pushing the metal towards the opening of the tapping hole when melted, Fig. 4 is a spoon for taking samples of metal, and by them to judge of its condition, Fig. 7 is a charging bar for use at the door of the furnace, and Fig. 8 is a clay plug for the air holes.

* * *

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS*

By J. WILLIAM JONES†

The charts in the accompanying Data Sheet Supplement are intended for rapid determination of the proper diameters of high-pressure cylinders for compound air compressors. By means of these charts it is possible to find instantly the required high-pressure cylinder diameter for various pressures and altitudes, when the low-pressure cylinder diameter is known.

The first of the three charts is laid out for sea level conditions. The diameter and stroke of the low-pressure cylinder are first computed with reference to the required piston displacement, and from this diameter the high-pressure cylinder diameter is traced on the chart as shown by the dotted lines and arrows, which indicate the method of procedure when the diameter of the low-pressure cylinder is 20 inches, and the air compressed to 200 pounds gage pressure. The ratio between the cylinder diameters when found in this manner divides the load equally between the two stages, provided the intercooler abstracts all the heat due to compression in the first stage. The two other charts are laid out for 5000- and 10,000-foot altitudes, but are otherwise used in the same manner as the first chart.

A problem which often confronts the compressor builder when manufacturing a standard line is to obtain cylinder ratios which will be approximately correct for various conditions. As an example, assume that it is required to determine the dimensions for the high pressure cylinder of a compound compressor having a low pressure cylinder of 30 inches diameter. It is required to find the correct cylinder ratios for 80 to 100 pounds gage pressures for altitudes from sea level up to 5000 feet. Referring to the sea level chart we find that the proper diameter of the high pressure cylinder for 80 pounds would be 18⅞ inches, and for 100 pounds, 18 inches. On the 5000-foot altitude chart we find that the high pressure cylinder at this altitude should be 18⅛ and 17¼ inches, for 80 and 100 pounds pressure, respectively. A convenient mean of the above pressures would be 18 inches diameter, which would meet the requirements of the case very satisfactorily.

TABLE OF ABSOLUTE RATIOS OF COMPRESSION

Gage Pressure, Pounds	Absolute Ratio of Compression		
	Sea Level	5,000 Feet	10,000 Feet
80	6.44	7.55	8.92
100	7.80	9.20	10.90
125	9.50	11.25	13.40
150	11.20	13.30	15.90
200	14.60	17.40	20.80
250	18.00	21.50	25.80
300	21.40	25.60	30.80

The ratios of the cylinder areas as given on the charts are obtained from the absolute ratio of compression. Assume, for example, that a compression of 150 pounds gage pressure is required. Then the absolute pressure equals 150 + 14.7 = 164.7 pounds, and the absolute ratio of compression is 164.7 ÷ 14.7 = 11.2. The square root of this ratio is the ratio of the low-pressure piston area to the high-pressure piston area, or,

$$\sqrt{11.2} = 3.35 = \text{ratio of cylinder areas.}$$

A table of absolute ratios of compression for various pressures and altitudes is given above.

The general formula for determining the high-pressure cylinder diameter when the low-pressure cylinder diameter, the initial pressure, and the terminal pressure are known, is as follows:

$$d = \sqrt{\frac{D^2}{\sqrt{\dfrac{P_1 + P_2}{P_1}}}}$$

in which d = diameter of high-pressure cylinder,
D = diameter of low-pressure cylinder,
P_1 = initial pressure,
P_2 = terminal gage pressure.

At sea level, of course, the initial pressure P_1 is the atmospheric pressure or 14.7 pounds per square inch.

As an example, assume that a given compressor requires a low-pressure cylinder of 33 inches diameter. Find the high-pressure cylinder diameter for compressing air to 100 pounds gage pressure at sea level.

$$d = \sqrt{\frac{33^2}{\sqrt{\dfrac{14.7 + 100}{14.7}}}} = 19.75 \text{ inches.}$$

This calculation, however, is somewhat lengthy, and the accompanying Data Sheet Supplement will be found very convenient, in that it gives the diameter required directly without any calculation whatever.

* With Data Sheet Supplement.
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* * *

Other things being equal, a grinding machine of massive construction can successfully use softer wheels and run at lower speeds than grinding machines of a lighter type. The greater mass of the heavy machine reduces the amplitude of the vibrations and makes the soft wheel work efficiently where a harder wheel would be required on the lighter machine. Lower wheel speeds, of course, means less power and less wear and tear of both the machine and the wheel.

THE CONVERSION OF COMPOUND ENGINEERING UNITS

By JULIAN C. SMALLWOOD

The purpose of this article is to present a simple method by which may be found such metric-English equivalents as are not ordinarily tabulated in hand-books and by the use of which one may conveniently translate the more commonly used compound units. The method may also be used for the conversion of constants in empirical formulas, so that, if given in the metric system, they may be made applicable to English units.

Briefly, this method consists in first writing the units involved in the quantity to be converted exactly as they appear in it, and then canceling them as common factors in the terms of a fraction are canceled. The units that remain are fundamental ones of the system to be translated, whose equivalents may easily be remembered. If these equivalents are substituted in the canceled form, a number results by which the given quantity is multiplied to effect the conversion.

In mechanical and thermodynamic quantities, the fundamental units are those of length, mass, temperature, and time. All compound units of measure in mechanics and thermodynamics are combinations of these. As the unit of mass is but little used in the English system, we may consider, instead, weight which is directly proportional to it. The following are the familiar equivalents of these fundamental units:

Length:	1 centimeter = 0.3937 in.	1 in. = 2.54 centimeter.
Weight:	1 kilogram = 2.205 lb.	1 lb. = 0.4536 kilogram.
Temp.:	1 deg. C. = 1.8 deg. F.	1 deg. F. = 0.556 deg. C.

The data given in either column of this table are all that are necessary to make any conversion. Suppose, as a simple example, that we wish to find the English equivalent of the modulus of elasticity having the metric value of 700,000. This quantity, in English, may be defined as the pressure per square inch divided by its elongation per unit length. Its units may be written:

$$\frac{\text{Pressure per square inch}}{\text{Elongation per inch}} = \frac{\dfrac{\text{pounds}}{\text{inches}^2}}{\dfrac{\text{inches}}{\text{inches}}} = \frac{\text{pounds}}{\text{inches}^2}$$

That is, the units of the quantity "elongation per unit length" cancel each other. Similarly, the French units of the modulus are kilograms per square centimeter.

Substituting in the expression

$$\text{Modulus} = 700{,}000\,\frac{\text{kilograms}}{\text{centimeters}^2}$$

the English equivalents of the kilogram and centimeter, we have

$$\text{Modulus} = 700{,}000 \times \frac{2.205\ \text{pounds}}{0.3937^2\ \text{inches}^2}$$

$$= 10{,}000{,}000\ \text{pounds per square inch, approx.}$$

Let us take as a more obscure quantity, the mechanical equivalent of heat—in English, 778. This is the number of foot-pounds of work equivalent to 1 B. T. U., or, to make the arrangement of the units clearer, foot-pounds of work per B. T. U. It is desired to find how many kilogram-meters there are to a calorie; the calorie being the amount of heat necessary to raise the temperature of one kilogram of water one degree C. As heat is measured by multiplying weight by temperature, the units of the mechanical equivalent of heat may be written:

$$\frac{\text{Units of work}}{\text{Units of heat}} = \frac{\text{feet} \times \text{pounds}}{\text{pounds} \times \text{degrees F.}} = \frac{12 \times \text{inches}}{\text{degrees F.}}$$

The metric value sought may now be obtained by substituting the equivalents of inches and degrees as follows:

$$778 \times \frac{12 \times \text{inches}}{\text{degrees F.}} = \frac{778 \times 12 \times 2.54\ \text{centimeters}}{0.556\ \text{degrees C.} \times 100} = 427$$

meters per degree C. or kilogram-meters per calorie.

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This is then the metric value for the mechanical equivalent of heat.

If the units of a quantity to be converted are not readily recognized, they may in some cases be determined by examining those of an identical one. For example, consider the quantity denoted by the symbol R in the equation for perfect gases

$$PV = RT.$$

In this equation P is pressure in pounds per square foot; V is the volume of one pound; and T, temperature. It may be written, to show the units of R, as follows:

$$R = PV \times \frac{1}{T} = \frac{\text{pounds}}{\text{feet}^2} \times \frac{\text{feet}^3}{\text{pounds}} \times \frac{1}{\text{degrees F.}} = \frac{\text{feet}}{\text{degrees F.}}$$

For air, $R = 53.4$, and the metric value is found as follows:

$$53.4 \times \frac{12 \times \text{inches}}{\text{degrees F.}} = 53.4 \times \frac{12 \times 2.54}{0.556 \times 100} = 29.3.$$

The factor 100 is used to change centimeters to meters.

It is in a similar manner that the constants of empirical formulas may be converted. For example, Francis' formula for suppressed weirs is, in English,

$$Q = 3.33\,B\,\sqrt{H^3},$$

in which Q is the discharge in cubic feet per second; B, the breadth of, and H the head on, the weir in feet. The metric coefficient may be ascertained thus:

Units of 3.33 =

$$\text{Units of } \frac{Q}{B\,\sqrt{H^3}} = \frac{\text{feet}^3\text{ per second}}{\text{feet} \times \sqrt{\text{feet}^3}} = \frac{\sqrt{\text{feet}}}{\text{seconds}}$$

Hence, by multiplying 3.33 by $\sqrt{12 \times 0.0254}$, the metric value, 1.84, of this coefficient is obtained.

Even if the empirical equation to be translated contains more than two compounded quantities, the conversion is in no way complicated. As an illustration, consider the metric relation

$$PV = 47.1\,T - 0.016\,P$$

in which P is the pressure of steam in kilograms per square meter; V, its specific volume in cubic meters per kilogram; and T, temperature, in centigrades. The units of the quantity $47.1\,T$ must be of the same kind as those of PV and of $0.016\,P$, for, if they were not, the quantities could not be added or subtracted as indicated. We, therefore, know that the units of the coefficient, 47.1, are the same as those of $\frac{PV}{T}$, or units of 47.1 =

$$\frac{\text{kilograms}}{\text{meters}^2} \times \frac{\text{meters}^3}{\text{kilograms}} \times \frac{1}{\text{degrees C.}} = \frac{\text{meters}}{\text{degrees C.}}$$

To find the value of the coefficient of T in an English equation using pounds, feet, and degrees F., it is, therefore, necessary to multiply 47.1 by $\frac{39.37}{12} \times \frac{1}{1.8}$; the value 85.85 is thus obtained. Similarly, the units of the coefficient of P are cubic meters per kilogram and its English value is 0.256.

There are some quantities that are misleading in regard to their units. For example, one might consider that the heat of vaporization, heat of the liquid, etc., as given in steam tables are expressed in heat units only. If it is remembered, however, that such a quantity is the number of heat *units to one pound of the material*, or heat units per pound, it will be seen that the unit of temperature is the only one to be considered in making a conversion; that is, the unit of weight in the denominator cancels that in the numerator. If, then, we multiply such a metric quantity by 1.8, the corresponding quantity in an English table will be obtained.

The foregoing examples should enable the reader to apply this method to any metric-English conversion. It is only necessary to add a word of caution that, in using it, *all* the units involved should be put down exactly as they appear in the expression to be converted.

* * *

"The eye of the master will do more than both his hands."—*Poor Richard's Almanack.*

THE EXPERIENCES OF A YOUNG TOOLMAKER*

By T COVEY

"Jim," said Mr. Corbin, "I want you to help George for a few days. He is building a special tool for putting slots in a taper hole, and will need considerable help. There is also some of the work that you can do."

"All right, sir," said Jim, and he hunted up George and told him that he was to help him on the job.

"Well, said George, "this is quite a big job, and I guess I will let you rough out this operating bar for me. Here is the blueprint of it. You will notice that there is a one-inch hole clear through it. I want you to turn it off, leaving about one-sixteenth inch on it so as to give us a chance to turn it up straight after the hole is bored, and bore the hole.

"The first thing will be to center it and turn some spots for the steadyrest. I think the best way to center it will be to roughly center one end with a breast drill, then put it in that lathe with the long bed, catch the uncentered end in the chuck and let the other end run on the center. True up the end in the chuck, and turn a spot a couple of inches long close up to the chuck; then turn the bar around and let this spot run in the rest with the other end running true in the chuck; then you can face the end off and center it. Then turn a spot next to the chuck again and turn the bar around, face the end off to length, which will probably take out the old center, and recenter it. It will be well to note if there are any bends in the bar and if so favor them when centering it, but don't try to spring the bar straight. When you get it centered I will show you how to start turning it."

Jim took the blueprint (see Fig. 1) and the stock to his vise and before starting work on it measured the piece of stock. He noticed that there was over one-half inch of stock to come off the diameter. Going over to George, he said: "George, there is over one-half inch of stock on that bar. Why didn't they give us a smaller piece? I think that a piece of 2-inch cold-rolled stock would have made that nicely; then we would not have needed to center it or turn it at all."

"That piece of stock is all right," said George. "It is low-grade annealed tool steel, and when you get it turned, if you have been careful, there will be no strains in it and it will be straight. If it were cold-rolled it would be in the form of an S or a rainbow when you got the hole bored to say nothing of the slots that are to be cut in it. This bar has got to be straight when done or it will be of no use, and as it will then be only a shell it should be of stronger material than cold-rolled machinery steel."

"Why is cold-rolled steel more liable to spring than forged steel or common rolled stock?"

"Well, that is not a hard question to answer. I suppose that the difference is due to the process followed in the manufacture. On bars that are well heated during the rolling or forging the kneading effect of the operations penetrates more deeply, and therefore such severe strains are not given to the metal; and if the bars are afterward annealed such strains as there may be are mostly eliminated. With cold rolling, however, the action necessary to bring the bars to the required shape takes place mostly on the outer surface, and the high places are of course rolled more, or receive more pressure than the low ones, and for this reason, as cold rolling certainly sets up strains in the metal, the effect of the process is to produce an unstable product, the removal of any part of which is liable to affect the remainder. This is proven in practice, as it is well known that scarcely any two pieces of cold-rolled steel act the same under machining operations."

"I don't know much about the stuff, and only suggested it because I thought that it would be much easier to make the bar of it," said Jim as he went back to center the piece, which he soon finished.

"Now," said George, "take off the chuck and put on the driver; put a dog on the bar and place it between centers, then put the steadyrest on as close up to the headstock as you can, so that it will not interfere with the dog; back the jaws of the rest away so that the bar can revolve without touching them, then turn a spot eight or ten inches away from the end that has the dog on it and be very careful to get the spot true and round, because if there is any error in the first spot it will not only appear in the next but will be increased. Bring up the steadyrest, close the jaws down on the spot carefully and fasten them, clamping the steadyrest fast to the bed of the lathe; now if the bar is stiff enough, turn a spot a little to one side of the center toward the headstock end. If the bar chatters too much, you will have to turn one about half way between this place and the spot that is running in the rest; then move the rest to that and turn the spot near the center and move the rest to that. You can then go ahead and take a heavy cut from half the bar, removing about two-thirds of

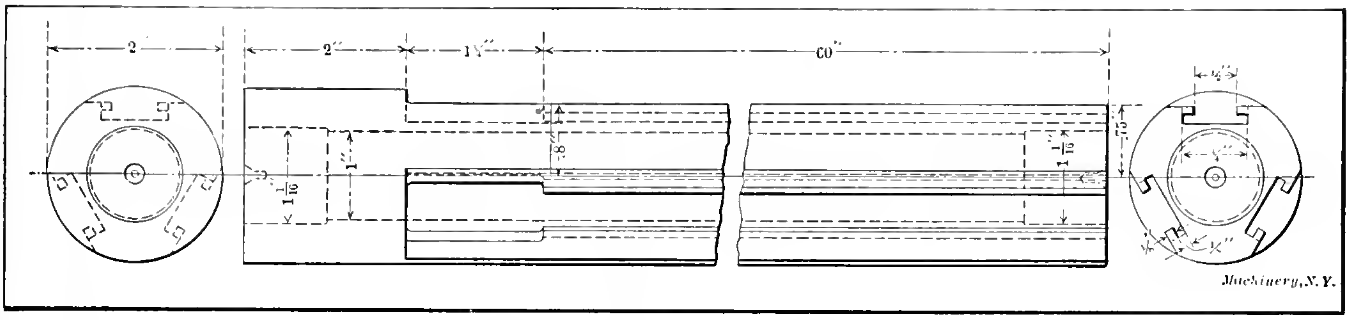


Fig. 1. Operating Bar for Taper Slotting Tool

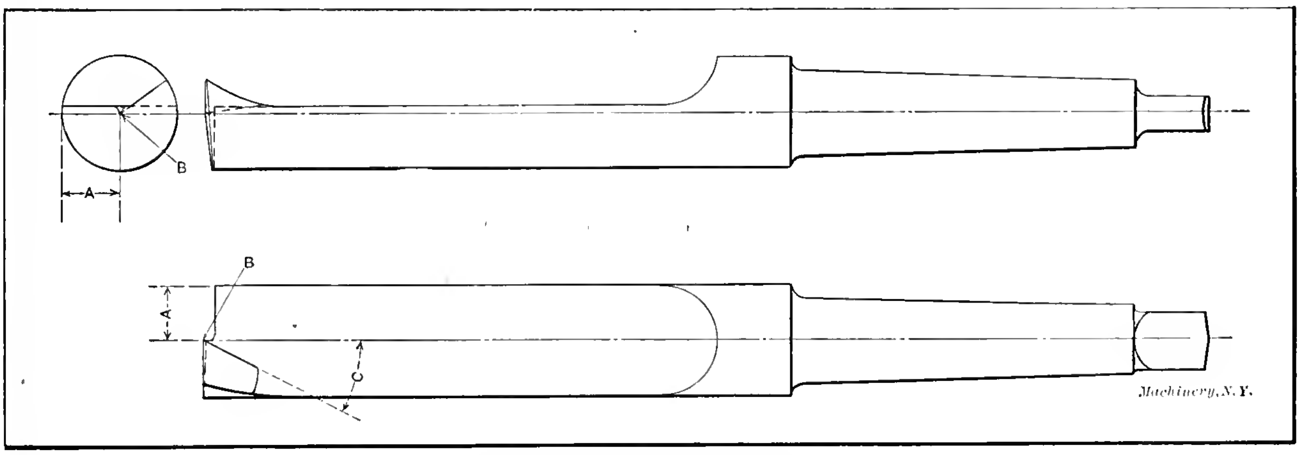


Fig. 2. Hognose Drill of Approved Form

* For previous installments of this series of articles, see "Experiences of a Young Toolmaker," with accompanying references, June, 1910.

the stock; then turn a smooth spot about four or five inches from where the cut stops, turn the bar around and rough off the other end, letting the spot last turned run in the rest. Now if you back the jaws of the rest away and start the lathe you will probably find that the bar is crooked, but as most of the strains have been removed with the outer surface the chances are that if you repeat the spotting process, beginning at the headstock end as before, and take another cut over the bar, you will then find it comparatively straight."

Jim went ahead and in the course of the day had the bar turned up, leaving about a sixteenth inch of stock on it to finish. Then he called George to look it over and tell him what to do next. George backed the steadyrest jaws away, and, revolving the bar rapidly, he found that it was pretty straight and told Jim he had done a good job so far.

"The next thing," said George, "is to get that hole in it. It is only put there to lighten the bar so it does not have to be so very accurate; still it must be straight enough to leave the walls fairly equal. I think that if we bore from both ends we will get it good enough. I am quite sure that there is a 7/8 extension shank about three feet long for drills with No. 2 Morse shanks in the toolroom, but if there is not we will have to make one. See if you can get one, and also a 3/4-inch twist drill and a 1-inch hognose drill."

Jim found that there was an extension and brought it with the drills to the lathe. George looked them over and said: "We had best drive each drill into the socket and drill and ream a small hole through the socket and the shank of each drill so that we can pin it fast in the socket while we are using it, for if we should get one of the drills stuck down in the hole we might have quite a bit of trouble in getting it out; there is not much danger if the drills are kept sharp but it is best not to take any chances. Now find a piece of steel about 1 1/8-inch diameter by about 3 inches long, catch one end of it in the lathe chuck and bore it out 3/4 inch diameter for about an inch, turn it for the same distance to a diameter of about two or three thousandths less than one inch, and cut it off with a parting tool, thus making a collar one inch in diameter and one inch long with a 3/4-inch hole."

Jim soon got the collar made and George told him to put one end of the bar in the chuck and run the other in the steadyrest, and to be very careful to have the end in the chuck running true and the steadyrest set up so as to bring the bar in line with the tailstock center, for on this depends the accuracy of the hole to a certain extent. "Let me look at it before you start boring," said George.

In a short time Jim had the bar chucked up and called George to look at it. George tried the chuck end and found it true, then he cleaned out the center in the other end put a little prussian blue on the center in the tailstock and carefully ran it into the center in the bar; then he backed it out looked at it and said: "It is just a little low but pretty good"; he raised it a little, tried it again and then told Jim to go ahead and put the twist drill in to about the depth of the flutes. Jim did this and then went to George and said: "I don't see how we can get that 3/4-inch drill through the bar with that 7/8 extension on it."

"That is easy," said George. "Drill in as far as you have gone with the twist drill with the hognose, then you can put the 3/4-drill in again and go four or five inches more, etc. Now to start a hognose drill properly you have to do one of two things—either start it through a bushing or bore the hole out for a short distance just the size of the drill. You can't use a bushing in this case, so you will have to bore the hole out for an inch or so with a boring tool. Be very careful to have the hole just the size of the drill for if it is either large or small the drill will not work good.

"A hognose drill to work right must be kept in good condition, and not be allowed to get dull or out of shape. It is a very easy matter to spoil one in grinding. The main thing to be careful of is not to grind away the center. That portion of the drill marked *A*, Fig. 2, should be ground back about three-thirty-seconds inch on this size of drill, and the wheel used should have a rounded corner. The lip is ground with a wheel having a rather square corner, and the edge of the lip leads away from the center at about the angle *C*. This is done so that sharpening the drill on the end will allow the center of the drill to come within the metal; then using a depth gage with the scale set to just half the diameter of the drill, grind the portion *A* and the lip of the drill so that the point *B* comes just in the center of the drill. The center is found by holding the depth gage against the sides of the drill with the end of the scale that is set to half the diameter pointing towards the center. You will notice that that portion of the drill cut away in making it is a little less than half of the drill; that is, it is not cut down to the center line; this shape combined with the radius at the center edge of the portion *A*, and the angle of the edge of the lip *C*, enables a new center to be obtained by grinding off the end. The inner end of the cutting edge *B* must be in the center because if it is too short or too low the drill would leave a core when drilling in solid metal, and if too long or too high would have no clearance at the center. It is best to have the cutting edge a very little short or low than long or high, as it is theoretically impossible to give the cutting edge of a hognose drill clearance at the center, but in practice they work very good with the inner end of the cutting edge central."

"Now each time that you follow up the twist drill with the hognose run the hognose in far enough to remove all the center left by the point of the twist drill, and then to start the twist drill central again clean out the hole either with the air blast, or with a piece of waste fastened to the end of a small rod, slip the collar you made down into the bottom of the hole using a rod to push it down into place. This collar will act as a bushing to steady the twist drill in starting. When you have the drill started you can pull it out with a rod that has a small hook bent on the end of it. In this manner you can prevent the twist drill from running off center, as it cannot run very far in five or six inches and the bushing will restart it central."

"How can I tell when I have run the hognose drill in far enough to take out all of the hole made by the twist drill?" asked Jim.

"You can see for the first time or so, or at any time with the aid of a small mirror; after the first time you will probably be able to tell from the way the drill feeds whether it is cutting in solid metal or not."

"If the hognose drill will cut to center, as you say it will if ground right, why use the twist drill at all?"

"This extension might not be strong enough to carry the full cut; and then the hognose working under the strain of a full cut would bear against the side opposite the cutting edge so hard that there would be great danger of the drill "picking up" and starting to cut or score, which would spoil the drill and make a bad hole. If you could keep the drill well flooded with oil you might do it, but I would not risk it. Keep plenty of oil in the hole anyway; get one of those squirt-guns out of the toolroom and use it often. Put a pan under the lathe where it will catch the oil and keep it off the floor; you can also fill the squirt-gun from it. Clean the chips out of the hole often, and don't allow them to pack tight at any time. If you are careful otherwise I think when you have the hole completed you will be unable to see where the holes meet in the center."

Jim found it a rather tedious job but in the course of a couple of days had the hole bored through. Taking the bar out of the lathe and looking through the hole, he found, as George had said, that he was unable to tell where the two cuts came together. He had George look at it and George said that it looked fine and told him to get a one-inch plug sizer; they tried it in the hole and found that it was an easy fit with no shape. George pushed it in as far as he could with his fingers and then taking a piece of cold-rolled stock that was lying near pushed the plug clear through the hole, finding a spot in the center where it was tight but still it would go through.

"Well, Jim," said he, "you have learned how to bore a long, straight hole. If you ever have a similar job to do again pin your faith to a hognose drill. It will do a good job if it is well ground and treated right. Now put the bar back in the lathe, bore out the ends to 1 1/16 inch and plug them up; then set up the bar and center again, which will be about all you can do with it."

MACHINE SHOP PRACTICE*

KEY FITTING

The proper method of fitting a key in its seat depends somewhat on the type of key used, which is governed largely by the class of work for which it is intended. In Fig. 1 several methods of securing a shaft and hub against relative rotary movements by the use of keys are indicated. The style illustrated at *A* is known as a "saddle key." This type, which is shown in perspective at *A*, Fig. 2, has parallel sides and is curved on its under side to fit the shaft. It is slightly tapered on top so that when it is driven tightly in place, the shaft is held by frictional resistance. This key should be fitted so that it bears lightly on the sides and heavily between the shaft and hub throughout its entire length. As the drive with this type of key is not positive, it is only used where there is little power to transmit. Of course, it is an inexpensive method of keying, as the shaft does not need to be machined.

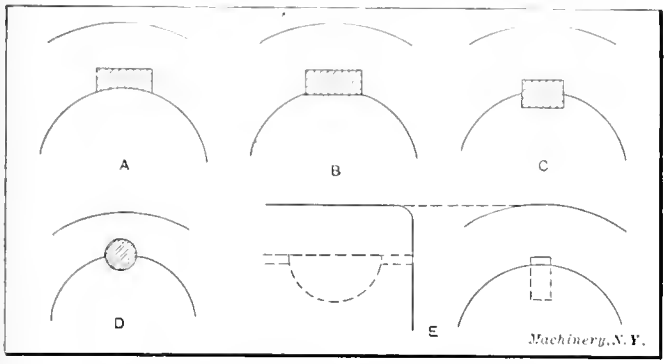


Fig. 1. Various Methods of Keying Shafts and Hubs

The "flat key" shown at *B* differs from the saddle key in that it bears against a flat surface on the shaft, which gives it a fairly good grip. This type is not adapted to heavy work, however, owing to the excessive strains to which the hub is subjected, as the shaft tends to turn. The method of fitting is practically the same as for the saddle key, there being a comparatively light bearing at the sides and a heavy bearing at the top and bottom. The "sunk key" shown at *C*, as its name implies, is sunk into the shaft, and it is more satisfactory than either of the other types referred to, as it gives a stronger and more positive drive. With this type of key, care should be taken to secure a good bearing on the sides. Ordinarily the bearing at the top and bottom of a sunk key should be comparatively light, though in some cases when it is used to resist endwise movement, as well as a rotary movement, it is given a heavy bearing on all sides. The principal bearing, however, should not be, in any case, at the top and bottom, as it is then more likely to work loose than when fitted tightly at the sides.

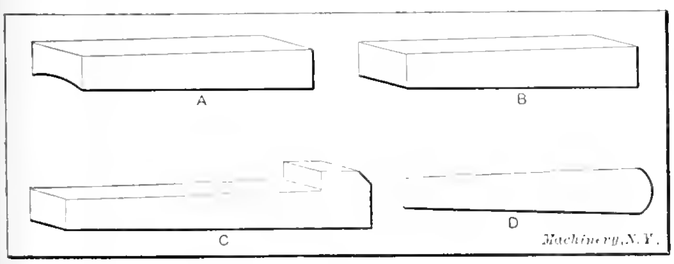


Fig. 2. Different Types of Keys

Keys are usually milled or planed slightly larger than their keyseats, so that they may be accurately fitted by filing. After a key has been reduced sufficiently to allow it to enter the keyseat, it is driven in as far as it will go by tapping lightly; it is then removed and the bearing marks filed away. This operation is repeated until the key can be driven home.

When a key is so located that it can be removed by driving against the inner end with a punch, the headless type shown at *B*, Fig. 2, is generally used. Very often, however, it is impossible to drive against the inner end; in that case the style of key illustrated at *C* is preferable, as the head enables it to be withdrawn when fitting or disassembling, by the use of a wedge or lever. The style of punch shown in Fig. 3 will be found excellent for driving out headless keys. Before driving a key into its seat, it should be oiled to facilitate its removal. It is also a good plan before driving a key in for the purpose of testing its bearing, to round the corners so that they will not interfere by bearing heavily on small fillets which may have been left in the keyseats. By covering the keyseat with a thin coat of black or red lead, the bearing can be more easily seen.

As the accuracy with which a sunk key can be fitted depends largely on the relative positions and sizes of the keyseats in the shaft and hub, it is, of course, essential that the keyseating be carefully done. Each keyway, in addition to being of the same width, should be in line with the axis of the shaft or bore and the sides should be parallel with a radial line passing through the keyway center. Obviously, when the keyseats of both shaft and hub are cut in this way, the sides, when the two are brought together, will line up both across and lengthwise of the shaft, making it possible to give the key a good bearing.

The Woodruff key, which is much used in machine tool construction, is in the form of a half-disk as shown at *E*, Fig. 1. The circular side of this key is seated in a slot which is milled to the same radius in the shaft, thus making it necessary to assemble both shaft and hub with the key in place. Little hand-fitting is necessary with this type of key. The bearing should be on the sides, and the top should be filed until it has a light bearing as with the sunk, rectangular key.

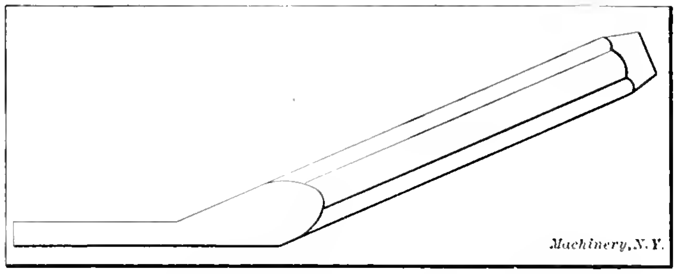


Fig. 3. Punch for Backing Out Headless Keys

Taper pins, similar to the one shown at *D* in Fig. 2, are sometimes used as keys for attaching handwheels to their shafts, and for other similar light work which requires an inexpensive method. The hole for the key is drilled partly in the shaft and partly in the hub, as shown at *D* in Fig. 1, so that the pin, when in place, resists any relative movement between the two. After a straight hole has been drilled, the pin is fitted by reaming the hole with a taper reamer.

* With Shop Operation Sheet Supplement

* * *

THE PERILS OF AVIATION

Navigating the air is a glorious but dangerous sport. The New York *World* has compiled a list of twelve aviators killed within the past two years, as follows:

1908

September 17—Lieut. Thomas E. Selfridge, U. S. A., fell with Orville Wright at Fort Myer, near Washington, D. C.

1909

September 7—E. Lefebvre fell in Wright machine at Juvisy-sur-Orge, France.

September 7—Ena Rossi killed in Rome in machine of his own invention.

September 22—Capt. Louis F. Ferber fell at Boulogne, France.

December 6—Antonio Fernandez fell 1000 feet at Nice, France, after motor exploded.

1910

January 4—Leon Delagrange fell at Bordeaux, France.

April 2—Herbert Le Blon instantly killed, falling on rocks at San Sebastian, Spain.

May 13—Chauvette Michelin fell at Lyons, France.

June 17—Eugene Speyer fell at San Francisco.

June 18—Robl fell at Stettin, Germany.

July 3—Charles Wachter fell at Rheims, France, in Antoinette monoplane after its wire stays broke.

July 12—Charles Stewart Rolls fell at Bournemouth, England, in French-built Wright machine after the forward directing plane broke under strain of too rapid descent.

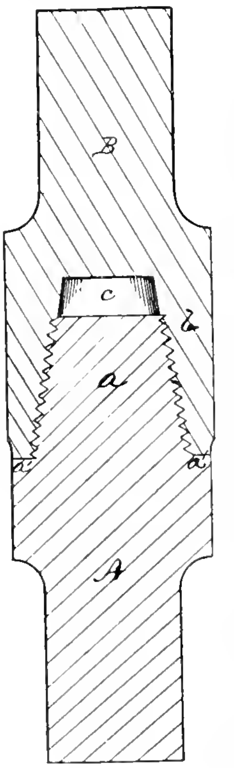
MACHINE WORK IN THE OIL COUNTRY—MAKING "JOINTS"

By V. J. M.

In the last fifty years a great many changes and improvements have been made in the method of drilling wells for oil, gas or water, and a comparison of the tools used by Col. Drake (who drilled the first well for oil in 1859 at Pit Hole, near Titusville, Pa.) with a modern outfit would cause one to think that Col. Drake surely had the right variety of "sand" to tackle such a job and bring it to a successful consummation.

Since that time the search for the green, brown or black fluid has spread to almost every civilized country on the globe. Several different methods of drilling are in use at present, but what is known as the cable system is the most common. In this system manila rope was used exclusively, but wire rope has recently been found useful for sand lines, although, as yet, it has not proved very successful for drilling. One of the prime reasons for this no doubt lies in the fact that the wire lacks the necessary spring or stretch as well as flexibility.

A common "string" of drilling tools consists of the various sizes of drills or bits, the auger stem, jars and rope socket.



To all whom it may concern:

Be it known that I, JOHN LYON ALEXANDER, of Edenburg, in the county of Clarion and State of Pennsylvania, have invented a new and useful Improvement in Joints for Oil-Well Tools, &c.; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being given to the accompanying drawing, forming part of this specification, and which is a longitudinal central section of a joint embodying my invention.

My invention relates to the construction of joints for oil-well tools; and consists in tapering the pin and interior of the box, and also tapering the threaded pin, so that their strength is greatly augmented at and near the shoulders, where they are subjected to the greatest strain, and are most liable to break.

Heretofore, in the construction of joints for oil-well tools, sucker-rods, &c., it has been common to form an internally-threaded socket or box of even bore (or interior diameter) throughout, and whose thickness was about one-fourth the diameter of the joint, so that the whole amount of metal was about equally divided between the box and pin.

When in use, the greatest strain occurs either at the top or shoulder of the box, or at the shoulder of the pin, and the joint frequently breaks either at one point or the other, causing much trouble and delay.

It is at once apparent that the strength of the ordinary joint is only equal to the strength of the pin or of a rod one-half the diameter of said joint, and thus in such connections the points where the greatest strains occur are in reality the least able to resist them. It is not possible to overcome this difficulty by increasing the thickness of the box and pin, for such a procedure would increase the diameter of the joint beyond what it is practicable to use in an oil or similar well.

In order that others skilled in the art to which it appertains may apply my invention, I will proceed to describe the construction of joint whereby I overcome the existing difficulties and objections.

A and B indicate the two sections of a joint with threaded pin *a* and socket or box *b*. The pin *a*, at its base, is slightly less in diameter than the whole diameter of the joint, and tapers thence to its extremity, which may be half the diameter of the joint, or less, if desired, or, in other words, is a frustum of a cone whose base is slightly less than a cross section of the joint.

The difference between the diameter of the pin at its base and the whole diameter of the joint is due to a slight shoulder, *a'*, against which the socket *b* abuts.

b is the socket or box section, having the tapered cavity *c*, corresponding to the form of pin *a*, so that the thickness of the box or socket increases steadily from its extremity toward the shoulder, and at the shoulder it is almost solid, whereby great strength is gained.

The pin *a* and box *b* are threaded, as before specified.

In connecting the parts much time is saved and less labor required, as the pin passes about half way into the box or socket before the threads engage, and the parts being centered, there is no difficulty or delay in causing the threads to engage properly.

The diameters of the pin and box at the shoulders being equal, or about equal, to the whole diameter of the joint, great strength is obtained; and if, from leverage or other cause, the upper part of pin *a* should be broken in the socket or box, the parts would not separate unless the force were sufficient to break the box also, which is very unlikely to occur, as the box at that point would be very thick.

Additional advantages of my devices are, that they can be screwed up or set much tighter than any other joint known to me, and this without danger of breaking. Longer and heavier wrenches may be used to tighten the parts, and the parts are more readily handled and connected.

I am aware that tapering sectional joints have heretofore been made, and do not claim the same, as such construction is directed sim-

Fig 1. Specification of Alexander Patent No. 201,082 for Improved Joint for Oil-well Drills

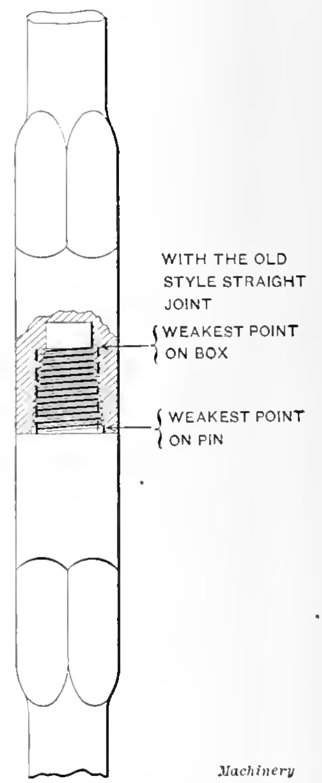


Fig. 2. Alexander's Taper Joint and the Straight Joint Compared

These separate parts are well connected by threaded joints for convenience in handling, and as the bits wear out of gage they are taken off, heated, dressed and hardened. This operation occurs quite often, the frequency with which

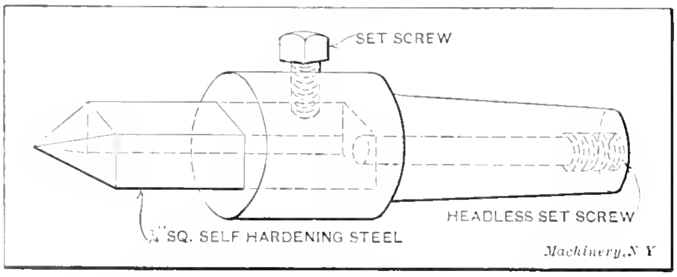


Fig 3 Square Center used in Tailstock of Lathe for Center Work

the bits require dressing depending largely upon the character of the rock being drilled. Formerly the joints were made with a straight screw thread, but the taper joint has come into extensive use and the straight screw joints have been almost entirely discarded. It was in 1878 that patent No. 201-082 (see Fig 1) was issued to John L. Alexander of Edenburg, Pa., for a taper joint for oil well tools. The model for his invention was made by James Sheridan of Franklin, Pa. It may be of interest to machinists who are working on this class of work to know that these first taper joints were made without a lathe taper attachment, the tools being fed in and out by hand.

The principal advantages of the taper over the straight

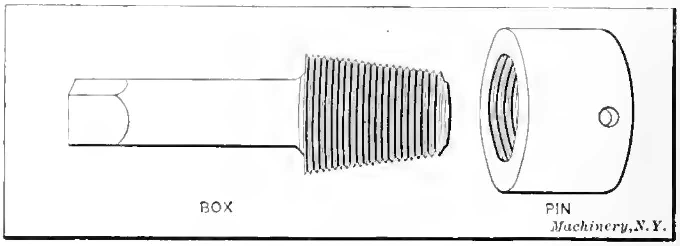


Fig. 4. Box and Pin Templets

joint are as follows: 1. Reinforcement or added strength at the weakest points (see Fig. 2). 2. Convenience in putting together as well as time saved in so doing. With the old style straight joints it was quite difficult to enter or start the thread, while with the taper joints it is a "cinch." From four to five turns are all that is required to bring the threads fully into mesh. 3. Renewal is made possible by facing back on the collars, taking the same amount off the end of the pin and re-threading. In the old style straight "joints" when the threads became worn or stripped the only way possible to renew them was to heat the box and swage. This practice had the disadvantage that the box, if worn much, would be too small in diameter after swaging. The pin had to be heated and upset in order to give enough stock. This often caused a cold-shut at the base, and the least sign of cross fracture condemns the piece unless the crack can be entirely removed in turning.

The material used in box and pin forgings is either soft steel of about twenty-six points carbon or faggoted iron, iron being preferred for the joints on the auger stem, because it withstands the jar and vibration better than steel. The box on an auger stem gets more use and abuse than the pin on the bit, especially as there is always one bit held in reserve, and all the different sized bits are used in the same box. The weight of the stem as well as the force of the blow comes upon the faces or shoulder at every stroke, and soft steel joints, especially on the lower end of the stem, upset too easily and in

consequence cause many "fishing" jobs. But for all the upper joints, such as the jar box and pin and those on the rope socket, soft steel cannot be surpassed, either in price, ease of machining or strength. The iron mostly used is old car axles, doubled over, piled up to get the proper amount, thoroughly welded and forged.

In making the forgings for boxes and pins, the blacksmith is never very particular as to size, excepting about 6 inches of the shank which is forged square to fit the standard size of wrenches. Plenty of stock is left on the collars.

When starting to machine the pin, the joint turner selects a forging with the proper sized square, say 3½ inches, puts a trial center in the pin end and grips the shank end with the chuck; then, by chipping, square centering (see Fig. 3) and

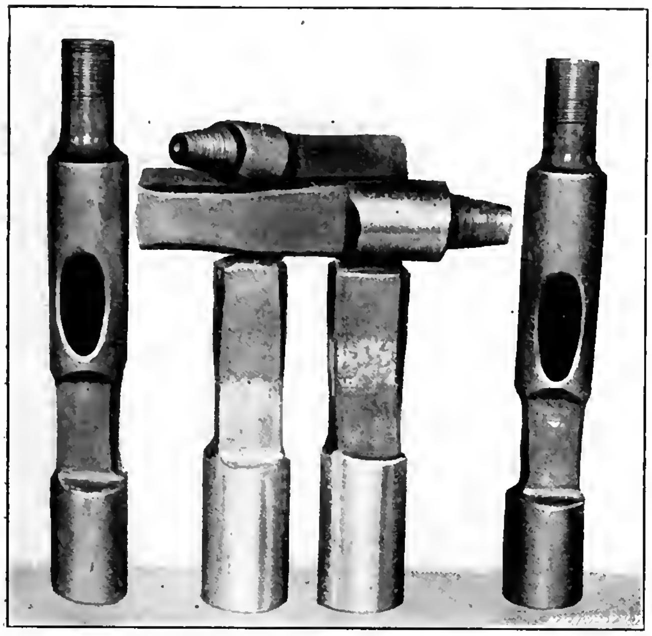


Fig. 5. Box, Pins and Rope Sockets

shifting in the chuck, he makes it run true with the wrench squares. Next the collar is turned to size by one roughing cut followed by a scrape with a broad-nosed tool, producing what is known in the oil country as the "Pittsburg finish." The collars are all made to some standard size, depending on the diameter of the hole to be drilled. Care in this respect is necessary so that in case a joint unscrews or for any other reason a part is lost in the well, the proper "fishing" tool may be "run" to remove it. The careful driller always keeps a record of the size of each joint and tool that goes into the well—and the writer has heard of some drillers who go so far as to bid the tools good-by each time they are lowered for fear they may never see them again.

The next operation is to rough down the pin nearly to size at the large end and square up the shoulder to give the pin the proper length, say 4 inches. A broad square-nosed tool is then used to bring the pin to the proper size at the large

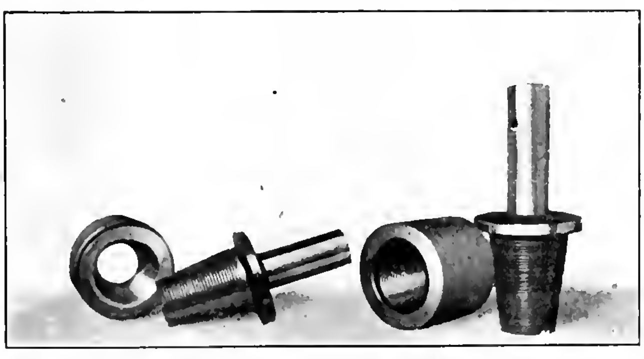


Fig. 6. Improved Templets with Collars on Pins

end, as this is the point where measurements are taken from. The taper attachment is then brought into use and the pin turned to the proper size for threading. Tapers vary from 3 to 3½ inches, and over, per foot, or from 7 to 10 degrees measured from the center line. The Gleason and Bridgeford lathes have the taper attachments graded according to a system of their own, the graduations corresponding to the taper per foot, in eighths of an inch. Thus 3 inches per foot is marked 24, which means 24/8, and 3 7/16 inches, per foot is marked 27½, which means $\frac{27\frac{1}{2}}{8}$. It is hardly necessary to say that in taper turning this, as well as any other kind, the

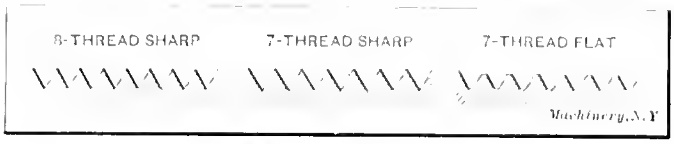


Fig. 7. Forms of Screw Thread Used on Oil-well Tools

point of the tool should be set level with the center line.

The thread is cut with a 60-degree angle, single-point tool. Many patent tool-holders work fairly well, but a solid tool forged from good high-speed steel gives the best results. The thread is cut as close up to the shoulder as possible in order that the box need not be counterbored more than ½ inch. It is good practice to use two threading tools, the first having its top face ground like a side tool, taking all the chips from the left-hand side, and being advanced for each cut by the compound rest set at 15 degrees; the second tool should be made with very little top rake and plenty of clearance on the bottom so that each side of the thread can be finished separately. There is a curious prejudice as to the lubricant for cutting threads on joints; while the drillers are not all Prohibitionists by any means, they all prefer their threads finished with a water cut. A superstition seems to prevail that lard

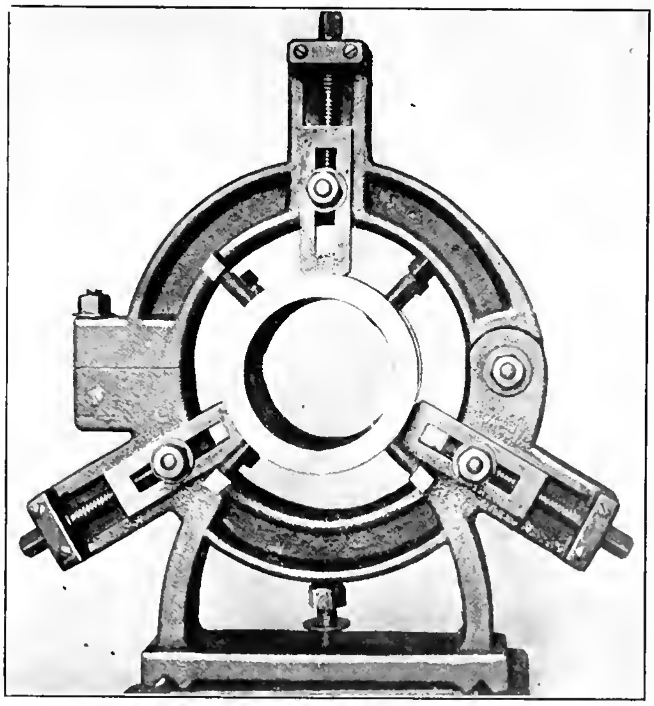


Fig. 8. Lathe Steadyrest with "Cat-head" or Revolving Ring

oil used when cutting the threads will make them unscrew unless burnt off.

After the thread has been finished, the gage or templet is screwed on, and the collar faced back to admit a finger or paddle gage between the two faces, thus bringing all the pins to the size of the gages. The gages (see Figs. 4 and 6) are made of iron or soft steel and need not be hardened. They are real boxes or pins, excepting that the boxes are shorter on the face end by ½, ⅝ or ¾ inch to suit the practice of any particular shop, and the pins have the collars cut back a like amount. When the pin templet is made without a collar it goes into the box flush and is tested by a straight-edge.

After the ring gage is removed from the pin a slight clearance or undercut is made in the collar next to the pin. This is done on the same principle that a carpenter, in laying flooring, undercuts his joints in order that they may fit closely

on the top, but the main reason is that when in use in the field the faces on the joint collars undergo a great deal of scouring to keep them clean, and by having this sharp corner removed it is easier to keep the faces level and thus avoid unscrewing.

The pin is now brought to length by paring off the small end with a side tool set at an angle of about 10 degrees, which completes the job with the exception of stamping the size on the collar. A stamp thus: 2¼ - 3¼ M 7 means 2¼ inches diameter at the small end, 3¼ inches diameter at the large

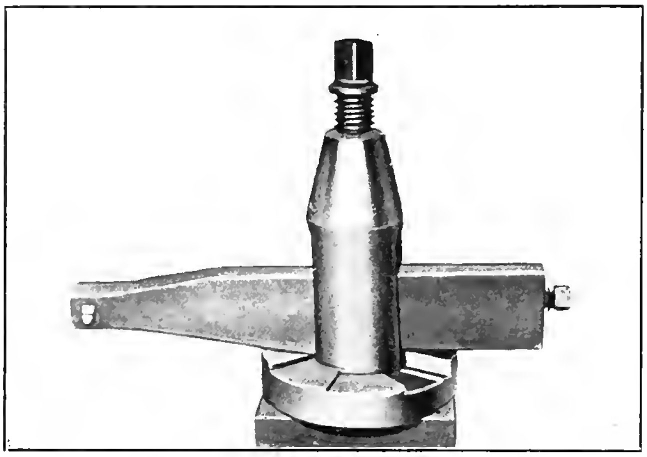


Fig. 9. Inside Thread Tool used for Drilling Boxes

end and 7 threads per inch. The M denotes this particular make, in this case known as the "Maloney." One hour is a fair average for the time taken to turn this pin. The pins on bits are turned in the same manner, excepting that a "cat-head" or a revolving ring in a steadyrest is used in centering, as the end of the pin can then be faced off and the center drilled and reamed. (See Fig. 8.) When the bits are made of tool steel throughout and the pins not perfectly annealed, this is a good method of getting a "loud" center—one that will hold up until the job is finished. If any one thing more than another tends to provoke an outburst of profanity it is to have a bit get tired of its small stingy center and go floating off into space when nearly completed.

The box is centered in the same manner as the pin and turned to size. The steadyrest is then placed near the middle of the round portion, the end faced off and a hole drilled the same size as the bottom of the threads on the small end of the pin and at least 1¼ inch deeper than the length of the pin. A very good tool for this purpose is a flat drill with the cutting edges lipped and the point ground heart-shaped. When made of high-speed steel this drill can be rapidly fed into iron or soft steel, making a 2¼-inch hole 6 inches deep, in 5 minutes. A set of jaws of hard brass for the steadyrest will last a year and will not mar the finished work. For boring the taper in the box, any good stiff tool will do, the size of hole being taken from a gage made to fit in on top of the threads in the ring templet. These are made of sheet steel 1/16 inch thick, with a scribe line, showing the depth to which it must enter when the box will be the proper size.

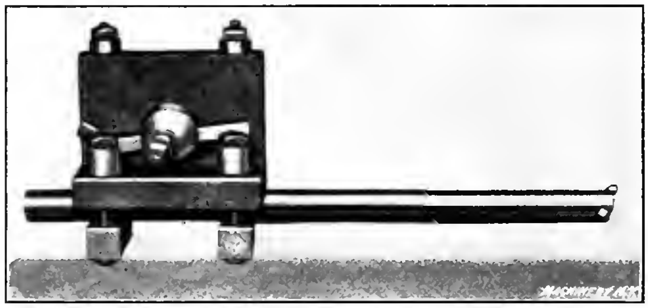


Fig. 10. Boring Tool used for Boring Taper Holes such as Tapers for Rope Knot in "Woodpecker" Sockets

For threading tools, one with an inserted cutter is best adapted for inside work; the cutters can be made of small square steel, no dressing being required. Care should be taken to have plenty of clearance so that the heel of the tool will not drag in the small end of the hole. The writer has used, for the last ten years, a tool made as shown in Fig. 9. The body is made of ⅞ × 2 inch annealed steel with a hole to fit ⅜-inch square steel; the top face is on the center line and ¼ inch

Fig. 11. Typical View of Work around "Joint Lathe" in Oil Country Shop

stock in front. A 13/32-inch hole is drilled from the back end to intersect the square hole and a piece of ⅜-inch drill rod put in for a plunger with a ½-inch set-screw behind it. This holder need not be loosened in the tool-post; simply slacken the set-screw to remove the cutter for sharpening. A boring tool for deeper holes is shown in Fig. 10.

When the thread in the box is finished, the chips are removed by spinning the lathe backwards and holding a stick of wood on top of the threads—which as the "cub" says "unscrews the chips." The gage is then screwed in and the box faced to size, care being taken to have the box bored large enough to let the plug gage enter far enough to leave stock on the face for this purpose. When the gage is taken out, the large end of the box is counterbored, removing three or four of the first threads. This is done because it is not

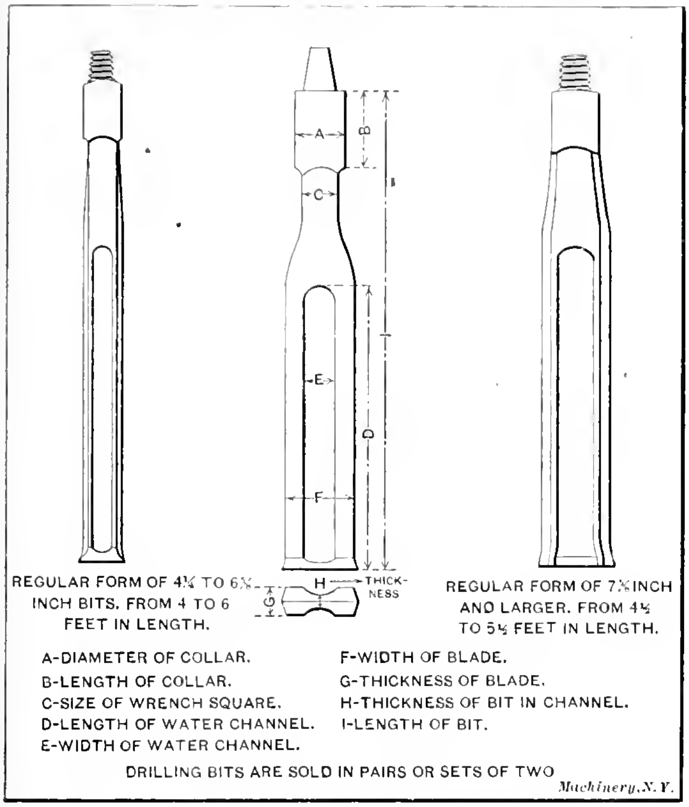


Fig. 12. Forms and Parts of Oil-well Drill Bits

possible to thread the pin clear into the collar. The corner of the box is chamfered off so that the face will correspond in size to that on the collar of the pin which fits it. After stamping, the box is complete, the time required being from 1½ to 2 hours. There is no allowance made for force fit; a good joint should have a slight shake just before shouldering, for, if made tight on the threads, when the shoulders become worn the threads get so tight that the pin is often twisted off.

* * *

VALUE OF ADVERTISING

The value of an advertisement in a trade journal or any other advertising medium, is determined *not* merely by the number of answers you receive, but by the number of actual sales resulting therefrom. There are third- and fourth-rate journals that can safely promise you hundreds or even thousands of answers to any advertisement that they may print—but what are the answers? They are on postal cards and scraps of paper, some of them so poorly written as to be absolutely undecipherable, all asking you for your catalogue and prices, but how often do such inquiries result in sales? On the other hand, an advertisement in the right kind of a trade journal may result in only ten answers, but they come in typewritten form, on firm's letterheads and are signed by someone with authority to buy and in eight cases out of ten who *does* buy, for the original inquiry was not prompted by mere boyish curiosity, but because the things advertised were needed.

It is the old, old question as to whether you prefer quantity or quality.

SOME KINKS FOR PUNCH AND DIE WORK*

By C. W. G

Before taking up the following suggestions for tool and die makers I would like to call the reader's attention to the fact that in order to acquire as much knowledge of his chosen craft as possible in the least time, he must read the journals devoted to his craft and especially those articles written by "the boys," who are actively engaged in the work. We may not find all articles literary gems, but the writer has yet to read a single article by one of "the boys" without adding some valuable information to his mental capacity or indexed notebook.

Just imagine the value each issue of MACHINERY is to both the young and the experienced toolmaker. How many years would the reader work at the trade before he found out by personal experience that this or that was the best way in which to successfully complete a particular job? On the other hand, let us follow a "roamer" or as they are called in the trade a "hobo" toolmaker. His restless disposition will not allow him to stay long in any one shop, but the few months of experience in each shop has given him the opportunity to grasp the valuable kinks, accurate methods, etc., that have taken men in that shop probably thirty years to discover. Say that this "roamer" lands in a toolroom that is devoted exclusively, and has been for the past forty years, to the most intricate class of die work, while he has just left a job where jigs were the specialty. In a few days he notices that the methods employed there are really valuable and that it never once entered his mind before that this or that clever scheme could be adopted. In a way he is a robber. Without spending more than a few days he is in possession of the valuable experience which it has taken other men a lifetime to collect. By means of a few rough sketches and an earnest attempt at a description his discovery, coupled with editorial touches, makes an article presentable from a literary point of view, and *the valuable idea* is sent broadcast. The following schemes and kinks, or whatever they may rightly be termed have been gathered here and there around the country by the writer, and while some of them are not new to all readers, it may be possible that some readers have not heard of them.

Proper Clearance Between Punch and Die

First we take up the clearance to be given the blanking die. It is a known fact that there is a happy medium where the fit of a punch and die governs their clean cutting. A loose fitting punch will cut absolutely free from burrs up to a certain point, but a little too loose or a little too tight results in ragged edges being left on the punchings. Experienced tool- and die-makers who have spent years in fitting punches can tell mentally just about how much to allow between the punch and die, providing, of course, that they have given them the thickness of the metal to be punched. But the young fellows do not care to wait until they are nearing the end of their usefulness before they are able to tell by personal experience. Therefore, the results obtained by the pioneers have been carefully recorded and information given for clean cutting on all thicknesses of stock. The general rule is to allow a clearance between the punch and die of 6 per cent of the thickness of the stock to be cut. For example, suppose that we desire to punch plain washers 0.040 inch thick. Then six per cent of that equals $0.040 \times 0.06 = 0.0024$ inch which would be the difference between the size of the punch and the die.

The above practice is in vogue in such reputable factories as the Burroughs Adding Machine Co., Detroit, Mich., and has been used by the writer with excellent results. There are many readers who are using this rule, but to those who know it now for the first time, I would advise that they make a mental note that this issue of MACHINERY has been the means of eliminating the worry on their next punch and die in regard to how much clearance to give. Of course, the temper of the stock to be punched enters somewhat into the above calculation, but not enough to make an appreciable difference.

Value of Annealing

Knocking around the country, the writer has noted that the majority of die- and tool-makers overlook the importance of

* For information previously published on punch and die work, see "Operation and Construction of the Sub-Press Die," MACHINERY, July, 1910, and articles there referred to.

first roughing the die nearly to size and then carefully annealing it. There are internal strains set up in the bar of steel during its manufacture which are sure to cause distortion of the die or tool unless these strains are removed before the work is brought to its finished size. Some steel may be found free from strains, but we have no way in which we can tell beforehand whether the steel has "settled" or not. Therefore, to guard against distortion, the careful toolmaker will not take chances, but will anneal the piece after it has been roughed out. Annealing allows the molecules, as it were, to twist and squirm, which seems to relieve these internal strains.

Some years ago the writer made the following test, which settled in his mind the value of annealing before finishing. Four pieces of tool steel were cut from the same bar and the same amount of stock was removed from each piece, finishing them all over to exactly the same dimensions. They were then marked *A*, *B*, *C*, and *D*. Pieces *A* and *B* were annealed after roughing, but *C* and *D* were machined to size. The pyrometer was used to insure heating all the pieces to the same degree, that is 1400 degrees F. The bath was clean water brought to a temperature of 68 degrees F. The pieces were heated individually in a muffle furnace and were allowed to remain in the bath exactly the same length of time (one minute). It should be remembered that it is poor practice, in fact disastrous, to allow dies, especially those having delicate parts, to become chilled in the the bath, as this results in unequal contraction which is the greatest cause of breakages. Leaving the pieces in the bath one minute enabled me to obtain a comparative test, as all conditions were parallel. The pieces *A* and *B* were slightly distorted, but the pieces *C* and *D* were distorted to such an extent that they were useless.

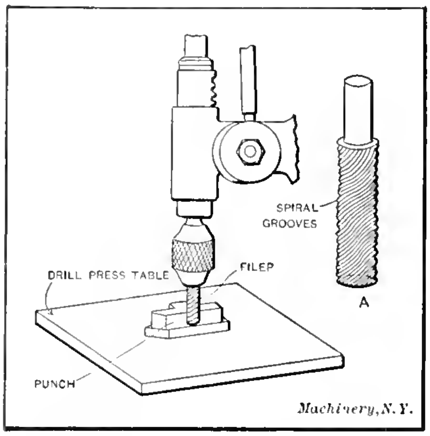


Fig. 1. Filing a Punch to the Finish Line

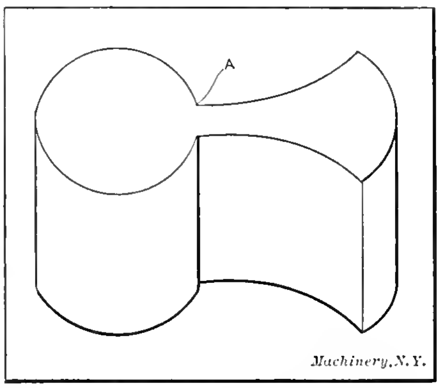


Fig. 2. Difficult Piece to harden without Cracking

How to Lay Out a Die

Another thing which the writer noted along this line, and some day expects to make a test to discover if possible just how much effect it has, is that the best results have always been obtained when long points were laid out lengthwise, that is in the same way in which the grain runs in the stock. It has been noted that dies having several long points which run lengthwise do not distort much in hardening, but that those which are laid off crosswise generally bend to a greater extent. We know in making flat springs that if we cut them out running lengthwise with the grain they will stand up much longer than if we cut them out running across the grain. From my own experience I would suggest to the young toolmaker that he lay out his die with the long projecting points running lengthwise of the grain.

Fitting Punches

Before transferring the outline of an intricate shaped die to the punch, it is good practice to coat the face of the blanking punch with solder. Then machine the solder so that it is level. Coating the punch with solder enables one to obtain a much better outline than would be possible when scribing on the hard steel, and the very narrow and intricate parts can be laid out more easily. Another feature of the solder face is that if there are weak projections it eliminates the chance of breaking them when shearing the punch through the die. If 1/16 inch of solder is evenly placed on the punch, it allows the die to cut a perfect impression in the solder, which is a great help in milling the punch, as the milling cutter can be brought down until it just scrapes the solder, and the cut taken. At the completion of the milling operation the solder is removed, when the punches can be nicely fitted by using the filer shown at *A*, Fig. 1. This filer is made similar to a spiral mill and is placed in the chuck of a drill press, as shown. It cuts remarkably fast, and also leaves a good finish on the punch.

Hardening Dies

There are more cranks on the subject of hardening than on any other subject I can recall. We each have our own pet theory and the writer will put forth his argument which is the result of years of successful hardening of steel that ought to bear out his theory. Let us assume that we are about to harden the piece shown in Fig. 2. This shape is selected to enable us to more clearly describe the theory. Steel expands about 1/8 inch per foot when at a bright heat, but for argument let us assume that the piece to be hardened expands 1/8 inch at 1000 degrees F. Then if the piece be heated quickly, the smaller portion will heat more rapidly and will be brought to 1000 degrees F. while the remaining portion will not be up to that point. Say that the remaining portion will be only 500 degrees F. Therefore, one half has expanded at the rate of 1/8 inch per foot while the other half has expanded only at the rate of 1/16 inch. There must be, of necessity, a weakening effect at the separating line *A*, caused by the unequal expansion. Granting that when heating, it will expand unequally, the reverse action will take place when we immerse it in the bath. That is, the small part will contract quicker than the larger one. Then as the heavier portion continues to contract, there must be a strain at the point separating the two parts which invariably results in a crack at the point *A*. This piece could be successfully hardened by removing it from the bath while it is "sizzling." This allows the heat from the heavier part to run out into the lighter, equalizing the heat, which removes the strain. It also causes the contraction to be more even. Some may say that to remove the piece while it is sizzling would draw the temper, but water will sizzle on steel when the temperature is a little over 200 degrees F., which is not high enough to noticeably affect the hardness of the steel.

Some toolmakers know from experience just when to remove the piece from the bath by the peculiar "singing" noise of the tongs which is familiar to most of them. Others judge from the size of the piece just about how long to leave it in the bath. But the tongs may not feel like "singing," and the bath may be cooler than imagined; the piece larger than estimated or a little hotter due to reflected sunlight, all of which tend to make the foregoing method a matter of guesswork. The best way is to place the hand in the bath alongside of the piece and remove the die just as soon as the fingers can remain on the die without "sticking" to it. Whether this theory is correct or not, it is a fact that those who will try hardening in this way will find that their hardening troubles are over.

* * *

The electrical manufacturing industries in Germany appear, from the annual statements for the business year 1908-1909, to be in a prosperous condition. The Siemens-Schuckert Co., which operates with a total capital of about $26,000,000, declared a dividend of 10 per cent on its capital, and the Siemens & Halske Co., which operates with a total capital of about $22,000,000, declared a dividend of 12 per cent.

* * *

"As keen as a razor" means something so sharp that it will cut a hair supported at one end, but what is the thickness of a keen razor's edge? It is claimed to be only 1/600,000 inch by a manufacturer advertising safety razors. It would be interesting to know how the thickness of edge was accurately measured.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

MAKING GEAR CUTTERS FOR A JOBBING SHOP

In reply to the question of R. G. D. published in the July number of MACHINERY, the writer would say that while situated in Melbourne, Australia, he made cutters which were used for automobile work in the following manner:

Starting with a broken spur gear *A*, which generally has two or more of its teeth in good condition, turn a tool steel plug to fit the space between the teeth, as shown at *B* in Fig. 1. After having turned, filed and polished this plug to shape, one-half is cut away as shown at *C* in Fig. 1. This plug is then used as a cutter. Using the toolholder shown in Fig. 2, and setting this up in the planer, it is possible to cut a forming tool to the desired shape. The forming tool is held on an angle plate, as shown in Fig. 2, which has its face set off at an angle of 20 degrees. The cutter is also held in the holder at a corresponding angle, this giving a clearance of 20 degrees on the forming tool. The point of application of the cutting tool is set beyond the center of the clapper-box pin so that the tool will spring away from the work and not dig into it. The angle plate is fastened to the planer bed as shown, care being taken to have the face *A* at right angles to the direction of stroke of the planer, or in other words, at right angles to the planer bed. The forming tool is roughed out to nearly the exact shape and clamped to this angle plate as shown. A hand-wheel for operating the planer table is used for taking the finishing cut. Turpentine will be found to be the best lubricant. After this forming tool is finished it is hardened and used in the lathe for forming the milling cutter. The milling cutter is then backed off with this same forming tool.

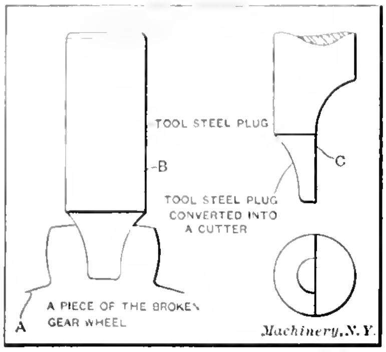


Fig. 1. Method of obtaining Shape from Gear Teeth for Forming Tool

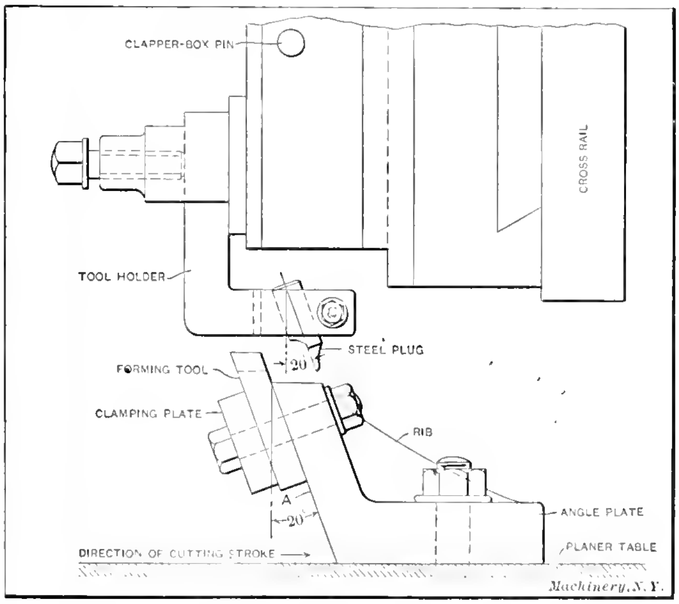


Fig. 2. Making Forming Tool on the Planer

In Fig. 3 are shown the details of the relieving attachment as used for backing off the milling cutter. *B* is a piece of cold rolled stock having its centers eccentric as shown, and having a piece *A* of machine steel pinned to it by a taper pin. A 1/2-inch hole is tapped into *A* for holding a handle which is used for operating this attachment. *C* is a tool-steel sleeve on which the milling cutter is held while being relieved. A series of 1/4-inch holes are drilled in this piece, the number depending on the number of teeth in the milling cutter. *E* is a nut for holding the milling cutter on the part *C*, and *D* is a nut for holding the part *C* on the arbor *B*. The way in which this backing-off attachment is operated is as follows:

After the cutter blank has been turned to the desired shape it is placed on the sleeve *C*, the 5/32-inch keyway fitting the keyway in the cutter and preventing it from turning while backing off. The nut *E* is then screwed on, holding the milling cutter tightly in place against the face of the sleeve *C*. The part *C* is then slipped over the arbor *B* and the pin *F* inserted in the hole shown in the part *A*, thus locating the part *C* in the desired position relative to the centers in the arbor. The nut *D* is then screwed onto the part *B* holding the face *b* of the part *C* tight up against the face *a* of the part *A*. The backing off is done by pulling the handle (not shown) which is screwed into the half-inch tapped hole. After one tooth has been backed off the nut *D* is released and the pin *F* pulled out and inserted in the following hole in the part *C*.

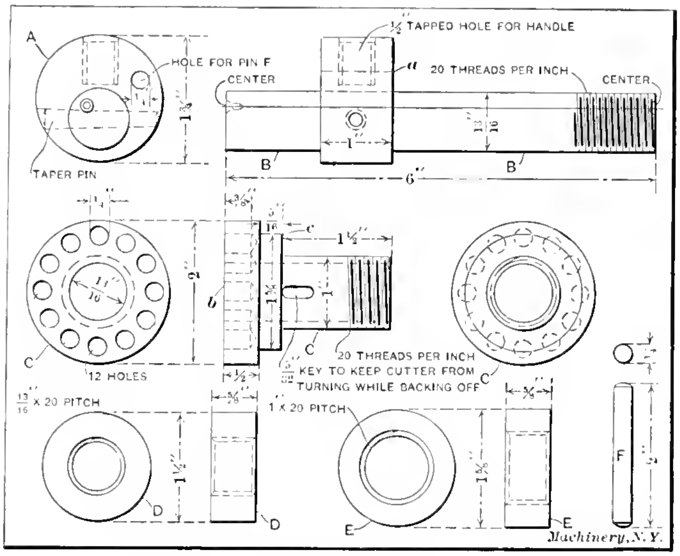


Fig. 3. Details of Backing-off Attachment used in the Lathe

The nut is again tightened and the method as previously explained followed until all the teeth have been backed off. This attachment does not give a true radial curve, but it has been found close enough in most cases, the writer having used this attachment for backing off milling cutters having a face 1 inch wide.

In the case of bevel gears, I made the diameter of the plug two-thirds the width of the widest space between the teeth, or in other words, the width of the space between the teeth at the pitch circle of the gear. After the plug had been cut away as shown at *C* in Fig. 1 it was hardened and drawn, and used as a cutter for making the forming tool as previously explained regarding the making of the forming tool for spur gears.

JACK FINLAY

Hartford, Conn.

HEAT TREATMENT OF STEEL

When, in making a die, I pick out a bar of Jessop steel that is machined only with considerable difficulty, especially in drilling, I know that the bar has not been properly annealed, but I go ahead with the hope that the die may be finished without the necessity of re-annealing. When finished and taken to the fire for hardening, I first heat the die to a cherry red and allow it to cool in the air. Then I am sure it will harden properly in the last heating. In other words, whenever I find a die will not harden, I know that the steel has not been properly annealed at the steel plant and that one good remedy is to heat the steel and allow it to cool in the air before heating for hardening. It is not necessary to anneal it in an annealing pot.

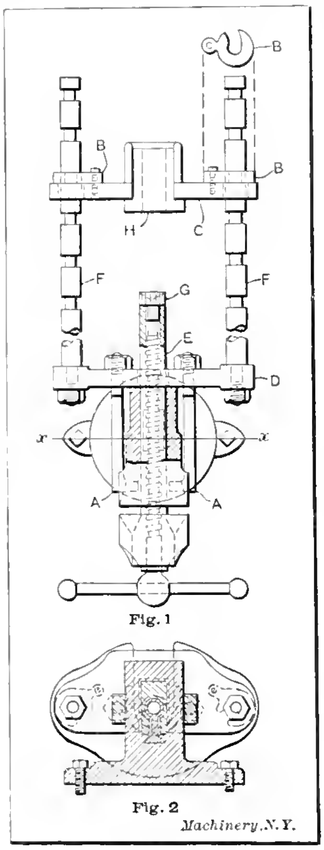
The following experiment bearing on "burnt" steel is in-

teresting: Place the end of a bar of tool steel about 3/8 inch square in the forge and "burn" about two inches—in fact melt the extreme end—then nick it so that it will break easily near the end. Allow the piece to cool in the air. After cooling, re-heat the bar to a cherry red and harden. Break off the end and you will find the steel is not burnt at all, but has just the same grain as before, due to the heat treatment. In my opinion there is really no such thing as "burning the carbon out of steel." CHARLES WESLOW

Buffalo, N. Y.

PRESS ATTACHMENT FOR A VISE

The accompanying engraving shows a vise attachment, the object of which is to enable the leverage of the vise to be used for pressing in lathe arbors, bushings, etc. There is sufficient leverage in the ordinary machinist's vise for this purpose, but the opening between the jaws is too narrow. It will be understood from the illustration that the attachment does not (except during the intervals when it is used as a press) materially interfere with the ordinary use of the vise.



Press for Arbors and Bushings which may be attached to an Ordinary Bench Vise

The attachment, a plan view of which is shown in Fig. 1, is secured to a common vise by two bolts *A*, which have L-shaped heads adapted to grip the fixed member of the vise under the jaw.

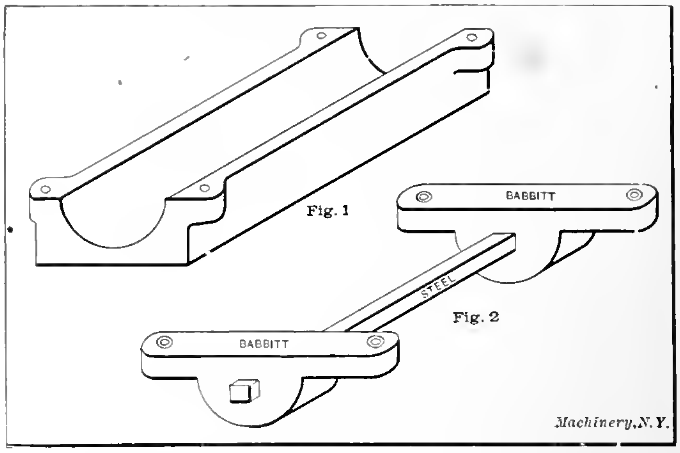
The clamp or sustaining plate *D*, in which the two bolts *A* are located, is slotted to permit the guide-bar *E* of the outer vise-jaw to pass through it. Secured to *D* are two grooved rods *F* carrying the thrust-plate *C*. The latter has drilled holes at each end large enough to admit of its being moved to different positions along the rods *F*. *C* is held in any required position by the engagement of the hinged latches *B* with the grooves in the rods *F*. While pressing an arbor into the work, one end of the arbor is centered in the conically-recessed plug *G* which fits into the end of the guide-bar *E*, the work into which the arbor has been entered being held against the thrust-plate. Some machinists might prefer to make the plug *G* with a flat end, to prevent cramping the arbor; but by careful manipulation of the work against the thrust-plate, no cramping will occur. The bushing *H*, which is shown inserted in the thrust-plate, is designed for use when handling small work.

This attachment is best adapted to the wants of those who need a small press occasionally, but who do not feel justified in purchasing a regular arbor press. The distance between the rods *F* may ordinarily be made sufficient for most of the work of a small press. If this distance should be greatly increased, the vise would need to be blocked up, or an opening through the top of the vise-bench would be required to clear work of large diameter. W. S. LEONARD

Atlanta, Ga.

SIMPLE METHOD OF MAKING A DRILL JIG

A simple and effective jig which was made by a method that is doubtless capable of many applications, is shown in the engraving, which also illustrates the work for which the jig was intended. This jig was used by a metal-pattern maker for drilling the pin holes in a metal core-box (Fig. 1) which were required to be interchangeable. One box was laid out and drilled and pins inserted in the holes. Stock bushings were then placed over these pins, and after closing the ends of the boxes so as to form pockets of the required shape at each end, babbitt was poured in, thus securing the bushings and forming the jig snown in Fig. 2. To obtain



Figs. 1 and 2. Metal Core-box and Jig for Drilling Pin Holes

the proper distance between the bushings lengthwise, a square steel rod was placed through the center.

Of course, this jig would not suffice for accurate work or for continuous use, but the method of making it could doubtless be applied to advantage for certain classes of work. The cheapness and ease with which the jig can be made, is the commendable feature. D. O. BARRETT

Freeport, Ill.

PUNCH AND DIE FOR PIERCING ANGULAR STOCK

It is a difficult proposition to pierce holes in angular stock which has been previously formed, without distorting it in any way and especially if the holes come close to the edge of the stock. A spring stripper is sometimes used for this pur-

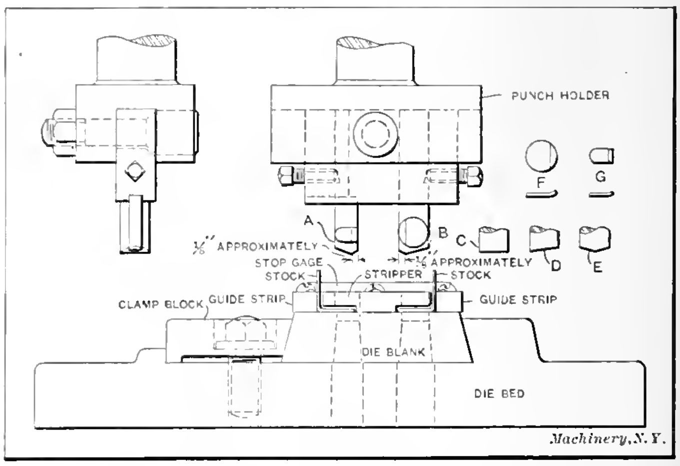


Fig. 1. Details of Punch and Die for Piercing Angular Stock

pose, but it is not always satisfactory. In Fig. 1 is shown a side elevation of a punch and die for piercing the angular stock shown in Fig. 2. This punch and die is used for punching both the holes and the slots, the blank being pushed

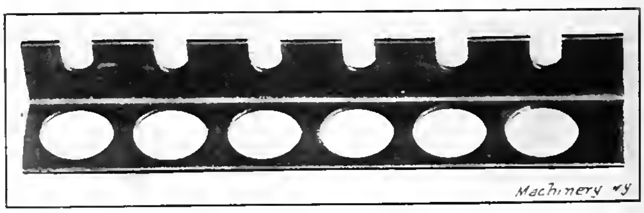


Fig. 2. View showing the Condition of the Anguler Strip after Piercing

through on one side of the die and then reversed and pushed through the opposite side, thus punching both the holes and the slots. The punches shown at *A* and *B* were found to give perfect satisfaction. The action of these punches is as follows: When the punch descends onto the stock, it gath-

ers the stock to the center as would occur when drawing a cup. This obviates the stretching of the material around the hole which would occur if the holes were pierced with punches such as shown at *C*, *D* and *E*. The shape of the blanks as formed by the punches *A* and *B* is shown at *F* and *G*. The other details of this punch and die are as ordinarily used and will therefore not require description. A stop gage is used which is operated by hand, thus spacing the holes at equal distances. CHARLES WESLOW

Buffalo, N. Y.

CONDENSED PRICE LEAF FOR MACHINERY HOUSES

We show herewith a No. 6 modern price leaf with illustration and full description of a line of punch presses that we expect to handle. This price leaf is one of the cleverest ideas that we have ever seen adapted for the use of salesmen,

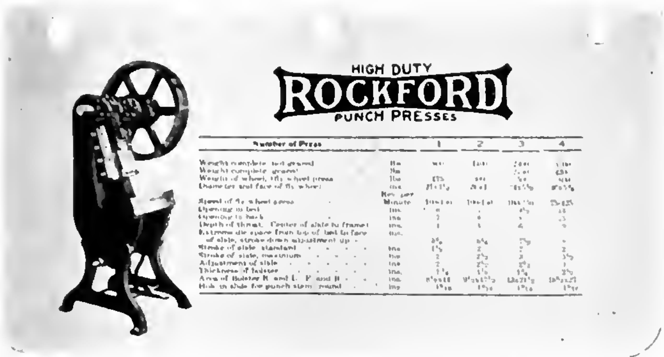


Fig. 1. Condensed Price Leaf for Salesmen

either in the store or on the road. We think it could be profitably adopted by quite a number of machine-tool and

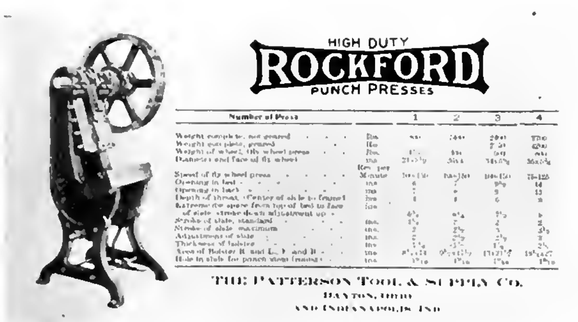


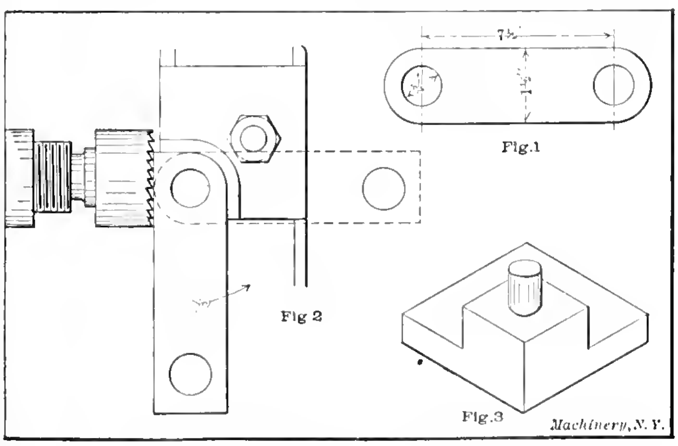
Fig. 2. Condensed Price Card for Mailing

small-tool builders. The same electrotype could be used for printing cards for mailing purposes, and we show a sample herewith in Fig. 2. Both the price leaf and card were gotten up at our suggestion.

THE PATTERSON TOOL & SUPPLY CO.,
Dayton, Ohio. W. B. Patterson, President

ATTACHMENT FOR ROUNDING LINK ENDS

One of our constantly-recurring jobs was rounding the ends of the links shown in Fig. 1. These were of drawn steel ½



Figs. 1, 2 and 3. Link and Attachment for Rounding Ends in a Lathe

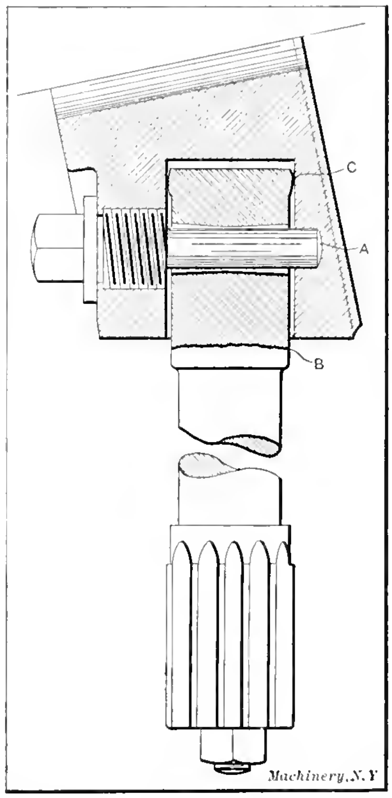
inch thick, and as they were called for in lots of from 2 to 40 at a time, the task of "knocking off" the corners in the shaper and finishing on a grinder was more or less laborious; neither was the finished piece always symmetrical. Something had to be done to put this work on a manufacturing basis both as to time and cost, and how this was done is shown in Figs. 2 and 3. A casting (Fig. 3) was made and fitted with a pin the size of the link holes. This block was then bolted to the lathe toolpost and an end mill fitted to a shank in the lathe spindle, which completed the outfit. Now after the links were cut off, drilled and reamed, they were slipped over the pin and given a quarter turn in a horizontal plane. A piece of pipe 18 inches long served to give the necessary leverage. In Fig. 2 may be seen a link, one corner of which has already been rounded, in position for operating on the second corner. The dotted lines indicate its position when one end has been finished.

This attachment was ridiculously cheap and so simple that a boy could round 50 links an hour and obtain a finish fully up to the requirements. DONALD A. HAMPSON

Middletown, N. Y.

FLOATING REAMER FOR INSURING STRAIGHT HOLES

The turret-head on a boring mill had become worn a little so as to throw it out of line, which caused the reamer to cut the holes cone-shaped; that is, they were larger at the top than at the bottom. The machine was used mostly for pulleys and couplings and the holes had to be straight and true with the turned part. This defect was overcome with very little expense and loss of time in the following manner:



Method of Holding a Reamer in a Turret so that it will follow the Bored Hole

First the turret head was removed from the machine and a threaded bushing having a ¾-inch hole was fitted to the screw hole. The reamer shanks were each placed in a hole in the turret and a ¾-inch hole was drilled through each shank and in the turret to a depth of 1 inch. The holes in the reamer shanks were then re-drilled 1/16 inch larger and taper reamed from each end, as shown in the accompanying engraving, which is a sectional view of one hole in the turret to which all the reamer shanks were fitted. The ends *B* of the shanks were then turned 1/16 inch smaller than the turret hole diameter to within ½ inch of the end. The end *C* was next turned spherical in shape, the diameter of the sphere being the same as the hole in the turret, so as to give a bearing on the end, and at the same time allow full play. A screw *A* was then made with a pilot pin ¾ inch in diameter. As will be seen, this screws fits the tightening screw hole and the back part of turret, but it is a loose fit in the reamer shank.

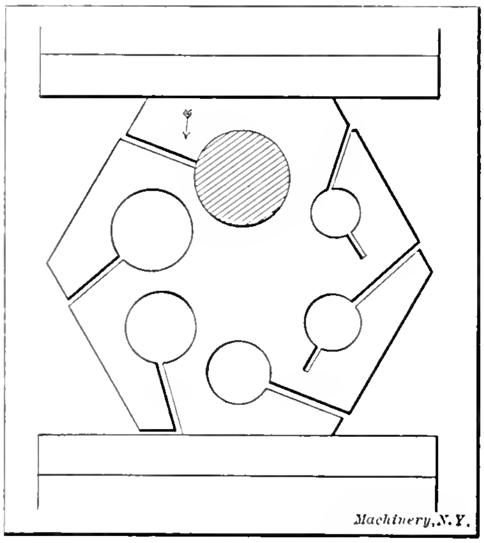
We have had no more trouble from large holes, the holes now being straight and to size. Before using, all the reamer shanks were tested to see that they had a free movement in every direction, because, if from some cause the holes are not drilled true and the reamer will not "float," a taper hole will result.

This method of holding a reamer can be applied with equal success to all forms of machines that finish holes with a

reamer, such as turret and engine lathes and drill presses that have become worn and are not true. JOHN BRANDLE
Jackson, Tenn.

A SPRING VISE-CLAMP

When finished or polished rods, spindles, tubes, etc., have to be held in the bench-vise, it is not always judicious to use ordinary flat clamps, because these do not afford a good grip, and in the case of thin pipes, they are likely to squeeze the



Spring Block for Holding Round Work in the Vise

metal out of shape. Some form of split block is better, in which the work rests in a bored hole and is gripped by the elasticity of the metal, the block being split so that the pressure of the jaws closes it in slightly. Some blocks are made of oblong form, with a series of holes and a longitudinal saw-cut to allow of the necessary elasticity. The illustration shows a neat form of block which is more compact than the oblong type. There are six holes of standard sizes, such as 1 inch, 7/8 inch, 3/4 inch, etc., and the block is hexagon in shape, and about an inch in thickness. The holes and the saw cuts are so arranged that the effect of squeezing the block in the jaws, is to close in the holes on opposite sides, thus clamping any work that may be put in them. The block is therefore turned around to suit the particular size of hole that is wanted. The same kind of block might be made octagonal in form and have eight holes, but I have not attempted to devise anything beyond the hexagon, as it seems better to have another block for the next range of sizes. FRED HORNER
Bath, Eng.

HARDENING HIGH-SPEED STEEL

There have been a number of articles reproduced in MACHINERY from time to time on methods of hardening high-speed steel, but I have never seen published the formula here given, which I have used for three years with good results. It is a well-known fact that high-speed steel made up into small and delicate tools such as taps, cutters, etc., should not be blistered or pitted, as this would spoil the cutting edges. It is generally a problem to harden high-speed steel successfully where the necessary equipment, the chloride barium bath, is not available. One of the principal precautions necessary, in hardening high-speed steel, to prevent blistering, is to keep it from the air while the steel is hot. A powder which is composed of corn meal, salt, and prussiate of potash mixed in equal parts has been found a very satisfactory composition. To harden the piece, heat it to a dull red and lay it in the powder. Then return the piece to the fire and heat to a bright red. Dip again in the powder and return once more to the fire and heat to almost a yellow color. Then quench the piece or pieces in cotton-seed or linseed oil. Pieces hardened in this powder will be found free from pitting and scaling and the sharp edges will be maintained. It will be noted that the hardening heat is a great deal lower than that recommended by the makers of various high-speed steels. W. C. BETZ
New Britain, Conn.

AUXILIARY SCALES ON THE TRIANGLE

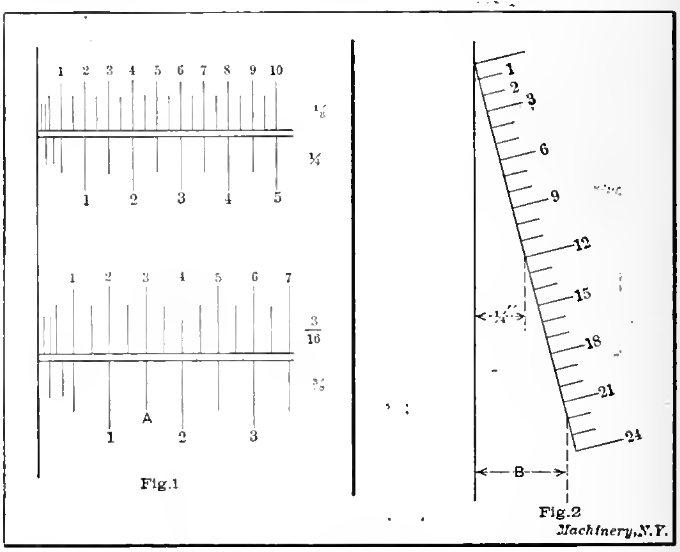
When working on small-scale drawings in which much detail is to be shown, such as the drawings of pipe connections, valves, fittings, etc., the auxiliary scales described in the following will be found of great convenience:

Fig. 1 represents a portion of a celluloid triangle with four scales lined on it. These are reproduced from those upon a draftsman's scale being 1/8, 1/4, 3/16, and 3/8 inch to one foot, respectively. The lines are made by scratching the triangle with a fine prick-point. After this is done, a little india ink rubbed over the marked surface will make the scales more visible. The triangle should then have the figures scratched upon the reverse surface.

To illustrate the use of the instrument, suppose it is desired to draw a vertical line 18 inches to the left of a center-line, to a 3/8-inch scale. The division marked *A* is placed over the center-line and the desired line is then ruled in. That is, the desired line is drawn without other measurement than that involved in the use of the triangle. Thus is accomplished a saving of the labor of removing the triangle for the purpose of measurement with a separate scale, the marking of the position of the desired line, and the replacing of the triangle that it may be drawn—a saving that will be found considerable on certain classes of work.

The scales on the triangle may readily be applied in a vertical direction if it is used in conjunction with another triangle. The surface of the triangle marked with the scales should always be placed next to the drawing paper, as otherwise an error of parallax may result.

Fig. 2 represents a different way of graduating the triangle, by which finer graduations may be made with less care in laying them out. The scale shown consists of twenty-four equal divisions and it is located so that the division 12 is 1/4



Figs. 1 and 2. Auxiliary Scales for Drawing the Details of Small-scale Drawings

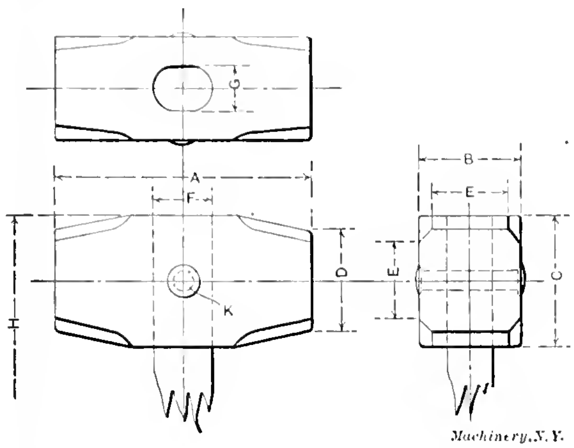
inch from the edge of the triangle and the zero division at its edge. With this arrangement a 1/4-inch scale is obtained. It will be seen that the edge of the triangle is 22 inches, to this scale, from the line *B*. This illustrates its application in use.

If desired, the lined scale may be made on a thin piece of celluloid instead of on the triangle. It may then be used for a variety of scales by simply changing its inclination to the edge of the triangle. For instance, if the 12 division is placed 3/8 inch from the edge of the triangle, a 3/8-inch scale results, and so on. An arrangement may readily be made by which the thin celluloid piece may be tacked temporarily in the position on the triangle corresponding to any desired scale.
Philadelphia, Pa. JULIAN C. SMALLWOOD

MACHINE ASSEMBLING HAMMERS

The machine assembling hammer shown in Fig. 1 is intended for the use of assemblers in the machine shop, where soft hammers are an absolute necessity. The table shown in connection with Fig. 1 gives the dimensions for four different sizes, and a convenient form of mold for casting these hammers is illustrated in Fig. 2. The heads are made of scrap lead or babbitt, which when heated to a molten state is

poured into the cast-iron mold. The handles are held in the heads by pins riveted at each end. The mold, as shown in Fig. 2, is made in two sections S and T which are hinged at Y in two places. The lug W is for holding the mold in the jaws of a bench vise while the metal is being poured. By means of pins V which pass through lugs in front, the upper half is held down when the mold is in use. It is well to have



No.	A	B	C	D	E	F	G	H	K
I	4	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{1}{2}$	1	1	$\frac{5}{8}$	14	$\frac{1}{4}$
II	$3\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{7}{8}$	1	$\frac{5}{8}$	12	$\frac{1}{4}$
III	$2\frac{1}{2}$	1	$1\frac{1}{4}$	1	$\frac{3}{4}$	$\frac{9}{16}$	$\frac{9}{16}$	10	$\frac{3}{16}$
IV	$1\frac{3}{4}$	$\frac{3}{4}$	1	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{1}{2}$	$\frac{3}{8}$	8	$\frac{1}{8}$

Fig. 1. Dimensions of Machine Assembling Hammers

these pins permanently fastened to the lower half of the mold by small chains to prevent their loss. The steel core X for the handle, is shouldered at one end to prevent it from slipping out of the mold. The metal is poured in through the

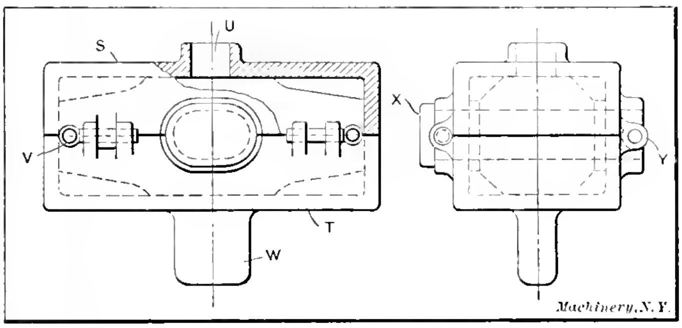


Fig. 2. Mold in which Hammers are cast

inlet U. By the use of these molds, soft hammers may be made with little trouble and they will also be neat in appearance.

L. H. GEORGER

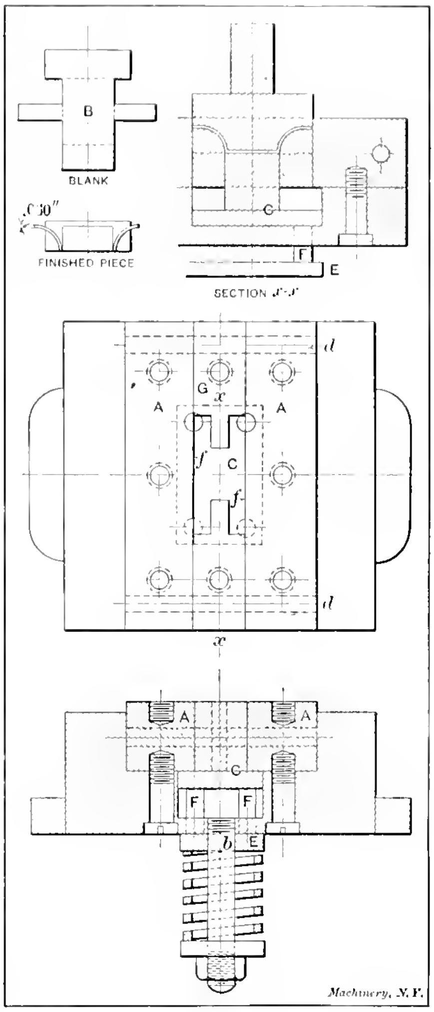
Buffalo, N. Y.

BUILT-UP REVERSIBLE-SECTION BENDING DIE

The die illustrated herewith is for bending the brass blanks B to the finished shape shown, the pieces being bent on the dotted lines. This die replaces a solid one which was continually wearing out on the inside flat faces and which could not be repaired without making a new block. The new die is so made that its sections are reversible; thus when the faces f are worn, the opposite side may be turned inward. When this becomes worn the block may be turned over and the lower half of the face becomes the wearing surface, making four positions which each block can assume to compensate for wear.

The die is made of the pieces A which are reversible, and the sections G which fit between the parts A. The alignment is secured by dowels d in each end, which pass through the three pieces. The four pieces are set into a base-block which is a steel casting, and are held to it by eight screws, three in each long piece and one in each of the small pieces. This makes a very solid construction and will stand any amount of strain without danger of breaking. All the sections were made of non-shrinking steel and were hardened very carefully, all holes being plugged with asbestos. After hardening, they were ground on a surface grinder, care being taken not to disturb the alignment of the holes.

As there was not room for the stripper springs in the base-block, a heavy coil spring of one-quarter inch square stock was wound and tempered. Plate E is loose on the shank of the bolt b and the pins F work through reamed holes in the base-block and bear on the bottom of stripper C. The spring passes through a hole in the bed of the press when the die is in use. The stripper is made in two pieces as shown, one of which passes through the die, the other being a bottom plate which acts as a stop.



Reversible-section Bending Die and Piece which it forms

The forming punch for the die has a round shank by which it is held in the press and which serves to hold it while machining the faces. It was held in a fixture on a lathe faceplate and the slots for bending the side projections on the blank were formed to a templet. The sides were slotted in order to bend the projections without a side-twist. Section x—x gives a good idea of the action of the die. The punch is shown at its full depth, leaving the thickness of the stock between it and the stripper.

The locating plate for the blank is not shown but it is fastened on the top of the die by screws which fit the same holes that are used to hold the die to the base.

E. C.

PRINTS WITH BLUE LINES ON WHITE GROUND

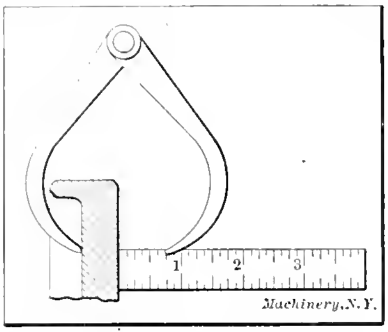
The process of making blueprints with blue lines on a white ground, described in the May number of MACHINERY is rather too complicated to be convenient. The thing may be done much more readily if one has the misfortune to be in a country where most of the carbon paper sold for typewriting is so bad that the first time it is used, the entire black surface is removed, leaving the paper practically transparent. To take advantage of this defect, one has only to place some of this paper with the smutty side up, cover it with a piece of copying paper (tissue paper), and draw or write with the stylus or even with a hard lead-pencil having a well-rounded point, whatever it is desired to print. The result will be two copies; a black or an opaque one on a white ground, and a white or transparent one on a black ground.

The carbon paper, when used as a negative with the ordinary iron paper, will give blue lines on a white ground; and the tissue paper, white lines on a blue ground.

Dresden, Germany. ROBERT GRIMSHAW

CALIPERING OVER FLANGES

A simple method and one which is as accurate as the one described in the July number of MACHINERY by Fred Horner to measure a web behind a flange is to set your calipers to some fixed distance which will clear the thickest portion, say 1 1/4 inch. Then, by the use of a steel scale, as shown in the accompanying illustration, held against the side of the part to be measured, read off the distance that the calipers extend on the scale, and deduct this amount from the distance at which the calipers are set. This will give the thickness of the web.

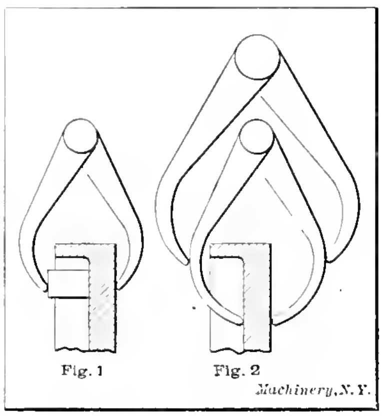


Method of Calipering over a Flange

Pawtucket, R. I. FRED G. KENYON

[A similar method was described in MACHINERY, February, 1904.—EDITOR.]

In the July number of MACHINERY was shown a method of calipering over a flange by making a prick-punch on each leg of the calipers, and measuring the points with a pair of dividers. It would not be possible to replace the calipers very closely by this means. The following methods here shown are quicker and more accurate, and also enable measurements to be taken closer to the corner under the flange. To get the thickness of the flange, simply use a block as shown in Fig. 1. Then subtract the thickness of the block from the opening of the calipers. This method can also be used for measuring a chambered recess. If a block is not handy, use a second pair of calipers as shown in Fig. 2. After removing the first pair of calipers from the work, replace them to size by means of a second pair.



Other Methods of Calipering over a Flange

Dayton, Ohio. JAMES DANGERFIELD

BOLLINCKX'S SCRAP-BOOK

In the machine shops of H. Bollinckx, Brussels, there is a very wonderful and useful scrap-book in several volumes. It consists of a series of sheets of blueprints of standard size, on which are reproduced in sketch form, hundreds of shop kinks from the various mechanical papers, with suitable inscriptions and reference to the date and page of the paper, in which, if desired, further particulars may be obtained. Copies of this scrap-book are placed at the disposal of those who may need them. This is a custom which other establishments would find well worth copying. The sketches can be made by an apprentice in the drafting-room, and in making them he will absorb a great deal of information. ROBERT GRIMSHAW

Dresden, Germany

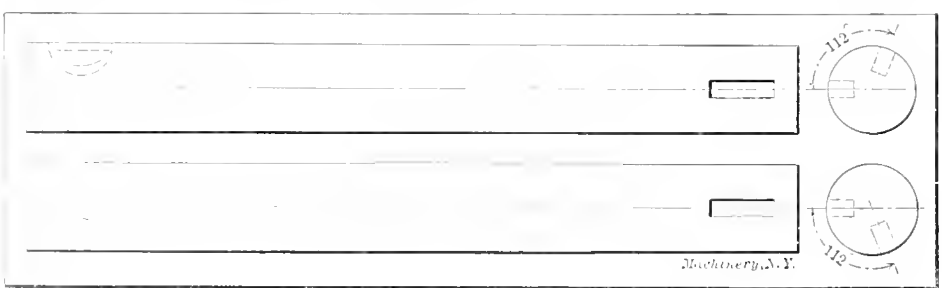
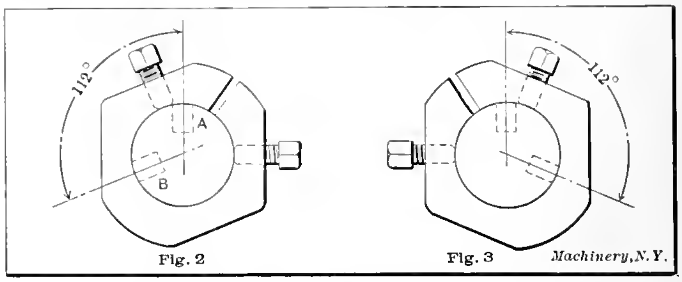


Fig. 1. Shafts with Woodruff Keyseats cut 112 degrees apart

FIXTURE FOR HOLDING SHAFT WHEN KEYSEATING

A number of cold-rolled shafts 7/8 inch in diameter and 9 inches long had to have Woodruff keyseats milled in each end, so that they were 112 degrees apart in pairs of lefts and rights, as illustrated in Fig. 1. The distance from the ends of the shafts to the center of the keyseats was 5/8 inch, and as the shafts were too short to reach through the dividing head, it was impossible to cut a keyseat in one end and use a level on it to get the position for the keyseat on the other end. The fixture in which these shafts were held while the keyseats were being milled is illustrated in Fig. 2. This fixture was first bored to a sliding fit for the shafts. Two sides were then milled parallel with each other, after which the work was indexed 112 degrees and two other surfaces were milled as shown. A 5/32-inch slot was next cut through the block and holes were drilled and tapped for set-screws to secure the fixture to the shaft. The keyseats were milled by placing the shaft in this block, which was held in the milling machine vise. The keyseat *A* was first milled at one end, after which the block was turned over, thus bringing the second keyway *B* 112 degrees from the first. This block was used in a similar manner for milling shafts with keyseats cut to the opposite hand, as illustrated in Fig. 3.



Figs. 2 and 3 Fixture for Holding and Locating Shafts shown in Fig. 1 while cutting Keyseats

In Fig. 4 a method of holding a long shaft when keyseating is shown. Two blocks are placed on the ends of the shaft to be keyseated, as illustrated, and a surface-plate or other smooth surface is used to bring the blocks into the same plane. By holding first one block and then the other in a vise while the keyseats are being milled, the latter are cut in alignment with each other. By cutting a single finished block in two, these two blocks may be made exactly alike without any difficulty. ARTHUR Z. WOLGAMOT

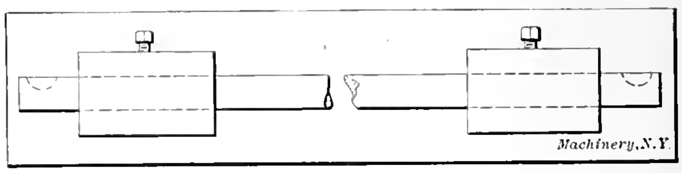


Fig. 4 Blocks for Aligning Long Shafts when Keyseating the Ends

Peoria, Ill.

IRREGULAR SPACING OF THE CUTTING EDGES OF REAMERS

After reading an article in the May issue of MACHINERY by "A," I see no reason for spacing reamers irregularly to prevent chattering and thus make accurate measurement difficult; for the chattering effect may be overcome by simply giving the cutting edges a slight spiral. A. NIELSEN

Cleveland, Ohio.

[Cutting the teeth on a helix, or spiral as commonly expressed, increases cost of production and grinding considerably, and the advantage of the spiral tooth action is doubtful. Is there a common angle best suited to steel, cast iron and brass, and if so what is it? Should the helix be right- or left-hand, and in what respect should the practice vary for machine and hand reamers? The opinions of readers are solicited for publication.—EDITOR.]

IMPROVED HYDRAULIC CYLINDER LINER

In Fig. 1 is shown a new design of hydraulic cylinder liner which does away with the troublesome features common to the ordinary cylinder liner which is shown in Fig. 2. This design shows clearly how to make feed connections to the cylinders without going through the liner. The greatest trouble as experienced with the ordinary cylinder liner shown in Fig. 2, is the making of a good joint at the heads.

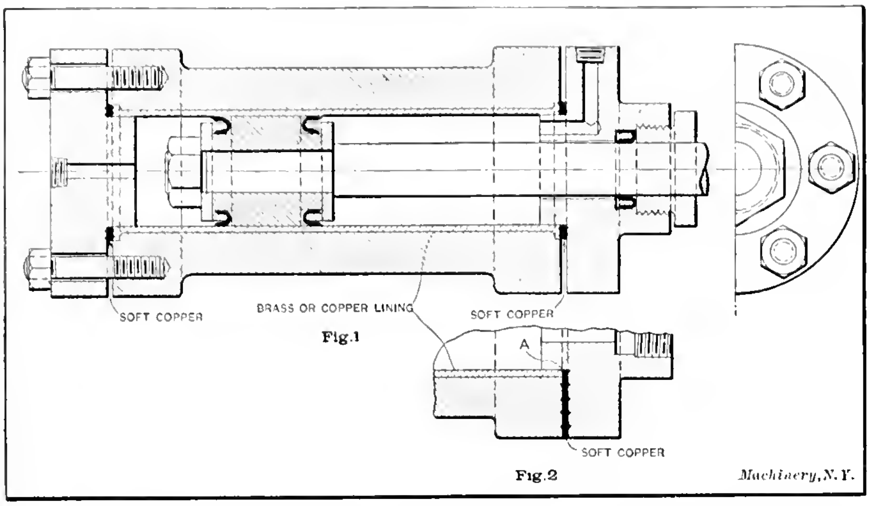


Fig. 1. Hydraulic Cylinder with Overlapping Ends. Fig. 2. Cylinder Liner of the Ordinary Type

Therefore, the reason for the failure of this joint at high pressure is easily explained. The ends and heads of this cylinder are scored or grooved and are put together with a soft copper gasket between the surfaces, which is compressed by the tension of the studs. As will be seen, this tension is not uniform over the whole surface of the gasket. Consequently the pressure of the water acting on the cylinder walls and against the head causes the former to stretch and become larger in diameter, and the latter to bulge and loosen at the gasket *A*. This stretching and bulging, though very slight, is yet enough to make a passage for the water under high pressure to reach the gasket *A*. When the water has once reached the gasket at *A* it soon makes its way between the gasket and cylinder and from there creeps in between the cylinder walls and the liner. It is very difficult to make a perfect fit between the surface of the liner and the cylinder wall and, of course, this is not improved after the cylinder has been used a while. When the water gets in between the cylinder walls and the liner the trouble begins because the water cannot get out, and with each time the pressure is put on and off there is a slight movement between the liner and cylinder. This movement causes the water to spread and make room for more water every time the cylinder is under pressure. The accumulated water soon distorts the liner and hinders the working of the piston, which, in turn, soon ruins the liner.

The design of liner shown in Fig. 1 overcomes this difficulty, and also makes a better joint which can easily be seen. The ends of the cylinder are counterbored as shown, and the liner inserted in the usual way. The ends of the liner are then lapped over into the counterbore, faced and scored or grooved, after which the heads are put on with a soft copper gasket between the joints, and the nuts shown, tightened.

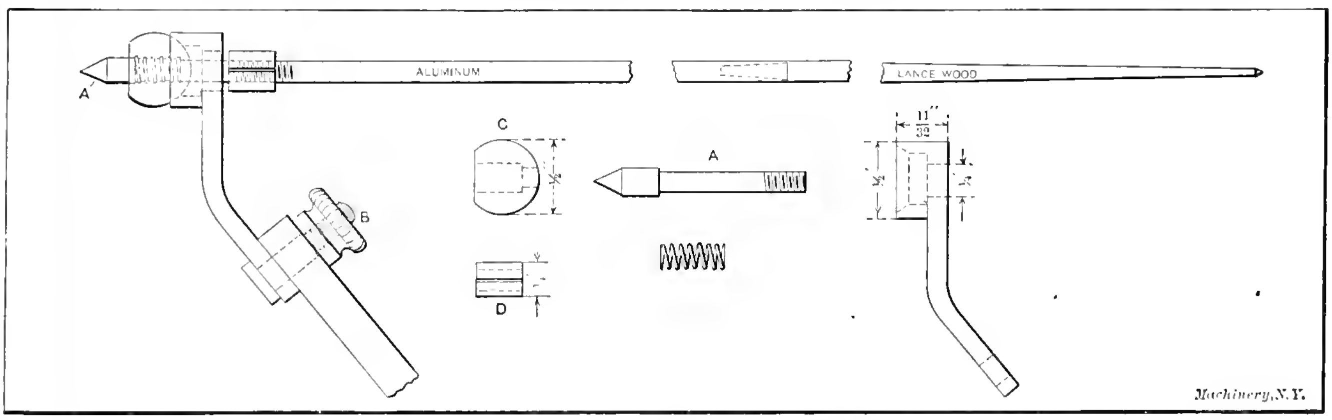
To illustrate that a greater pressure is exerted on the gasket shown in Fig. 1, we will compute the difference in the area between these two joints. For convenience we will call the joint and its parts as shown in Fig. 1 *X*, and those shown in Fig. 2, *Y*. Then to prove that the pressure per square inch of area on gaskets *X* is greater than the pressure per square inch of area on gasket *Y*, assuming, of course, that the total pressure produced by the tension of the studs would be the same in both joints, let the bore of the cylinder equal 4 inches. Let the outside diameter of gasket *X* equal 5 inches. Then the area of gasket *X* equals 7.0686 square inches. Let the outside diameter of gasket *Y* equal 9 inches. Then the area of gasket *Y* equals 51.05 square inches. $\frac{51.05}{7.0686} = 7.22$. Therefore, the pressure per square inch on gasket *X* is 7.22 times the pressure per square inch on gasket *Y*. Hence, the joint as shown in Fig. 1 is far superior to that in Fig. 2. The extra amount necessary for the lapping over of the liner as used in Fig. 1 should be from two to three times the thickness of the liner for each joint.

BENJAMIN BROWNSTEIN

CENTER INDICATOR FOR THE BENCH LATHE

Those who have spare time on their hands may use it to good advantage by making the center indicator shown in the accompanying illustration. The ball-and-socket bearing and the light needle are the good features of this tool.

When centering a point in the lathe, the point *A* is pushed back through the ball and against the spring, the spring pushing the ball against the socket, thus eliminating all play and vibration. After setting the indicator in the tool-holder, loosen the knurled nut *B* and raise or lower the point of the tool to the desired position; then tighten the nut.



Simple Form of Test Indicator for Precision Work

If, in making the needle, it is difficult to get a good piece of wood, the handle of a paint brush may be worked to shape. When making the spherical piece *C*, use a half-inch ball bearing and grind the hole carefully. The point *A* should be hardened and ground, care being taken that it is made a good fit in the part *C*. The bushing *D* keeps the ball and needle in position when the tool is not in use, and plays no part in the working of the tool.

This indicator may, of course, be attached to a larger holder for use in a bigger lathe. I have found it superior to those on the market.

GUSTAVE REMACLE, JR.

Newark, N. J.

* * *

Charcoal should never be used on aluminum while melting, as it cannot be completely removed in skimming and black spots will be found on the castings which are made from it.—*Brass World*.

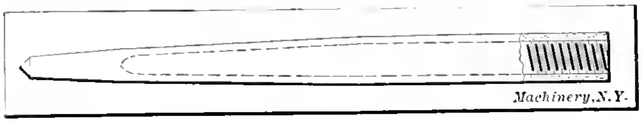
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

HOLDER FOR SHORT PENCIL

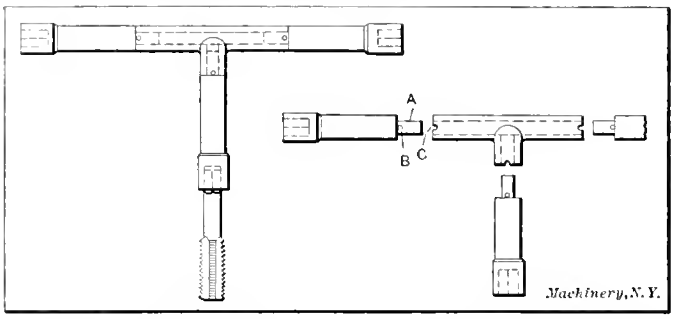
The short pencils which are thrown away by draftsmen can be conveniently used by means of the holder shown in the sketch. This holder was made from a hard rubber pen-



holder, which had been broken at the pen socket. About one inch of the solid end was cut away and the hollow part was tapped with a 5/16-inch tap. By inserting a short pencil in this threaded hole, it is rigidly held, and practically the entire pencil can be used. C. G.

TAP WRENCH WITH INTERCHANGEABLE SOCKETS

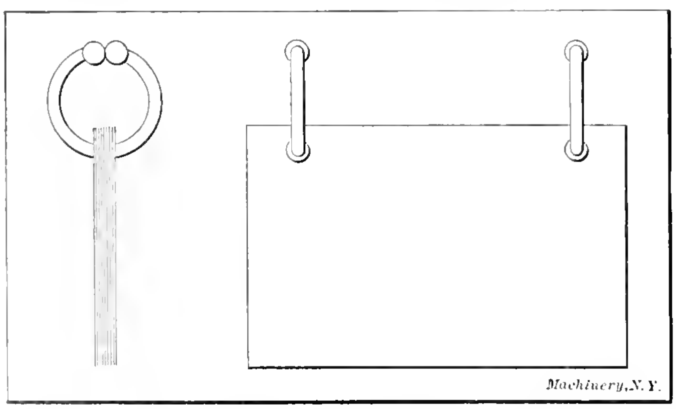
When tapping out holes by hand on heavy machine parts, such as beds, frames, etc., where several size taps are used, it is inconvenient to handle, several times, the different tap wrenches and tap extensions that must be used in operations of this kind. It also requires time to first find the various wrenches and extensions wanted. By combining three extensions to a tee, as shown in the accompanying engraving, a



tap wrench is formed having interchangeable ends of three different sizes. The changing of the extensions in the tee is the work of a second. This tee is a forging in which holes are drilled to fit the reduced ends *A* of the extensions. Small pins *B* which fit into slots *C* prevent the extensions from turning with relation to the tee. Two of these sets in a shop will meet any condition. There should be a small set having extensions for ¼-, 5/16- and ⅜-inch taps, and a larger set for 7/16-, ½- and 9/16-inch taps. J. E. C.

LOOSE-LEAF CARD INDEX FILE

The simple form of loose-leaf book or card index file shown in the engraving, is made of suitable cards held together with two key-rings, that may be obtained in any hardware store for ten cents. I find this file very convenient, as it can be

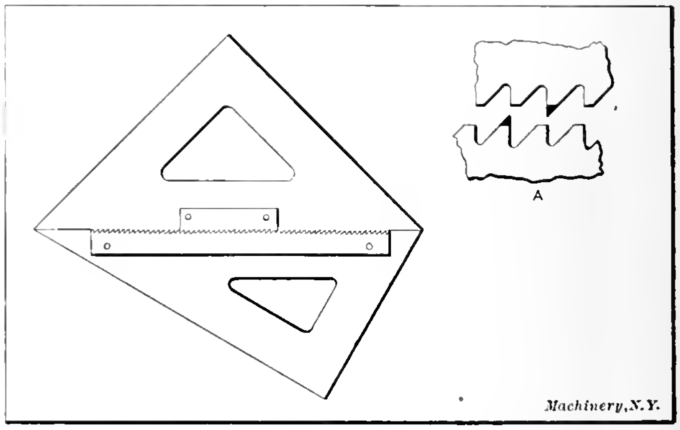


opened at any page and will not occupy more room on the desk than a single sheet or card. It has the additional advantage that a page can be taken from or added to it with little difficulty. D. F. Huddle, Jr.

Wilkinsburg, Pa.

SECTION LINER

A sectional liner, which works very satisfactorily, can be made by attaching pieces of a hack-saw blade to two triangles, as illustrated herewith. I made a section liner in this way by using an old saw blade. The blade was first annealed, after which the sides were ground and also the points of the teeth (as shown in the enlarged view at *A*) so that they would not bear in the fillets. Two pieces of blade, one 6 inches long and the other 2 inches, were then cut and drilled for pins. By using these two pieces as jigs, the triangles were drilled and the pieces attached by pins so that the long one was flush with the edge of one triangle and the short one was in mesh with the other as illustrated. When using this section liner, either one, two or three teeth can be used for

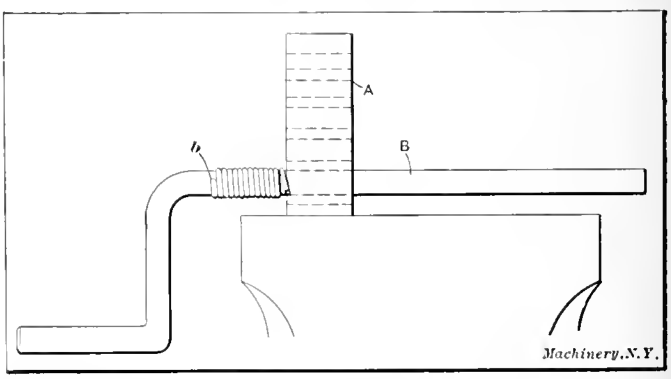


spacing. If a fine sectioning is desired, lines can first be drawn with single-tooth spacing, after which a second set can be drawn with the same spacing but with the triangles so adjusted that the last lines drawn come between the first set of lines. This attachment is easily made, and it does not prevent the ordinary use of the triangles, for when the blades are not required for sectioning, they can be removed.

Milwaukee, Wis. H. Blount

DEVICE FOR WINDING LIGHT SPRINGS

A very simple device that may be used for winding light springs is illustrated herewith. This tool will often save much time when a spring is wanted in a hurry, as springs of a variety of sizes and pitches can be made at a moment's notice. This apparatus is inexpensive and is easily made. The part *A* is made of a piece of ¾-inch square steel about 12



inches long. In this steel piece a series of holes are drilled about one-half inch apart and ranging from ⅛ to ½ inch in diameter. The mandrel *B*, on which the springs are wound, is made of wire or round stock of the size required. It has a handle formed on one end and a small hole is drilled at *b* to hold the end of the wire when starting the spring. To wind a spring, an arbor having a diameter equal to the inside diameter of the spring is selected and inserted in a hole of corresponding size in the piece *A*, which has been clamped in an upright position in the vise as indicated. One end of the wire is caught in hole *b* and, while the arbor is turned with the left hand, the right is used to hold and guide the wire. With a little practice a well-formed spring can be wound with this tool. H. B. Comstock

St. Paul, Minn.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

AUTOMATIC TWIST DRILL GRINDER

As is well known, twist drills, to give efficient service, must be kept sharp and be ground correctly, which means that the cutting edges, in addition to being of the same length, have a proper and uniform angle, that the clearance is so shaped as to give good support to the cutting edges and at the same time permit a free cutting action. In order to simplify the operation of drill grinding, A. Mill, M. E., Cincinnati, O., has designed the twist drill grinder, front and rear views of which are shown in Figs. 1 and 2, respectively. This machine is automatic in its operation and grinds drills ranging from 3/16 inch to 3 inches in diameter.

The drill, while being ground, revolves continuously at a uniform speed, and the ordinary two-lip drill oscillates twice in one revolution about a center which exactly coincides with the axis of the drill and which is more or less away from the drill point. This oscillation, which produces the required amount and form of clearance for the drill lip, is caused by a cam *C*, Fig. 3, which works against a stationary roller *B*, that

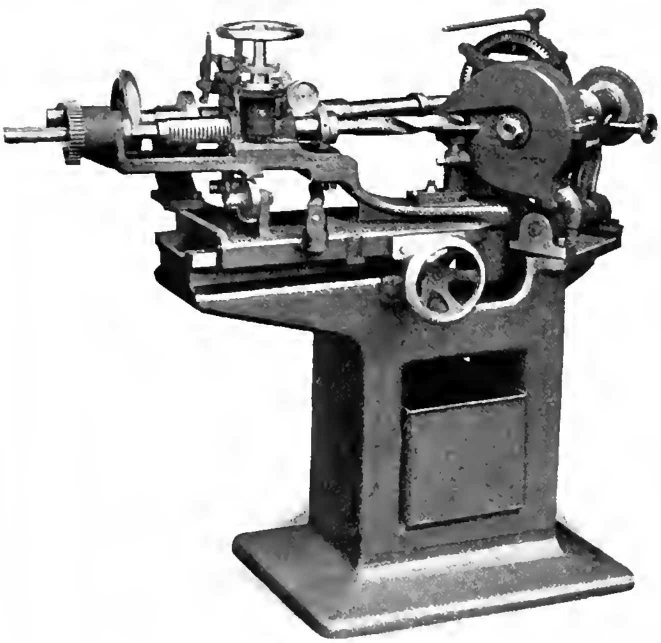


Fig. 1. The Mill Automatic Twist Drill Grinder

is attached to the carriage containing the drill-holding spindle and the feeding mechanism. The back shaft on which the cam *C* is mounted, is driven by means of a universal joint connection, and it revolves at twice the speed of the drill spindle. The drill, in addition to having this oscillating movement, is reciprocated to and from the emery wheel twice during each revolution by face cam *A*, which, through a lever, operates block *D*, Fig. 4, in which the drill spindle is mounted. The point of the drill is, of course, in contact with the wheel while the clearance for one lip is being ground; it is then withdrawn from the wheel by the face cam *A*, an amount sufficient to bring the opposite lip in the correct position for grinding. This reciprocating or longitudinal motion of the drill spindle also affects the automatic feed of the drill. The spindle in which the drill is held, revolves in a rack-sleeve or quill, which is engaged with a pinion as shown. The shaft on which this pinion is mounted, carries a handwheel *F* for the rapid traverse of the spindle and also a worm-wheel which is always in engagement with a worm. This worm-wheel is loose on the shaft, but it can be secured to it by a friction disk and hand-nut for the automatic feed. The small handwheel, shown at the front of the worm-shaft, is for feeding by hand, while the ratchet wheel at the other end furnishes the automatic feed when its pawl is released from the catch. This feed is effected, as before stated, when slide *D* is reciprocated; as this movement takes place, the pawl *H* moves with relation to its ratchet wheel, so that on the return of *D*,

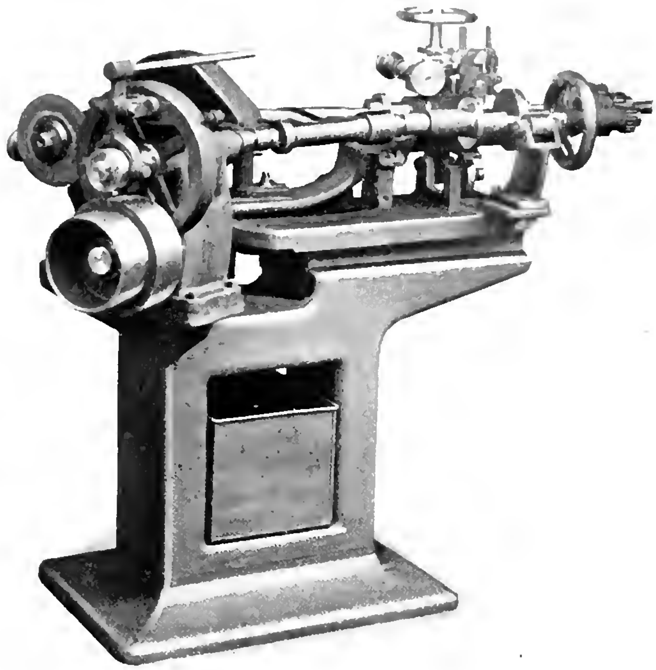


Fig. 2. Rear View of Automatic Drill Grinder

the spindle sleeve containing the drill is fed forward through the worm gearing and pinion connection. This automatic feed can be instantly released by simply disengaging the pawl from its wheel. An automatic stop can also be arranged by having an adjustable pin on the drill spindle sleeve, so located as to strike the lower part of the trip-lever and disengage the pawl.

The emery wheel frame is made oscillating to prevent the cutting face of the wheel from clogging up and also to insure uniform wear. This oscillating movement is effected by an

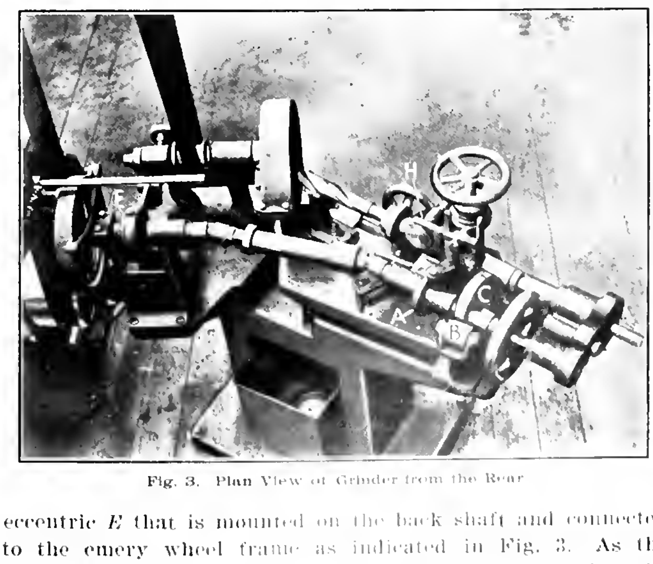


Fig. 3. Plan View of Grinder from the Rear

eccentric *E* that is mounted on the back shaft and connected to the emery wheel frame as indicated in Fig. 3. As the wheel is thus given a continuous movement to and fro, the drill will receive a smooth grinding and the wheel itself will always remain sharp. An adjusting screw is provided to lengthen or shorten the connection with the eccentric so that the entire face of the cup wheel may be used, thus keeping the

wear uniform. The emery wheel is 9 inches in diameter and has a grinding face 1¾ inch in width.

Before inserting a drill in the spindle, the latter is moved to the end of its oscillating stroke by turning a handwheel on the back shaft until an arrow point on the spindle hearing coincides with a mark on the spindle collar. A threaded hand-nut with a conical bore serves to close the slotted spindle end around the drill shank, thus securely locking it in place after the lip of the drill has been set to a gage. These few simple adjustments in connection with the automatic operation, make it possible for a boy to operate several of the machines if necessary.

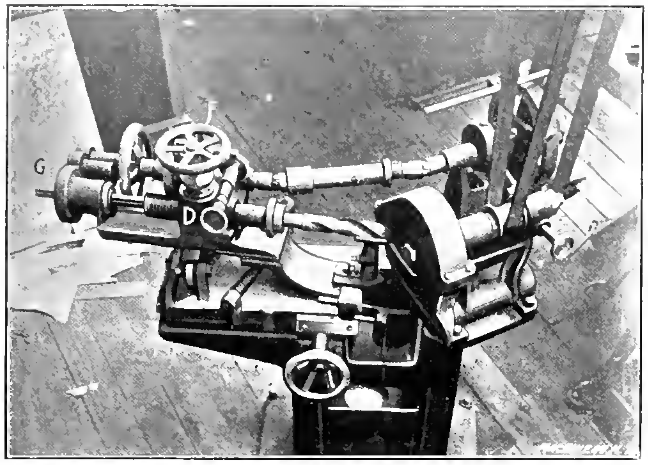


Fig. 4. Plan View from the Front

For different sizes of drills, the distance to the center of oscillation is changed according to a graduated scale by means of a handwheel at the front of the machine, which adjusts the carriage along the bed by a rack and pinion movement. As the engravings show, a small, narrow wheel is mounted at the outer end of the emery wheel spindle. This small wheel is for reducing (by hand) the thickness of the drill web at the point, when this becomes necessary. A rotary pump (not shown in the illustration) is attached to the machine for wet grinding. This grinder can be used for sharpening either right- or left-hand drills, and by the use of change gears *G*, drills having any number of lips, can be ground.

IMPROVED TOLEDO PRESSES

The two presses shown in Figs. 1 and 2 are improved patterns which have been recently designed by the Toledo Machine & Tool Co., Toledo, O. The machine shown in Fig. 1, which is designated as No. 96 C, is a double-crank press so constructed that the press operators or attendants can work on the right- or left-hand ends and on the front and rear sides of the machine. This press is double back-geared and it is operated by a friction clutch (not shown) which is located on the lower of two pinion shafts on the right-hand side in the rear. This friction clutch is operated by the hand-lever seen on the right side of the machine, which gives the operator complete control for starting and stopping at any position of the stroke or slide motion. The two pinion shafts in the rear have been elevated above the gear centers, which gives a clearance or free space from the floor line to the lower pulleys of 7 feet, so that the operators are not subjected to danger because of the driving mechanism. Large openings are provided in each of the two housings, which will permit material being passed through from one side to the other when it is necessary to form parts of greater length than the width between the housings would permit without this construction. As the illustration shows, the press frame is built up of four pieces and is reinforced by a similar number of powerful steel tie-rods. The outboard pedestal bearing is eliminated in this type of machine so that a minimum of floor space is required. The weight of the machine is 65,000 pounds; the distance between the housings, 73 inches. The stroke and the distance from the bed to the slide are made to suit specifications.

Fig. 2 illustrates the No. 59 single-crank forging-trimming press which is a new type developed for trimming drop forgings. In this machine the detached outboard pedestal bearing has also been eliminated, which reduces the floor space and prevents any disalignment of the flywheel or pulley shafts. This press is operated by a powerful block clutch with gravity release or controlling mechanism. It has an unusually heavy balance wheel which, though small in diameter, provides sufficient power or momentum for obtaining the maximum output. The press is double back-geared, and it is intended for trimming long forgings for crankshafts and for similar work. The stroke of this machine is 9 inches; the distance from the

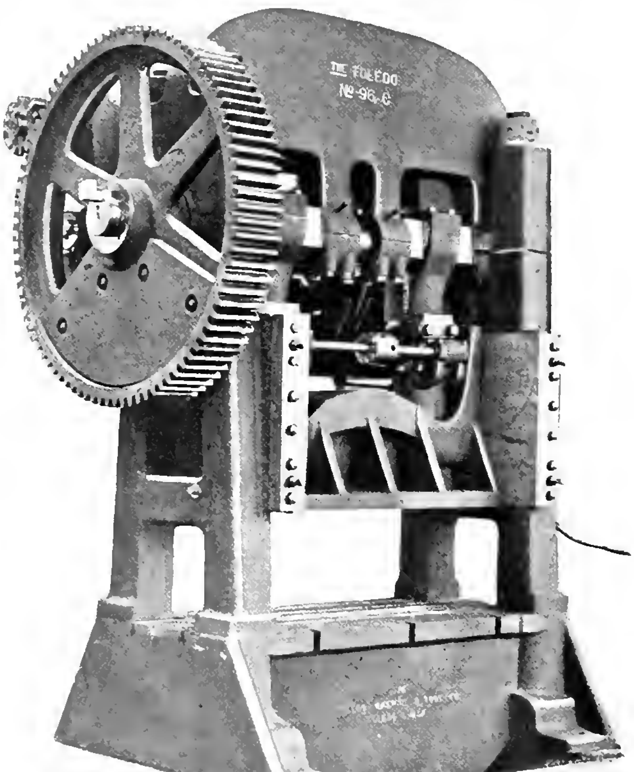


Fig. 1. No 96 C Toledo Double-crank Press

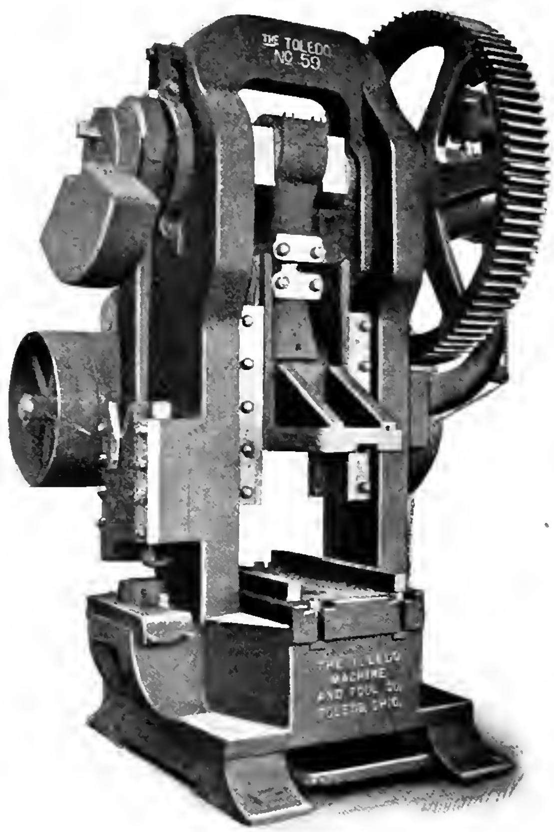


Fig. 2. No. 59 Toledo Single-crank Trimming Press for Forgings

bed to the floor, 24 inches; distance from the bed to the slide, 29 inches; width between the housings, 30 inches; length of bed, 56 inches. The stroke of the outer trimmer is $3\frac{1}{2}$ inches, and the bed measures 14 by 20 inches. The weight of this machine is about 12,500 pounds.

YOUNG MACHINE AND TOOL CO.'S LATHE MILLING ATTACHMENT

A lathe milling attachment that is particularly adapted for small shops and garages where there is not enough milling work to warrant the purchase of a regular milling machine, has been put on the market by the Young Machine and Tool Co., Worcester, Mass. This attachment is capable of a wide range of work and it has the commendable feature of being easily attached to or removed from a lathe. Its general construction is clearly illustrated in Fig. 1, which also shows the dividing-head, tailstock, vise, etc., while the other views, Figs. 2 to 6 inclusive, show the way it is fastened to the lathe carriage and also some of the milling operations which may be performed.

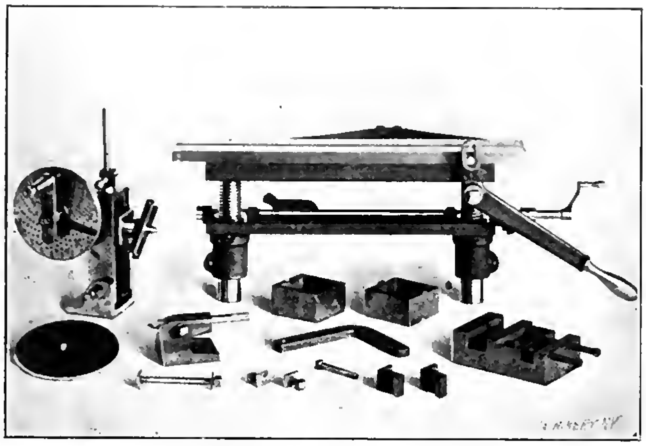


Fig. 1. Lathe Milling Attachment built by the Young Machine & Tool Co.

The attachment consists principally of a work-table that is supported by two square-threaded screws passing through nuts located in a base that is attached to the lathe carriage by two brackets, one of which is bolted to the front and the other to the rear. Meshing with these nuts, which have teeth cut in their peripheries, is a worm-shaft that may be operated by a crank at the front of the lathe to effect a vertical adjustment of the table, the nuts revolving about the screws which are rigidly fixed to the work-table. The attachment, in addition to being bolted to the carriage, is further steadied by two angle-pieces, located inside the ways on each side, one of which is adjustable, thus insuring a close sliding fit.

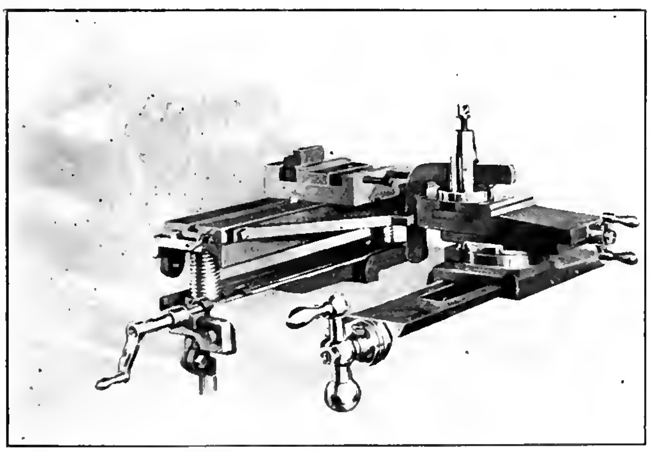


Fig. 2. Attachment set up for End Milling

Either hand or power cross-feed is available, the power feed being obtained from the lathe itself by connecting the table of the attachment with the lathe cross-slide. This connection is made by simply inserting an angle-piece in the tool-post (as in Fig. 2) and clamping it in such a position that engagement is made with a slotted side-piece bolted to the table. By this simple arrangement, a range of feeds is obtained equal to that available on the lathe. When a hand feed can be used to better advantage, the cross slide and table are disengaged by removing the angle-piece, which places the cross movement of the table under the control of the hand-lever seen on the left side of the attachment. This lever is in the form of a bell-crank and it has a slotted end which engages a pin attached to the table.

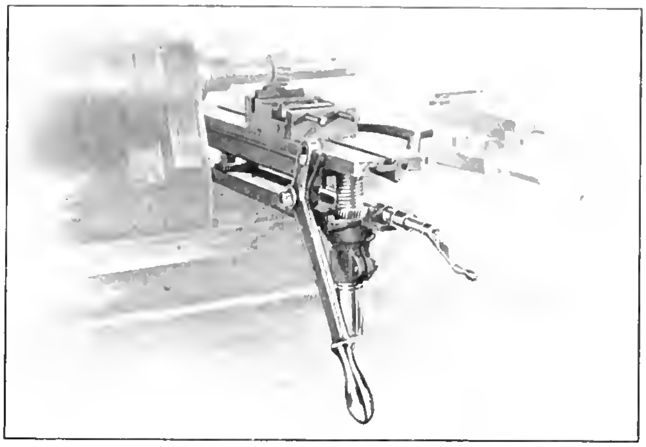


Fig. 3. Milling Light Work by using Lever Feed

By means of the dividing head furnished with this attachment, 133 divisions can be obtained which are as follows: Any number from 1 to 50, every other number from 50 to 100, and beyond that irregular divisions. This head is so attached to its base that it can be swiveled to a maximum angle of 55 degrees from the vertical, and graduations are provided indicating its position. Provision is made for taking up any wear which may occur between the worm and wheel of the dividing head, and a taper gib is used to eliminate play between the table and the slide.

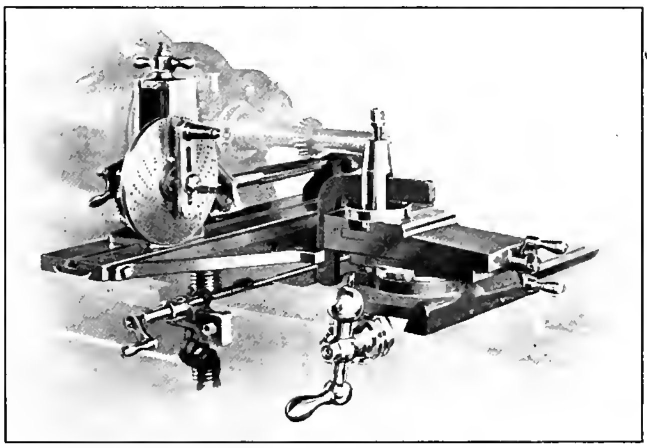


Fig. 4. Fluting a Taper Reamer

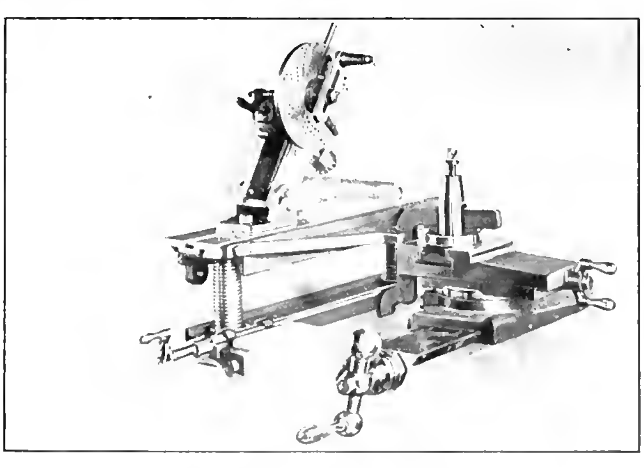


Fig. 5. Cutting a Bevel Gear

In Fig. 2 the attachment is shown set up for an end milling operation with the power feed in use, while Fig. 3 illustrates

the method of milling small parts with the lever feed, the work in both cases being held in the vise, which is part of the regular equipment. In Fig. 4 the method of fluting a taper reamer is indicated, the proper setting for the taper being obtained by the vertical adjustment of the dividing-head center. Fig. 5 shows the way the attachment is arranged for cutting a miter or bevel gear, the work being held in the spindle of the dividing-head, which is set over to the required angle. The method of using the attachment for cutting a spur gear is shown in Fig. 6, the work in this case being mounted on a mandrel between the centers. It will be noted that height

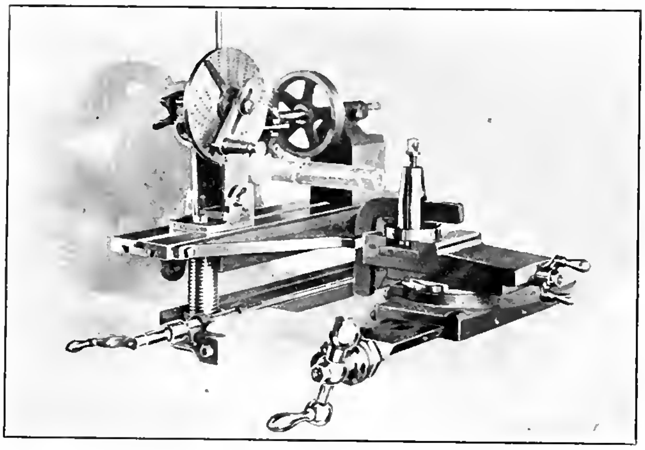
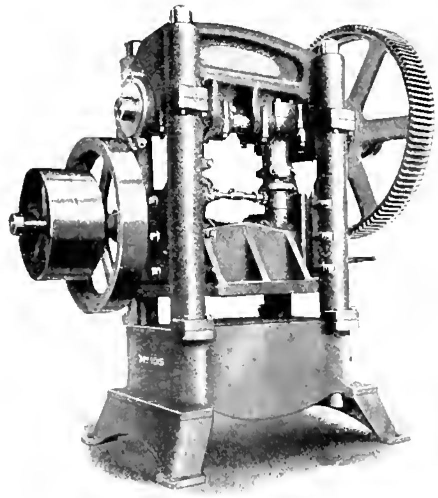


Fig. 6. Cutting a Spur Gear

blocks are used beneath the tailstock to bring it to the required elevation.

Of course, much of the work for which this attachment is adapted can be bolted directly to the table, which is provided with a T-slot throughout its entire length, and has a working surface of 4 by 22 inches. The maximum distance between the centers of this attachment is 13 inches, and the dividing-head center can be adjusted vertically to a height of $5\frac{1}{2}$ inches above the table. This vertical adjustment is effected by a hand-nut at the top, which may be locked in any desired position. The spindle will be bored to receive either a No. 1, 2 or 3 Morse taper as desired.



No. 1015 Double Pitman Press built by the Max Ams Machine Co.

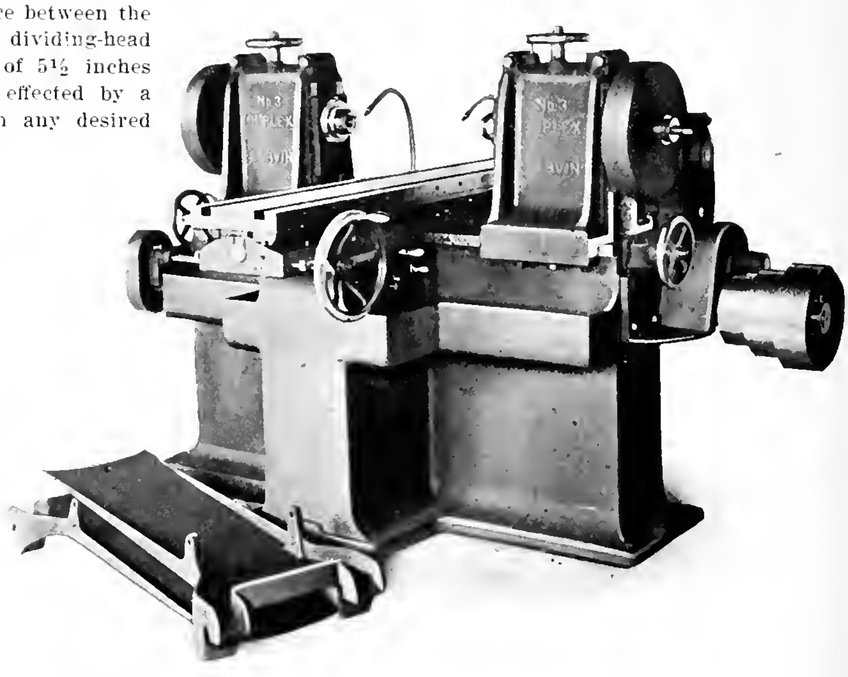
MAX AMS DOUBLE PITMAN PRESS

The Max Ams Machine Co., Mt. Vernon, N. Y., has brought out an interesting design of double pitman press, which is intended for stamping and forming operations of a severe character. The frame of this machine is of the built-up type, the entire working strain being taken by four steel tie-rods, as shown. The slide extends through openings in the uprights at each end, which makes it possible to utilize the entire length of the press bed, so that sheets 20 by 48 inches may be handled, while the distance between the uprights is only 34 inches. A sheet 25 by 25 inches can also be worked when feeding from front to back. The double eccentric shaft on this press is rigidly supported by bearings located on each side of the pitman connections as shown. The eccentrics are solid enlargements of the shaft itself, which gives very large bearings. The strain is taken directly by the main frame instead of the cranks, which prevents springing and eliminates any uneven wear. The clutch is solid with the shaft, and, besides being strong and durable, is practically noiseless. All other features common to this style of press, such as parallel adjustment of the slide, strong pitmans, etc., are embodied in the construction. The driving pulleys of this machine are 28 inches in diameter, and have a 6-inch face. The flywheel weighs 1100 pounds, and the gearing ratio is $8\frac{1}{2}$ to 1. The complete weight of the press is 20,000 pounds.

GARVIN NO. 3 DUPLEX MILLING MACHINE

The Garvin Machine Co., Spring and Varick Sts., New York City, has brought out the duplex milling machine illustrated herewith, which is designed to give a longitudinal table feed of 60 inches without any deflection or cramping action in the slide. The table is 64 inches long and its bearing in the saddle has a length of 60 inches. The feed to the table is by means of a square-threaded steel worm of large diameter and a spiral rack. This spiral rack is cut from the solid on the under side of the slide, and the worm is made in halves for taking up wear. It should be explained that the grooves in the slide illustrated were made for special work, the regular pattern having three standard T-slots.

Particular attention has been given by the makers to the matter of taking care of the chips and the lubricant from the cutters. The two shield castings shown on the floor are bolted to the saddle and serve to drain all the lubricant that drips from the slide when the latter overhangs the saddle, to the oil and chip channels which are cast all around the upper edge of the base, as shown. These channels communicate with one another, and in them there are chip strainers located about half-way in their depth, thus leaving a clear oil space all around from which the pump draws its supply through a fine strainer and delivers it through flexible pipes to the work.



Garvin No. 3 Duplex Milling Machine

The drive to the spindle is from a common splined shaft through spur gearing, back-geared in the ratio of 6 to 1, from a three-step cone pulley, which is driven from an overhead countershaft. The machine has 12 positive feed changes, and 3 speed changes for the spindles. The taper holes in the spindles are No. 11 Brown & Sharpe taper, and they have the positive slot drive. A draw-rod which reaches through from the rear end of each spindle holds the taper shank of the tool firmly in its seat. The threads on the outside of the two spindles are cut right- and left-hand, respectively, and to

the standard Brown & Sharpe size of $3\frac{1}{4}$ inches in diameter by $3\frac{1}{2}$ pitch. The table has a working surface of 12 by 64 inches. The maximum distance between the spindles is 27 inches, and the minimum distance, $4\frac{1}{2}$ inches. The spindles may be adjusted vertically from $1\frac{1}{4}$ inch to 9 inches above the surface of the table.

AUTOMATIC KNIFE ROLLING MACHINE

Over two decades ago it was discovered that table knives could be correctly shaped by grinding them on the face of a cup wheel somewhat beveled inward. This gave the convex cross-section of blade which pleases the eye and backs up the

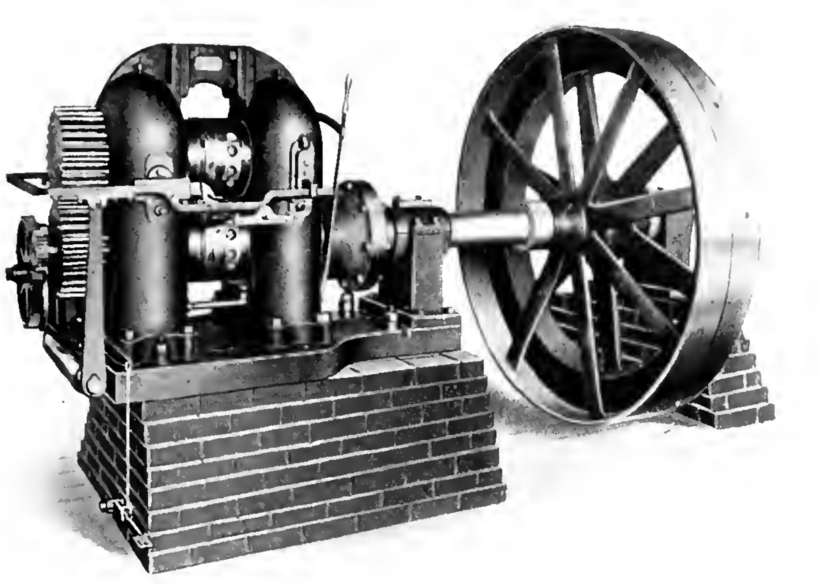
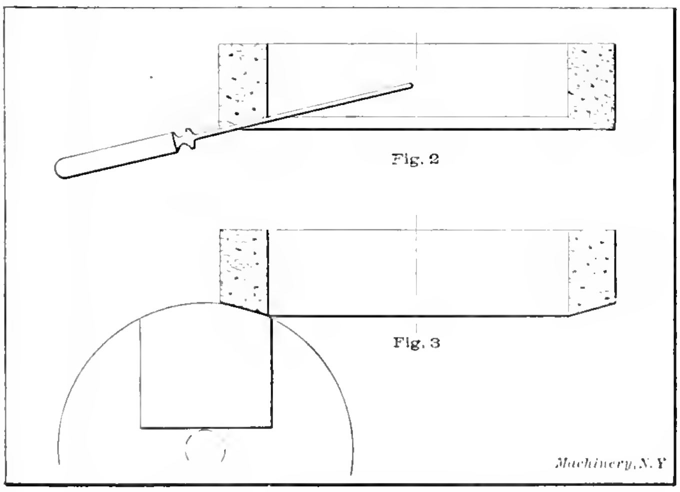


Fig 1. Automatic Knife Rolling Machine built by the New Britain Machine Co

cutting edge. The discovery was important and it formed a foundation upon which automatic knife grinding machines then and since have been built for eliminating the drudgery and uncertainty of hand work.

Singularly enough, the same inventor, but years later, thought out the correlative process of shaping dies for hot-rolling knife blades by grinding these dies concave on the face of a cup wheel beveled in the opposite direction from the knife grinder.

The use of and connection between these two discoveries will be seen from Figs. 2 and 3 considered in connection with the cross-sections of the typical knife blade shown in Fig. 6. These sections show the uniform thickness of the cutting edge,



Figs. 2 and 3. Diagrammatical Views illustrating Use of Cup-wheel to obtain Convex Blade and Correlative Process of Shaping Rolling Dies

the convexity of cross-section and the tapering back, the thickest part being at the bolster.

Previous to rolling, the knife blank appears as shown in Fig. 4, the handle and bolster having been drop-forged and the metal near the bolster spread enough in width to start rolling. It will be noted that the flash need not be removed, and that stock of either round or elliptical section may be used for rolling. Fig. 5 shows the knife as rolled automatically in two passes, and Fig. 6 the knife as finished forged and trimmed with a uniform grinding allowance.

It has been common practice for years to roll blades in interrupted or kidney rolls, running toward the operator, the work held in tongs, being pushed through and the dies forcing it back. Two passes through and back are necessary, owing to the tendency of the first rolling to bow the blade scimitar shape and to leave it rough. The second pass in second dies straightens the blade and leaves a better surface.

In hand rolling, the presentation of the work to the rolls must vary with the workman's skill, and the blank must be held for both rolling operations. In automatic rolling, with the machine illustrated in Fig. 1, the knife is always brought to the same position on the die, and as accurately transferred to the second die without the attention of the operator beyond the initial placing of the heated blank in the gripper. When this has been done, the operator can turn to the fire for a second blank while the first is still in the rolls, and he can easily maintain an output of over four hundred blades an hour—more than twice the hand rolling production. The gripper and the mechanism for transferring the blank from one die to the other are illustrated in Figs. 7 and 8, which show respectively, front and rear views of the rolls.

It has been found advantageous to use alloy steel for the dies, as they hold their shape four or five times longer than do carbon steel die blocks. These dies, which are plainly shown in Figs. 7 and 8, are held in the rolls by wedges, and they are readily removed for grinding or changing. The barring holes shown in the fly-wheel rim (Fig. 1), assist in setting the dies.

The grippers too are readily changed for handling various shapes of bolsters and tangs, a few of which are shown in Fig. 9. Fork blades are similarly rolled and held.

The hand lever with the notched quadrant shown to the

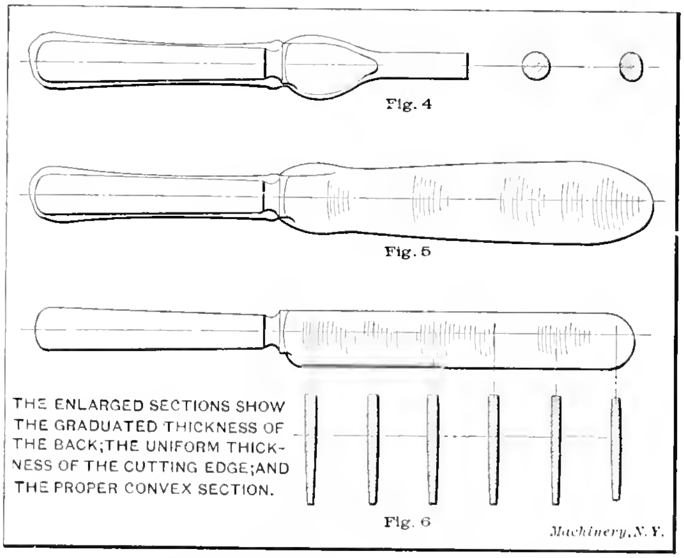


Fig. 4. Blank previous to Rolling. Fig. 5 Knife as rolled in Two Passes
Fig. 6. Knife as finish rolled and trimmed

right of the machine (Fig. 1), controls the thickness of the finished blade; its position may be varied while the machine is running, thus grading the thickness in steps of 0.001 inch. This machine, as illustrated, has the gear guards and belt shipper removed to more clearly show its construction.

Obviously, the closer and more uniformly blades are rolled, the better for the grinding machine, as a small variation in the rolled product means fewer passes by the wheel to bring all blades to a standard. It will be clear then, that a die grinder forms an essential part of the outfit. The grinder shown in Fig. 10 has been designed to produce or duplicate any shape of die desired. The dies are shown in the left foreground with their grinding holders next to them.

Interchangeability in the cup wheels is provided for. The

wheel runs in a safety hood and the spindle in self-oiling boxes. All controlling adjustments are made without recourse to wrenches and without leaving the operating position. The wheel when in use is flooded with water through the piping shown.

These machines are patented and are made by The New Britain Machine Co., which is located at New Britain, Conn., in the immediate proximity of the largest knife concerns in this country.

WATERBURY FARREL AUTOMATIC SCREW SLOTTER

The automatic screw slotting machine illustrated herewith, which is a design recently developed by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., embodies a number of new and interesting features which insure accuracy and high quality in the product, as well as economical production. The blanks to be slotted are automatically fed from a hopper

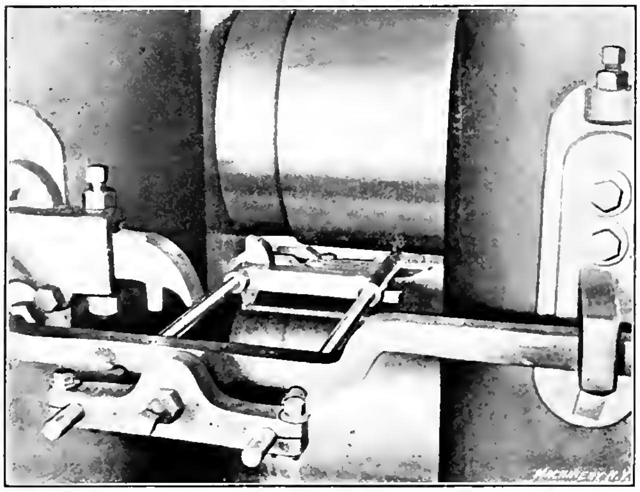


Fig. 7. Front View of the Gripper

to the slotting saw, from which they are delivered to a receptacle without attention on the part of the operator. While the slotting operation is taking place, the screw blank is rigidly held and the frame which carries the saw is also rigidly fixed to avoid chattering. This frame is provided with sensitive lateral and front-to-back adjustments, which accurately locate the position of the saw with respect to the screw-head. The saw also has an adjustment for determining the depth of the slot, which can be operated when the machine is running, and provision is made for allowing the maximum amount of time

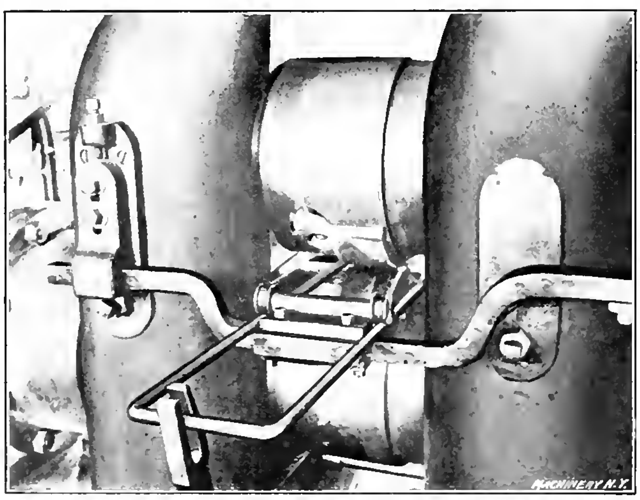


Fig. 8. Rear View of the Gripper

for slotting, even though the slots are of varying depths. The saw is well guarded, not only to protect the operator, but also to prevent the oil and chips from flying. This guard is so constructed that it may be quickly swung out of the way when changing saws.

The machine is arranged so that the chips and finished blanks are delivered into separate receptacles, the chips entering the small removable box seen in the illustration, while the screws are delivered into a pan (not furnished with the machine) placed at the right of the box. Provision is made for supplying the lubricant to the blanks and saw while the slotting is taking place. This lubricant is pumped from a tank (located below the bed), by a small geared pump, which forces it through suitable piping to the operating point, whence it flows with the chips into the chip box, where the chips sink to the bottom and the lubricant flows off the sides and drains back into the tank.

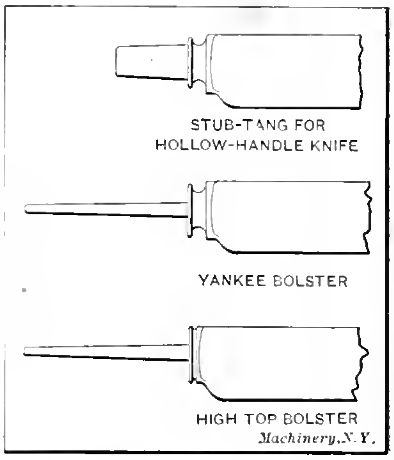


Fig. 9. Bolsters and Tangs of Various Shapes

This machine can be operated at the speed which is most suitable for the particular screw to be slotted. The power for driving the saw is obtained from a countershaft, by belt on a pulley 4 inches in diameter by 1½-inch face, which is geared to the saw spindle in the ratio of 3 to 1 for steel work, while for brass a pulley of the same size is located directly on the spindle. The hopper-feeding mechanism has simple adjustments which adapt the machine not only for work which is done in long runs, but for short runs as well. To shift from

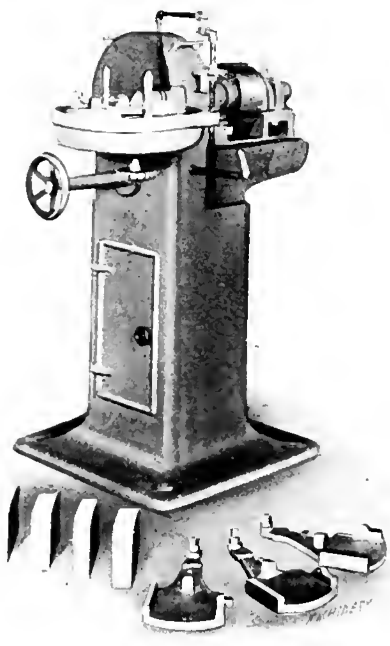
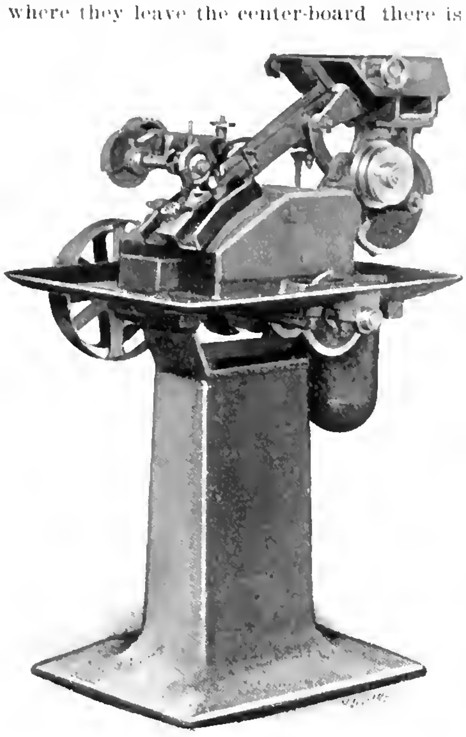


Fig. 10. Machine for Grinding the Diee

one size blank to another, it is necessary to replace two pieces only. Blanks having short shanks are handled equally as well as those with long ones within the capacity, which is 1½ inch under the head. The maximum diameter of shank for which the machine is adapted is ¼ inch. Blanks having a length of shank equal to one diameter have been successfully fed by the hopper and slotted, but so much depends upon the shape and size of the head that it is difficult to give definite information regarding the minimum lengths allowable. For this reason the builders solicit samples of the blanks to be slotted before recommending this machine. The hopper is driven by a round belt from the machine itself through cone pulleys, which provide means for speeding the hopper to suit the work.

In the operation of this machine, the blanks are placed in the hopper where they are caught by their heads in a blade or center-board, which has a slot along its top a little wider than the diameter of the blank bodies. This center-board, which, at its lower position is parallel with the bottom of

the hopper, swings vertically through the latter; as it is elevated through the mass of blanks, some are caught in the slot by their heads and are carried to the upper position where the center-board acts as an extension to the inclined chute. Here the blanks slide down into the chute, and near the point where they leave the center-board there is a rapidly-



Automatic Hopper-fed Screw Slotting Machine

revolving toothed wheel located and adjusted so that any blanks which enter the chute in an improper position are thrown back into the hopper. This leaves the entrance to the chute clear and prevents clogging. At the foot of the chute, the blocks enter what is called the carrying dial, which is 2 7/16 inches in diameter and ½ inch thick. If a blank should be held so that it was half in the dial and half in the chute, a slight special motion which is given the dial agitates the column of blanks and starts the feed after the loss of only one revolution of the machine and entirely without attention from the operator. This carrying dial has V-notches cut in its periphery in which the blanks are carried from the chute to the point where they are slotted. After this operation has taken place, the blanks are carried a little further and delivered into a receptacle.

The chute cover is hinged so that it can be swung up for removing any blanks that might become lodged. The hopper blade is made with a removable top containing the pick-up slot, which is changed for screws of different sizes. These can be furnished slotted and drilled for fastening them to the hopper slides. The carrying dials can also be furnished ready to put on the machine. The chute is adjustable for different diameters within the limits of the machine, and the design of the latter is such that it can be readily adapted to larger or smaller sizes.

The main drive of the machine is through a two-step cone pulley. The saw is held on its spindle between two clamps by a nut, no key or dowel pin being used. The size of the saws for which the machine is designed is 2¾ inches in diameter. Slightly larger saws can be used, as well as the standard sizes which have grown smaller by grinding. The saw spindle runs in bronze bushings, and the one next to the saw is tapered and split for taking up wear.

A feature to be considered in connection with this machine is the size of the head and slot. For example, a 1/8-inch screw having a very large head might be slotted on this machine, while a ¼-inch screw with a head of extraordinary size might require a larger size machine, whereas if it had an ordinary sized head, the one illustrated would handle it with perfect satisfaction.

Standard stock machines are furnished with a countershaft, a pulley for the saw spindle for brass-work, a set of wrenches, a saw and a dial, all suitable for work similar to the sample which should be furnished so that each machine can be tested on blanks for which it is intended, before shipment.

INTERNATIONAL BELT SHIFTER

A design of combination belt shifter is shown in the accompanying engravings, which, in addition to shifting the belt, retains it when in the off position, thus completely disconnecting the belt from the shaft pulley. The general construction and the method of operation of this shifter are indicated in Figs. 1 and 2, which show the belt on the driving pulley and its position when shifted, respectively.

The apparatus consists of a frame, similar in form to a segment of the pulley rim. Projecting from the curved part of this frame toward the pulley rim there are a number of spindles which carry sleeves or rollers. These rollers form a support for the belt when the latter is shifted, thus performing the function of the ordinary loose or idler pulley. The mechanism employed for shifting the belt consists of front and rear shift-bars, which are mounted in brackets and from which project rollers for engaging the belt. The front shift-bar moves the belt from the driving pulley onto the retaining rollers, and the rear bar shifts it back to the pulley. These shifters, as the engravings show, are operated by pull-chains and they are automatically returned to their original position

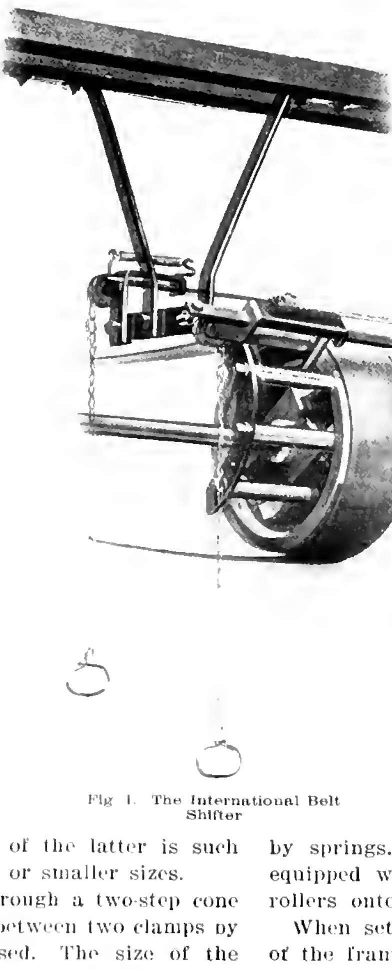


Fig. 1. The International Belt Shifter

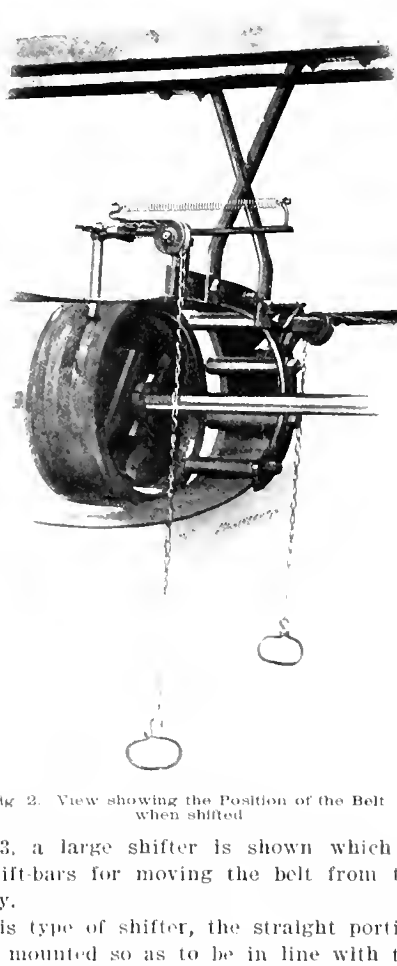


Fig. 2. View showing the Position of the Belt when shifted

by springs. In Fig. 3, a large shifter is shown which is equipped with two shift-bars for moving the belt from the rollers onto the pulley.

When setting up this type of shifter, the straight portion of the frame must be mounted so as to be in line with the belt. The first roll is located at the point where the belt runs onto the pulley, and the first three or four rolls should be 1/8

or 3/4 inch higher than the pulley rim. A sufficient number of holes are drilled in the frame so that the shifter can be bolted to the hangers in any position. It is stated that large, as well as small belts, can be shifted rapidly and without exertion. By the use of this type of belt shifter, particularly in large plants, it will be seen that considerable friction will

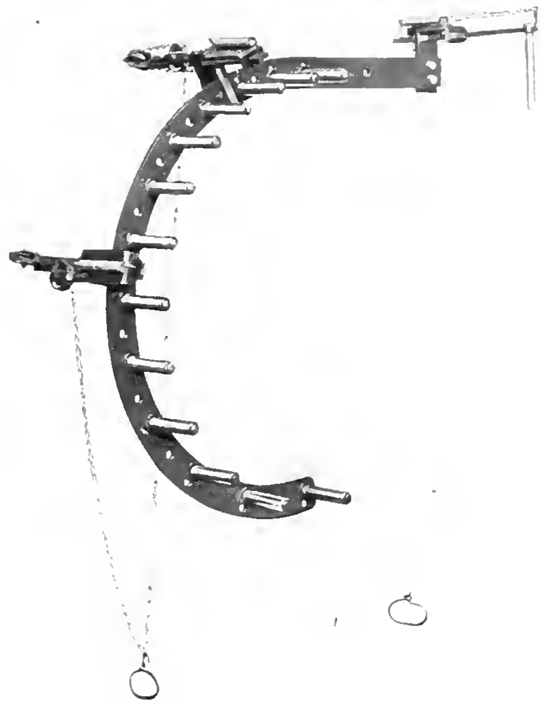
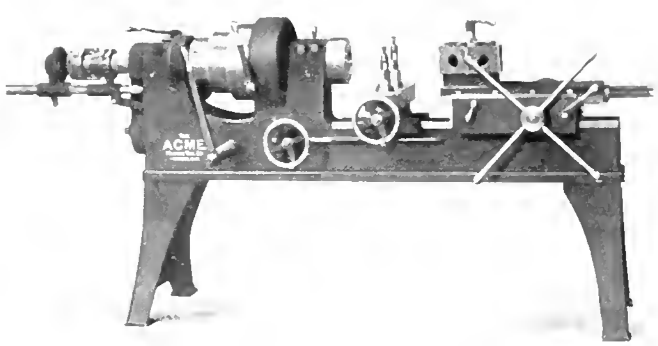


Fig 3. Large Shifter with Two Shift-bars for Transferring the Belt to its Pulley

be eliminated and the life of the belts prolonged. It is manufactured by the International Belt Shifter Co., 624 Vance St. Toledo, O.

ACME TURRET LATHE

The Acme Machine Tool Co., Cincinnati, O., has recently brought out a line of turret lathes of the design shown in the accompanying engraving. These machines are especially constructed to withstand the strains incident to the use of high-speed steels. They are furnished with or without a power feed to the turret, and also with or without an extra capacity automatic chuck. The head is of the friction geared type and the back-gears can be thrown in or out without stopping. Two



Turret Lathe built by the Acme Machine Tool Co.

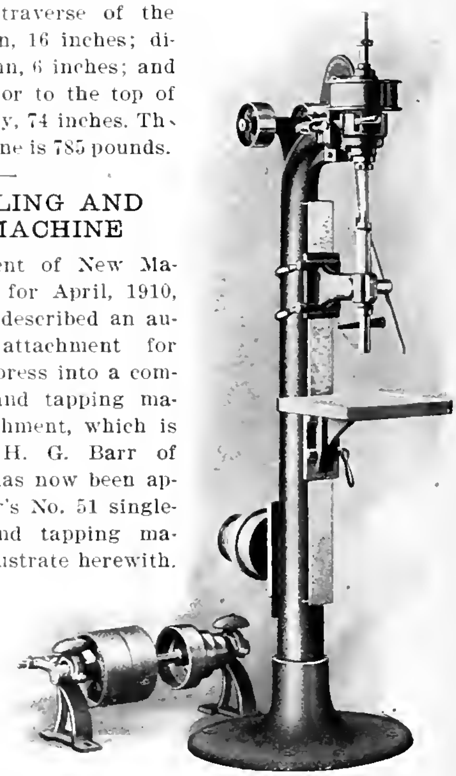
spindle speeds are available for each cone step. The turret, which is of hexagonal form, has a hole through the central stem, of the same diameter as the tool holes. Tapped holes are provided for bolting tools to the turret faces and there are independent adjustable stops for each hole of the turret. The abutment for these stops can be shifted, thus allowing a slight further movement beyond any stop, when this is desired, without disturbing the adjustment. The power feed of the turret is of the geared type, and four rates of feed are instantly obtainable by shifting a lever. The distance from the center of the turret to the top of the slide is sufficient to permit swinging large dies and turret tools. The cut-off has a hand longitudinal adjustment, and it is set low so that work of large diameter will swing over the slide. A double-friction countershaft of improved design accompanies every machine.

SNYDER 20-INCH UPRIGHT DRILL

A new design of 20-inch upright drill has recently been brought out by J. E. Snyder & Son, Worcester, Mass. While the general design of this machine does not differ from the 20-inch size formerly manufactured by this company, it is of somewhat heavier construction, the main column, the arm for supporting the table, and the base, being rigidly designed. The spindle may be fed either by handwheel or lever and the latter is equipped with a ratchet mechanism. The spindle is counterbalanced by a weight inside the column and it has a quick return motion. This machine will drill to the center of a $20\frac{1}{2}$-inch circle, and its general dimensions are as follows: The vertical traverse of the spindle is 9 inches; the greatest distance from the base to the spindle, 41 inches; the greatest distance from the table to the spindle, 26 inches; diameter of the spindle in the sleeve, $1\frac{1}{2}$ inch; traverse of the table on the column, 16 inches; diameter of the column, 6 inches; and height from the floor to the top of the upper cone pulley, 74 inches. The weight of the machine is 785 pounds.

BARR DRILLING AND TAPPING MACHINE

In the department of New Machinery and Tools for April, 1910, we illustrated and described an automatic tapping attachment for converting a drill press into a combination drilling and tapping machine. This attachment, which is manufactured by H. G. Barr of Worcester, Mass., has now been applied to the builder's No. 51 single-spindle drilling and tapping machine, which we illustrate herewith. This machine drills holes up to 3/4 inch in diameter, and has a tapping capacity for holes up to 1/2 inch in diameter in cast iron. All gears are made of machine steel and the clutches and trip pins are of tool steel tempered singly. The general construction of this machine is plainly indicated by the engraving.



Barr Single-spindle Drilling and Tapping Machine

This tapping attachment is also applied to the Barr multiple spindle machines. With this type, the tapping spindles can be arranged in combination with the spindles having lever or power feed, in the way best adapted to meet individual requirements.

MOLINE MULTIPLE SPINDLE DRILL

The Moline Tool Co., Moline, Ill., has recently added to its line of drilling machinery another design of multiple spindle drill, which we show in Fig. 1. This machine is equipped with the company's regular double spiral drive, but it has a spindle feed in place of a table feed. The feed is entirely spur geared, there being no worm reduction, and the feeding mechanism is so arranged that it can be tripped automatically at any point.

By referring to Fig. 1, it will be seen that there is a continuous pinion, or what might be called a pinion shaft, running the entire length of the machine. Meshing with this pinion shaft for each spindle is a combined gear and pinion, so mounted on a swinging stud that the pinion can be brought into or out of mesh with a large gear A, Fig. 2. This gear is mounted on the same shaft as the feed pinion B, which

meshes with a rack cut in the spindle quill. On the lever *C* which carries this swinging gear and pinion, a feed handle is mounted, so that when this handle is pulled down, the feed is thrown in and locked, and when it is pushed up, the feed is unlocked and thrown out of engagement. To the upper end of the spindle quill, a bracket is attached, carrying a stop-rod *D*, which, as it descends, engages with the tail of the feed catch *E*, thus throwing the feed out automatically. As the

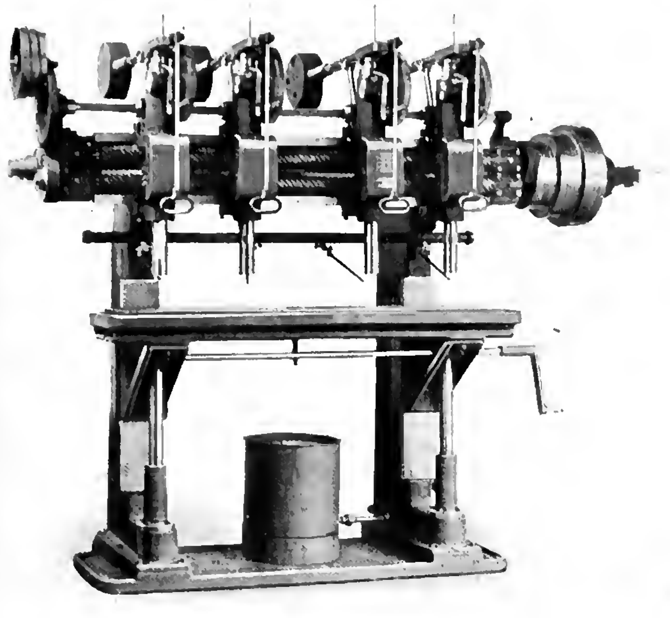


Fig. 1. Moline No 22 D Multiple Spindle Drill with Spindle Feed

engraving indicates, this stop-rod can be adjusted to disengage the feed at any predetermined point. This arrangement of the feeding mechanism gives each spindle, in addition to an automatic stop, independent feed, which is easily controlled.

The spindles are counterbalanced, and they may be rapidly traversed by the handled rods shown. This drill has a capacity for drills up to 2 inches in diameter in steel, with minimum and maximum center-to-center distances of 6 inches

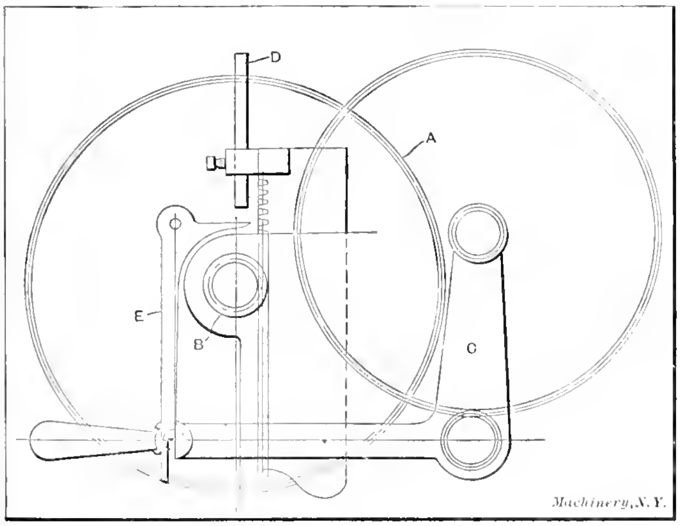


Fig. 2. Arrangement of the Feeding Mechanism

and 5 feet, respectively. The spindles run in bronze bushings and the feed racks are cut from the solid in the steel quills, which are also bronze bushed. The machine has ball thrust bearings and it is back-geared. The table is vertically adjustable by the crank and elevating mechanism shown, and it is provided with a wide channel for catching the lubricant. A pump with tank and piping will be furnished when so ordered.

REINECKER UNIVERSAL TOOL GRINDER

The increasing use of the hobbing machine for producing spur, worm and spiral gears, has created a demand for a tool grinder fitted with a spiral dividing head for grinding spiral-fluted hobs. In Europe, where the practice of hobbing gears has been developed to greater proportions than in the United States, makers of hobs have almost entirely discarded the straight-fluted type in favor of the spiral flute, their experience being that a spirally-gashed hob is more easily driven and cuts more freely than one that is straight-gashed. This has been found particularly true in the case of hobs used for cutting worm-wheels, a marked improvement being noticed when the gash runs at right angles to the thread, especially for hobs of small diameter or those having double or multiple threads. In these cases the spiral gash insures equal cutting angles for both flanks of the tool.

The tool grinder shown in the accompanying engraving, which is the product of J. E. Reinecker, of Chemnitz, Germany, is especially designed for grinding hobs as well as other spiral- and straight-fluted tools. This machine is also adapted for grinding cylindrical and taper work, and for internal grinding as well, by the use of an internal grinding attachment. Besides the uses mentioned, the machine may be employed for grinding milling cutters of all types, cylindrical and taper reamers, taps, etc. It can also be used for surface grinding on such work as dies, small plates, form cutters, etc.

Universal Tool Grinder set up for Grinding a Spirally-fluted Hob

The machine illustrated is the No. 2 size, which has a capacity in length between the centers of 25½ inches, and for diameters up to 7 7/8 inches. The table travel of the grinder shown, is automatic, but it is also built with the hand table traverse. The table is driven from the cone pulley at the base, which is connected with the reciprocating mechanism, through the column of the machine, by gears and shaft connections.

The indexing mechanism of the No. 2 machine is operated by hand, although the makers build a larger machine of the same type with an automatic indexing head, so that the dividing motion, as well as the traverse of the table, takes place automatically. The feed of the table for obtaining the correct lead for the spiral flute to be ground, is obtained by change gears the same as with the milling machine. Twenty change gears are provided, which give leads ranging from 6 to 280 inches. The lead of the spiral flutes in the particular hob shown mounted in the machine, is 172 inches.

The longitudinal and cross-slides are mounted on a base which swivels on the knee, the angular position being indicated by suitable graduations. The knee itself can also be swung about the column and, as the engraving shows, it can be adjusted vertically on the column by a handwheel at the side, which connects through bevel gears with a vertical ele-

vating screw, that passes through a nut supported by a projection on the base. On the back end of the spindle, a fixture

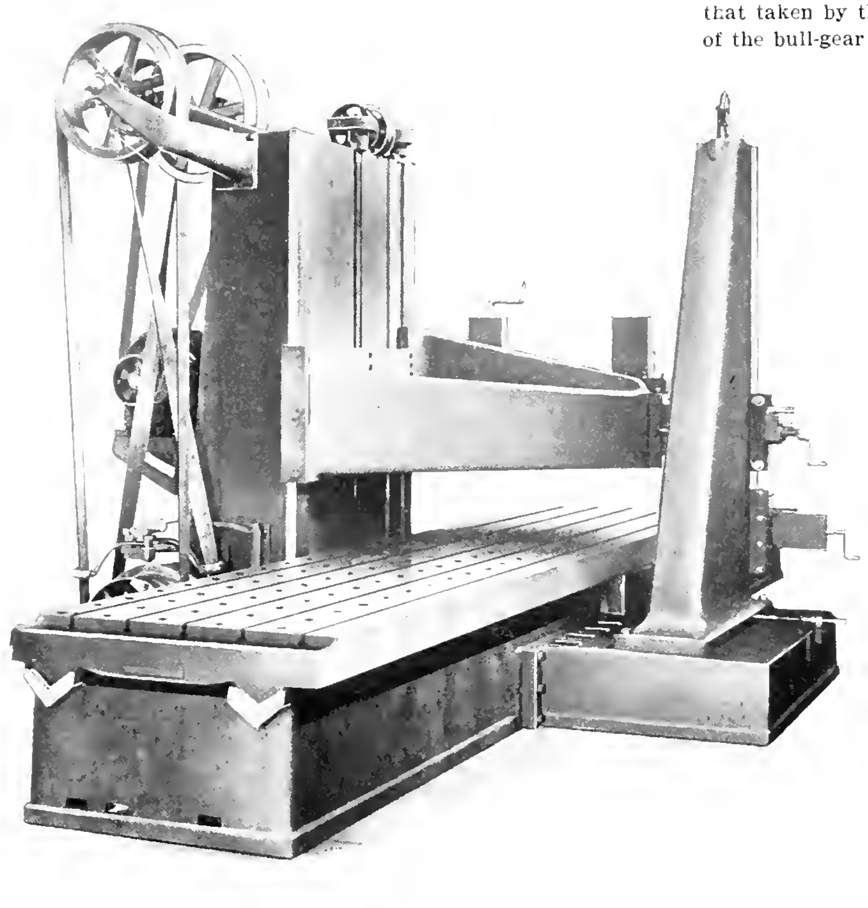


Fig. 1. Cleveland Open-side Planer with Removable Column for Supporting a Fourth Head

is arranged for grinding thin milling cutters and plain tools on a hand-rest.

The Carpenter-Kerlin Gear & Machine Co., 77 White St., New York City, are the American agents for this machine.

CLEVELAND OPEN-SIDE PLANER

The Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, O., has recently added to its line of open-side planers the 60- by 84-inch machine illustrated herewith. This planer is arranged with an outside column which may be employed to support a fourth head when such an addition can be used to advantage. It should be stated that this is the sole function of the extra column which is not intended as a stiffener for the cross-rail. The bed of this planer, and also the column and cross-rail, are of box section, which gives a stiff and strong construction. The bed is cast closed on the top and it has a number of solid cross-ribs located at frequent intervals. The column is cast solid with the bed up to the table level, at which point the upper section is securely bolted and doweled to it as shown. The cross-rail, which is raised and lowered by power, has an extremely broad bearing on the face of the column, as the engraving shows. It is square-gibbed to the column and can always be drawn up parallel to the table. The heads can be operated from either side of the machine, and automatic feeds are provided in all directions. The side-head has a broad bearing directly on the column and it can be lowered entirely out of the way when it is desired to use the rail-heads close to the table. The table has a depth of $9\frac{1}{2}$ inches, and it is provided with T-slots and holes at frequent intervals which are not bored through. The bull-gear pinion is of forged steel and integral with its shaft. The bearings for the bull-gear are in heavy bosses cast in the sides of the bed and they occupy the entire space between the sides except that taken by the bull-gear hub. All gears with the exception of the bull-gear and its pinion run in oil, and all the bearings are lined with phosphor-bronze. These bushings are pressed in so that they can easily be removed at any time, when worn, without interfering with the alignment of the machine in any way. All the gearing in the running parts can be removed from the sides of the machine, thus making it unnecessary to disassemble the planer if repairs should be needed. The large loose driving pulley runs in a box bushing set in back of the column base, thus relieving the running shaft and stiffening it out to the hub of the double tight pulley.

Some of the principal dimensions of this planer are as follows: Length of the bed over all, 21 feet 8 inches; distance between the V's, 36 inches; angle of the V's, 100 degrees; number of automatic oilers, six. The table has a length over all of 15 feet, and a width of 54 inches. The height of the cross-rail bearings on the face of the column is 36 inches; the width of the cross-rail bearing on the face of the column, 64 inches; and the length of the saddle bearing on the rail, 19 inches. The table has a return of from $2\frac{1}{2}$ to 1 to 3 to 1, and the cutting speed is suited to the requirements of high-speed steels. This planer, as the engraving shows, is electrically driven, the motor being mounted on a bracket attached to the side of the column. The motor is of the variable speed type, and develops 25 horsepower.

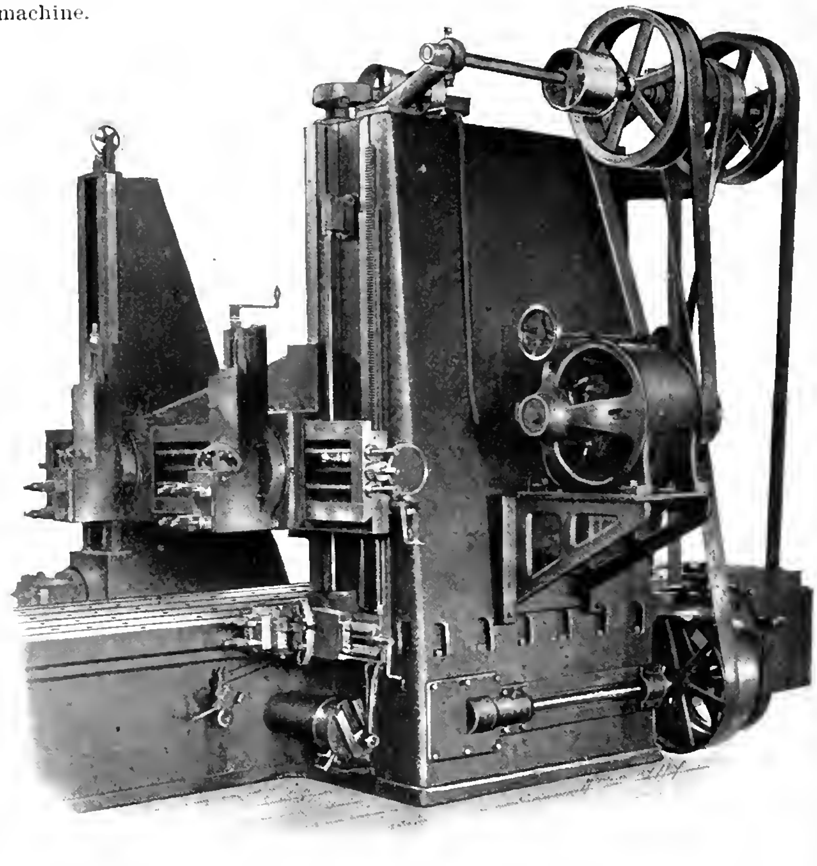


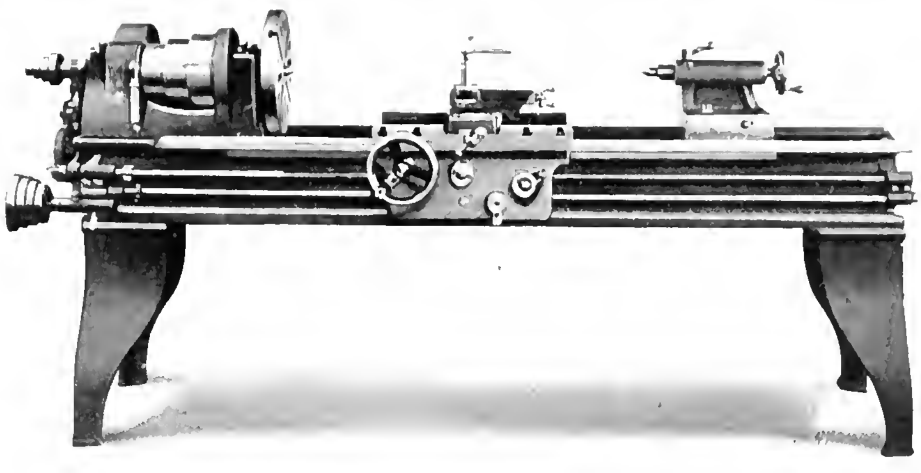
Fig. 2. Front View of the Cleveland Open-side Planer

MIAMI VALLEY 16-INCH ENGINE LATHE

The latest design of engine lathe brought out by the Miami Valley Machine Tool Co., 843 Germantown St., Dayton, O., is shown in the accompanying engraving. This machine, which is of the same general design as the single back-geared 16-inch

lathe manufactured by this company, is equipped with a double back-gear and a wide three-step cone, which gives a powerful drive, thus adapting the lathe to heavy duty.

The back-gears are shifted by the hand lever shown at the front of the headstock, and their respective ratios are 5.6 and 9.6 to 1. The carriage of this lathe has a bearing $23\frac{1}{2}$ inches in length, and it is gibbed both front and back. The cross-bridge is heavily ribbed, and the cross-slide and compound rest are of heavy design and well gibbed. The compound rest slide has been lengthened so as to give a feed of 5 inches. The tailstock is of the offset design which allows the compound rest to be set at 90 degrees, or in a position parallel with the bed.



Miami Valley 16-inch by 8-foot Standard Engine Lathe

Either a belt-driven or positively-geared feed can be used on this lathe, a gear on the feed-rod meshing with either a gear on the cone-shaft or one on the screw, thus giving, in addition to the four belt feeds, those obtainable with the change gears. The thread-cutting capacity ranges from 5 to 40 threads, including $11\frac{1}{2}$ threads to the inch. The regular equipment of this lathe includes a full set of change gears, a compound rest, both large and small faceplates, steady- and follow-rests, wrenches and a double-friction countershaft.

HENRY & WRIGHT MULTIPLE SPINDLE DRILL

The eight-spindle ball-bearing drilling machine shown in the accompanying engraving is a new model that is being built by the Henry & Wright Mfg. Co., Hartford, Conn. The

New Model Henry & Wright Eight-spindle Drilling Machine

new features of this design include a new dust-proof thrust bearing; a wider, heavier, and better-balanced base; a new design of idler pulley with bearings twice as large as those formerly used; a new weight chain; different design of belt guide for adjusting idler pulley; a wider table weight, and a much heavier table with oil grooves twice as wide and deep as those of former designs.

The advantages which these improvements give this machine over the older models are a heavier and stiffer construction, and a more serviceable and accurate machine. While the machine illustrated has eight spindles, these new models are built in forty-eight different styles with the spindle heads ranging in number from one to eight. The arms are made to overhang four different sizes—7-inch, $9\frac{1}{2}$-inch, 12-inch, and 15-inch with tables of the correct width to match.

* * *

CORRECTION

In the description of the Colburn Machine Tool Co.'s heavy-duty drill press, which appeared in the July number of MACHINERY, an erroneous figure was given in the reference to experiments made with a 3-inch Celfor drill. It was stated that this drill was driven through cast iron at a cutting speed of 262 feet per minute; the correct speed was 205 feet per minute for the test referred to.

* * *

NEW MACHINERY AND TOOLS NOTES

Hand Vise: Wade Machine Co., Boston, Mass. Small hand vise $7\frac{1}{2}$ inches long with a maximum opening of 2 inches. The parts are casehardened drop-forgings and the vise is neat in appearance and well designed.

Core Molding Machine: Henry E. Pridmore, Chicago, Ill. Machine for molding odd-shaped cores, such as cannot be produced on the usual core-forming machines because of their non-uniformity of section. The rapidity with which the sand can be jolt-rammed, the facility with which the core-box board is clamped and the box rocked over, and the accuracy with which the finished core is released from the box are among the principal advantages claimed for this machine.

Tapping Attachment: J. H. Dorman, 1 Bethune St., New York City. Tapping attachment for the drill press which is built in three sizes with capacities ranging from 0 to $\frac{3}{8}$ inch, $\frac{3}{8}$ to $\frac{3}{4}$ inch, and $\frac{3}{4}$ to 1 inch. The tap is held in a chuck of the floating type, and it centers in a female center in the end of the main spindle. The gears are of steel, and the body of the attachment in which they are enclosed is made of aluminum. The chucks of the two largest sizes are provided with a sliding plate which allows the use of small taps when necessary.

Hand Knurling Tool: Wade Machine Co., Boston, Mass. Knurling tool intended to be held in the hand and adapted for light knurling. It is shaped somewhat like a micrometer, two knurls being located at what might be called the anvil end, and a third central knurl in the spindle or handle, which is adjustable. This handle is hollow and contains an extra set of knurls for finer work. A maximum opening of $\frac{3}{4}$ inch may be obtained between the knurls. The body of the tool is made of a casehardened drop-forging, and its total length when fully open is 7 inches.

Storage Rack: Manufacturing Equipment & Engineering Co., Boston, Mass. Rack with shelves made of No. 16 gage galvanized-iron wire cloth for the storage of wooden patterns. The use of wire cloth tends to eliminate the warping of the patterns as they are exposed equally on both sides to the air. This type of shelves also allows the dirt to fall to the floor. The rack is so constructed that, if desired, sections can be removed, shelves can be adjusted, or new ones added at any time. This rack can also be utilized for the storage of metal patterns simply by using a heavier gage of wire cloth for the shelves.

Electric Radial Drill: United States Electrical Tool Co., Cincinnati, O. Portable electric drill designed particularly for drilling frames and for doing general work in connection with automobile manufacture. Holes may be drilled to a radius of 12 inches on either side of the vertical column, and a hand-feeding movement of 5 inches is available. The drill is made in two sizes for holes from 0 to $\frac{7}{8}$ inch and to $1\frac{1}{4}$ inch, respectively. Either a direct or alternating current may

be used, and two speeds can be obtained. A complete illustrated description of a tool similar in construction was published in the department of New Machinery and Tools, August, 1908.

Planer Elevating Device: Cincinnati Planer Co., Cincinnati, O. Mechanism for elevating or lowering the planer cross-rail by power. It is mounted on top of the tie-piece between the housings, and is so arranged that the cross-rail may be lowered at twice the elevating speed. As the device is only used occasionally, it has been designed so that the gearing does not revolve except when it is in use. It is operated by two small clutches which are mounted on the driving shaft and controlled by a lever at the side of the housing. This lever is provided with a locking handle for holding it in a central or neutral position, so that the clutches cannot be engaged by accident.

Foster Fixed Focus Pyrometer: Taylor Instrument Co., Rochester, N. Y. Pyrometer which may be used by simply pointing the receiver tube at the furnace or other hot body whose temperature is to be measured. It is not necessary to focus the tube, and the instrument does not require accurate leveling. The only rule that must be observed when using this instrument is that the pryometer be placed within a distance equal to ten times the diameter of the hot body or opening. If the pryometer is inside this limit, the reading is not affected, so that accuracy as to distance within the limit is not necessary. The indicator is connected to the receiving tube by a flexible cable. This pyrometer is very rapid in its action, a steady reading being obtained in about 15 seconds.

Tumbling Barrel: Abbott Ball Co., Hartford, Conn. Tumbling barrel designed for burnishing, by the use of steel balls, large quantities of such articles as saddlery, hardware, buckles, etc. The barrel is built in two compartments and its construction is such that the number of compartments may be varied from one to four to suit individual requirements. Each compartment is 30 inches in diameter and 8 inches in width. This comparatively narrow width causes a pressure on articles at the bottom of the barrel, thereby increasing the friction and giving a more rapid burnishing effect because of the long sliding space for the balls which roll in and out around the pieces; at the same time impact in the barrel is eliminated so that there is no danger of denting the work.

Car Wheel Grinder: Norton Grinding Co., Worcester, Mass. Machine for grinding unmounted wheels and intended for the use of manufacturers of car-wheels rather than railroads. The machine is fitted with two faceplates cast integrally with the driving spindle. The loose wheels are attached to these faceplates by a bolt passing through cored holes in the center. The location of work is effected by means of V-supports which are previously adjusted. By simply moving a crank, these supports are moved away from the wheels slightly so that no high spots will come in contact with them when the machine is started. In each faceplate there are three half-round openings, which permit the crank-hook to be admitted to one of the core holes in the casting. By having three of these openings, it is comparatively easy to stop the machine with one of them at the top. The weight of this machine is 16 tons.

Multiple Punch: Cleveland Punch & Shear Works Co., Cleveland, O. Large multiple punch having two rows of adjustable punches, which construction permits the punching of tapering lines of holes which is often desired in punching the stakes for pressed steel freight cars. There are 34 punches in all, divided equally into two rows. The bolster blocks are so arranged that when parallel rows of holes are not desired, they can be diverted. The machine is motor-driven, the motor being connected to the flywheel shaft through cut gears, from which the power is transmitted through an intermediate shaft to the crankshaft. This machine has a 6-inch stroke, and the distance between the housings is 10 feet, 2 inches. The housings are of semi-steel castings, and the shaft of hammered steel. The bolster blocks are cast steel and all the bearings are bushed. The sliding crosshead is counter-balanced with weights hung on levers.

Electric Riveter: Electrical Machinery Sales Co., Milwaukee, Wis. Electrically-driven riveter which will punch the hole, drive and head a rivet with one pressure on the pedal. The mechanism consists of a sliding solid-steel revolving-disk block with three specially-designed striking shoes on its lower surface. These shoes strike a resilient plunger which, in turn, delivers the blow directly upon the work. The riveting operation is controlled by a treadle and the force of the blow is proportional to the amount of pressure applied. When the pressure is released, the blow is stopped instantaneously. This control is one of the advantages of the machine, as it will strike either a light continuous tap, a medium, or a heavy blow as required, and the changes are made instantly. These machines are built in either the bench, pedestal or portable types and each type is made in three sizes. They may be driven by a self-contained motor or by belt, as desired.

Wood Screw Threader: E. J. Manville Machine Co., Waterbury, Conn. High-speed wood screw threader for making wood and machine screws from blanks made by the cold-heading process. This machine has a new type of grooved-blade fan hopper, which is sufficiently rigid to overcome any "snapping" action on the part of the pick-up arm. The hopper blade is operated by a friction device which can slip in case anything gets caught, and by means of a comb or scavenger all oversized or misplaced screws are thrown back into the hopper. The feeding mechanism is self-contained and it can be removed by simply loosening two screws which fasten the bracket to the frame, when the machine is to be changed from one size screw to another. The forming shoe may also be quickly removed or adjusted and it is located where it is easily accessible. This machine is designed throughout to insure against breakage, yielding movements being provided wherever necessary. The gearing is accurately cut and it is well protected by guards.

Internal Grinder: Rivett Lathe Mfg. Co., Boston, Mass. Internal grinder with rated capacity of 3 inches, by 6-inch stroke. The table reciprocating mechanism is so designed that a positive point of reversal is assured, thus enabling the wheel to be run up to shoulders with accuracy. The table has thirty-six speed changes, six being obtained from a change gear box; this number is increased six times by the countershaft which gives six variations for the gear box driving pulley. The spindles of this machine are mounted on ball bearings in quills, and it may be equipped with spindles and quills designed to suit various classes of work. The table has an adjustable positive locating stop which may be disconnected at will for moving the table by hand, without disturbing the original setting. Both the table and wheel-head may be swiveled to any required angle, and their positions are indicated by suitable graduations. The wheel-head has an automatic power cross-feed, which may be adjusted to operate to the fractional part of a thousandth of an inch.

Expansion Boring-bar: Buck Boring Bar Co., Huntington, W. Va. Expansion boring-bar which is intended particularly for the boring of steel and cast-iron car-wheels. It has four cutters, two of which are for finishing, while the remaining two are for roughing. The finishing cutters are adjusted simultaneously by a single expansion screw that is located in the center of the bar, and the roughing cutters have an independent adjustment. The bar has a water attachment by means of which a small stream is applied directly to the point of the cutting tools, thus keeping them cool and making high speeds possible. To adjust the cutters to bore the size of hole wanted, a gage is used that extends the full width of the cutters. This gage is placed over the cutters and the latter are expanded until they come in contact with it. The cutters have a 2-inch range of expansion which enables one bar to be used for two sizes of M. C. B. standard bore. A fifth tool, located near the base of the shank, is used as a chamfering tool for giving the wheel a slightly larger bore, to facilitate starting it on the axle.

Cold Saw Cutting-off Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Twenty-six inch cold saw cutting-off machine arranged for motor drive and with four positive feed changes. The table and body of the machine, including the saddle slides, are of one solid casting. The different feed changes are engaged instantly by the movement of a single lever. Four changes of feed are provided, ranging from 0.547 to 1.109 inch per minute with a 26-inch saw running at a peripheral speed of 45 feet per minute. The spindle of the machine revolves in brass-bushed cap bearings, and the drive is by a self-contained electric motor. Power quick-return to the spindle saddle is provided which is available in both directions, if a double-throw switch and reversing motor are employed. A Brown & Sharpe geared pump supplies cooling lubricant directly at the point of cutting, and the reservoir for the lubricant is located in the base casting. The machine has a capacity for round stock up to 7½ inches in diameter, square pieces 7 inches on a side, and for 15-inch I-beams on a square or miter-cut in a vertical position.

Embossing Press: Standard Machinery Co., Providence, R. I. Toggle embossing press with extra heavy reinforced uprights and massive proportions throughout. The crankshaft is of forged nickel steel and it drives the main toggle, which is also of forged steel and bronze bushed around the wrist-pin, in a horizontal direction. The two vertical toggles, by means of which pressure is applied, are also of forged steel, and the lower one seats in a phosphor-bronze thrust shoe, which is in the cast steel slide of the press. The driving shaft is fitted with a 1300 pound flywheel which is mounted in close to the frame. The opposite end of the driving shaft is equipped with a forged steel pinion, meshing with a cast steel clutch driving gear. Both pinion and clutch gear have cut teeth, and the gear is fitted with an instantaneous patented roller friction, allowing less than 1/32 inch travel of the flywheel after the clutch is engaged. The machine has both a hand-lever and treadle tripping device, and it is set upon a substantial cast-iron base. The distance between the uprights at the bed of the press is 17½ inches and the minimum distance is 15¾ inches. For special purposes, however, the machine can be made with a minimum space of from 8 to 12 inches between the uprights for small pieces requiring heavy pressure.

Hydraulic Press: United Engineering & Foundry Co., Farmers Bank Building, Pittsburg, Pa. High speed hydraulic forging press which is operated partly by a steam-driven, water-pressure intensifier and partly by steam working in cylinders located on top of the press, which combination gives a rapid action and the required power. This machine is built on the Davy patents, and the principle of its operation was described in an article published in the May, 1907, number of MACHINERY. In order to obtain a practical forging stroke and still keep the proportions of the intensifier within reasonable limits and the steam consumption low, the press ram is operated by steam until the forging part of the stroke is reached. The variation in water supply required for forgings of different thicknesses is obtained from a tank that is partly filled with water under an air pressure of 30 pounds. When the press head is lowered by exhausting steam from the balance cylinders, a check valve connecting this tank with the high-pressure system opens, thus admitting the required amount of water. This press is controlled by a single lever, so that the movement of the hand determines both the speed of the ram and the distance of the traverse. The forging stroke can be repeated as often and as quickly as the hand can be moved, which, in practice, is 150 strokes per minute on small presses and 60 on large ones. Nearly all parts of the press are of steel, and it is so constructed that packings can be renewed without dismantling any part or employing any power outside the machine itself.

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JOINT MEETING OF A. S. M. E. AND INSTITUTION OF MECHANICAL ENGINEERS

About 160 members and guests of the American Society of Mechanical Engineers sailed for Liverpool, July 16 on the *Celtic* to attend the joint convention of the society with the British Institution of Mechanical Engineers that was held at Birmingham and London, July 26-29. Business matters prevented Pres. Westinghouse attending. W. F. M. Goss and Charles W. Baker presided.

An interesting program had been prepared for the entertainment of the members on the voyage. On Monday evening there was a reception by the officers and past presidents of the society; Tuesday evening, illustrated address by W. R. Warner: "What are the Astronomers Doing?"; Wednesday evening, musicale; Thursday evening, illustrated address by John R. Freeman: "Construction of the Panama Canal"; Friday evening, dancing; Saturday evening, conversazione, awarding of prizes for deck games, etc. The party landed July 25 and was joined by other members and guests who had gone before or by other routes. The program of their entertainment arranged for in England was replete with interesting events and is too long to be reproduced. The program of technical papers as prepared is substantially as follows: "English Running-Shed Practice," by Cecil W. Paget, Derby; "Round-house Practice, or the Handling of Locomotives at Terminals to secure Continuous Operation," by Frank Henry Clark, Chicago, Ill.; "Handling of Locomotives at Terminals," by Frederick M. Whyte, New York; "Handling Locomotives," by Henry H. Vaughan, Montreal, Can.; "American Locomotive Terminals," by William Forsyth, Chicago, Ill.; "High-Speed Tools and Machines to Fit Them," by H. I. Brackenbury, Newcastle-on-Tyne; "Tooth Gearing," by J. D. Steven, Birmingham, England; "Involute Gear Tooth Standards," by Wilfred Lewis, Philadelphia, Pa.; Discussion by C. R. Gabriel, New York; Topical Discussion on Rapid Production in Machine Work, by John R. Calder, Ilion, N. Y., Luther D. Burlingame, Providence, R. I., Alexander Taylor, East Pittsburg, Pa., L. P. Alford, New York; "Electrification of Suburban Railways," by F. W. Carter, Rugby; "Cost of Electrically-Propelled Suburban Trains," by H. M. Hobart, London, England; "Electrification of Trunk Lines," by L. R. Pomeroy, New York; "Electrification of Railways," by George Westinghouse, New York.

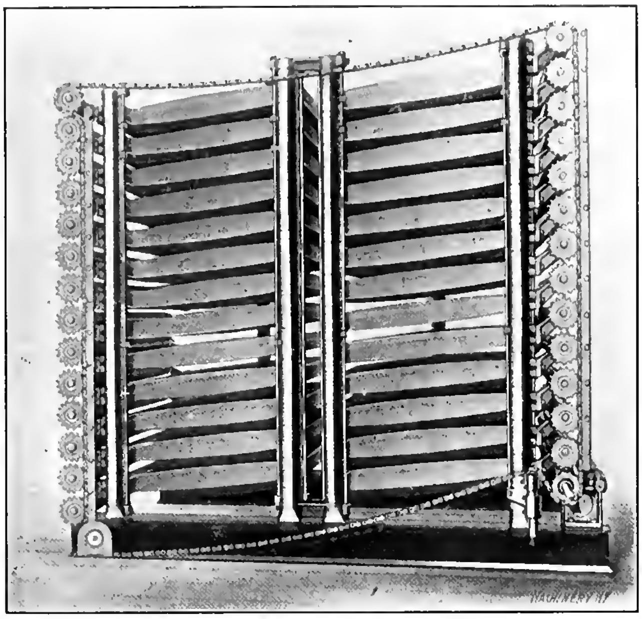
* * *

Aluminum-coated sheet metal has been placed on the market to be used in place of galvanized iron. The sheet metal, however, is not coated with aluminum, as the name would imply, but with a zinc alloy containing but a small percentage of aluminum. The alloy consists of 77 per cent of zinc, 13.5 per cent of tin, 7 per cent of aluminum and 2.5 per cent of copper. The advantage of this coating over the ordinary zinc coating is that it will not peel or strip off when the metal is bent, and a heavier coating than is possible to produce by zinc alone can be obtained.

NEW TYPE OF CHAIN DRIVE

A new method of driving series of parallel shafts or rolls has been recently patented and is now being successfully used on cell driers for drying textiles, pulp, paper, etc. This new drive, which employs a roller chain and sprockets, as shown in the illustration, is said to be much more efficient than the trains of spur gears, and the bevel gear drives formerly used.

Referring to the illustration, the drive has a set of rolls for each tray, the drying unit varying in size from six on the smallest up to forty trays on the largest machines. A single loop of 1 1/2-inch pitch Diamond roller chain made by the Diamond Chain & Mfg. Co., Indianapolis, Ind., runs around the machine and meshes with a sprocket on each roll. The lowest right-hand roll sprocket is the driver on the machine shown, and turns clockwise. The chain is kept in contact with the sprockets by means of two steel guide-rails, one on each



View of a Cell Drier showing Arrangement of Chain Drive for a Series of Parallel Shafts

side of the machine. These rails being slightly narrower than the width of the chain rollers, compel the chain to mesh with the sprockets. The lower strand of the chain runs loose and at the left of the driving sprocket an idler is provided which is adjustable vertically to take up the slack.

The bevel gears and trains of spur gears that formerly drove the rolls consumed considerable power and were noisy at high speeds. The chain is much quieter and absorbs little power in friction load. A 1/2 horsepower motor with a 1-inch belt will easily drive an empty machine of the size shown at high speed, and, as a matter of fact, this is the method used to limber up new machines. The chain drive so far has proved less expensive in initial cost and upkeep and seems to wear less than the gears formerly used.

* * *

DETROIT INDUSTRIAL EXPOSITION

The Detroit Industrial Exposition held in Detroit, Mich., opened June 20, and after a successful run attended by good weather conditions, closed July 6. There were 163 exhibitors representing principally manufacturers of mechanical or engineering products. The exposition was managed by Mr. William G. Rose, who was also manager of the Cleveland exposition, and the object of the whole thing is best expressed in the words of the little booklet issued, which are: "To teach Detroit to know itself, to teach the world to know Detroit; to advance the general interests of the city; to show the variety, scope and importance of Detroit industries; to bring benefits to the manufacturers, merchants and citizens in general; to offer the people of the city an entertainment of far greater magnitude and interest than has ever been attempted before and to stimulate civic pride, encourage the citizens to patronize home industries and advance the spirit of: 'One for All and All for Detroit!'"

MANUFACTURING THE SIBLEY HIGH-SPEED DRILL PRESS

In the manufacture of a high-speed drill press, the Sibley Machine Tool Co., South Bend, Indiana, has recently made some radical changes in its manufacturing methods which have resulted in a greatly increased production. A few of the more important of these methods, as well as the machines on which the work is performed, are illustrated herewith.

The high-speed drill press referred to is shown in Fig. 1, which gives a general idea of the work to be done, and of the parts to be bored, milled and drilled. The columns are first centered and turned in a heavy lathe. The finished part of the column is then placed in a V mounted on the table of a universal (horizontal boring machine), as shown in Fig. 2, and the top bracket to receive the gear box is milled. After this operation, the milling cutter is removed from the spindle, and a boring-bar inserted as shown in Fig. 3, and the bearings for the crown gear and spindle sleeve are bored, as well as all other parallel holes. The column is then swung around at right angles, and the hole for the pinion shaft, and other parallel holes are bored; this completes the work on the column.

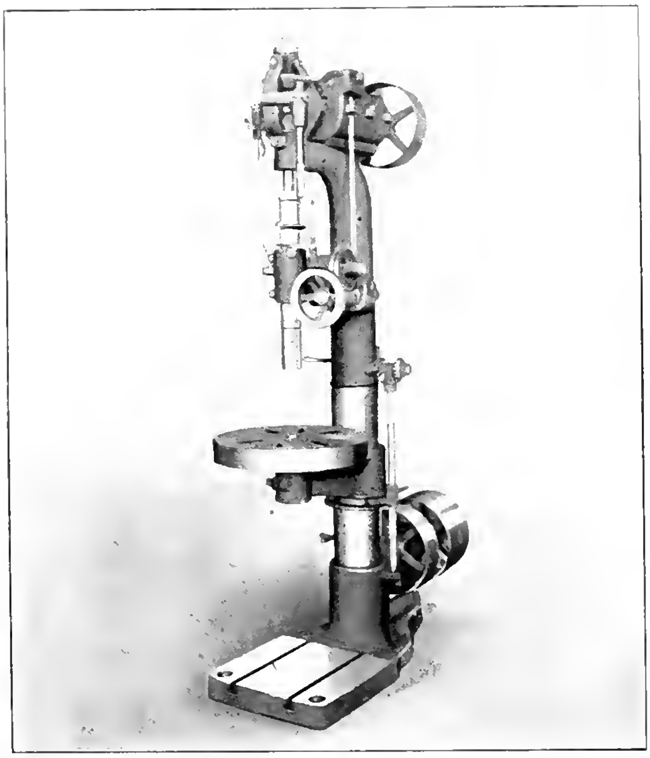


Fig. 1. The Sibley High-speed Drill Press

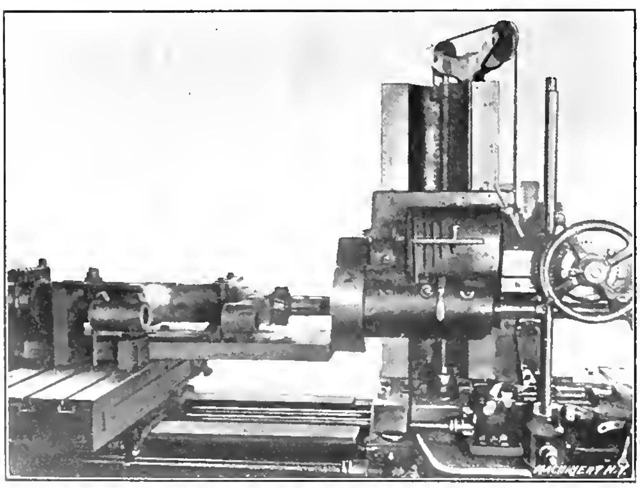


Fig. 2. Milling the Top of a Column for the Gear-box on a Horizontal Boring Machine

The machining of the castings for the speed change box shown in Fig. 4, comes next. This work is also done to the best advantage on the horizontal boring machine. As will be noted from the engraving, the gear case is made in halves. The top and bottom halves are milled together and placed in a jig. The six bearings are then bored. After the gear cases have been machined, they go to the assembling department, where the bronze bearings are fitted and the gears and internal shafts assembled.

In the gear case there are two solid shafts and one hollow shaft on which run the gears for the speed changes. The constant-speed driving pulley may be connected by either of two sets of gearing with the horizontal shaft at the left of the casing (as viewed from the front). The change from one set of gearing to the other is made by the lever in front of the driving pulley at the top of the machine. This shaft, at the left, carries a set of four gears meshing with a corresponding set of four gears on the spindle driving shaft to which the driving bevel gear is connected. By the manipulation of the lever at the front, any of the four ratios provided may be obtained. The combination gives eight speed changes in all.

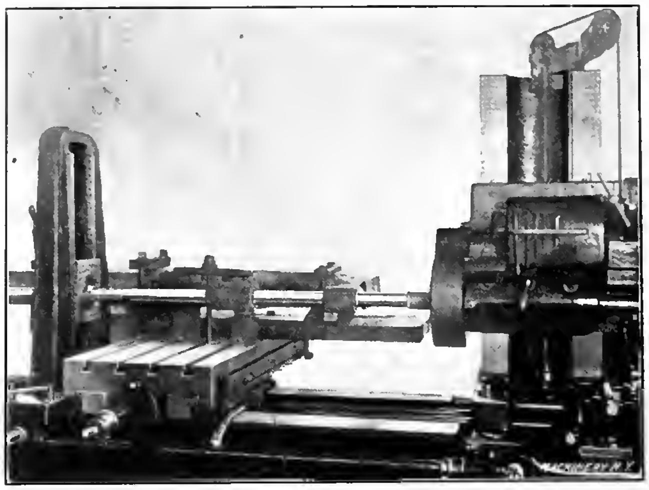


Fig. 3. Bearings for Crown Gear and Spindle Sleeve being bored

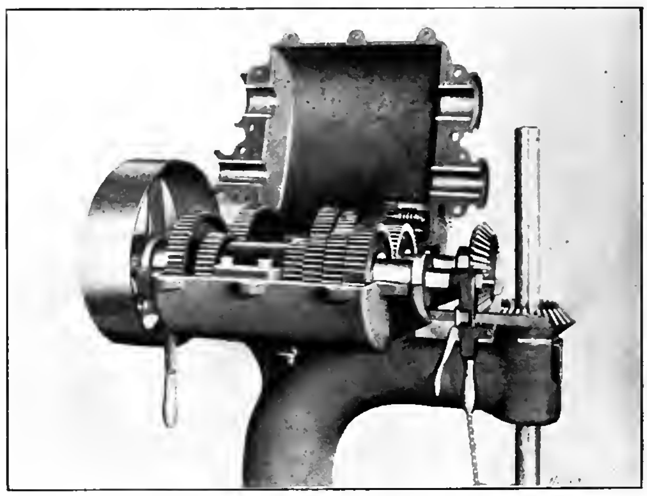


Fig 4 Speed Change Box of Machine shown in Fig. 1

The hollow shaft for the speed change gear box is bored out of solid stock in a turret lathe and the outside is then roughed off. In each end of this hollow shaft sliding keys operate, the hollow shaft being slotted on a miller of the company's own design. After plugs are inserted in each end, the shaft is finished by grinding.

A Pfauter gear-hobbing machine is employed for hobbing the spur gears used in the speed change gear box. That the hobbing principle as applied to gear cutting will result not only in a rapid but accurate production, is now universally acknowledged and appreciated. The spiral hob by which the gear is generated, may be described as a circular rack, the thread of which is a correctly shaped rack tooth. The pitch of the threads being as the pitch of the required gear, such a hob, rotating in conjunction with a gear blank on the generating machine, produces an ideal shape of tooth, for it removes only the parts of the blank that interfere with its free

rotation. Between the straight line of a rack tooth, which would be an exact copy of the hob itself, and the curved shape of a small pinion tooth, there are as many different tooth-curves as there are numbers of teeth. The generating principle, as employed on this machine, automatically forms the correct curve required by any gear within the capacity of the machine. One hob only is required to generate gears with any number of teeth of the same pitch, from small pinions to wheels of a diameter equal to the full capacity of the machine. Prior to the hobbing operation, the rough casting blanks are bored and faced in a chucking attachment in a turret machine; they are then placed on the hobbing machine and the teeth cut, as shown in Fig. 5. After this, three keyways are cut in the loose gears. All the spur gears of the feed mechanism are cut by the hobbing process.

The hubs of the spindles are electrically welded to their shanks; they are then roughed out in a lathe, a Morse taper socket bored, and the drift hole milled on a two-spindle miller of the company's own design. The spindles are then placed in a grinder and the bearings as well as the hub and shank are

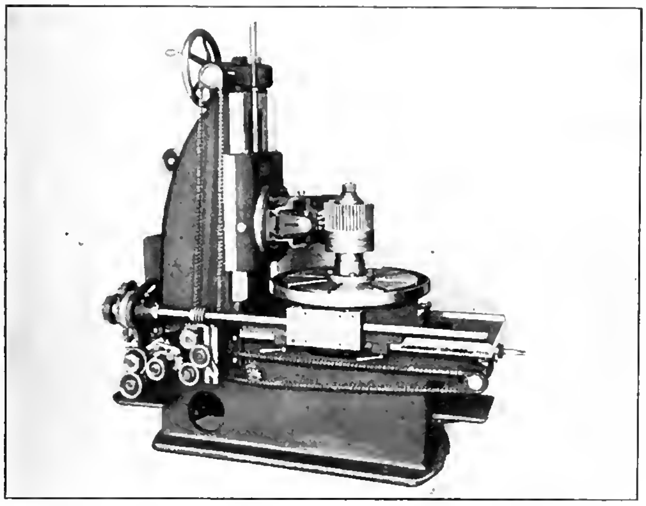


Fig. 5. Pfauter Gear-hobbing Machine generating the Teeth on a Stack of Spur Gears

ground to a finish. All shafts on this machine are ground, after first being roughed out on a lathe. The spindle sleeves, when received from the foundry, are first bored and reamed, then placed in a grinder and ground to a finish after having been graduated.

The engraving Fig. 6 shows the base of the Sibley drill being milled off in the horizontal boring machine. As will be seen, the base is bolted to an angle-plate mounted on the table. With the base still in position on the angle-plate, the hub is

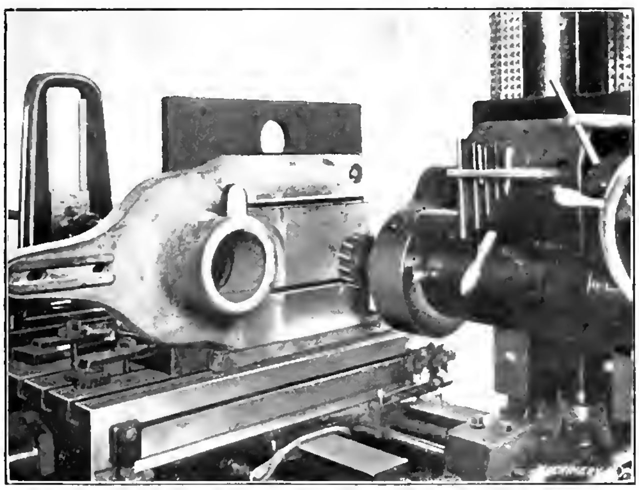


Fig. 6 Milling the Drill Press Base in a Horizontal Boring Machine

bored out and also the bearings for the table screw, as shown in Fig. 7, all three operations being done with but one setting of the casting. This method eliminates the necessity of setting up the base on a boring mill for the boring job, and then re-setting the work on a planer to finish.

The four pulleys are bored and the hubs faced in a turret lathe; they are then placed in a pulley turning lathe, and the faces turned and ground.

All the castings used in the construction of this machine are of the very best grade of iron. After several years of experience in the company's own foundry, a mixture has been selected which gives the proper toughness, as well as the re-

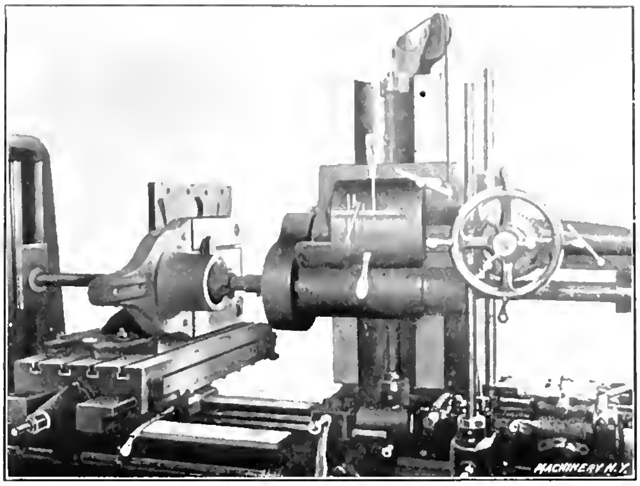


Fig. 7. Boring the Hub of the Drill Press Base

quisite softness for easy machining. Before being sent to the machine shop, all castings are put through exhaust mills which remove all core and molding sand, as well as fins and other rough surfaces.

Practically all the manufacturing on this drill press is done in one department, whence it passes into the inspector's hands. All parts that pass inspection go into stock and are drawn out by the assembling department as required. After the machines are completely assembled, they are run for forty-eight hours, and then tested. One of the tests is drilling through a hammered steel block 4 inches thick, as well as boring out the table arm to insure perfect alignment of the table with the spindle. After thorough inspection, the machines are painted, a sufficient length of time being taken to give a very nice finish. From the paint department, they pass into the shipping room ready for delivery.

* * *

A CHROMIUM ALLOY FOR EDGE TOOLS

As chromium hardens copper and its alloys to such a degree that it will take a cutting edge, James Naulty and John Scanlin of Philadelphia, Pa., have proposed the use of a copper, nickel-zinc and chromium alloy for edge tools (U. S. Patent 959,156, May 24, 1910). The alloy is as follows:

Copper	45 per cent.
Nickel	25 per cent.
Zinc	25 per cent.
Chromium	5 per cent

The method of making the alloy, the inventors say, is to melt the copper and the chromium separately and then mix, after which the nickel and zinc are introduced. It is claimed that the alloy will work hot and will take an edge good enough for edge tools, and at the same time is non-corrosive.—*Brass World.*

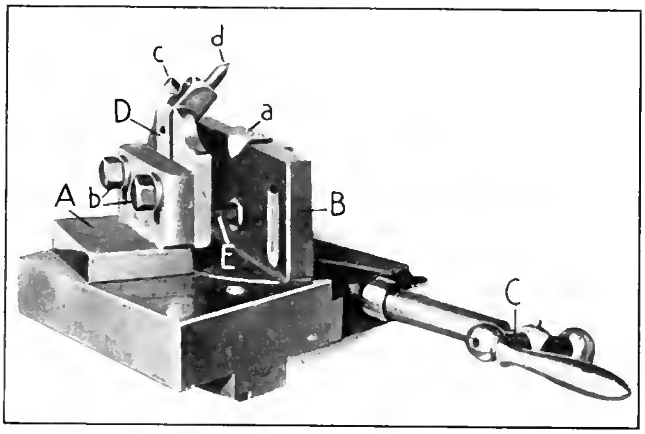
* * *

It is common practice to mount the motor of a motor-driven planer on the housings, this position in most respects being admirably suited for the purpose. The motor takes up no additional floor space, and though out of the way it is "get-at-able" whenever anything goes wrong. It is conceded, however, to be an objectionable position for the motor where highly-finished planed surfaces are required. Some concerns have so highly developed their planer practice that planed work is turned out of extraordinary smoothness of finish. If the motor is mounted on the housings the vibrations and jar due to defective balance and gear tooth action will show in the work. The inaccuracy resulting is so small as to be impossible of measurement, but the appearance cannot be tolerated on the class of work referred to, and when such work is to be produced it is probably best to mount the motor on the floor or on a separate support so that the vibrations will not be communicated to the planer housings.

ATTACHMENT FOR TURNING SPHERICAL WORK

In the July number of MACHINERY, an interesting taper turning attachment designed by W. Z. Bean, West Medford, Mass., was illustrated and described, and mention was also made of an auxiliary attachment to be used in connection with it for turning spherical work. The spherical turning attachment *A* is shown attached to the swiveling part *B* of the taper turning attachment by the adjusting screw *E*, in the accompanying illustration. The sleeve *F* containing the spindle *G* and its operating handle *H*, which was described in connection with the taper turning attachment in the previous article as mentioned above, has been removed and the spherical attachment substituted as shown. The method of operating this attachment is as follows:

After the sleeve and spindle have been removed, the adjusting screw *E* is secured in the part *A*, and is screwed into a threaded sleeve located in the part *B*, the tool-holder *D* being slotted at its lower end to clear the adjusting screw *E*. The tool-holder *D* is then adjusted to approximately the required height and held in position by cap-screws *b*. The turning tool *d* is then inserted and held in position by set-screw *c*, and it is brought to the desired position either by adjusting the part *A* by means of the screw *E* or by bringing the tool further out of the part *D*. The radius required is obtained by measuring the distance in a horizontal line between the point of the tool *d* and the face *a* of the swiveling part *B*, the face *a* being in line with the center of the plug on which the part *B* swivels. When the tool *d* is set to the desired radius the work can be turned by rotating the handle *C* in either direction as required.



Attachment for Turning Spherical Work applied to Taper Turning Attachment

* * *

WRECK OF AIRSHIP ZEPPELIN VII.

The world's first airship line was inaugurated in Germany by the Aerial Transportation Co., June 22, when the third large Zeppelin airship, *Deutschland VII*, started from Friedrichshafen, on Lake Constance, to Dusseldorf. The distance of 250 miles was made in about nine hours, the average speed being about 28 miles an hour. The project came to a disastrous end on the third trip, June 28, when a party of twenty journalists was taken for a special trip. The vessel was wrecked in the Teutoburg forest by a gale which forced a descent with thirty-three persons aboard, including the crew. Tree tops pierced the silk envelope and twisted the aluminum frame, and the wind completed the total wreck of the finest of the Zeppelins, 485 feet long and costing $137,000. The passengers and crew descended by rope ladders, and no one was injured. It is said that, notwithstanding his many disasters, Count Zeppelin will build another airship.

* * *

PERSONALS

W. H. Kinsel, formerly with the Thompson-Bassett Co., has taken charge of the toolroom at the plant of the Detroit Radiator Co., Detroit, Mich.

C. L. Smith has succeeded Mr. Hall as Cincinnati editorial representative of the *Iron Age*. Mr. Smith is located at 612 Second National Bank Building.

V. M. Palmer, chief engineer of the Selden Motor Vehicle Co., Rochester, N. Y., has resigned his position to take a similar position with the Sheldon Axle Co., Wilkesbarre, Pa.

B. M. Switzer, for the past five years superintendent of the Brattleboro Machine Works, Brattleboro, Vt., has taken a lease of the works and will continue the business along the established lines.

Sylvester S. Howell has become associated with Paul Chamberlain, Marquette Building, Chicago, Ill., under the firm name of Chamberlain & Howell. The firm will carry on the designing and consulting engineering practice established by Mr. Chamberlain.

William Lodge, of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, sailed July 16 on the *Celtic* to attend the joint meeting of the American Society of Mechanical Engineers and the British Institution of Mechanical Engineers, held in Birmingham and London, England, July 26-29.

George Cherrington, formerly with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, and lately salesman with Brown & Zortman Machinery Co., Pittsburg, Pa., has opened an office in the First National Bank Building, Cincinnati, Ohio, where he will act as manufacturers' representative for high-speed steel specialties and machine tools.

* * *

OBITUARIES

Henry C. Clark, senior member of the firm of H. C. Clark & Son, manufacturers of paper machinery, Lee, Mass., died at his home, July 3, aged seventy-two years.

Joseph Thomas, an inventor of note, died at his home in Hoboken, N. J., July 1, aged eighty-eight years. He was born in Paris, France, and came to America at the age of nineteen. He became a machinist's apprentice and early displayed inventive genius. He was employed by Isaac W. Singer when Singer was perfecting his sewing machine in Ann St., New York, and helped perfect the oscillating feed which made the machine a success. Mr. Thomas invented the first machine for the manufacture of sulphur matches, but his principal reputation was made by the invention of the steel wire hoop skirt which was the fashionable rage in the fifties and sixties. Like many other inventive geniuses, Mr. Thomas was not a success as a business man, and did not profit largely by his numerous valuable inventions.

William Henry Brown, late chief engineer of the Pennsylvania R. R., died of heart failure at Belfast, Ireland, June 25, aged sixty-four years. Mr. Brown was assistant engineer on United States military railroads and telegraphs in 1861, in which service he attracted the attention of Col. Thomas A. Scott, then Assistant Secretary of War, and afterwards president of the Pennsylvania R. R. Co. But it was not until Mr. Brown had worked four years in various capacities on railroads, including a brief term of special service with the Pennsylvania R. R., that he made the connection with the latter in 1865, which was destined to continue for the remainder of his active life. The development of the great Pennsylvania system during Mr. Brown's connection therewith is almost unparalleled in the history of railroads. Mr. Brown retired in 1906, after forty-five years of active railroad work.

Edwin T. Marble, president and treasurer of the Curtis & Marble Machine Co., Worcester, Mass., and for nearly half a century a leading figure in the public life of Worcester, died Sunday, July 3, at his home in that city, aged eighty-two years. Mr. Marble was born in Sutton. His education was received in the Worcester County Manual Training School, now known as Worcester Academy. Entering the employ of Albert Curtis as a machinist at eighteen years of age, he worked up until, after holding many responsible positions with other companies, he entered into partnership with his former employer under the name of Curtis & Marble Machine Co. He saw the business grow to be one of Worcester's most thriving concerns, and in 1895 he became sole owner. Aside from his business interests, he served the city in many ways. He was at different times representative, state senator, alderman, member of the common council, school committeeman, besides being associated with many banking institutions and civic organizations.

* * *

COMING EVENTS

August 16-18.—Annual convention of the International Railway Master Blacksmiths' Association, Detroit, Mich. A. L. Woodworth, secretary, Lima, Ohio.

August 16-19.—Annual convention of Traveling Engineers' Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

August 19-23.—Exhibition of nut, bolt and forging machinery at Tiffin, Ohio, by the National Machinery Co. A special excursion train will be run from Detroit for the conveyance to the works of the master blacksmiths in attendance to the annual convention of the International Railway Master Blacksmiths' Association.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. H. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

NEW BOOKS AND PAMPHLETS

NATIONAL METAL TRADES ASSOCIATION PROCEEDINGS. 12TH ANNUAL CONVENTION, NEW YORK, APRIL 13-14. Published by the Association. Robert Wuest, Commissioner, 605 New England Building, Cleveland, Ohio.

The proceedings include the following technical papers: "The Fitchburg Plan of Industrial Education," by W. B. Hunter; "Growth of the Cooperative System," by Professor Herman Schneider; "A Plea for Continuation Schools," by Dr. Frank B. Dyer; "The Compensation of Workmen," by H. L. Gantt; "Cincinnati's Continuation Schools," by J. Howard Renshaw; "Employers Liability Insurance," by Miles M. Dawson; "Modern Methods of Shop Management," by Frederick A. Waldron; "Labor Bureaus," by Joseph A. Holland; "Industrial Education," by Prof. Dexter S. Kimball. The proceedings will be found of much interest by all concerned with the problems of industrial education.

WORK, WAGES AND PROFITS. By H. L. Gantt. 194 pages, 4¾ x 7¼ inches. Published by the *Engineering Magazine*, New York. Price $2.

This work is a re-issue in book form of a series of articles, "Compensation of Workmen and Efficiency of Operation," published in the *Engineering Magazine*, to which have been added three of Mr. Gantt's most important preceding contributions, revised and brought up to date. The work, as a whole, is a complete statement of Mr. Gantt's ideas on methods of works management and compensating workmen. The contents by chapters are: The application of scientific methods to the labor problem, utilization of labor, compensation of workmen, day work, piece work, task work with bonus, training workmen in habits of industry and cooperation, fixing habits of industry, profits and their influence on the cost of living. The work is one that can be read with interest by those not directly connected with the problems of manufacture.

TESTS OF TIMBER BEAMS. By Arthur N. Talbot. Bulletin No. 41. 77 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The investigations were undertaken to obtain information on the structural properties of full-sized timber beams such as are used in bridge practice, but of course, the results are applicable to timbers wherever employed in all forms for building construction. The tests include 112 full-sized stringers and several hundred smaller test pieces cut from large beams. The woods tested were long-leaf pine, short-leaf pine and Douglas fir. The fiber stresses developed in beams not shearing horizontally is generally low, averaging, on untreated timber tested, from 3690 in Old Douglas fir to 5300 pounds per square inch in the long-leaf pine. The results disclose the very interesting fact that timbers having knots and cross grains are generally less stiff than clear timber. From this fact it is obvious that when strong sticks and defective sticks are placed side by side in a structure, the weaker stick usually takes less than its share of the load.

A PATHFINDER—DISCOVERY, INVENTION AND INDUSTRY: Subject, Edward G. Acheson. 143 pages, 6 x 9 inches. Published by the Press Scrap Book, 209 Broadway, New York.

We are indebted to the International Acheson Graphite Co., Niagara Falls, N. Y., for this beautiful example of bookmaking, of which company Dr. Acheson is the president. The world knows vaguely that Dr. Acheson is a renowned discoverer and inventor, but few know just what remarkable things he has accomplished. Originally written for the benefit of his family and friends, it has been secured from Dr. Acheson and published to give the youth and young men of the country a life story that is an incentive to ambition. It records his early struggles, his experience with Edison at Menlo Park, travels in Europe, discovery and development of carborundum, graphite, Egyptianized clay, direct reduction of aluminum and silicon, production of siloxicon, aquadag and oildag. Dr. Acheson has read many important and valuable papers before scientific societies and has had many honors conferred on him. The work is one that should interest all who are attracted to advanced and original scientific work.

ENGINEERING CHEMISTRY. By Thomas B. Stillman. 755 pages, 6 x 9 inches, 174 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price $5.

This work, which now appears in the fourth edition, is a manual of quantitative chemical analysis for the use of students, chemists, and engineers. Much of it has been re-written by the author, who was formerly professor of engineering chemistry at Stevens Institute of Technology. It describes the proximate analysis of coal and coke, analysis of limestone, iron ores, manganese ores, blast furnace slag, copper, lead and zinc, boiler waters, chimney gases, etc. It also describes the construction and use of the Uehling gas compositemeter and Junker's gas calorimeter. A chapter is devoted to practical photometry. A partial list of contents will give an idea of the scope of the work: Manufacture of water gas, composition of natural gas, natural gas under steam boilers, liquid fuel, the blast furnace as a power plant, method of the United States Steel Corporation for commercial sampling of iron ores, foundry chemistry, carbon compounds of iron, analysis of tin plate, analysis of clay, fire sand, composition of natural cement, the chemical and physical examination of Portland cement, testing of brick, saline efflorescence of brick, asphalt, soap analysis, examination of lubricating oil, oils used for illumination, paint analysis, etc.

WORK-ACCIDENTS AND THE LAW. By Crystal Eastman, edited by Paul Underwood Kellogg. 345 pages, 6 x 9 inches. Illustrated. Published by the Charities Publication Committee, New York, under the Russell Sage Foundation. Price $1.50, postage 15 cents extra.

This remarkable and absorbingly interesting work treats of the industrial problem in its relation to the laboring classes, without gloves. It is a terrible indictment of conditions with some phase of which most of us are familiar, but of which very few realize the monstrous proportions in the country as a whole. One reads with pity, horror and indignation of accidents that have crippled men, bereaved wives and parents, and thrown dependent children upon charity which could have been prevented if the simplest precautions had been observed. "Man's inhumanity to man makes countless thousands mourn" takes on a new significance after having read the chapters on the railroaders and steel workers. On the other hand, a large proportion of work-accidents are the result of individual carelessness or deliberate disobedience to rules. A great deal of educational work has to be done with employes to bring about a general sense of the need of always being careful in the use of machinery, the piling and handling of material, etc. Space will not permit giving this great work the thorough review that it merits. It should be in the hands of all manufacturers and others employing labor, especially in hazardous occupations. It treats of the causes of work-accidents, economic cost of work-accidents and employers' liability. Those who believe that every large industry should bear the burden of caring for its employes killed, maimed or injured and their families, will read this book with heartfelt approval and be moved, we hope, to promote the movement to secure such state legislation as shall be just and equitable to all concerned.

CATALOGUES AND CIRCULARS

CLINTON EDWARDS, 27 East 22nd St., New York. Bulletin on industrial engineering.

BROWN INSTRUMENT CO., 311 Walnut St., Philadelphia, Pa. Circular No. 5 of Brown thermometers.

ASSOCIATION OF AUTOMOBILE ENGINEERS, 1451 Broadway, New York. List of members of the association.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin No. 8108 on "Crown" bench and floor sand rammers.

AMERICAN BLOWER CO., Detroit, Mich. Bulletins Nos. 267 and 273 on "Detroit" steam traps and the "A B C" heater.

HILL CLUTCH CO., Cleveland, Ohio. Catalogue No. 8 on friction clutches for general power transmission purposes.

SPRAGUE ELECTRIC CO., 527-531 West 34th St., New York. Bulletin No. 600 on single-phase and polyphase induction motors.

HAMMACHER SCHLEMMER & CO., 4th Ave. and 13th St., New York. Catalogue 400 on hand screws and clamps of all kinds, comprising practically everything in this line.

T. R. ALMOND MFG. CO., Ashburnham, Mass. Circular of Almond right-angle coupling for power transmission, built in four sizes, 5, 10, 20 and 40 horsepower, respectively.

ROCKFORD LATHE & DRILL CO., Rockford, Ill. Descriptive circular of 13-inch floor drill having a drilling capacity up to ¾-inch hole and to the center of a 13-inch circle.

C. W. HUNT CO., West New Brighton, N. Y. General catalogue 102 of coal-handling and hoisting machinery, conveyors, industrial railways, electric locomotives, steam hoists, etc.

RUSSELL JENNINGS MFG. CO., Port Chester, N. Y., has published an illustrated booklet entitled: "How to Sharpen Auger Bits, and How to Care for Them." Copies will be sent free on request.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Bulletin of 48 pages entitled "Battery Charging Rheostats," which illustrates and describes the company's entire line of battery charging rheostats.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio. Booklet entitled "Pointers on Machinery." The company carries a complete line of machinery for automobile, carriage, wagon, sheet-metal and structural shops.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin No. 8803 on "Imperial" high-duty pneumatic-hammers, comprising scaling hammers, chipping hammers, riveting hammers, chisel and rivet shanks, duplicate parts, etc.

HUTHER BROS. SAW MFG. CO., INC., Rochester, N. Y. Catalogue of patent dado heads, milling saws, box board matcher cutters, lock corner cutters, concave saws, saw fitting machinery and all kinds of special grooving saws for wood working.

MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio. Descriptive circular of the Miami Valley No. 1 universal tool and cutter grinder having a capacity of 16 inches between centers and swing of 8 inches. See description in MACHINERY, March, 1910.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Bulletins Nos. 18 C and 19 C, illustrating and describing the design and application of fixed rail automobile multiple-spindle milling machine designed especially for builders of automobile gasoline motors.

FIDELITY & CASUALTY CO., 92 Liberty St., New York. Rules for operating low-pressure steam pumps, and rules for operating high-pressure steam power boilers. These rules should be placed in the hands of engineers and firemen of steam plants generally.

RICHARD DUDGEON, 24-26 Columbia St., New York. Booklets 9 and 11 on the Dudgeon universal hydraulic jack, printed in Spanish and French, respectively. The pamphlets illustrate the construction of the Dudgeon hydraulic jacks and contain directions for use. Copies are sent free on request.

NEW YORK BELTING & PACKING CO., 91-93 Chambers St., N. Y. Engineers' catalogue showing high-grade packings for all conditions of service, comprising piston-rod packings, valve-stem packings, high-pressure steam packings, waterproof packings, hydraulic packings, sheet packings, gaskets, pump valves, pump diaphragms, valve disks, asbestos wicks, etc.

BRISTOL CO., Waterbury, Conn. Illustrated index of Bristol recording instruments for pressure, temperature and electricity, and Bristol electric pyrometers for high temperatures. This attractive pamphlet should interest all shop managers, central station engineers, and others desiring accurate and reliable records of temperatures, machine operations, pressures, etc.

AMERICAN CHAMBER OF COMMERCE, 3 Rue Scribe, Paris, France, has issued bulletin No. 82 on the Franco-American tariff agreement which contains a synopsis of the new French tariff on American products. Manufacturers, exporters, and others doing business with France will find this synopsis of value. It is printed in French and English, in parallel columns, on opposite pages.

INTERNATIONAL ENGINEERING CO., 1779 Broadway, New York. Price list of Lemoine springs for motor cars. The price list includes useful data for engineers and designers such as load, length, width and camber for front, semi-elliptic rear and three-fourths-elliptic springs; also tables showing distances springs may be deflected without taking permanent set, the material being mangano-silicon, premiere qualite steel, qualite courante steel, etc.

ANDERSON FORGE & MACHINE CO., Detroit, Mich. Folder briefly describing the company's new drop forge plant which occupies thirteen acres located on Jefferson Ave. The folder illustrates a 7500-pound steam drop-hammer that will be installed. The hammer takes a die weighing five tons, and delivers a blow of 12,000,000 foot-pounds. The equipment of the plant will be of the most advanced type. Oil will be used as fuel throughout. The plant is expected to be ready for occupancy September 1.

INGERSOLL-RAND CO., 11 Broadway, New York. Pamphlet 9001 on the Davis "Calyx Diamondless" core drill. One form of the Davis "Calyx" drill employs a cutter of the hollow mill variety, the teeth being made of steel. The cutter does not cut the rock, but chips it away, which is doubtless the secret of its ability to stand up in hard rock. Another form of cutter employs chilled shot. The advantages of the "diamondless" drill, of course, are lessened first cost and reduced cost of up-keep.

AETNA LIFE INSURANCE CO., Hartford, Conn. Pamphlet on the care and operation of elevators, published with a view of preventing accidents. The purpose of the pamphlet is to call attention to certain matters in the care and operation of elevators which should never be overlooked or neglected if accidents are to be prevented. It treats of general considerations affecting elevator installation, investigation, the attitude of the owner, agent, the engineer, operator, passenger, safety of equipment, careful operation, useful information, elevator warning signs, etc. The pamphlet will be sent free to those interested.

BROWN INSTRUMENT CO., 311 Walnut St., Philadelphia, Pa. Catalogue No. 3 containing 48 pages on electric pyrometers. The Brown pyrometers are made with nickel-chrome alloy couples for use at temperatures up to 2200 degrees F. and for intermittent use up to 2400 degrees F. For temperatures up to 3000 degrees F. they are supplied with platinum-rhodium couples and horizontal indicators. Electric recording pyrometers and methods of installing the various parts of pyrometers in furnaces, etc., are shown. The catalogue also illustrates the Brown radiation pyrometers for measuring the highest temperatures. This instrument is similar to a telescope with a tripod, the

CONTENTS FOR AUGUST

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition

part corresponding to the eye-piece in the ordinary telescope being directed to the flame whose temperature is to be measured.

ASSOCIATION OF AUTOMOBILE ENGINEERS, 1451 Broadway, New York, has issued a list of material specifications, published under the direction of Mr. Henry Souther, metallurgist, with complete instructions on the method of purchasing, inspecting and handling materials used in motor car construction. The materials include low- and high-carbon steel, carbon spring steel, screw stock and high-carbon nickel steel, chrome-nickel steel, chrome vanadium steel, chrome vanadium spring steel, silicon spring steel, alloy steel, steel castings, gray iron castings, malleable iron, babbitt metals, white brass, phosphor-bronze bearing metal, aluminum alloys and automobile engine lubricating oil. A great deal of attention is given to the heat treatment of steel. The work will be issued only to the members of the society.

TRADE NOTES

GILBERT & BARKER MFG. CO., Springfield, Mass., manufacturer of gas machines, and gas and oil furnaces, is building an addition to its factory.

WAGNER ELECTRIC MFG. CO., St. Louis, Mo., has changed the location of its Denver office from the Ideal Building to the Gas and Electric Building.

BURROUGHS ADDING MACHINE CO., Detroit, Mich., is building a four-story concrete-fenestra building that will add 80,000 square feet to its floor space.

WINKLEY CO., Detroit, Mich., has more than doubled its capacity by the building of a large one-story concrete and steel addition in which the installation of machinery has been practically completed.

UNION MACHINE CO., INC., 164 University Ave., St. Paul, Minn., has been appointed general manufacturing and selling agent for the products of the Plunger Plastic Packing Co., Inc., St. Paul, Minn.

BRIGHTWOOD MOTOR MFG. CO., Springfield, Mass., has bought the plant and equipment of the Bailey Automobile Co., and is adding considerable machinery for the manufacture of a new line of automobiles.

C. W. HUNT CO., West New Brighton, New York, has made arrangements with the San Francisco Bridge Co., San Francisco, Cal., to handle the company's Pacific coast business in coal handling, conveying, and hoisting machinery.

MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio, has recently completed an addition to its building, greatly increasing its floor space, for assembling purposes. The addition will enable the company to considerably increase its output of engine lathes, universal cutter and plain tool grinders and drills.

LAPOINTE MACHINE TOOL CO., Hudson, Mass., gave its employes their first annual outing Saturday, June 25, at Treaty Elm Grove, Stow, Mass. About 150 attended. Sports were provided and prizes given to the successful competitors. Music was furnished by the Hudson Band. The event was a great success.

BROWN & SHARPE MFG. CO., Providence, R. I., announces that its works will be closed from August 5 to 22 for the annual vacation. During that period the offices will be opened as usual and orders for machine tools, machinists' tools and measuring tools will receive attention as at other periods of the year.

INVINCIBLE ELECTRIC BANK PROTECTION CO., Munroe, Wis., manufacturer of double steel electrified vaults, linings and complete electric alarm systems, has added to its output a line of improved safe-deposit boxes, filing cases, roller shelving, omnibuses, desks, tables, etc. The capacity of the company has been more than doubled during the last three months.

BAUSH MACHINE TOOL CO., 200 Wason Ave., Springfield, Mass., has begun the publication of a house-organ entitled *The Driller*. The second number is attractively printed in black and red and, besides the advertising and argument for the Baush multiple-spindle drill, contains interesting shop notes and miscellany. It will be sent on request to those interested.

CINCINNATI PLANER CO., Cincinnati, Ohio, reports an improvement in foreign business during the month of June. The company booked orders for planers from Siberia, Germany, Holland, Italy, Mexico, Cuba, South America and Canada. It also booked some large orders from prominent concerns in the United States, and the prospects for a big year's business are good.

BANTAM ANTI-FRICTION CO., Bantam, Conn., through its president, Mr. W. S. Rogers, who is spending the summer in Europe, has secured sole representation in America for the well-known steel balls made by Heller Bros., Marienthal, Germany, and DKF ball bearings made in Leipsig. It is the intention of the company to open branch offices in Philadelphia and Detroit in the Autumn.

ST. LOUIS STEEL FOUNDRY, St. Louis, Mo., owned and operated by Curtis & Co. Mfg. Co., has increased its capacity about 100 per cent as a result of the success the company has made in the manufacture of manganese steel crossings, frogs, switches, etc., for steam and electric roads, and miscellaneous manganese steel castings. The addition has been completed and additional crane and grinding equipment has been installed.

T. R. ALMOND MFG. CO., Ashburnham, Mass., is distributing copies of tests recently made at the Orswell Mills, Fitchburg, Mass., showing the horsepower required to drive spinning mules. The tests demonstrate the desirability of using flywheels of about 30 inches diameter, weighing about 600 pounds, to reduce the power fluctuations, and it is expected that a No. 3 Almond right-angle transmission will drive two mules satisfactorily.

ELECTRIC WELDING PRODUCTS CO., Cleveland, Ohio, has moved into its new factory addition 94 x 100 feet, three stories high. New machinery has been installed and offices have been fitted out on the second floor of the new building. The number of men now employed is about 350. The company solicits business particularly from automobile and parts manufacturers, manufacturers of machinery, electric apparatus, and stationary engines.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., will erect a large addition to its works on the lands of the Niagara Falls Power Co. in that city. The addition will be a furnace room having a capacity for ten or twelve new furnaces. The building will be of brick and steel construction. The additional furnaces will largely increase the output of graphite which is used in the manufacture of electrodes, paint pigment, lead pencils, electroplaters, molding and polishing leads, lubricants, etc.

ACHESON OILDAG CO., Niagara Falls, N. Y., has purchased a factory site of thirty acres at Port Huron, Mich., where it will erect a building for the manufacture of oildag. The price of oildag has been reduced to approximately 60 per cent of that recently quoted, which brings it down to a price, when bought in quantities, considerably less per gallon than that of the oil with which it is mixed. It is claimed that the presence of deflocculated graphite in the oil makes each gallon equal to from two to four gallons of plain oil.

WAGNER ELECTRIC MFG. CO., St. Louis, Mo., has removed its Charlotte, N. C., office to the Woodward Building, Birmingham, Ala., where it will be in charge of Mr. J. F. Jones. The Birmingham office will serve that part of Tennessee east of the Tennessee River and all of the states of Mississippi, Alabama, Georgia and Florida. North and South Carolina, which have hitherto been handled from the Charlotte office, will now be served by the Philadelphia office, which is located in the Real Estate Trust Building, in charge of Mr. John Mustard.

WAGNER ELECTRIC MFG. CO., St. Louis, Mo., has opened an office in the Woodward Building, Birmingham, Ala., which will be in charge of Mr. J. F. Jones. Mr. Jones, who is a Southerner, graduated from the Alabama Polytechnic Institute in 1901, when he entered the employ of the General Electric Co., working in its testing department, inspection department and finally becoming transformer salesman. In 1905 he became transformer sales engineer for the Fort Wayne Electric Works, and in 1909 joined the home office force of the Wagner Electric Mfg. Co.

TAFT-PEIRCE MFG. CO., Woonsocket, Mass., has opened an office at 1311 Majestic Building, Detroit, Mich., where competent mechanics will be located for the express purpose of looking after the company's interests in the Middle West. The increasing demand for prompt and high-grade service in the designing and construction of special tools

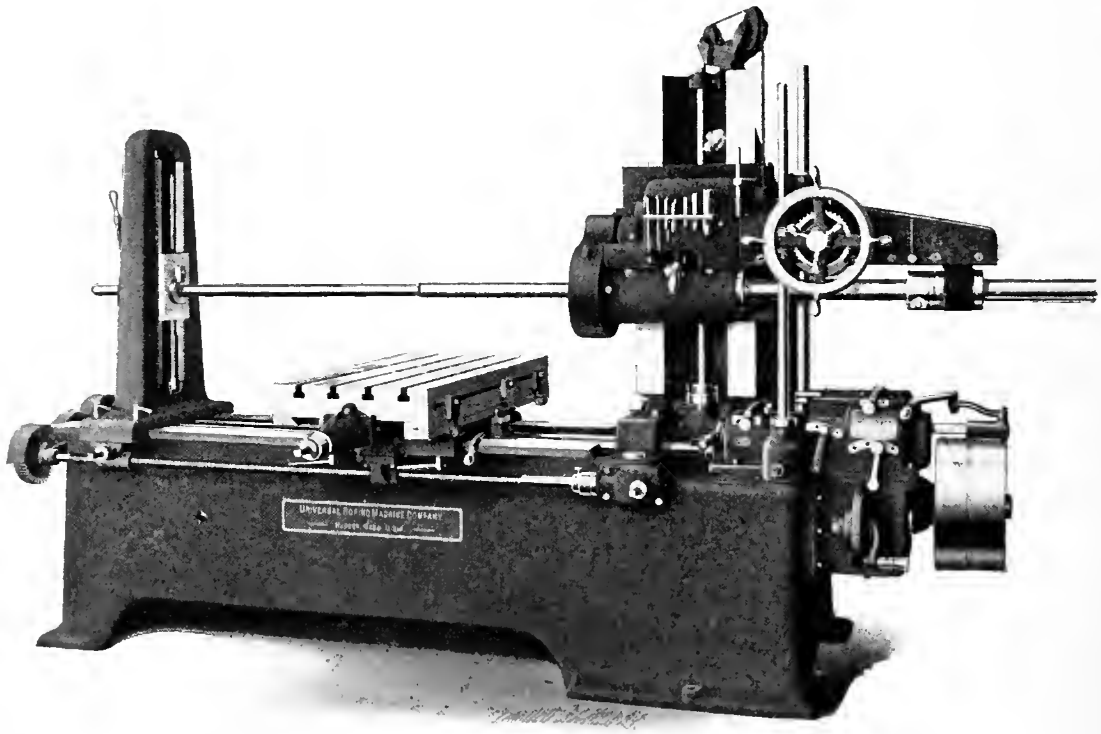
such as jigs, fixtures, gages, etc., has required the Western office. The company now has, in its Woonsocket plant, one of the most completely equipped tool-rooms in the country, with ample facilities for at least 250 workmen.

JOSEPH T. RYERSON & SON, Chicago, Ill., have removed their New York office to the seventh floor of the Hudson Terminal Building. The office will be maintained in connection with the machinery display rooms and warehouses immediately adjacent to the Jersey City terminal of the Hudson-Manhattan tunnel. A complete stock of boiler, structural and machine shop fittings and specialties, Morison corrugated furnaces, Glyco bearings, tool steel, metal-working specialties and shop supplies and equipment will be carried. The shipping facilities are unexcelled.

B. F. STURTEVANT Co., Hyde Park, Mass., manufacturer of fans, blowers, fuel economizers, and mechanical draft apparatus, held a salesman convention June 15-18. The company's branch office managers and principal salesmen from all over the country assembled at the works and general office of the company at Hyde Park, and spent four busy days in going over general business. The evenings were enlivened by banquets and other social features. The last day of the convention closed with a delightful sail down the harbor and an afternoon and evening at the Cohasset home of Mr. E. N. Foss, treasurer of the company.

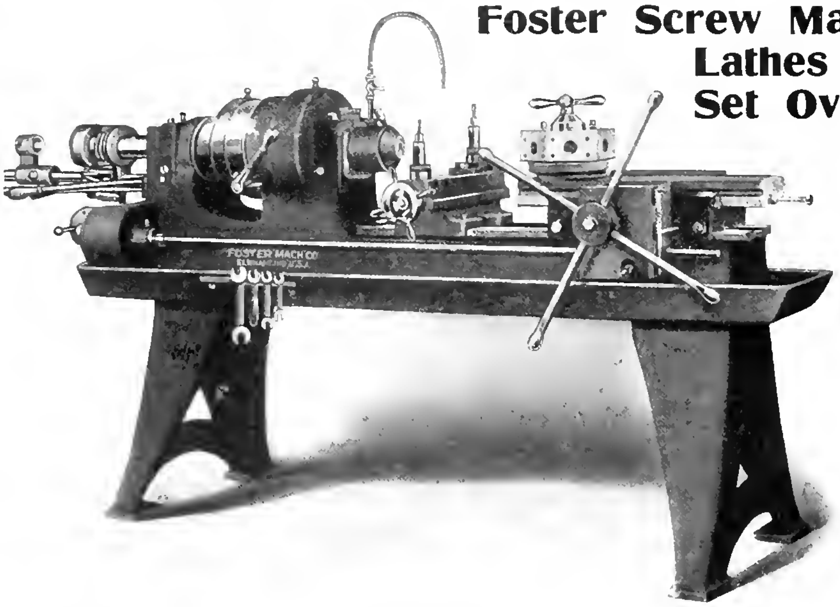
KEUFFEL & ESSER Co., Hoboken, N. J., manufacturer of drawing materials and engineering supplies, celebrated the forty-third anniversary of the founding of the house Tuesday evening, July 19, by a banquet to its employes at Grand View Park, Jersey City Heights, N. J. Interest was added by the fact that four employes this year complete their twenty-fifth year of service with the company. Appropriate gifts were presented to them by the company and some very handsome testimonials were given them by their fellow workmen. Twelve employes, who have completed a quarter of a century of service with the company, occupied places of honor with the officers. The evening proved to be so great a success in cementing the interest of all concerned that the banquet no doubt will be made an annual institution.

AGNEW ELECTRIC WELDING Co., 868 Military Ave., Detroit, Mich., has issued a statement regarding its activities and business control. The control and management of the company recently changed hands. A party of Cleveland men, active in the management of the Electric Welding Products Co., Cleveland, Ohio, has bought out the Agnew interests. The officers of the company are: C. E. Thompson, president; J. A. Krider, vice-president; R. K. Loofburrow, secretary and treasurer. The company will immediately add to its facilities, and expects to move from 868 Military Ave. to a better location in Detroit. Application has been made to change the name of the company to the Michigan Electric Welding Co. The company makes a specialty of welding automobile work such as the forging of rod yoke ends assemblings complete, drag links, fore-and-aft connections, propeller shafts, and in short the welding of any sort of forgings and parts that can be successfully welded to rods, shafts, tubes, etc.



Foster Features that are Financial Factors

in the rapid production of duplicate machine parts and are incorporated in



Foster Screw Machines, Foster Turret Lathes and Foster Universal Set Over Turret Lathes

are as follows:

Independent stops for each hole in the turret.

Quick Change Gears to the power feed.

Adjustability in all directions—allowing re-alignment when worn out of true, and in all Foster Universal Machines, Independent stops to the turret slide—an advantage not found in any similar machine.

You can save money, insure accuracy and handle a wider range of work with Foster Machines.

Screw Machines have capacity from ¾" to 4½"—Turret Lathes take work from 10" to 24" swing and Set Over Lathes 16" to 18" swing.

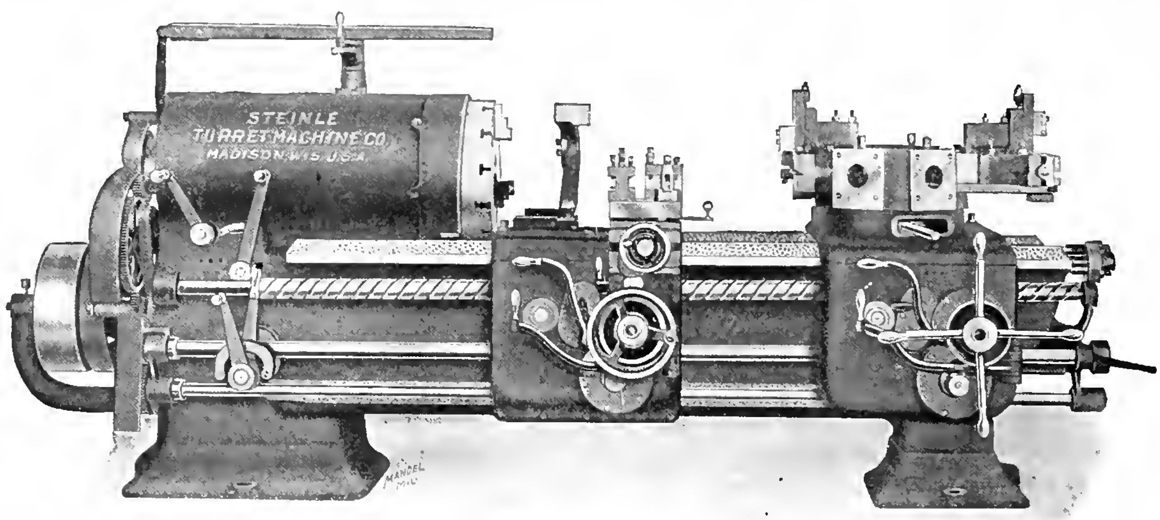
Ask us for estimates on your line of work.

Foster Machine Co., 1100 Beardsley Ave., Elkhart, Ind.

AMERICAN AGENTS—The H. A. Stocker Machinery Co., Chicago, Ill C. C. Wormer Machinery Co., Detroit, Mich. Manning, Maxwell & Moore, New York, Philadelphia, Pittsburg, Syracuse, Buffalo, Cleveland, St. Louis, Atlanta, Ga., Milwaukee, Wis., Portland, Ore., Seattle, Wash., Boston, Mass., Chicago.

FOREIGN AGENTS—Manning, Maxwell & Moore, Japan, China and Philippine Islands. Schuchardt & Schutte, London, England. A. R. Williams Machinery Co., Toronto, Ontario. Williams & Wilson, Montreal.

Steinle Full Swing Side Carriage Turret Lathe



Pre-eminently a manufacturing machine with every advantage for the economical production of duplicate machine parts, it has strength, rigidity, all operating conveniences and is built for the heaviest service. Tools have practically no overhang. Tool post carriage is arranged to run past the chuck. Both carriages are operated by power. Single drive. Thirty changes of speed all under immediate control. We shall be glad to send further description on request.

STEINLE TURRET MACHINE CO., Madison, Wis.

SELLING AGENTS

Manning, Maxwell & Moore, Inc., New York.
Atlanta, Boston, Chicago, Cleveland, Detroit, Milwaukee, Philadelphia Pittsburg, St. Louis, Syracuse, Seattle, Portland, Japan, Mexico.

Ludw. Loewe & Co., A. G., Berlin.
Austria, Belgium, Denmark, France, Germany, Holland, Hungary, Italy, Norway, Romania, Russia, Spain, Sweden, Switzerland.

It has never been our custom to forward our interests by discrediting others

Lincoln-Williams High Speed Twist Drills

meet all competitors fairly and squarely and stand on their own individual merit.

We have centered all our forces and energies on making the best twist drill that could be offered—

Lincoln-Williams High Speed Twist Drills

made from the finest materials, after improved patterns and under the supervision of trained mechanics are "The Perfection of Mechanical Art".

The staying qualities of these high grade, high speed drills have been so well demonstrated that their economy is firmly established. They meet the highest speeds of which modern drilling machines are capable, stand heavy feeds and do their full duty under all conditions.

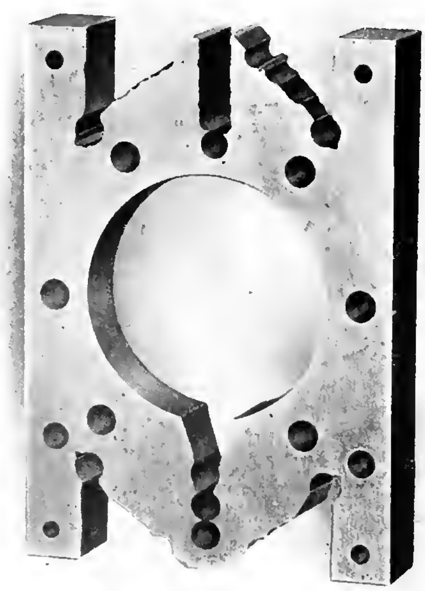
We can lessen your drilling costs by a considerable amount if you will use Lincoln-Williams High Speed Drills—full line of styles and sizes.

Catalogue on request.

Lincoln-Williams Twist Drill Co.

Taunton, Mass., U.S.A.

Steel for High Grade Dies



The making and working of high class dies is one of the tests that brings out the good qualities of the steel or shows up its deficiencies.

The die, here shown, made by a manufacturer of extremely fine and expensive dies, did not vary 1-10000" in the hardening, notwithstanding the unusual difficulties offered by reason of the many angles, holes and thin sections.

No change in hardening.

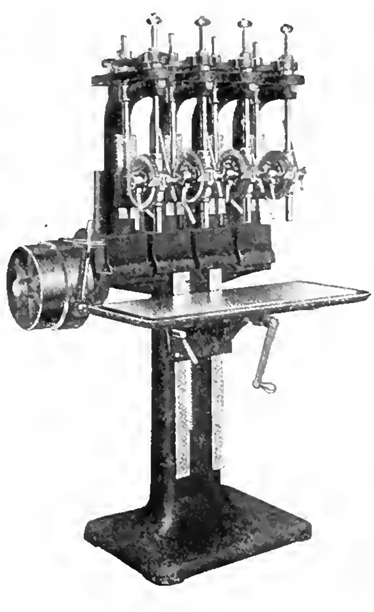
Our steels are particularly well adapted for die making—write us your requirements and give us a trial.

Cammell Laird & Co., Ltd., (Sheffield)

25 Cliff Street, NEW YORK CITY

Manufacturing Drills

Capacity $\frac{1}{4}$-inch to $\frac{3}{4}$-inch Holes



In convenience, speed, adaptability and simple but absolutely up-to-date construction these machines meet and pass all competitors. They are built in a wide range of sizes with five different types of heads, have positive gear drive and silent chain, thus avoiding the annoyances consequent to slipping or broken belts, frictional losses from tight belts and other belt troubles. There is power and rigidity to drive high speed drills to their full limit and a dependable accuracy that counts largely in the days work.

New catalogue showing all sizes will be sent on request.

The Taylor & Fenn Company

HARTFORD, CONN.

EUROPEAN AGENTS—E. Sonnenthal, Jr., Berlin, Cologne and Vienna. R. S. Stokvis & Zonen, Ltd., Rotterdam and Brussels. Alfred H. Schutte, Paris, Milan and Barcelona. Schuchardt & Schutte, Stockholm and Copenhagen.

WHEN THE CENSUS MAN WENT ROUND

If he had kept score of the number of **skilled workers machinists, toolmakers** and others—who are using **American Swiss Files** to the exclusion of other brands, there would have been some **surprising figures.**

Files have come to stay. We are making new friends every day, but what's more to the point, we keep our old friends. You can persuade a man to *try* a new thing, but it must have **quality dependable, ingrained quality**—before he will "tie to it".

We should like to send a few *free* sample files as **"persuaders"**—they will do the rest themselves. Your preference in size, shape and cut written on your *business letter head* will bring the samples.

Address nearest agency below.

American Swiss File and Tool Company
24 John Street, New York, N. Y.

DISTRIBUTORS:

E. P. REICHHELM & CO., 24 John St., New York.
THE MACHINISTS' SUPPLY CO., 119 No. Canal St., Chicago, Ill.
THE BOYER-CAMPBELL CO., 64 Congress St., Detroit, Mich.
DUCOMMUN HARDWARE CO., 300 No. Main St., Los Angeles, Cal.
CHANDLER & FARQUHAR CO., 34 Federal St., Boston, Mass.
CHAS. A. STRELINGER CO., 96 Bates St., Detroit, Mich.
WHITE TOOL & SUPPLY CO., 1313 Sixth St., N. W., Cleveland, O.
TRACY, ROBINSON & WILLIAMS CO., Hartford, Conn.
THE MACHINISTS' SUPPLY CO., 324 Third Ave., Pittsburg, Pa.

Bearing vs. Wearing

The solution to the question, in so far as it concerns High Speed Drilling, is found in the inserted, interchangeable bearings of

Henry & Wright Drilling Machines

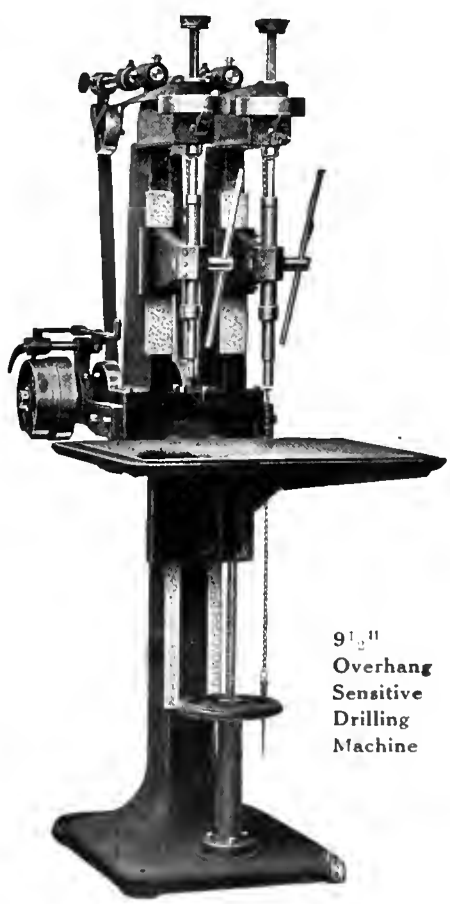
Wearing never ceases, yet by this plan it not only decreases but becomes a secondary consideration in the life of our machines.

They allow a **200** to **400** per cent. production increase and speeds that would destroy an ordinary machine. Bearings seldom need replacement and guarantee a new length of life and service with each renewal.

9½", 12", and 15" Overhang.

Catalogue on request.

THE HENRY & WRIGHT MFG. CO.
HARTFORD, CONNECTICUT, U. S. A.



9½" Overhang Sensitive Drilling Machine

THE SPOTLIGHT
"Nothing but Views"

COATES

Voluminous | **AUGUST, 19 TEN** | **Second Offense**

THE SPOTLIGHT
"Nothing but Views"

Published—Why, of course.
Subscription Price—Higher yet.
Circulation—Better than ever.
Editor—T. Paywell, Ph. B. C.
Office Boy—Impossible.

IS LIFE A GRIND TO YOU?

To the preacher life's a sermon,
To the joker it's a jest;
To the miser life is money,
To the loafer life is rest.
Life is but a long vacation
To the man who loves his work;
Life's an everlasting effort
To shun duty—to the shirk.
To the heaven-blest romancer
Life's a story ever new;
Life is what we try to make it—
Brother, what is life to you?

Away with the pessimist who says the world is growing worse. Working conditions, bad as they seem to-day, are not to be compared with the barbarous olden days.

Even in England, some centuries ago, if an ordinary workman moved from one parish to another without permission, in search of work or better wages, he was branded with a hot iron.

Consider the ever-increasing number of helps on simple operations such as grinding or cleaning castings. Not only is the old-fashioned way pure drudgery, but moving heavy, cumbersome work about is inconveuient, to say the least.

Now, a light, speedy tool which moves freely wherever required does the work more efficiently and in a fraction of the former time. This same outfit has several interchangeable tools which multiply its usefulness.

If life is a grind to you, we recommend a Coates Flexible Shaft Outfit—it shortens the grinding time.

EDITING THE SPOTLIGHT

You say it's a simple matter.

It is (if you only have to read it) but with our foreman at home shot three times, a printer in the jail half-shot, another in the office not worth shooting, the SPOTLIGHT is issued under difficulties this month.

But to come to the point. Some of our readers have had interestiug experiences with Coates Flexible Shafts and Tools. Many users have reduced working time on several operations to one-half or one-third of that formerly necessary.

The Editor would like a few details of these things first-hand. Just drop him a line addressed: "Editor of THE SPOTLIGHT, care Coates Clipper Mfg. Co., Worcester, Mass." It will be promptly acknowledged and possibly published here. Please let us hear from you soon—in time for the next issue if possible.

SUMMER BOARDERS—"Haow do them summer boarders of yourn keep busy?" "They play golf." "What'n Sam Hill's that?" "S near's I kin figger, it's solitaire shinny."

YOU can fool udder peoples some of der time, but you can fool yourself all der time.

NERVE CURE—"Prisoner, are you guilty or not guilty?" "Let my lawyer plead not guilty for me, judge; I ain't got the nerve."

COMPANION WANTED—The absent-minded professor returned home one evening, and, after ringiog his front door bell for some time to no effect, heard the maid's voice from the second-story window, "The professor is not in."

"All right," quietly answered the highly educated man, "I'll call again." And he hobbled down the stone steps.

SOME mens go through dis vorld on der brincible dot der more noise dey make, der more salary dey vas voith py pay day oo.

Please Mention THE SPOTLIGHT Ad.

The COATES Way—1910

200 years ago they cleaned castings by hand. But up-to-date manufacturers cannot afford to use slow, costly methods especially when one

Coates Flexible Shaft Outfit

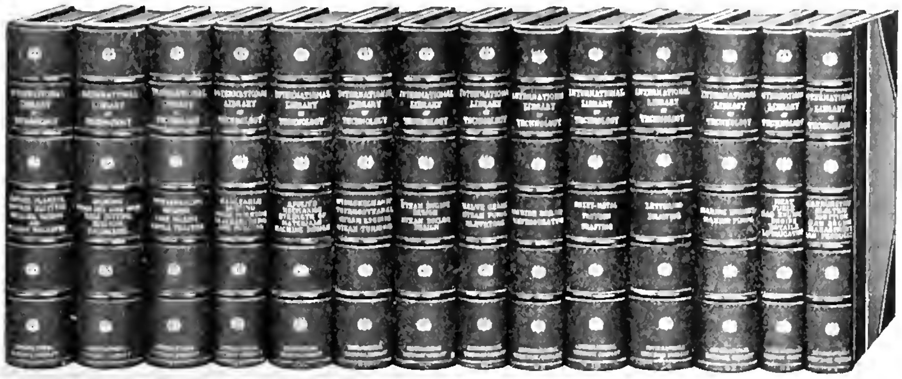
does the work of several different tools and as many men.

Grinding is only one of the possibilities. Drilling, surfacing, snagging, scratching, polishing, chipping, boring, etc., are all within its capacity.

The outfit takes the place of sand blast in removing rust, and for slicking up metal work or preparing castings so the paint will look smooth. It can't be equaled either in point of economy or efficiency.

Catalogue 22 will tell you many things of interest. Have you a copy?

Coates Clipper Mfg. Co.
Worcester, Mass.



The World's Best Mechanical Library

This Library of Mechanical Engineering is part of the 99 volumes of the International Library of Technology that cost over $1,500,000 in its original preparation. They contain the results of years of experience of the best mechanical experts in the country. They contain the best modern practical methods used in every branch of the mechanical profession. The matter has been written by the foremost technical experts and illustrated by a special staff of artists and craftsmen. Not only are they suited for mechanical engineers already well trained in their profession, but they are especially adapted for the use of those learning the profession and desiring to advance to the higher places, and those that wish to acquire in the easiest and most thorough manner the knowledge that will qualify them for such advancement. This Library is the only practical library in existence wherein the subjects treated can be readily understood and practically applied by persons having no knowledge of higher mathematics.

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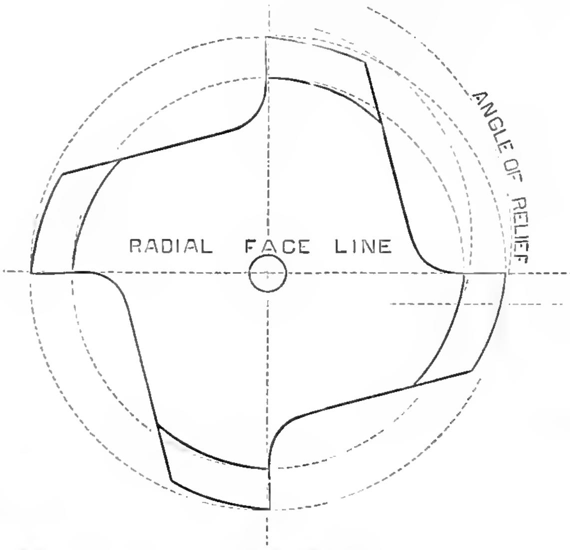

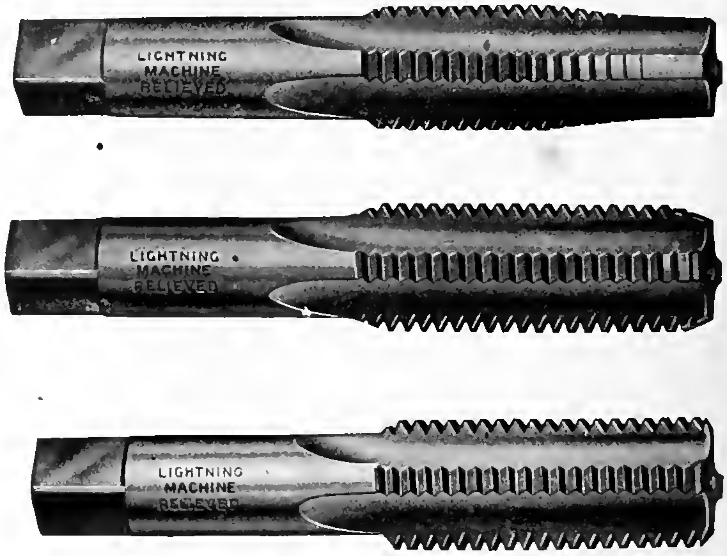

The value of the MACHINE RELIEF as applied to the LIGHTNING TAPS is recognized by leading mechanics and they specify *"must be machine relieved"* on their requisitions.
Our method of relieving (every tooth separately) insures easy cutting and smooth, clean threads.
Easier for the workman and cheaper for the proprietor.

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All merchandise is subject to TWO general tests—the "eye" test and the "service" test. You have probably found that some tools are only built for LOOKS—in fact, just to SELL. And you know there are other tools that don't look very fine but get the work done.

LITTLE GIANT tools will pass BOTH tests. They are made FIRST to do the work RIGHT, to do a lot of it, to do it for a long time—and THEN we finish them to pass the "eye" test—you'll find them the best looking tools of their class on the market. They ARE right and they LOOK right.

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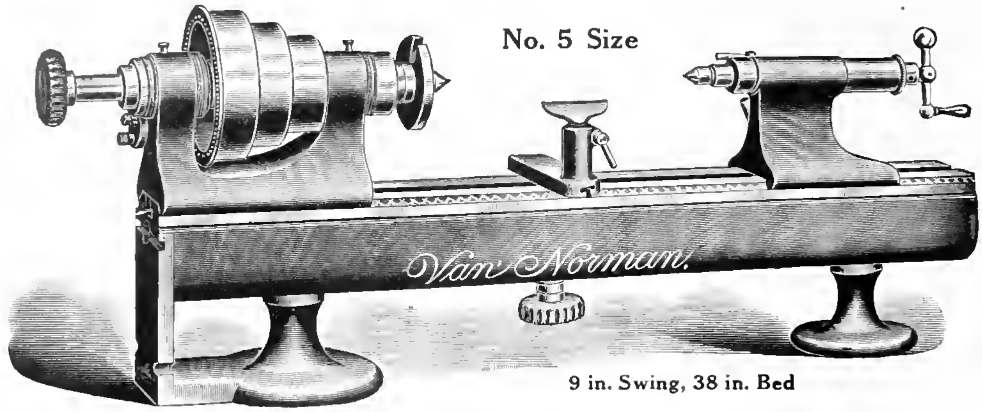

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with attachments for milling, etc., make a most complete outfit for all around Tool Fixture, Gauge, Experimental and Laboratory Work.

Three Sizes—Nos. 3, $3\frac{1}{2}$, 5

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A Money-maker that will Quickly Earn its Cost.

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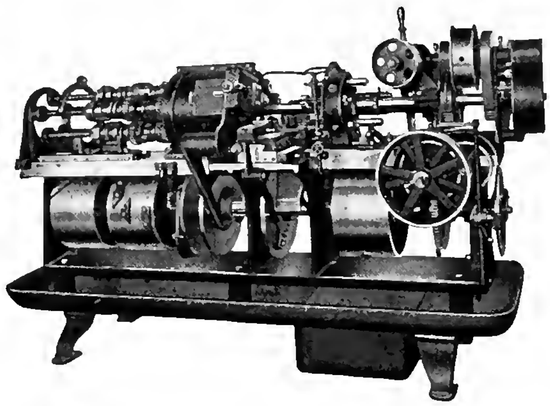
for any manufacturer who uses large quantities of metal parts.



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and strong enough for almost every class of work milled from the solid bar.

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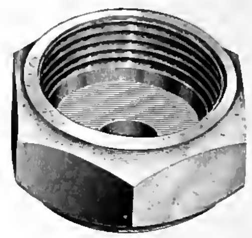
Then the "Universal Automatic" is a necessity. Absolutely simple design and construction, does the work of a score of machines in an almost incredibly short time and bears the strain of the heaviest cuts without spring or binding. We have collected data on economical production of small metal parts, steel, iron or brass—any shape. This information is always at your service. *May we send it?*



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The "Favorite" is the only nut wrench for a cramped place.

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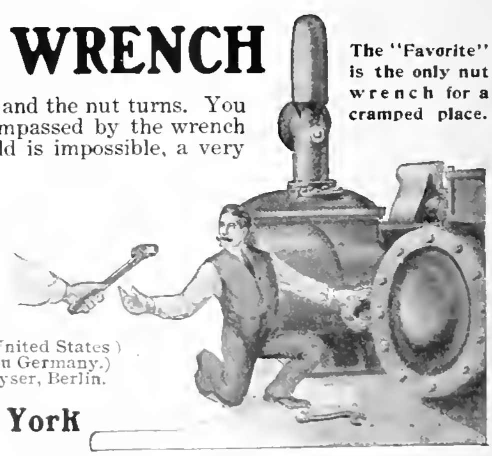

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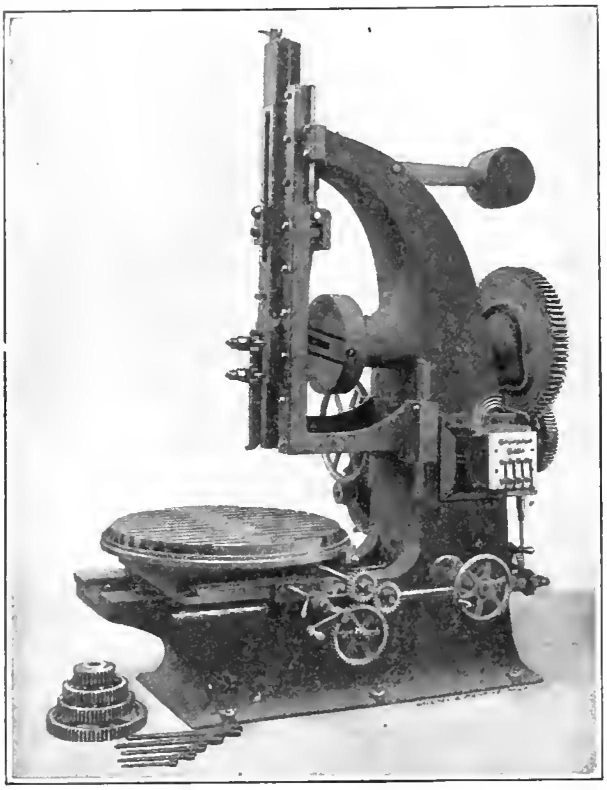

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Our **Slotting Machines** embody the most valuable features such tools should possess—viz.: stability, accuracy and convenience of manipulation—hence the largest and best product in a given time.

Our regular standard sizes are:

9″	stroke,	to slot	to centre of	36″	diameter.
10½″	"	"	"	42″	"
12″	"	"	"	48″	"
16″	"	"	"	60″	"
20″	"	"	"	72″	"

We have supplied more than 125 Slotters of various sizes to the Baldwin Locomotive Works in the past 11 years.

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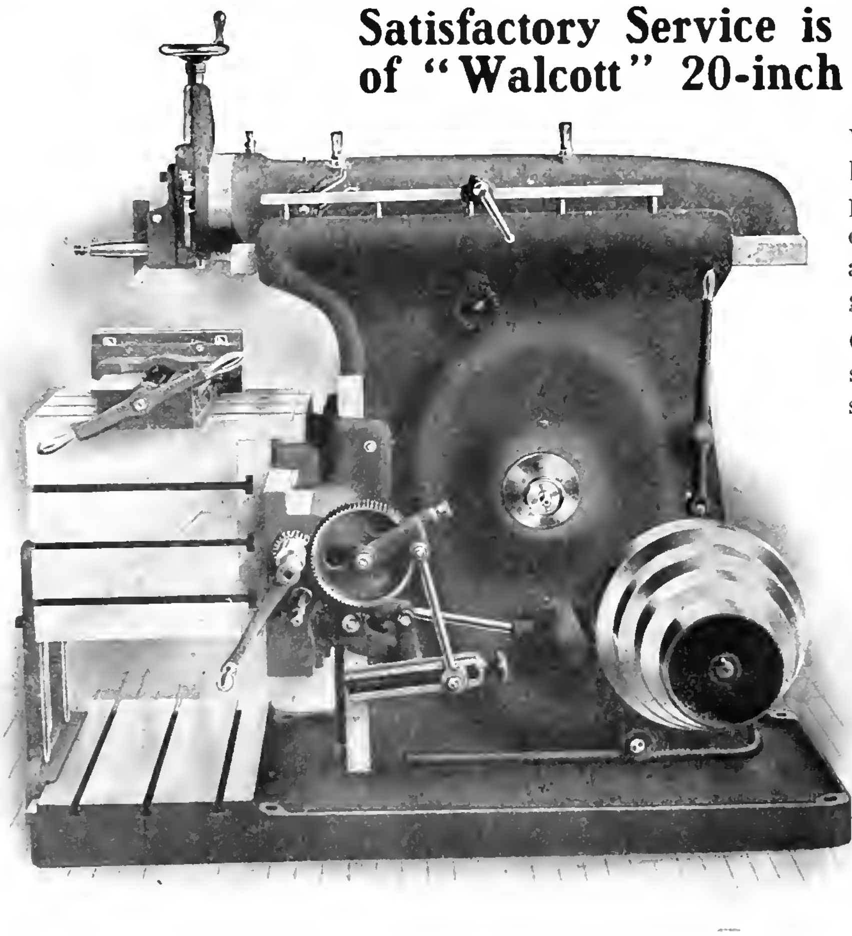
Satisfactory Service is the Record of "Walcott" 20-inch Crank Shapers.



Very powerful, compactly built, convenient and rapid producers. Have the strongest ram ever designed for a crank shaper, and driving gear of unusual strength.

Quick return; eight cutting speeds for each length of stroke: original feed mechanism equipped with safety device. Fitted with all improvements.

New catalog of Lathes and Shapers on request.

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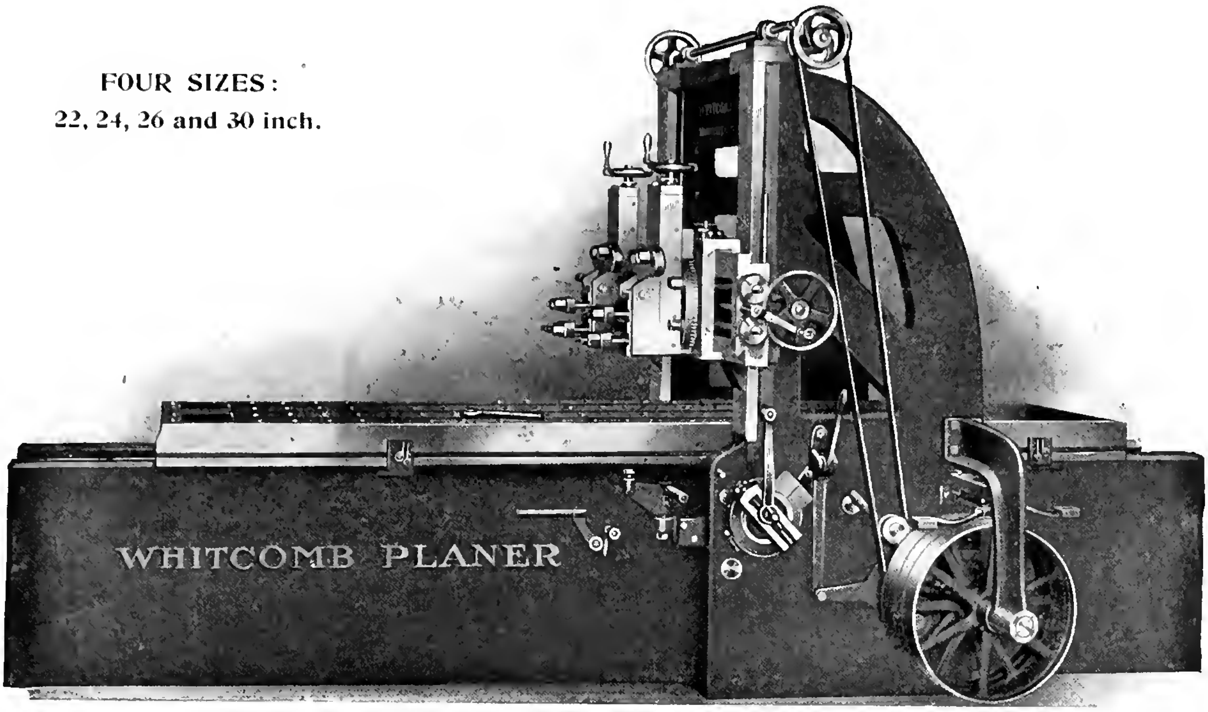
Second Belt Drive Planers

FOUR SIZES:
22, 24, 26 and 30 inch.



Speeds that would ruin old style machines are regular with the Second Belt Drive.

They are powerful and rapid, consuming less power than full geared planers, with a considerably greater output.

WHITCOMB-BLAISDELL WB

Softening the cutting action of high speed steel tools, running without jar or shock, and almost without noise, makes an appreciable difference in favor of quality results.

The prompt reverse, so arranged that little backlash can develop, combined with simplicity of construction reduces wear and tear, liability to accident and adds to operating convenience.

Ask us for the Planer Catalog, also a full description of New Model High Speed Engine Lathes.

WHITCOMB-BLAISDELL MACHINE TOOL CO.

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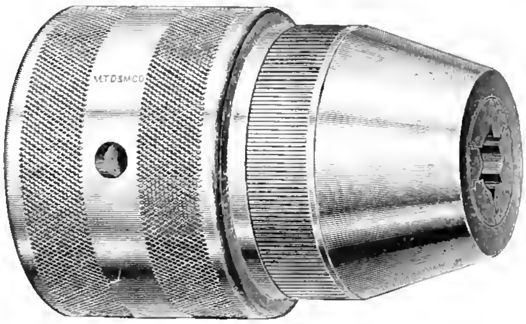
STETSON PATENT DRILL CHUCK.



This chuck is strong and of heavy construction. The jaws are controlled by separate drivers and are guided in that part of the chuck which is attached to the driving spindle. This arrangement gives increased strength to the chuck.

The threaded and working parts of the Chuck are covered, and thereby protected from injury and dirt.

No. 2 Holds from 0 to $\frac{3}{8}$ inch diameter.
No. 3 Holds from $\frac{1}{16}$ to $\frac{1}{2}$ inch diameter.
No. 4 Holds from $\frac{3}{16}$ to $\frac{5}{8}$ inch diameter.

These Chucks are so designed that a hole can be drilled through the center if desired.

No. 2 will permit of a hole $\frac{1}{4}$ inch in diameter.

Nos. 3 and 4 will permit of a hole $\frac{3}{8}$ inch in diameter.

With Chuck No. 2 is furnished a spanner wrench, illustrated below.

These wrenches are of steel, drop forged, finished and case hardened.

With Chucks Nos. 3 and 4, instead of a spanner wrench there is furnished a special pin used in tightening and for rapid adjustment.

ARBORS FITTING THESE CHUCKS

Morse Twist Drill & Machine Company

NEW BEDFORD, MASS., U. S. A.

A New Catalog

Covering all the different lines of grinding machines we manufacture has just been received from the printer, and we would be pleased to send you a copy without charge if you will furnish us with the address.

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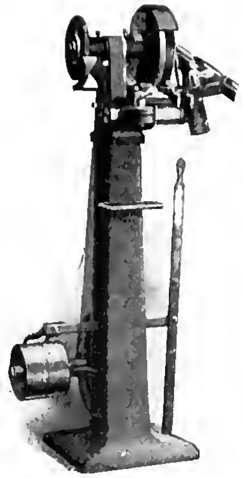
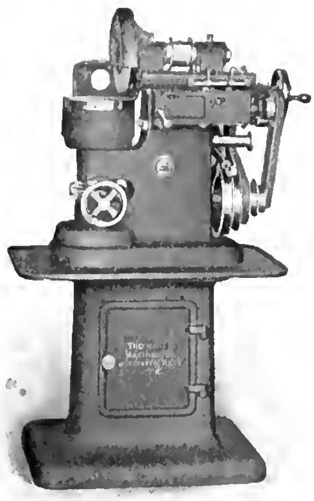
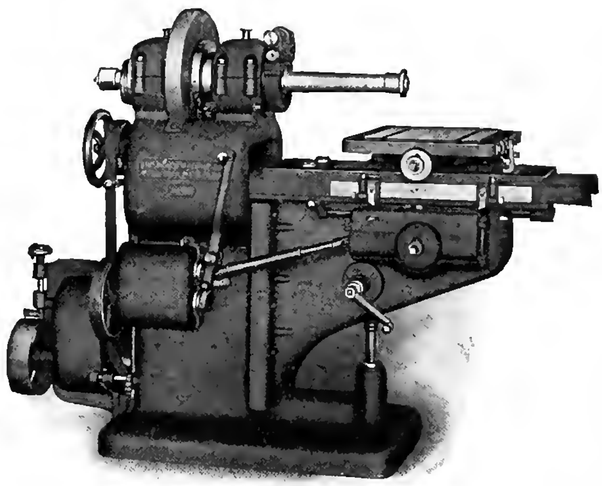


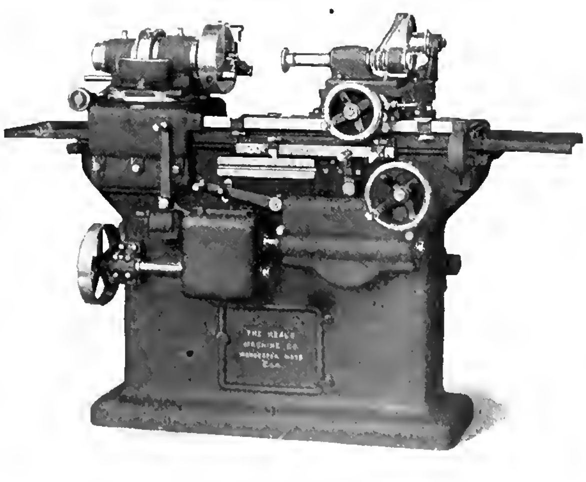
Drill Grinder



Ring Grinder



Cylinder Grinder



Internal Grinder

NORTON

THE CUTTING FACE OF A GRINDING WHEEL

has thousands of little tools cutting off little chips. It makes a big difference what these little tools are made of, just as it makes a big difference what quality of steel is used in making steel tools. It makes a big difference as to how each little tool holds its cutting edge.

A Norton wheel gets its good-cutting face from Alundum. Each little grain of Alundum that is working is a tool in perfect condition for good work.

Insist on a grinding wheel made of Alundum, just as you would insist on the best grade of steel for your steel tools.

INDIA OIL STONES

Every user of edged tools should have a list of India Oil Stone shapes and prices. The "India" cutting quality is recognized wherever tools are used. Made in 64 different shapes. Send for list to Pike Manufacturing Company, Pike, N. H., Sole Selling Agents for the India line.

NORTON COMPANY

WORCESTER, MASS., U. S. A.

New York	Chicago	Niagara Falls
50 Church St.	11 No. Jefferson St.	Alundum Plant

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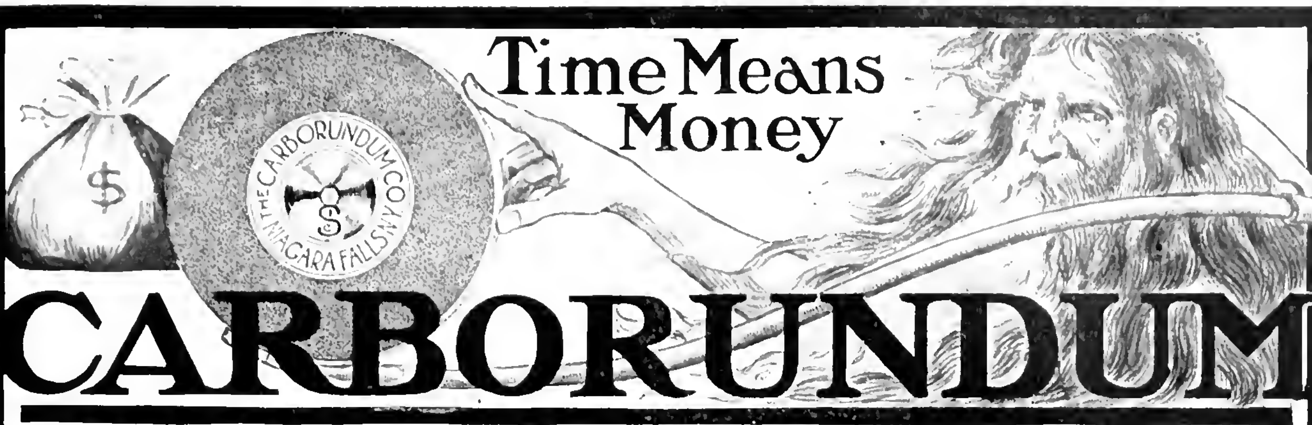


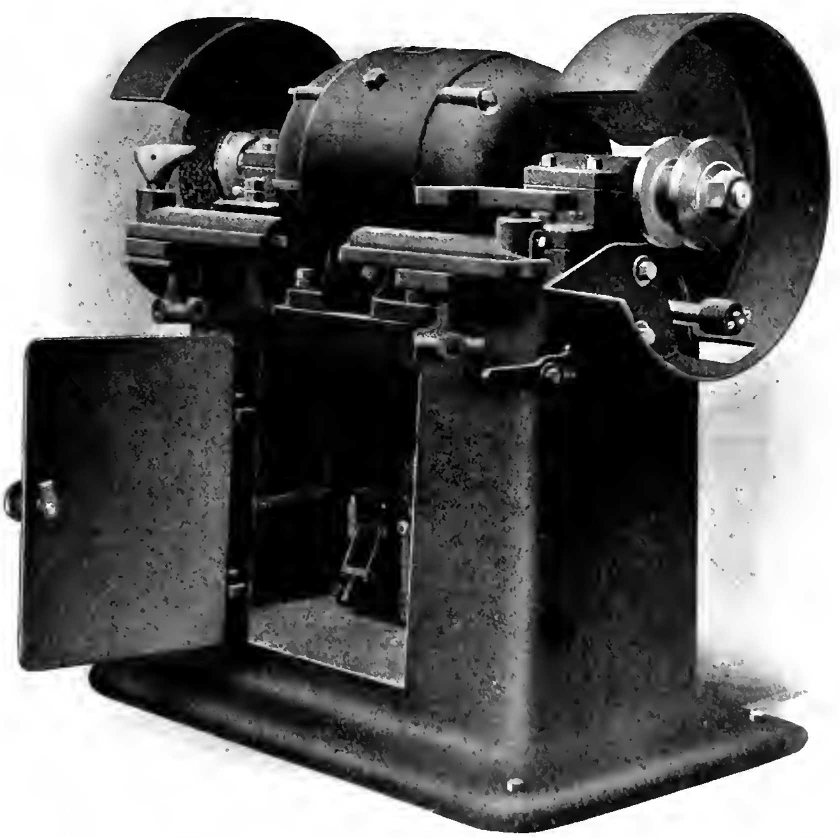
FASTER AND BETTER

IN grinding large steel dies for stamping out buckets and coal hods, Carborundum was tested out in competition with the best grinding wheels that could be found of other makes. Carborundum ground one die every fifteen minutes—It did not heat the die—It held up well on the corners and did not throw chunks or raise dust—

The best of the other wheels took 30 to 40 minutes for each die—It threw chunks and did not hold up on corners—It also raised so much dust that the operator could not finish a die without taking fresh air. Carborundum not only worked twice as fast, but it held up better, lasted longer and was clean. It will do the same thing in your grinding shop.

THE CARBORUNDUM COMPANY, Niagara Falls, N. Y.

The Ransom Patent Speed Controller Applied to Ransom Motor Driven Dry Grinders



Makes an A-1 combination of economy, convenience and efficiency.

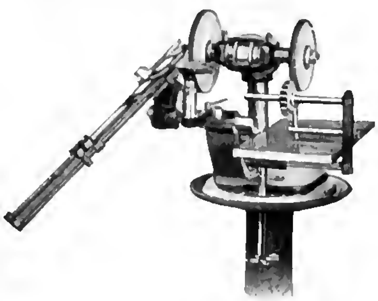
Gives the operator complete control of speed variation. Keeps the machine running at correct speed as the wheel wears down. Assures the maximum production at all times without power losses.

Adapted for any direct current grinder.

Ask us for complete details.

RANSOM MANUFACTURING CO., Oshkosh, Wis.

The Robinson Tool Grinder for Twist Drills and General Work



Any mechanic can grind twist drills theoretically correct on the Robinson Improved Grinder. Especially satisfactory on three and four flute drills.

Selected wheels and smooth, steady running insure the efficiency so necessary for fine tool grinding.

Combines many special features of larger, more costly machines. Moderate price. Write for details.

THE ROBINSON TOOL WORKS
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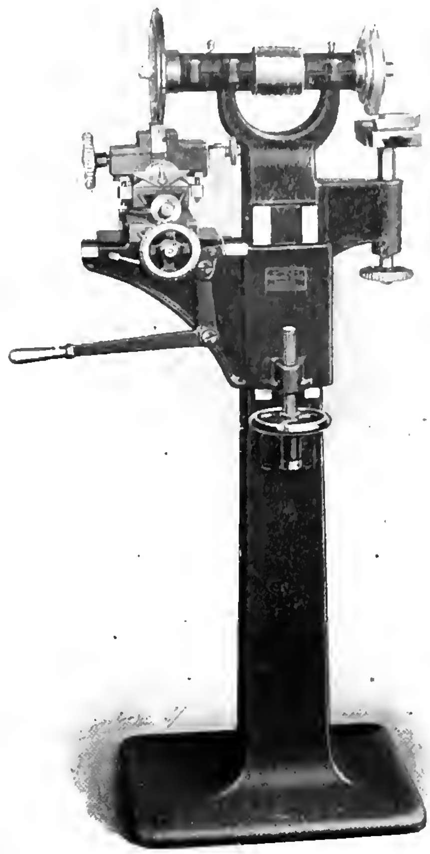
The New Geometric Chaser or Die Grinder Insures Continued Accuracy.



That's the chief requirement of all screw-cutting tools. Correct grinding by hand is no easy matter and the Geometric Grinder is distinctly designed to overcome these difficulties and secure clean cutting dies quickly and economically, within any desired limit of tolerance.

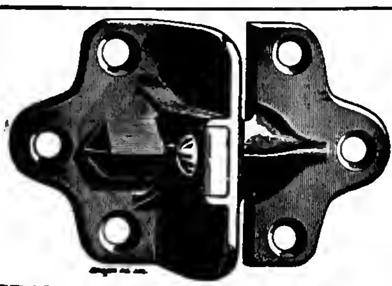
For "touching up" or complete regrinding all makes of thread chasers, either stock or special, this machine is unequaled and a second wheel provides for ordinary tool grinding.

Universally mounted vise with adjustments for grinding to any radius, right or left hand, is part of the equipment.

Let us send the full description.

The Geometric Tool Co.
Westville Station, New Haven, Conn.

PACIFIC COAST AGENTS—The Compressed Air Machinery Co., San Francisco, Cal. FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin. Van Rietschoten & Houwens, Rotterdam, Holland.



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saves time, expense, and makes true castings. Quickly applied and easily adjusted.
Send for prices on our line of Pattern Makers' Specialties.

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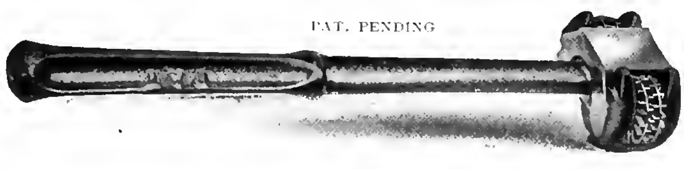
Milwaukee, Wis.

MARBACH EMERY WHEEL DRESSER

Double Life
No Danger



The best Wheel Dresser made. Safeguards the operator because the patent side handle keeps him out of the path of flying emery or pieces of the wheel in case of accident. Outwears several ordinary dressers, has two sets of cutter wheels, leverage is under easy control. Price $1.00—and nothing like it on the market at any price.

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For Machinery Builders

We have Steam Hammers, Drop Hammers, Trip Hammers and Upsetters.

The Machinery Forging Co.
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Different Styles and Sizes for Floor and Bench.

EMERY WHEEL DRESSERS

No. 1 For Regular Shop Use

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These Dressers in connection with our Cutters make a most powerful and efficient tool, especially our No. 2 which is made proportionately larger and stronger for large wheels.

CUTTERS

We make the regular "Huntington" (pattern) Paragon Cutter and Roughing Cutters for Dresser No. 1, and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2.

Let us send you descriptive circular and prices.

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The King Machine Tool Company.
CINCINNATI, OHIO, U. S. A.
VERTICAL TURRET BORING AND TURNING **MACHINES**

ARMSTRONG TOOL HOLDERS

will do more work and cause less trouble than any other tools you can put on your lathes and planers.

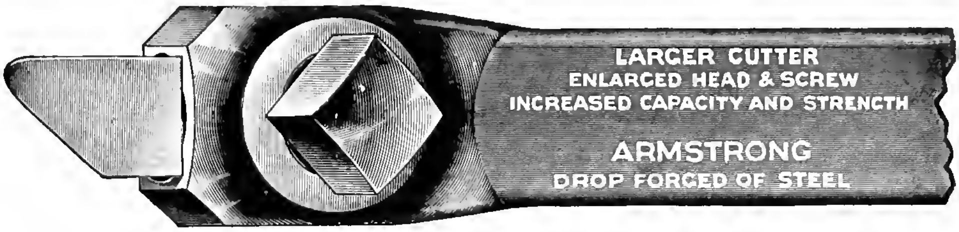
We make a complete line. A Tool Holder for every operation on the lathe or planer.

Cutter is Extra Large

and has *Reinforced Support* directly under strain of cut.

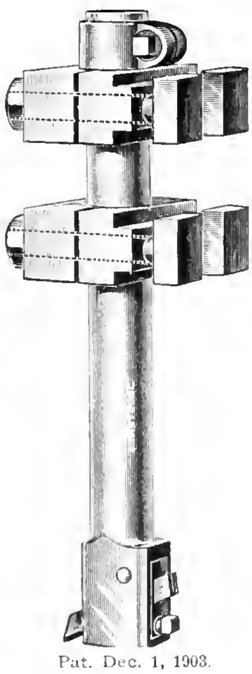
Our Patented Relieved Seat

prevents chattering and breaking of cutter.



Make One lb. of Tool Steel Equal Ten lbs. in Forged Tools.

This HOLLOW BAR SLOTTER TOOL



Pat. Dec. 1, 1903.

Is made in 5 sizes

6 to 24-in. Stroke

Bar $1\frac{1}{2}$ to $2\frac{3}{4}$-in. Diameter

It relieves on return stroke and will cut clear down to table. It is very stiff in proportion to its weight and the split collar enables the machinist to adjust it easily.

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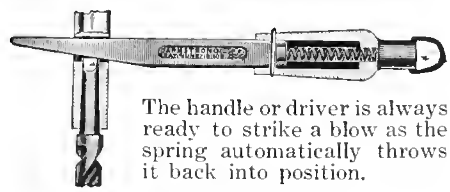
It's as Handy as an Extra Hand.

THE AUTOMATIC DRILL DRIFT

You'll wonder how you got along without it.



The handle or driver is always ready to strike a blow as the spring automatically throws it back into position.

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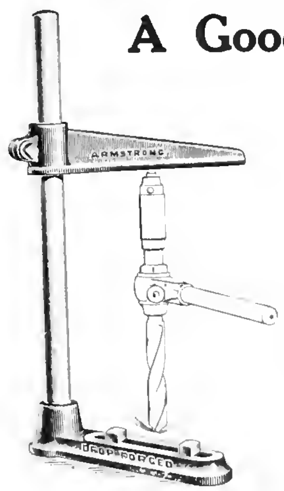

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Drilling Post

For Use With Ratchet Drills.

SPECIAL FEATURES

Drop Forged Arm and Foot. Removable Post. Hardened Binding Screw.

Packed one in a box and labeled.

3 Sizes: 8, 10 and 12 inches.

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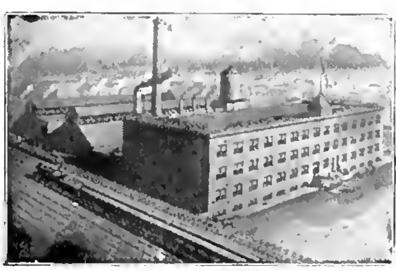
We make a complete line of Ratchets.



Do you want our new catalog? It's a Tool Holder Encyclopedia.

Armstrong Bros. Tool Co.

"THE TOOL HOLDER PEOPLE"

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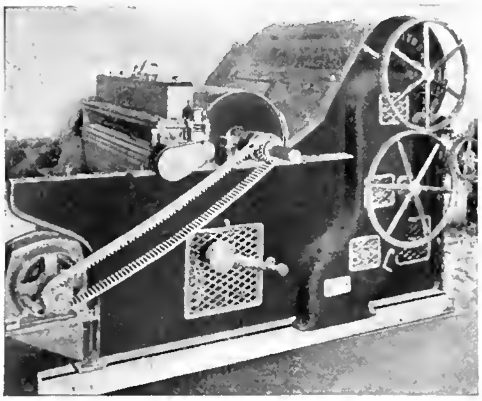
Imitations are Unsatisfactory. Infringements are Unlawful.

Morse Chain Silent Drive



Power transmission of the highest degree of efficiency and uniformity

is demanded in the textile industry. Both the quality and quantity of product depend upon a drive of uniform speed. This explains the rapidly increasing use of Morse Chains in this industry.

We illustrate a 5 horse-power Morse Chain Drive to picker; some details are: 1730—1565 R. P. M., 18-inch centers; Sprockets 19 and 21 teeth; Chain $\frac{5}{8}$-inch pitch, 2 inches wide; Speed 1720 feet per minute.

Send for Circular No. 9

Morse Chain Co.

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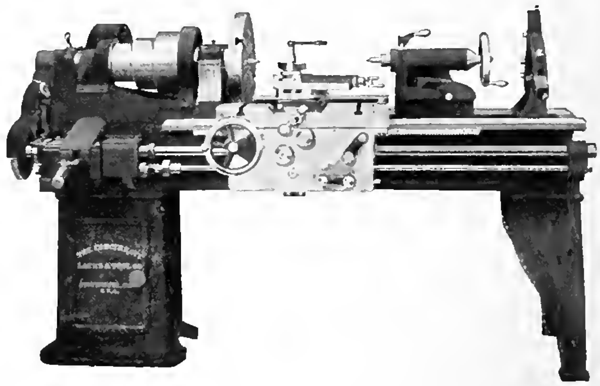
Licensees for Great Britain and Europe: The Westinghouse Brake Co., Ltd., York Road, Kings Cross, London, N.

Demand for Cincinnati Lathes



everywhere because of our experience intelligently applied. At its price is the best and most thoroughly made it is possible to buy. All have **double wall apron, chasing dial, and automatic stop.** Furnish **Quick Change** or another unlimited **Feed Box.** Compare in detail with others.

The Cincinnati Lathe & Tool Co.

Station B, Cincinnati, O., U. S. A.

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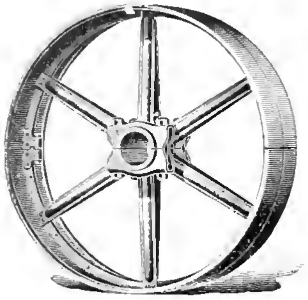
In the machine shop—railway or manufacturing—the "Dill" is a cost reducer and first-class producer of accurate work. The traveling head makes a big slotter of a small one, and permits large or awkward pieces to be handled easily and quickly. Power traverse, safety device for feed and a wide range of speeds are also Dill advantages—all described in detail in the catalog.

THE DILL SLOTTER PEOPLE

KENSINGTON, PHILADELPHIA, PA.



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Then you need give no second thought to that part of your transmission equipment for you will have pulleys of the most accurate design and construction, perfectly balanced, light yet strong, thus requiring much less power to turn, easily put up or taken down from shaft—in fact, pulleys which will win your increased liking every additional day in use.

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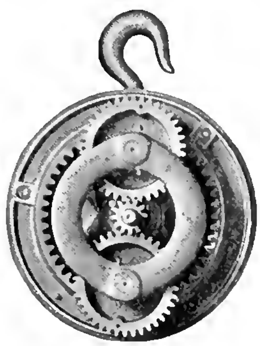
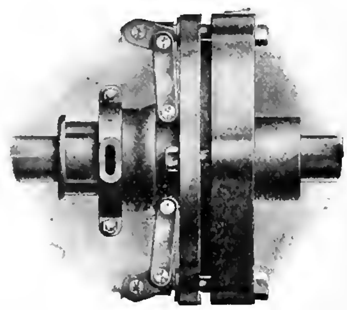
Interchangeable
Steel Parts



135 No. Second Street
PHILADELPHIA, PA.

The Acme of Simplicity



In Clutch Construction

has been reached in the Latest Improved Worrall Friction Clutch. It is built on the principle of a solid flange coupling with the addition of simple levers to afford a means of connecting and disconnecting instantly. In addition to its simple mechanism, this clutch offers advantages which are not met with in any other make. It has demonstrated its superiority over all other clutches for all purposes, and is the choice of practical men the world over. The almost universal use of the Worrall Clutch under all conditions is its strongest claim for favorable consideration.

We build "A Special Clutch for every Special Purpose". Better let us design a special clutch to meet your requirements and give you the benefit of our long experience.

Send for catalog. It illustrates various improved methods of transmitting power by means of this clutch.

American Twist Drill Co.

Established 1865 — Dept. A, LACONIA, N. H.

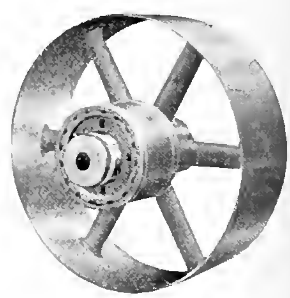
3,000 GRIPS A DAY WITHOUT A SLIP

The perfect control of "AKRON" Friction Clutches in the line of heavy service brought us the following:

> "These clutches must be operated 3,000 times every 24 hours in our work and naturally the service is very severe. Your clutch has stood up to this work in the best possible manner and we have not spent a cent on it for repairs."

The smooth, positive action of "AKRON" clutches is always assured because all pressure is in line with the shaft and, once engaged, all end thrust is eliminated.

If you need a powerful, satisfactory clutch, write for the Akron booklet.



The Williams Foundry & Machine Co., Akron, Ohio, U.S.A.

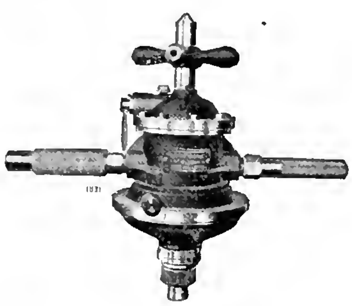
TOOLS THAT NEED NO NURSING

A tool that isn't dependable—that is erratic in its behavior—that must be "nursed" to make it do its work at all—isn't a good tool for your purpose.

The tool you want is always ready for business, and works hard and fast and profitably.

The difference between these two kinds of tools is in the amount of care and "know how" applied in their design and construction.

"CROWN" AND "IMPERIAL" PNEUMATIC HAMMERS AND DRILLS NEED NO NURSING. OPEN THE THROTTLE—AND THEY'RE READY FOR THE DAY'S WORK, AND A VERY GOOD DAY'S WORK, TOO.



We have built them as well as we possibly can, with thirty-nine years of experience to teach us. We know that no tools can be better built.

We offer you "Crown" and "Imperial" Tools with no wildly extravagant claims as to their performance, and with no "extras" thrown in.

We urge them upon you with the firm conviction that you will find them to be steady, reliable, profitable "tools for service."

Your request will bring you our Tool Bulletins.

AIR COMPRESSORS AIR HOISTS

INGERSOLL-RAND CO.

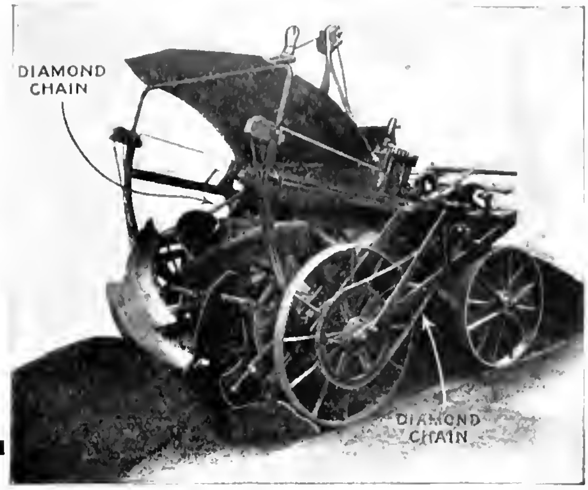
NEW YORK LONDON

DOMESTIC OFFICES:

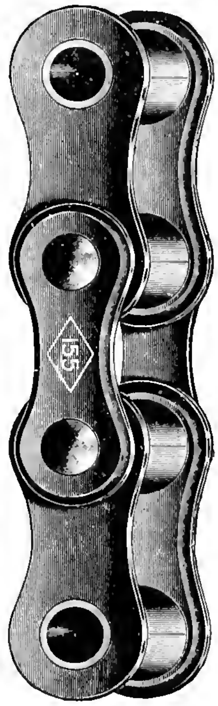
Birmingham	Cleveland	El Paso	Philadelphia
Boston	Denver	Los Angeles	Pittsburg
Butte	Duluth	New York	St. Louis
Chicago	Salt Lake	San Francisco	Seattle

FOREIGN OFFICES:

Budapest	Johannesburg	London	Mexico	Paris
Dusseldorf	Kobe	Melbourne	Montreal	Yokohama



DIAMOND CHAINS ONLY WOULD DO THE WORK HERE



This machine mixes foundry sand, the knives making a cut every half inch from the top to the bottom of the pile. Of course some of the damp sand gets onto the power transmitting mechanism around the knives, and this would knock out belting or gears in no time.

Diamond Chains have long been used to drive both wheels and cutting knives, and do their work well in spite of the dampness and the dirt. In fact, the whole machine is dependent for its success upon durability and satisfactory service from the chains.

That Diamond Chains are honestly good and are able to withstand such rough treatment is emphasized by Mr. George Lorimer, President of the Auto Sand Mixer Co., Piqua, Ohio, makers of the above machine, who comments as follows:

"The chains have given satisfaction and wear remarkably well considering that they are working in sand at all times and one of them at quite high speed. The chains wear longer than the sprockets under very hard conditions."

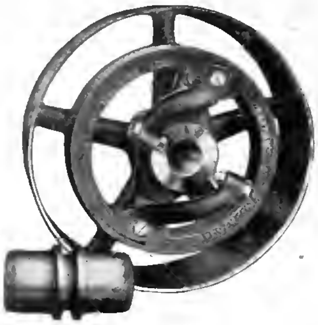
Let our engineers advise you about your troublesome drives. Ask for book "Chain Transmission of Power."

TRADE MARK

DIAMOND CHAIN AND MANUFACTURING CO.

240 W. Georgia St., Indianapolis, Ind.

Capacity 8,000,000 Feet Per Year.



THE EDGEMONT FRICTION CLUTCH PULLEYS

are made to stand the hard usage and abuse the countershafts are subjected to, since the advent of high speed steel and heavy duty machine tools. This is the reason many of the leading Machine Tool Manufacturers have adopted the Edgemont Clutch. Our catalogue C tells who and is descriptive of the different style Clutches we make. Our Extended Sleeve style is made for lineshaft drive up to 50-H.P.

Write today for catalog.

The Edgemont Machine Co.
995 Washington St., Dayton, Ohio

"BROWNHOIST"

LOCOMOTIVE CRANES

Are the Most Efficient on the Market

The crane shown in the engraving is a standard 15-ton, 8 wheel, M. C. B. truck, two drum crane, equipped with a "Brownhoist" 54 cubic foot Grab Bucket.

We can interest you—write us.

THE BROWN HOISTING MACHINERY CO.
Main Office and Works, Cleveland, O.
Branch Offices, New York and Pittsburg.

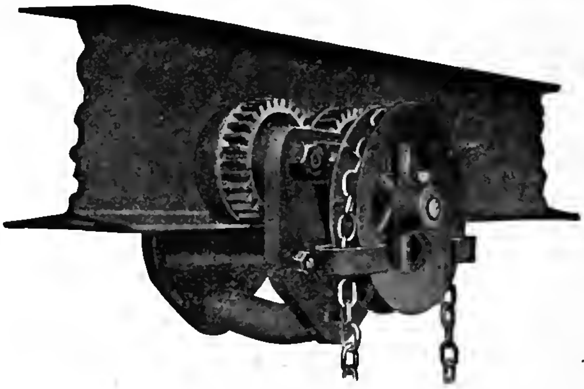
DIE CASTINGS

Stamped Metal Parts

Finished Brass Castings

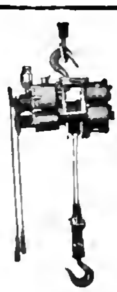
To your Drawings

Parker White Metal and Machine Co.
Erie, Pennsylvania, U.S.A.



Trolleys

MARIS BROS.
PHILADELPHIA
PA.



ONE TO TEN TONS

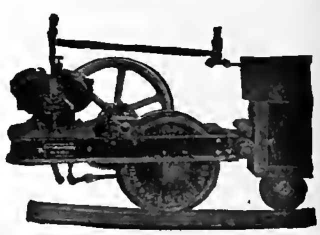
PNEUMATIC

GEARED HOISTS

and other labor saving compressed air appliances.

Durability and efficiency guaranteed.

Locomotive
Turntable
Pneumatic and
Electric Mule



DETROIT HOIST AND MACHINE CO.
Successors to PILLING AIR ENGINE CO.
DETROIT, MICH.

REAMERS

The KELLY Adjustable

MADE IN

ONE STYLE ONLY

Finish, Ream or Rough-bore ANYTHING from a

ONE-INCH to a SIXTY-INCH CYLINDER

Type B for the Turret. Type C for Cylinders.

THE KELLY REAMER CO., Cleveland, U. S. A.
Successors to THE KELLY TOOL CO.

CRANES

AND

HOISTS

All Types and Capacities

ALFRED H. BOX & CO., Philadelphia, Pa.


This Steel Hardens at Low Heat in Water or Oil
FOR DIES
Absolutely Non-Shrinkable
FOR END MILLS
Holds a Cutting Edge
FOR SHEAR BLADES
Tough and Strong
FOR PUNCHES
Density to Stand a Blow or Pressure
FOR MILLING CUTTERS
Increases Cutting Power
THE UNIVERSAL STEEL
INTRA
FOR ALL PURPOSES
FOR REAMERS
No Loss in Shape or Size
FOR LATHE TOOLS
"High Finishing Steel"
FOR TAPS
Long Wearing
An Alloyed High per cent Tungston Steel especially adapted for cutting steel on a water finish. All the advantages of the highest quality steel at a moderate price.
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PACIFIC COAST AGENTS
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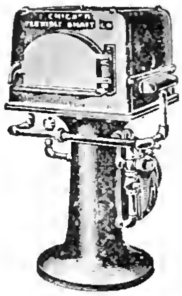
STEWART FURNACES

Adapted for use with any kind of gas, or with crude oil.

Proven efficiency and economy

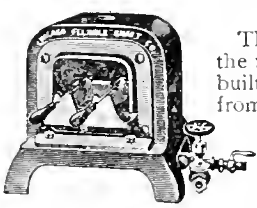
Send for our large catalog. Shows dozens of styles; gives descriptions and prices of each. Free on request.



Muffle and Oven Furnace

For heating dies, milling cutters, tools of all kinds, cutlery, springs, reamers, etc., this furnace is unquestionably the most practical made.

No. 1—Complete, with blower........ $100.00
" " without blower 75.00
No. 2—(as illustration) with blower.. 160.00
" " without blower 120.00



Soldering Iron Heater

For Gas Only

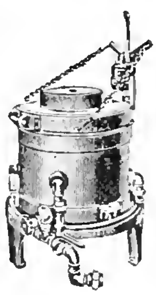
The most efficient of its kind on the market. Compactly and solidly built. Flame is projected upward from the bottom and surrounds the irons, heating them uniformly. Flame may be regulated by valves at right.

Price $8.00

Barium Chloride Furnace

Designed especially for hardening high speed steels. Special analysis fire-clay linings; no useless apparatus. Perfect combustion and absolute control of heat. Allows the life of high speed steel tools to be doubled.

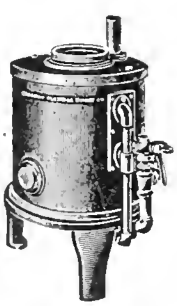
Prices.................. $40.00 to $150.00



Metal Melting Furnace

This is the most satisfactory furnace made for melting brass and other metals. The specifications are similar to those of the Barium Chloride furnace for high speed steels, but is fitted with an automatic device for swinging the cover

Prices...................... $43.00 to $155.00

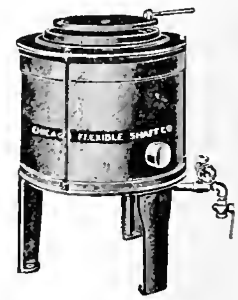


Cyanide Hardening Furnace

Similar to the single crucible furnace, but is more practical for use on cyanide hardening. Allows cyanide to be raised to desired temperature quickly, and retained indefinitely. Very compact and requires little attention.

Price, with blower $75.00
" without blower................ 50.00

SEND FOR CATALOG TODAY

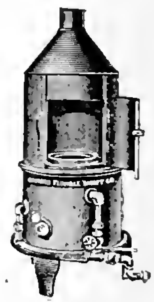


Soft Metal Melting Furnace, No. 3

For Gas Only

Cover is of cast iron and swings easily on a metal pin hinge. This allows all the heat to be retained and expedites the bringing of metal to the melting point. In fact, with this furnace melting point can be reached in 15 minutes after the furnace has been heated.

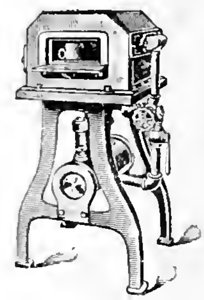
Price, without blower..................... $55.00
" with blower.......................... 80.00



Cyanide Hardening Furnace, No. 10

This furnace allows cyanide to be brought to hardening heat in about 40 minutes (starting with the furnace cold) and can be retained at this heat indefinitely. Burners are so arranged that flame strikes the pot at a tangent, giving a rotary motion to the heat and allowing heat to be evenly distributed.

Price, complete, with blower $100.00
" " without blower 75.00

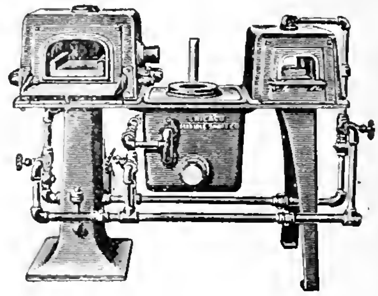


Stewart Forges

(No. 3 Illustrated)

These are ideal for making small forgings for tool dressings, etc. required heat is quickly produced and can be retained for almost any length of time. Takes only one minute to reach a forging temperature.

Price, without blower.................$40.00
" with blower..................... 65.00



Special Combination Furnace

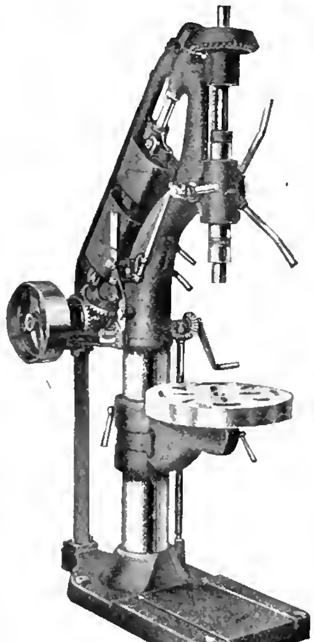
Here's an oven furnace — crucible and forge furnace — all combined on one base for reasons of economy and convenience.

Price,
With blower..$125.00
Without " 100.00

Chicago Flexible Shaft Co.
149 La Salle Avenue, Chicago

Foreign Agents: FENWICK FRERES......Rue de Rockroy, Paris, France
CHICAGO FLEXIBLE SHAFT CO.......London, England

Our All Geared Automatic Tapping Machine



is very strong, powerful, rapid and accurate. Reverses instantly and automatically at any exact depth required.

Specially adapted for tapping blind holes and bottom or depth work, but will handle regular tapping with equal advantage.

The friction clutch gears are on the driving end of the machine—not on the spindle.

There are no cone belts, machine has four direct **geared speeds** and four **back geared speeds**. Furnished with our wide range of **positive power feeds** when desired, thus adapting it for drilling as well as tapping.

It is very conveniently arranged for ease and speed of control, and has but one pulley for driving and reversing.

Built in 20-inch and 24-inch sizes.
Bulletin gives details, send for it.

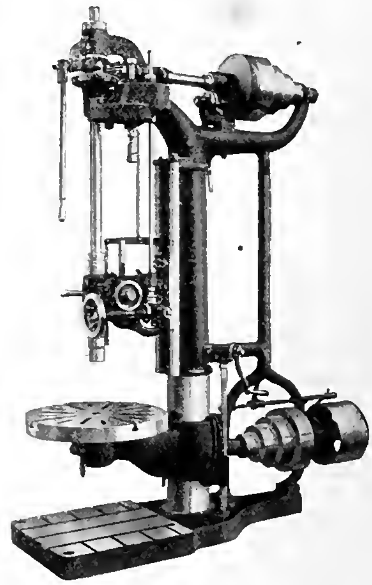
BARNES DRILL CO., Inc. 1907

814-830 Chestnut St., ROCKFORD, ILL., U. S. A.

Agents for Germany and Austria: E. Sonnenthal, Berlin, C.2, Cologne a/Rh, Frankfort a/Main, and Vienna. Agents for Great Britain: C. W. Burton, Griffiths & Co., London, E. C. Agents for Belgium G & F. Limbourg Freres. Agents for Ontario: Kellogg & Co., 196 King St., West, Toronto.

New Upright Drill No. 32

With Tapping Attachment and Geared Feed



The Mechanics line of high grade drills is noted for simple but powerful construction. No operating convenience has been overlooked, strength and rigidity are everywhere apparent, but the entire lack of complicated mechanism brings the manufacturing cost to a very moderate figure.

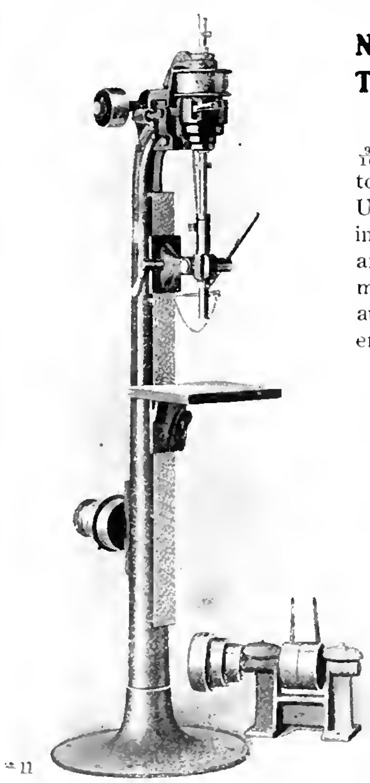
Write us for particulars, our line includes Standard Drills 32", 26", 24", 20", 14", 12"-B, sizes and No. 1 and 2 Friction Drills. All feeds "Positive." "Positive Feed".

Mechanics Machine Company

19th Avenue, Rockford, Ill., U. S. A.

AGENTS: Garvin Machine Co., New York. C. W. Burton, Griffiths & Co., London. Ateliers Demoor, Brussels.

Something Entirely New and Worth Your Attention



No. 11 Drilling and Tapping Machine.

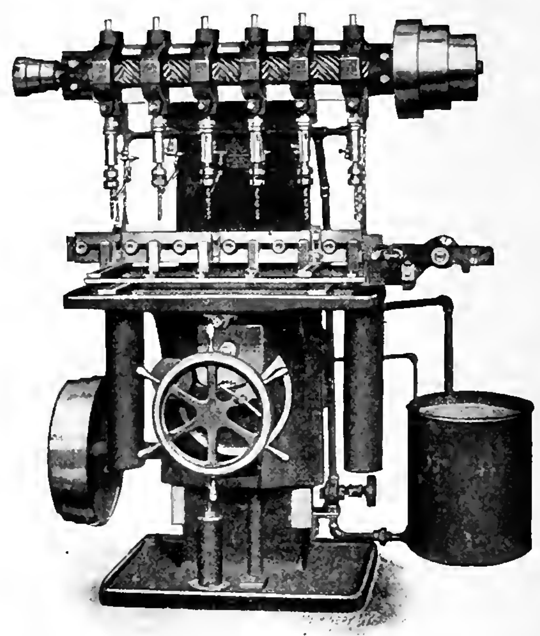
This machine drills $\frac{9}{16}''$ holes and taps up to $\frac{7}{16}''$ holes in cast iron. Used as a drilling machine, all tapping parts are idle. As a tapping machine it reverses automatically at both ends of the stroke. This is a convenience that you cannot afford to be without. We have two styles in single spindle machines, and any combination in multiple spindle drills.

Write for circulars.

H. G. BARR, WORCESTER, MASS.

21 HERMON STREET

Continuous Drilling



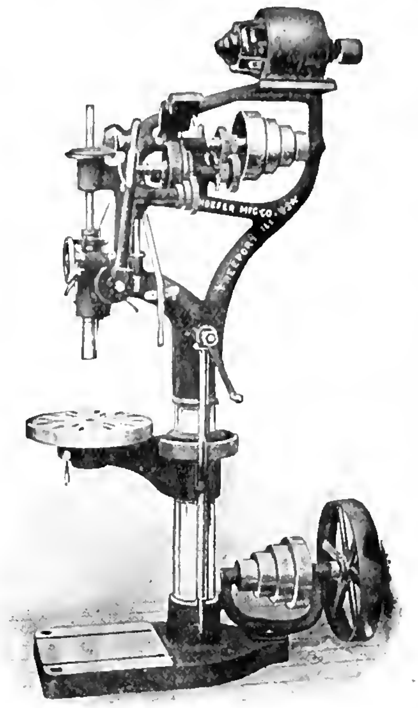
The sliding jig of **Moline Multiple Spindle Pin Drills** allows one set of work to be removed while the other is drilling, so operation is practically continuous.
Adjustment for holding different length and diameter cotter pins and similar work. Ball thrust bearings—vertical adjustment for various drills.

Send for complete details of Multiple Spindle and Gang Drills for every purpose.

MOLINE TOOL COMPANY, Moline, Ill., U.S.A.

AGENTS: Marshall & Huschart Machinery Co., Chicago, Milwaukee, St. Louis and Indianapolis.

A Line on Hoefer Drills is a Straight Line.

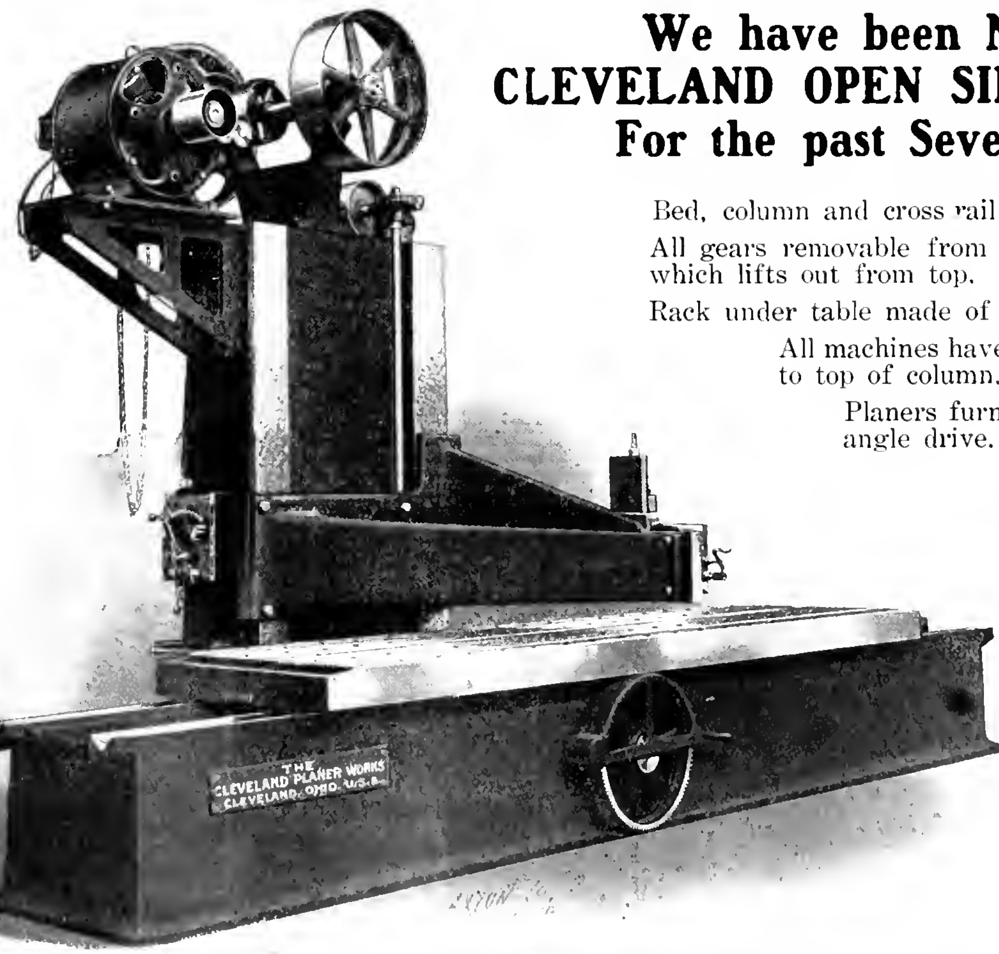


They are "straight" goods from the foundation up. We do our full duty when we build the machines spare no time, labor or expense to secure and maintain the most accurate alignment in every part. Grind all sleeves, worms and shafts to accurate standard size and to secure true running fit. Make the machines a little heavier and more rigid than usual to handle the heavier work, use sufficient metal, properly distributed, to provide for working strain. Incorporate all the time-saving devices that practice has proved worthy. We make the Hoefer Drills as near right as a mechanical proposition can be made and shall be glad to send full particulars on request.

Hoefer Mf'g. Co.
120 Jackson St., Freeport, Ill.

DOMESTIC AGENCIES—Motch & Merryweather Machinery Co, Cleveland, Cincinnati, Ohio, Detroit, Mich.; Vandyck Churchill Co., New York City, Philadelphia and Pittsburg, Pa; C. H. Wood Co., Syracuse, N. Y.; O. L. Packard Machinery Co., Milwaukee, Wis.; H. A. Stocker Machinery Co., Chicago, Ill.; H. J. Brunner Machinery & Mfg. Supply Co., Kansas City, Mo.; Pacific Tool & Supply Co., San Francisco, Cal.; Pacific Coast Mfg. Co., Los Angeles, Cal.; Colcord Machinery Co., St. Louis, Mo.; Cotton States Belting & Supply Co., Atlanta, Ga; J. L Osgood, Buffalo, N. Y.; W. P. Davis Machine Co., Rochester, N. Y.; Morrison Machinery & Supply Co., Richmond, Va.; Thomas & Lowe Machinery Co., Providence, R. I.; Scott Supply & Machinery Co., Denver, Colo.; Zimmerman-Wells-Brown Co., Portland, Ore.; Aumen Machinery Co., Baltimore, Md.; Hannon-Finton Co., Springfield, Mass.

We have been Making CLEVELAND OPEN SIDE PLANERS For the past Seven Years



36-in. x 36-in.—12-ft. Planer, with Motor Drive.

Bed, column and cross rail of Box Section Design.

All gears removable from side except bull gear, which lifts out from top.

Rack under table made of semi-steel.

All machines have countershaft attached to top of column.

Planers furnished parallel or right angle drive.

Any size from 30″ to 60″, any length.

Simplicity, without sacrificing any movement or convenience, is our aim.

Workmanship and facilities unexcelled.

Manufactured by

THE CLEVELAND PLANER WORKS

JAMES G. DORNBIRER
GEO. W. FORD

3150-3152 Superior Avenue
CLEVELAND, O., U. S. A.

THREE ESSENTIALS

QUALITY

Too little attention is given the big factor of QUALITY in buying. There are generally as many grades of quality as bidders and the tendency to regard prices only is altogether wrong.

You will find in our products – first of all—the best grade of material for the purpose – a distinctly different method of manufacture is used and the products are actually stronger and of better finish than others on the market.

PRICE

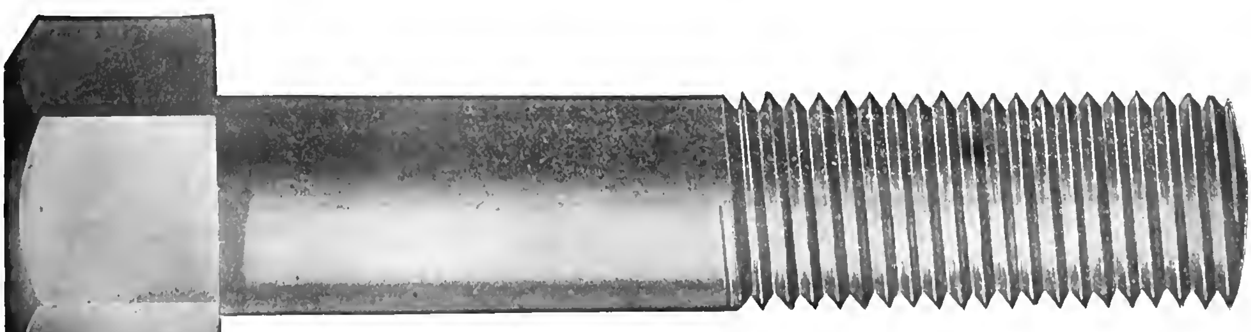
Our large finished steel bolts and screws, drill spindles, vise screw blanks, valve stems, rods and other machine, engine and automobile parts cost less the majority of times than inferior work made by other processes than the electric welding process.

In rare cases the price may be a trifle higher, but the difference in the quality, when considered, far over-balances the difference in prices.

SERVICE

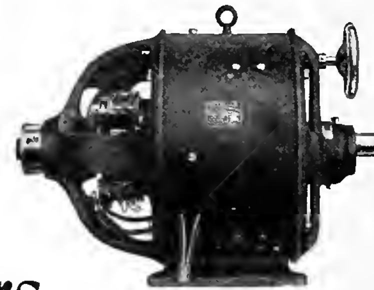
With your co-operation in anticipating your orders as far ahead as practicable, we'll give you the goods when you want them, as we are adding very heavily to our equipment.

You can ask about any other things of importance to you which we may have overlooked when you send in your next order or inquiry.



The Electric Welding Products Co., Cleveland, Ohio

When you install motor drive in your plant—get all the advantages



Why be satisfied with the ordinary type of motor which *almost* gives the desired results when you can get a *real* adjustable speed motor that *does* give the best possible results – the kind you want.

Reliance Adjustable Speed Motors

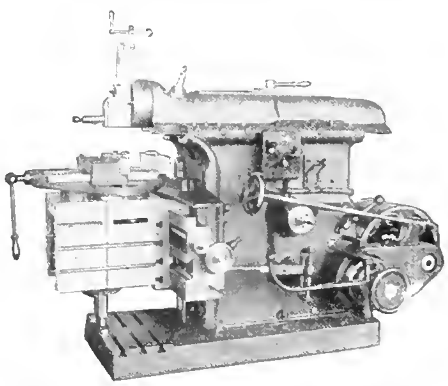
will give you all the usual advantages obtained with ordinary motors, such as greater cleanliness, better light, clear overhead space, flexible arrangement of machines, absence of belt and line shaft accidents, ample power at the cutting tool, and the greatest possible power economy.

What is of added importance on your machine tools is the accurate speed adjustment throughout wide and unbroken ranges in speed. The changes are smooth and gradual—no steps or jumps. You get the right speed for every operation on all kinds of work.

This is all accomplished easily and quickly by a simple mechanical method inside the motor—*no electrical controller is needed.*

The Ideal Drive for Your Machine Tools

Look at the illustration of the motor driven crank shaper. Note the compactness, and the simple and convenient method of speed control. An operator with a spark of energy will get the most out of such a machine.



Every machine in your plant regardless of its make or type is capable of producing certain maximum results. You can get these results all the time if you will provide your machines with the means of meeting the changing conditions which are constantly arising, especially in machine tool work. The power, overload capacity, and really accurate speed adjustment over wide ranges necessary to meet these conditions can be found only in the Reliance Adjustable Speed Motor.

If you have never had a chance to investigate the many merits and advantages of this wonderful motor at first hand, let us tell you of some of your neighbors who are using them. Our motor is its own best advertisement and the more familiar its users become with its efficiency and simplicity of speed control, the surer we are of a hearty recommendation.

If you are inclined to be skeptical when someone attempts to tell you how to increase the efficiency of your machine tools 25 to 100 per cent., we wish that you would read our Bulletin 101, "The Crank Shaper". It contains some real information—facts and figures that are the result of extensive and thorough tests.

Our Folder 10-M is interesting reading for motor users and we will gladly send copies for all of your engineers.

RELIANCE SERVICE

We are not electric motor manufacturers in the ordinary sense of the word but are specialists in complete motor equipments for Machine Shops. We furnish not only the motors but are also prepared to design and manufacture all brackets, gears, etc., for converting your belt driven tools to motor drive.

If you have work on which motors can be used to advantage, our engineers will gladly make a careful investigation of your needs. All we ask is an opportunity to show you what we have to offer as we are confident that sooner or later you will be convinced of the superior merit of Reliance Motors.

We manufacture Reliance Constant Speed Motors for either alternating or direct current service.

Reliance Electric and Engineering Co., 800 Huron Road, Cleveland, Ohio

---

It Is Shop Economy

to have a **Cut-Meter** for every machine tool. With this device at hand there is no excuse for speeds below the standard. It is simple, requires no timing or calculation; adaptable, can be used on any machine; convenient, can be held in any position—and shows the operator instantly and exactly, the cutting speed in feet per minute at which his machine is running.

Built for hard service and will save its cost a hundred times over in a year.

Send for catalogue.

Warner Instrument Company

56-59 Roosevelt Avenue, BELOIT, WIS.

1781 Broadway, New York. 143 Federal Street, Boston.

Eck Dynamo and Motor Co.

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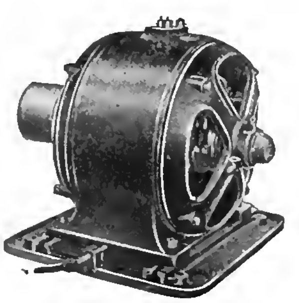
Specialists in the manufacture of



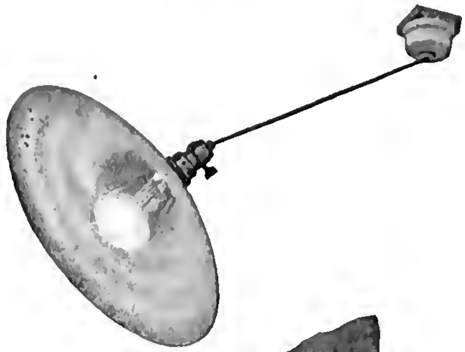
ELECTRIC MOTORS

for application to all classes of machinery.

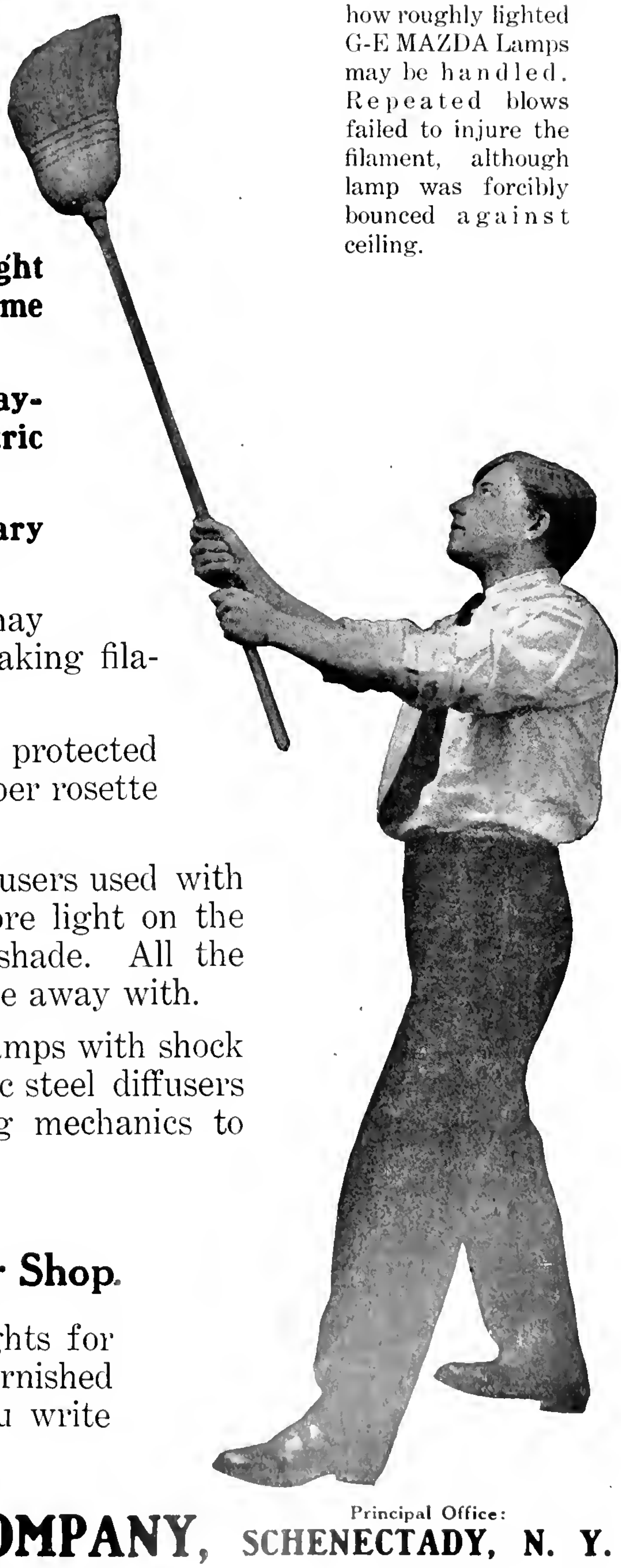
1-32 to 20 H.P.

Tell us your needs.

Sturdy G-E Mazda Lamps Stand Rough Treatment



This illustration is made from an actual photograph of a man demonstrating how roughly lighted G-E MAZDA Lamps may be handled. Repeated blows failed to injure the filament, although lamp was forcibly bounced against ceiling.



For shop lighting G-E MAZDA Lamps have three characteristics that place them far ahead of all other illuminants.

1. They give three times as much light as ordinary incandescent lamps of the same current consumption.

2. They show colors nearer to real daylight values than any other type of electric incandescent lamp.

3. They will withstand any ordinary shock without breaking.

When lighted, G-E MAZDA Lamps may be roughly cleaned without fear of breaking filament.

When not lighted, these lamps are protected from vibration by a special shock absorber rosette on the ceiling.

The 16 and 21″ concentric steel diffusers used with these lamps reflect from 15 to 20% more light on the work than is possible with any glass shade. All the light is reflected and black shadows done away with.

The combination of G-E MAZDA Lamps with shock absorbing ceiling rosettes and concentric steel diffusers will increase your output by enabling mechanics to watch their cuts clearly and surely.

A Lighting Plan for Your Shop

showing size and location of lights for most efficient lighting will be furnished promptly without charge if you write at once.

GENERAL ELECTRIC COMPANY, Principal Office: **SCHENECTADY, N. Y.**

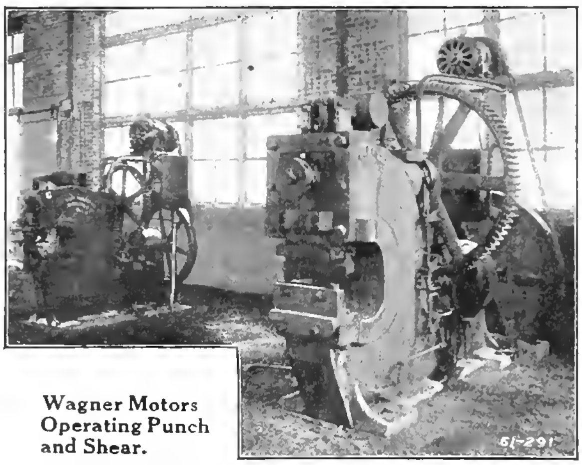
SALES OFFICES IN ALL LARGE CITIES

2012

Wagner Electric
Manufacturing Company, St. Louis, Mo.

The Wagner Single-Phase Motor

takes less current per line wire at starting and therefore disturbs less, the single-phase from which it takes **all** its current than a squirrel-cage motor disturbs each of its two or three phases. This is true even though the Wagner Single-Phase motor is thrown directly across the line without the intermediary of **any** starting device, while the demands of the squirrel-cage motor are moderated through an auxiliary auto-transformer.



Wagner Motors Operating Punch and Shear.

There is nothing novel about this statement. It has been advertised before and known for years. Let us send you, however, our Single-Phase bulletin which contains an excerpt from a paper read by the Manager of the Small Motor Department of one of our big competitors. The remarks in question outline clearly the present trend of opinion on the subject of single-phase distribution, particularly the change of sentiment on the part of manufacturers, who, unable to supply commercial single-phase motors have heretofore claimed the single-phased system to be uneconomical.

Wagner Quality

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Montreal, Bell Telephone Bldg
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New York, 50 Church St.
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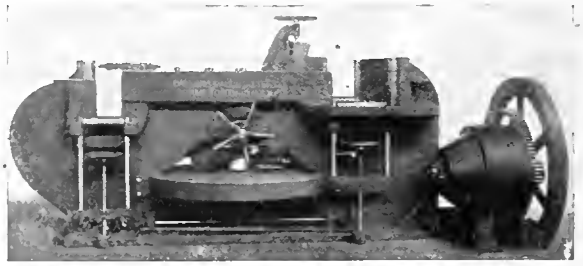
Type "S" Direct-Current Motors
have stood the test of time



Westinghouse Type "S" Motor driving Horizontal Punch and Bender.

Their reliability under the severest operating conditions, their efficiency, durability, great overload capacity and low operating temperature are some of the reasons for their constantly increasing use. Type "S" Motors are made in standard capacities suitable for almost any possible demand and immediate shipment can be made from stock. The standard ratings range as follows:

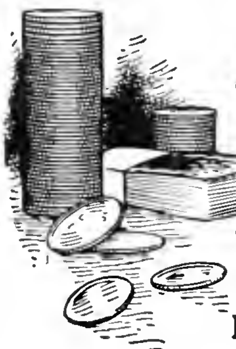
2 to 75 horsepower, 110 volts
2 to 150 horsepower, 220 volts
2 to 150 horsepower, 500 volts
6 to 100 horsepower, 600 volts

Special motors for higher voltages up to 650 can be supplied on order.

Full particulars in Circular 1068.

Westinghouse Electric & Mfg. Co.
Sales Offices in all large cities. Pittsburg, Pa.

Member of American Association Electric Motor Manufacturers AAMM



Motor Profits

Before you spend much money for electrical equipment you probably want to know what interest you will make on your investment. This can be determined quite accurately before you spend a cent.

Anything that reduces your unit cost of production means additional profit and here is where

Fort Wayne Motors Prove Their Superiority

We will be glad to furnish you with guarantee performance curves for any of our motors and if you will send us your specifications our engineers will solve your individual problems and recommend sizes, etc.

With this information you can easily figure out how much you will gain by installing electric drive in **your** plant.

There are a great many advantages also on which it is hard to place a **money** value, such as cleanliness, convenience of locating machines regardless of power supply, ease of control, automatic operation, economy of floor space, elimination of belts and pulleys, increased safety and freedom from accidents to employees, more light and less noise.

These points apply in general to almost all motors but there are particular features about Fort Wayne Motors that make them the **best purchase** on the market. Anyway it will pay you to send for our Bulletin "Motor Drives." It's free.

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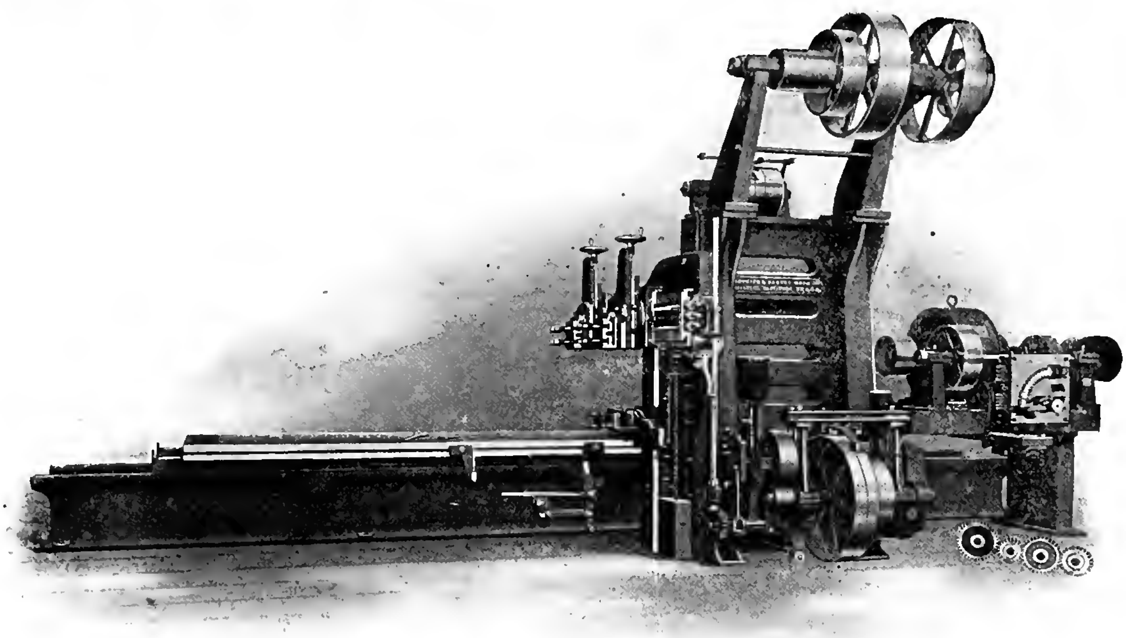
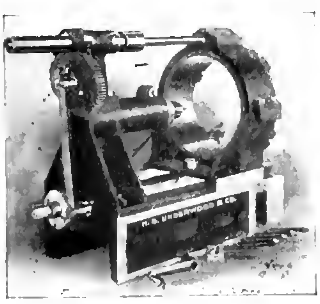
M 12 Branch offices in most large cities





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Crank and Triple Geared.

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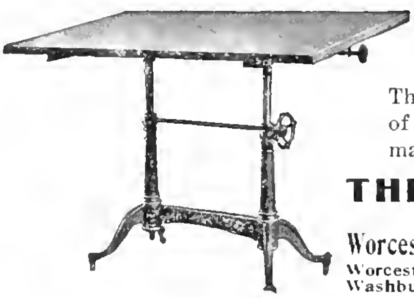

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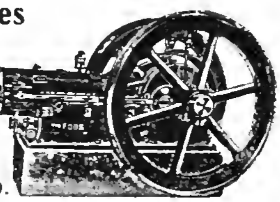

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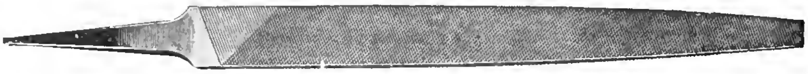

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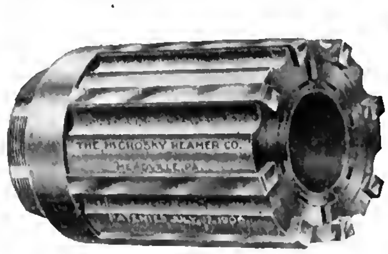

A Reamer Combining the Advantages of both Solid and Adjustable Types. Principle of Construction Unequaled. Workmanship and Material Unexcelled.

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Successors to F. B. McCROSKY MFG. CO.

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Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes

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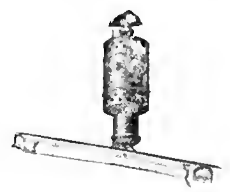
TRADE "BETTER THAN DAYLIGHT" MARK

COOPER HEWITT LAMP

An Array of Facts:



Theories are good for the inventor and the scholar, but facts are what you want when you are estimating on a job. You always give yourself the benefit of the doubt, with a liberal margin of safety.

Here are the facts concerning the Cooper Hewitt Lamp, proven beyond doubt and stated with a hundred per cent margin of safety.

The Cooper Hewitt Lamp gives a light of an entirely different quality from any other light-source, because the light comes from a luminous vapor instead of a luminous solid.

The quality of light from the Cooper Hewitt is such as to enable the eye to distinguish finer details than is possible with any other light, not even excepting daylight.

You can see objects plainly in a much dimmer light from the Cooper Hewitt Lamp than from any other light-source; hence there are no shadows that you cannot see to work in.

The light of the Cooper Hewitt Lamp contains no red rays, which are heat-producing and irritating; hence is the easiest of all lights on the eyes.

The Cooper Hewitt Lamp is the CHEAPEST of all electric lamps to operate and maintain; lamps frequently run two or three years without other attention than an occasional wiping off of the tubes.

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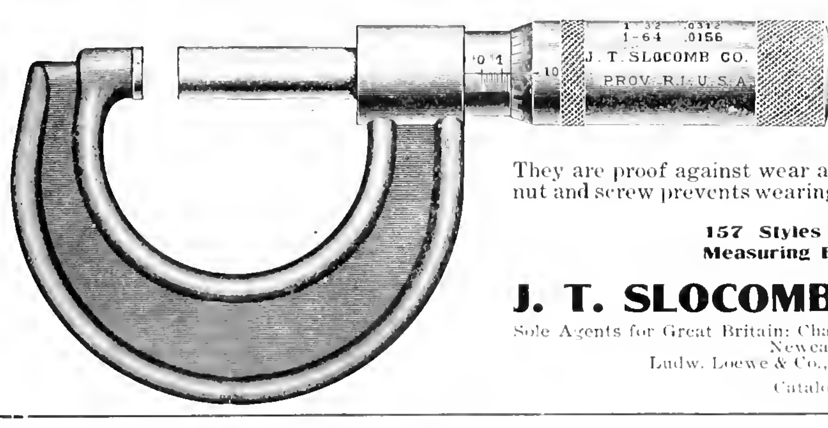

Stick it on the order sheets and on the walls. Make it a war cry. Then you'll begin to cut costs. You can't do it with the ordinary shop caliper, but you can with Slocomb Micrometers, because they give absolute accuracy in all measurements.

They are proof against wear and variation. The extra long bearing between nut and screw prevents wearing out of pitch even after years of hard service.

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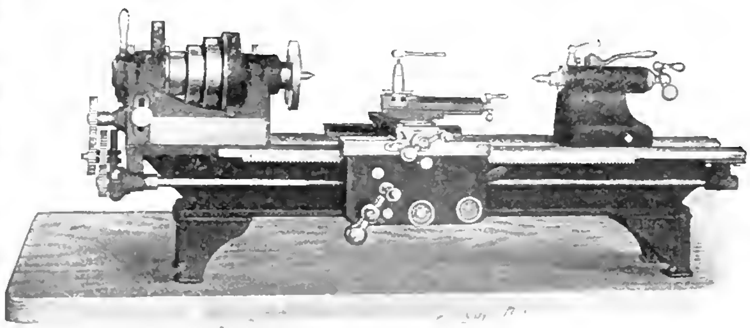

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For tool, model and scientific instrument makers, laboratory and experimental work, in short, for profitable use in all lines of fine, accurate manufacturing and precision service.

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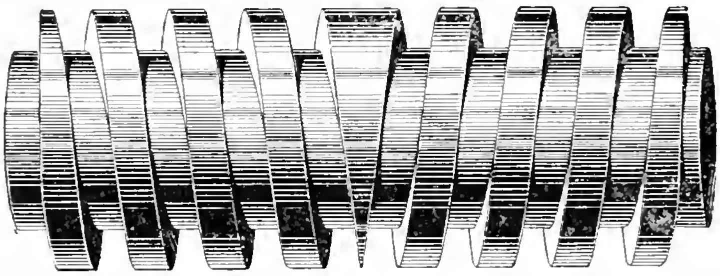

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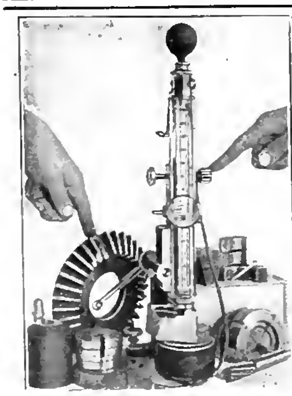

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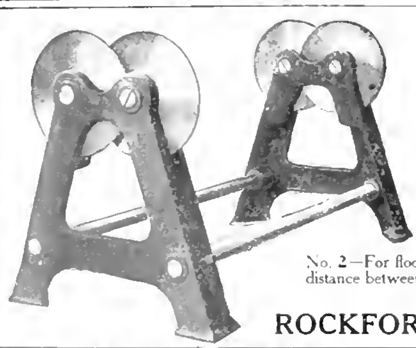

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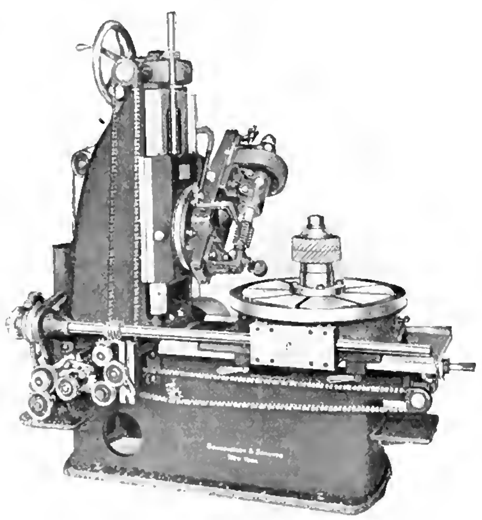

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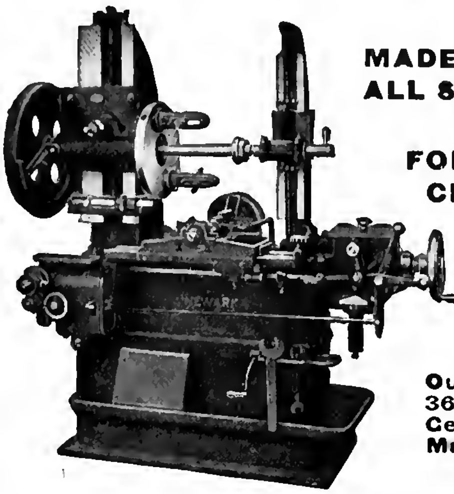

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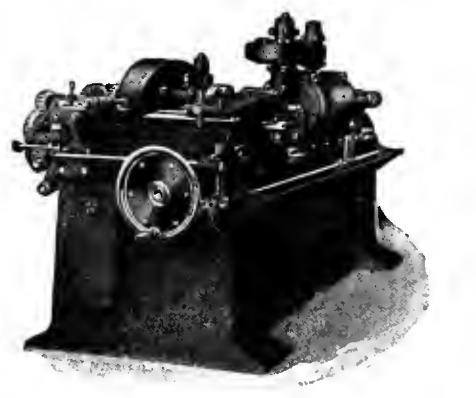

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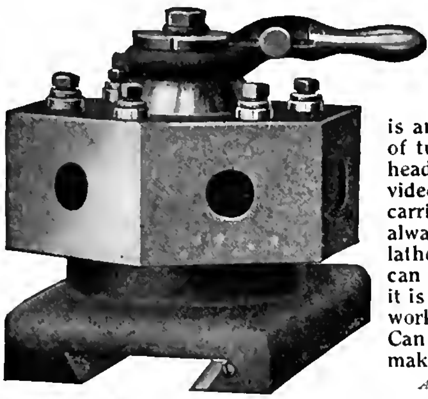

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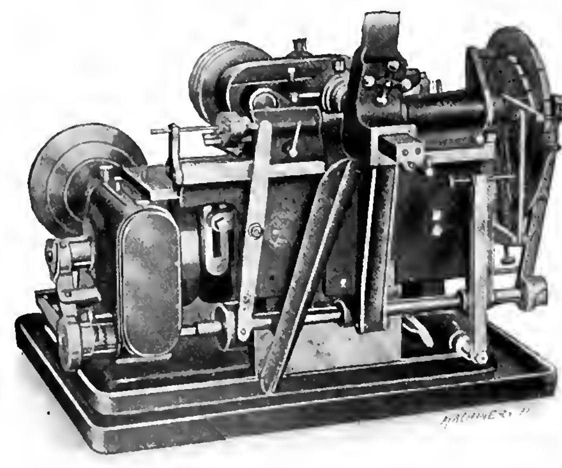

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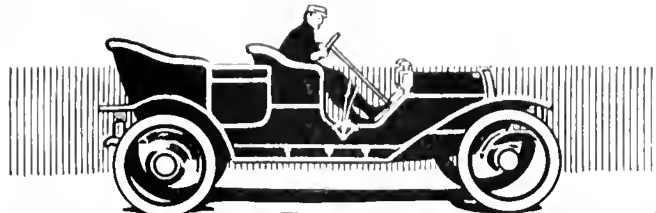

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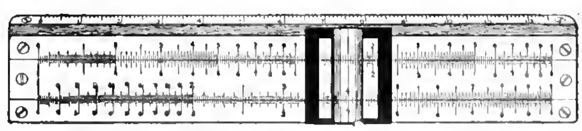

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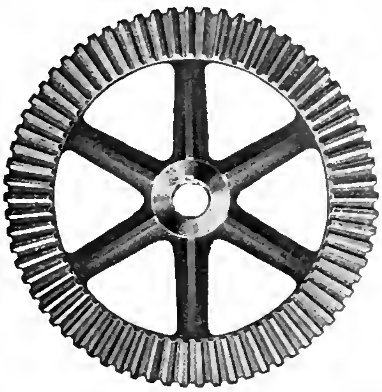

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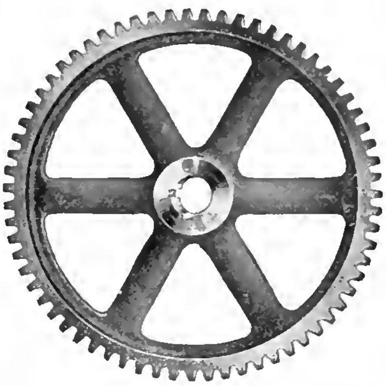

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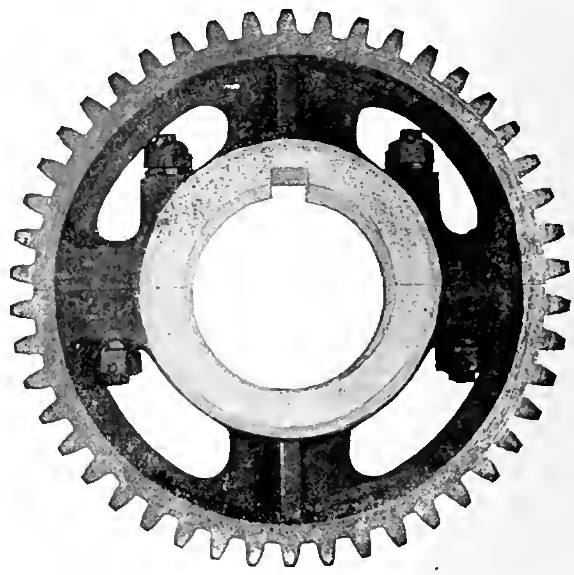

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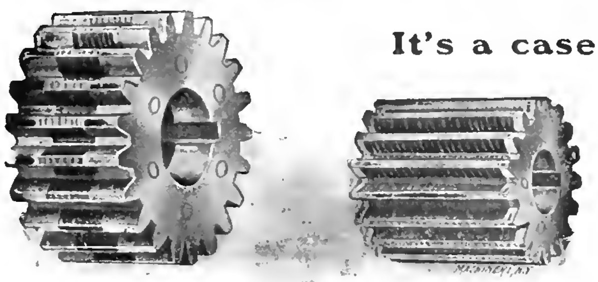

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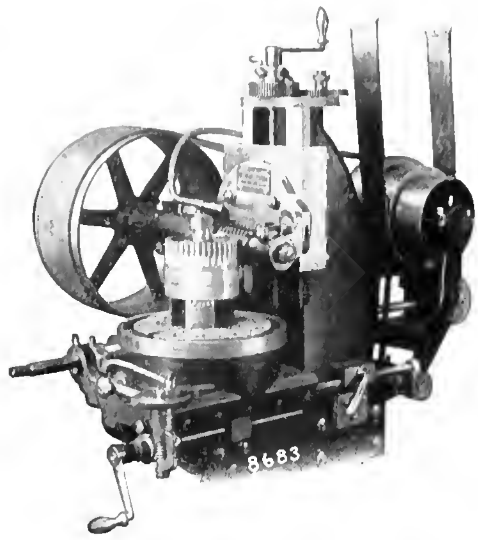

Our hob operates upon more teeth at a time than any other type of cutter, and cuts continuously from start to finish of an arbor full of blanks. Correct teeth and true pitch circles are generated, and the output so far exceeds all competition that you can not afford to cut spur gears on any other type of machine, or let your work to any concern not using FARWELL GEAR HOBBERS.

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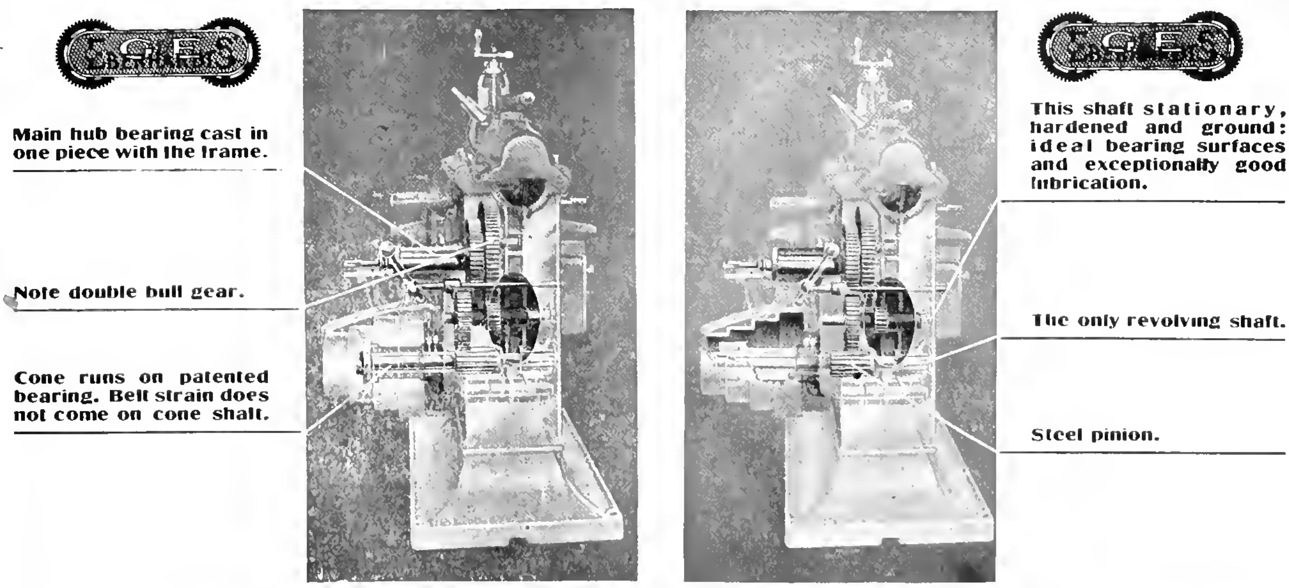

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MACHINERY'S Shop Operation Sheets

Specimen Shop Operation Sheet

Showing size, style, binder holes, etc.

SHOP OPERATION SHEET No. 101

Franklin D. Jones — MACHINERY, June, 1909

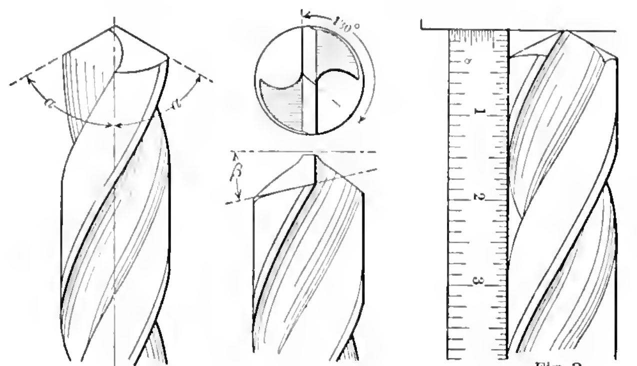

Fig. 1 Fig 2 Fig. 3 *Machinery,N.Y.*

Grinding a Twist Drill

NOTE.—The cutting edges of a twist drill should, as with the flat drill, be equiangular, of the same length, and have the same clearance. When both the cutting edges of the drill are ground to the same angles a, one cutting edge supports or counteracts the tendency of the other to spring from the cut (providing the clearance is also correct), but when the angles a are different, one edge will do more work than the other, thus subjecting the drill to an unbalanced twisting or torsional strain.

1. Grind each cutting edge to an angle a of 59 degrees (see Fig. 1), using the face of a wet emery wheel, and proceeding the same as if a flat drill were being ground, as described in paragraph 2 of the preceding sheet. The end of the drill will then appear as shown in Fig. 2. The clearance angle will be approximately correct when the line joining the cutting edges is at an angle of 130 degrees as shown.

NOTE.—There is a difference of opinion as to the best angle a of the cutting edge. As this angle is decreased the pressure required to force the drill through the metal becomes less, but the length of each cutting edge is increased with the result that more power is required to turn the drill. An included angle of 118 degrees is thought by some to equalize the thrust and torsion to the best advantage, while others advocate much more acute angles.

2. Grind away the metal back of each cutting edge, indicated by the shaded portion (Fig. 2), by moving the outer end of the drill, which is fulcrumed on the tool-rest, up and down with the right hand. Continue grinding until a surface, which should be approximately conical in form, is blended into the flat part previously ground. The backing or clearance of the cutting edges should be of such a form and angle as to allow the drill to cut freely and without binding as it is fed into the metal.

3. The clearance for each cutting edge may be tested by placing the drill point against a flat surface, and then slowly revolving it close to a scale held in the position shown in Fig. 3. If the clearances are not approximately alike, this will be shown by their relative positions to the graduation marks upon the scale, as the drill is turned.

The Shop Operations are laid out in note-book form, three operations on a sheet which measures about 9 x 13 inches. They are printed on tough manila paper and may be cut apart for filing in a binder, which is furnished at cost. Most of the Shop Operation Sheets have been issued monthly with MACHINERY, as supplements, and have been reprinted for general sale; but some have been and are published independently from time to time.

The Shop Operation Sheets contain the essentials for the apprentice as well as for the skilled worker who lacks the knowledge and experience of the all-around mechanic. Draftsmen can acquire a knowledge of a wide range of shop operations by studying these sheets, in which the instructions are so direct, simple and straightforward, that it is possible for any intelligent man to acquire a fundamental knowledge of all-around shop practice, and which only a comparatively few have an opportunity to secure except by actual experience in the works. Teachers of machine shop practice show their appreciation of the practical value of these Shop Operation Sheets by using them as instruction sheets in their classes, and supplying the students with them.

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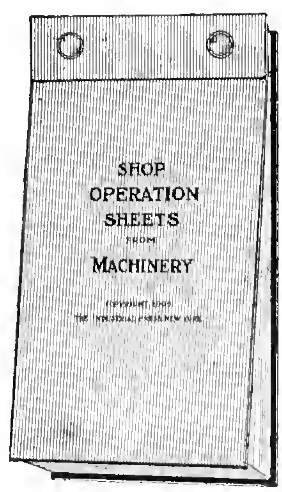

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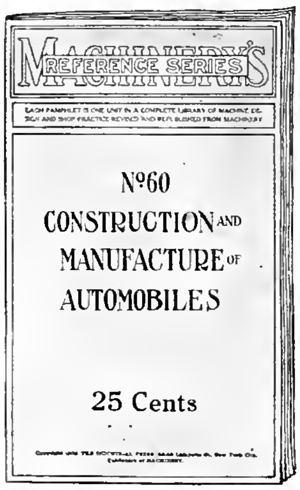

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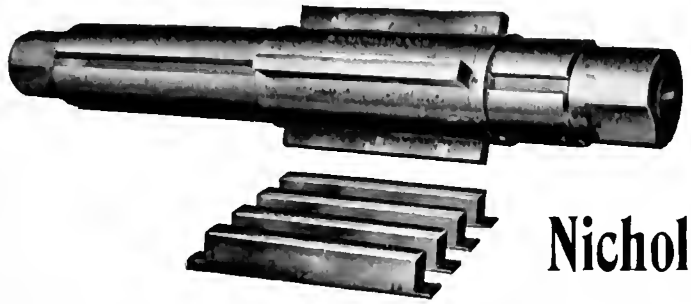

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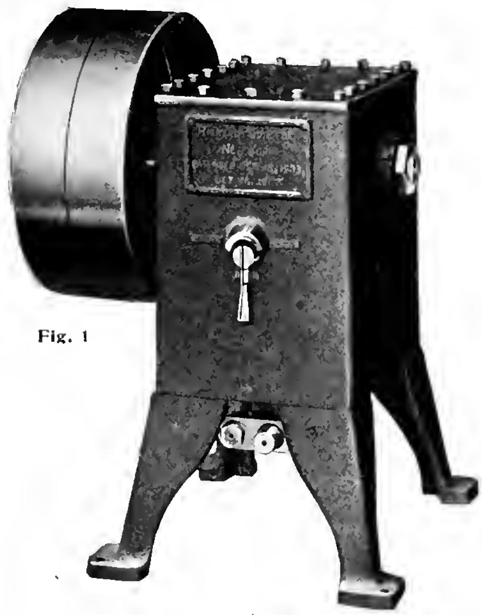

Fig. 1

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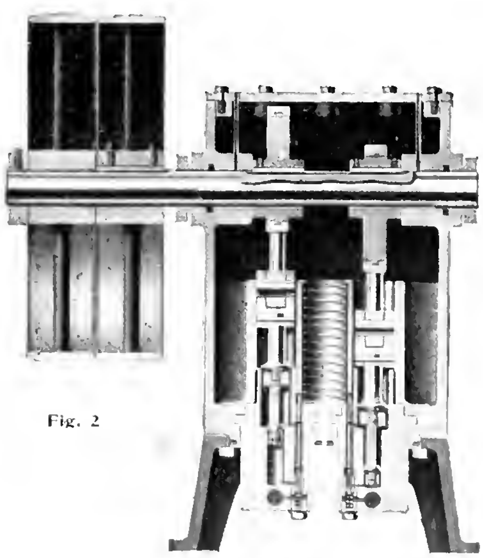

Fig. 2

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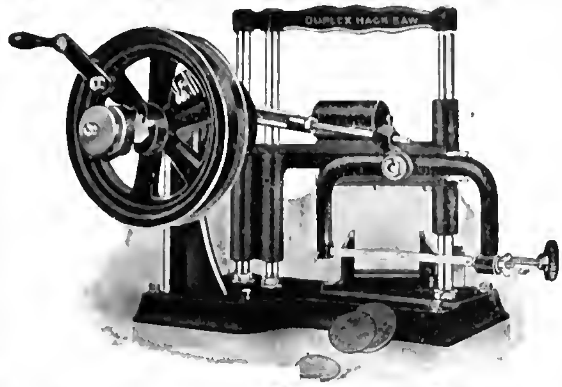

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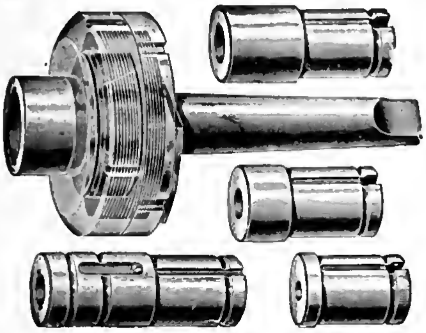

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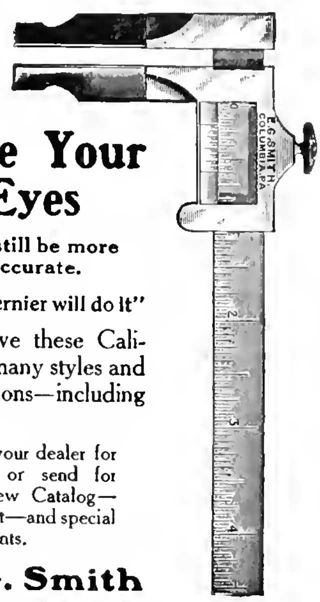

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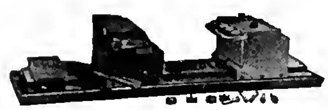

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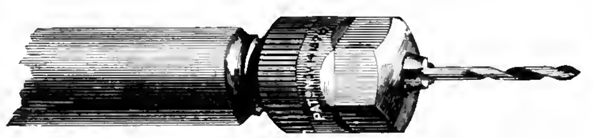

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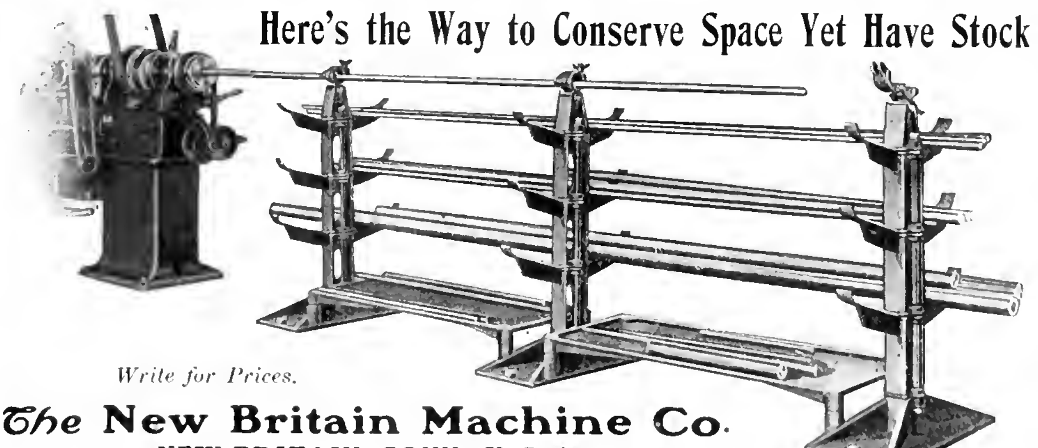

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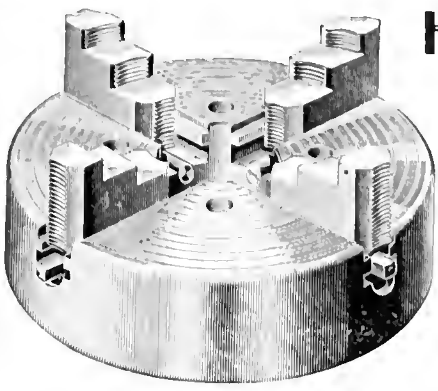

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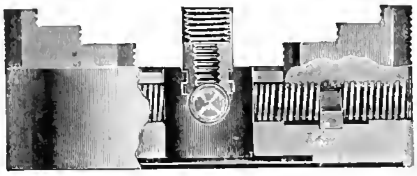

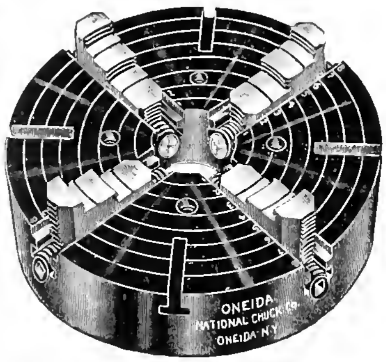

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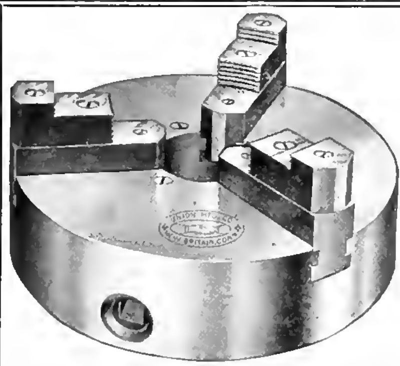

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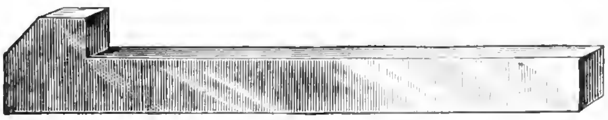

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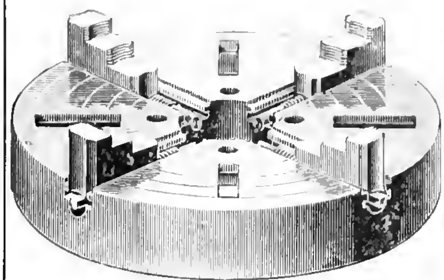

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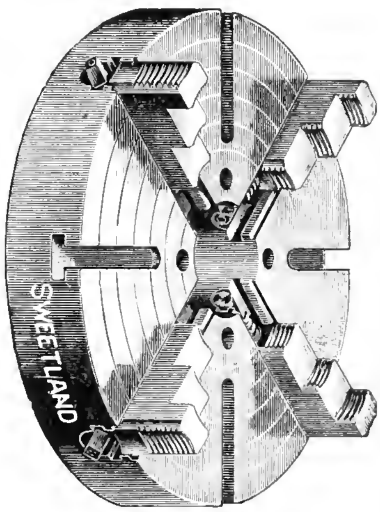

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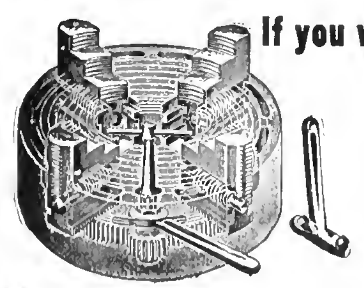

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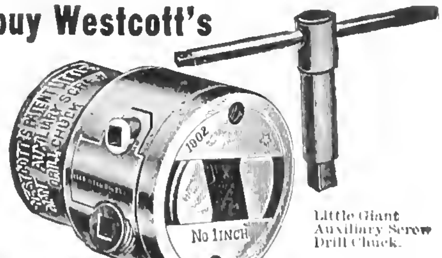

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A Few Advantages of the Coit 20th Century Ball Bearing Drill Chuck

The Coit Drill Chuck

has few parts, is simple in construction and equally simple in operation. No wrench or key is required to adjust it, a turn of the threaded mandrel sleeve serves to open or close the jaws. It is the only self-tightening, ball bearing drill chuck with round removable jaws, and the jaws can be removed without taking the chuck apart. The mandrel is part of the tool, bearings are dust proof, one oiling will serve for months.

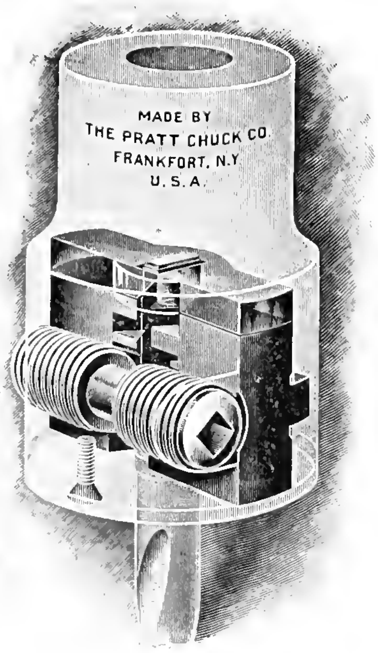
The special business of a drill chuck is to *hold the drill* and the Coit does this to perfection—no slip, no twist, no broken drill shanks; the greater the resistance on the drill, the tighter the grip of the chuck—moreover, this chuck holds short tang drills as firmly and easily as those of full length.

Made in five sizes; may we send our book?

THE STANDARD MACHINERY CO.

MYSTIC, CONN., U. S. A.

This X-Ray View of the Pratt Drill Chuck



Shows just why it always grips and never slips. Why it holds the tool firmly and easily, and demonstrates its simplicity, convenience and wearing qualities.

Pratt Simplicity Makes Pratt Efficiency

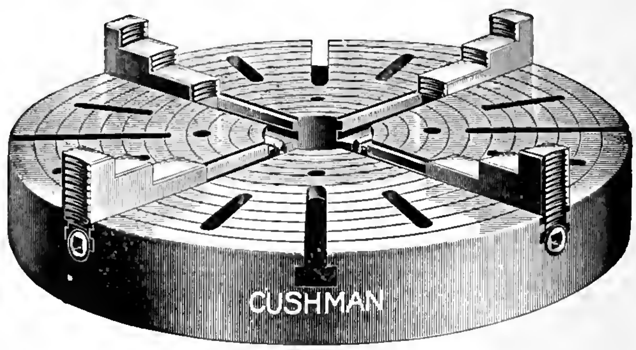
Latest catalogue sent on request.

THE PRATT CHUCK COMPANY

FRANKFORT, N. Y.

EUROPEAN AGENTS: Selson Engineering Co., Ltd., 85 Queen Victoria Street, London, England.

"CUSHMAN" CHUCKS



We have just issued our 1910 catalogue and price list which will be sent free upon request.

This catalogue describes fully the line of chucks we manufacture, consisting of Heavy Pattern Lathe Chucks, Drill Chucks and Face Plate Jaws.

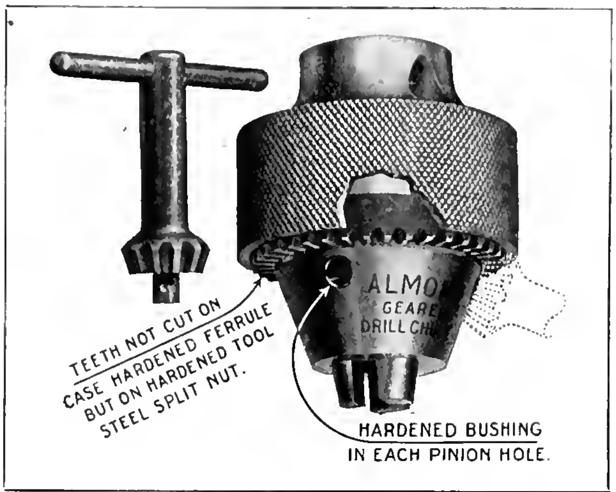
The Cushman Chuck Co.

39 Ann St., Hartford, Conn.

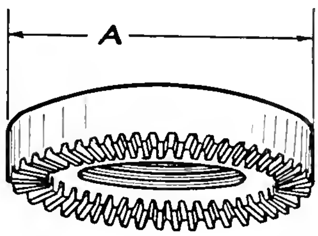
The Solution of Every Chuck Problem

THE NEW ALMOND GEARED CHUCK

Practically Perfect



Positively Accurate

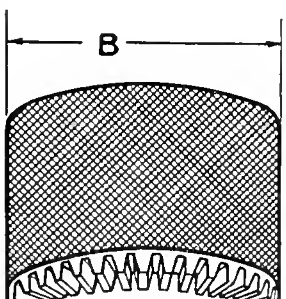


Teeth Cut on Geared Nut.

MERIT WHERE MERIT COUNTS

The sketches herewith presented show honest comparison with competitive drill chucks and illustrate an important feature of the New Almond Geared Chuck—the greatest leverage of any similar chuck manufactured.

SIZE	-A- THE ALMOND	-B- OTHER CHUCKS	
No. 2	1.815"	1.625"	ALMOND 5.2% MORE LEVERAGE.
No. 3	2.439"	2.312"	ALMOND - 10.7% MORE LEVERAGE.



Teeth Cut on Geared Ferrule.

It has the additional advantage of affording direct power because the teeth are cut on the geared nut.

The body of the New Almond Geared Chuck has been designed and constructed to insure the best service, greatest convenience and economy to the user.

Keys are guaranteed against breakage.

Almond Chucks have been known and approved for 30 years.

Ask for a copy of our story, "Why the New Almond Geared Chuck Was Evolved".

T. R. ALMOND MANUFACTURING COMPANY

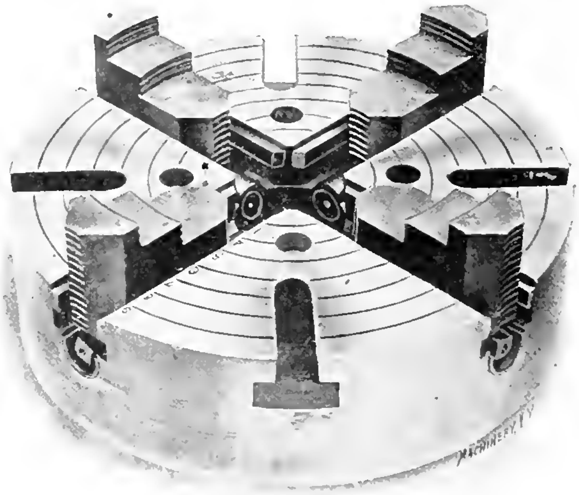
2 MAPLE AVE., ASHBURNHAM, MASS.

Cincinnati—the Independent Chuck

A CHUCK WITH NINE LIVES

Screws are mounted in hardened steel bushings which receive all end thrust and provide full bearings for the screw trunnions.

Wear and end play are also minimized by the highest grade spindle steel screws.



When worn, these bearings are quickly replaced and the Chuck is as good as new. Screws always held in line with the jaws to prevent tilting and cutting of threads. All bearings are perfectly ground and fitted by expert machinists.

Those who use them agree that the Cincinnati is the best Independent Four Jaw Chuck on the market. Write to the makers while you think of the best.

The Cincinnati Chuck Co., Cincinnati, Ohio

Chicago Office: 11-13-15 N. Canal St. **New York Office; 136 Liberty St.**

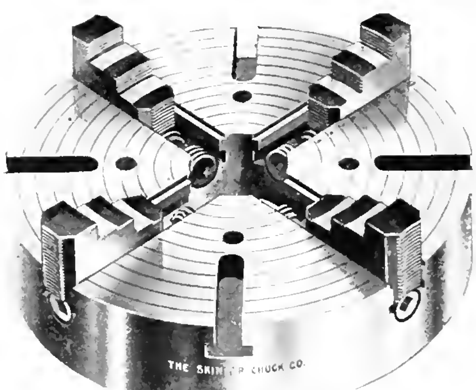


Figure 900

Buy The Skinner Independent Chucks They are Reliable

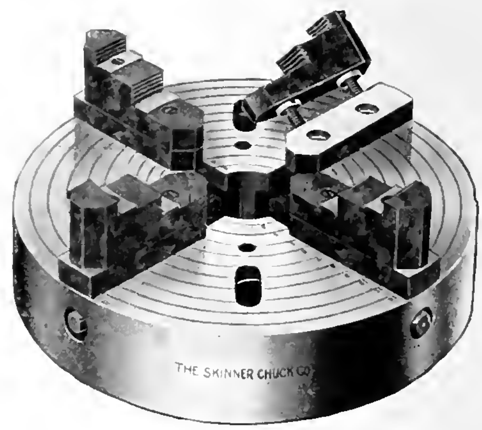


Figure 100

Our Fig. 900 Independent Chuck is made exceptionally heavy, strong and durable, and embraces all the very latest improved methods of Chuck making. It is practically impossible to improve upon the construction of this Chuck.

Hardened steel thrust bearings for taking the thrust of the jaw adjusting screws insure the Chuck long life, these bearings being practically indestructible. Because of the jaw screws being threaded their full length, the Chuck will hold much larger pieces than the rated size. The jaws are carefully hardened and, after being assembled in the Chuck body, are ground on the steps to insure accuracy. The Face of the Chuck is accurately graduated in inches.

You will not find all these features contained in any other one Chuck. Give us your next order. We guarantee you satisfaction.

Our Fig. 100 Independent Chuck is not intended for quite as heavy work as the Fig. 900, but is a very serviceable and convenient tool, being equipped with our Patent Reversible "J" Jaws. They can be reversed very quickly and without difficulty.

We manufacture all kinds and sizes of high grade Lathe, Drill, and Planer Chucks, Drill Press Vises, Heavy Face Plate Jaws, etc.

Write for our **free catalog.**

94 Reade Street New York City **The Skinner Chuck Co.** Factory: New Britain, Conn.

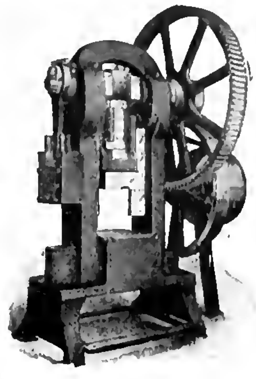
Drop Forging Machinery

Drop Hammers, Trimming Presses and Dies.


Stiles Automatic Friction Roll Drop Hammer.

STILES DROP HAMMERS are rapid and accurate. They are strongest where most strength is required. They are quickly adjusted for any height dies, and have extra wide space between uprights. The hammer always picks up on rebound. The bottom stop is cushioned and prevents bumping a hole in the lifting board.

BLISS TRIMMING PRESSES—have frames of unusual strength, very large diameter hammered steel shafts and unusually long gibs insuring perfect guidance of slide. The connections are strong, and all adjustments are convenient and easily made.


Bliss Trimming Press for Drop Forgings.

Drop Forging Machinery Catalogue No. 13A on request.

5 ADAMS STREET, **E. W. BLISS CO.** BROOKLYN, N. Y., U.S.A.

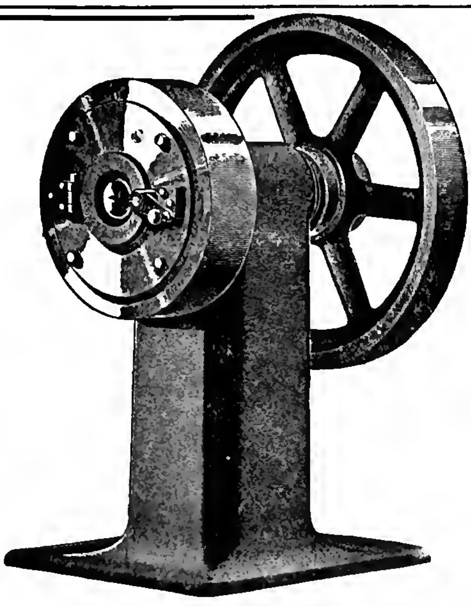
Representatives for Chicago and Vicinity: Stiles-Morse Co., 562 Washington Boulevard, Chicago, Ill.
European Office: 100 Boulevard Victor Hugo, St. Ouen (Paris), France. London Office: 114 Queen Victoria St., London, E. C., England.

2000 to 6000 Blows Every Minute

Are struck by a

Dayton Swaging Machine

giving a reduction by pressure—not by blows.



The result is a steady flow of metal, allowing a readjustment of the molecules, preventing all warping, straining, unevenness, and all with no waste of material such as follows reduction by grinding, milling, or by other methods, and the finished pieces more nearly uniform.

Get our book "The Modern Art of Swaging".

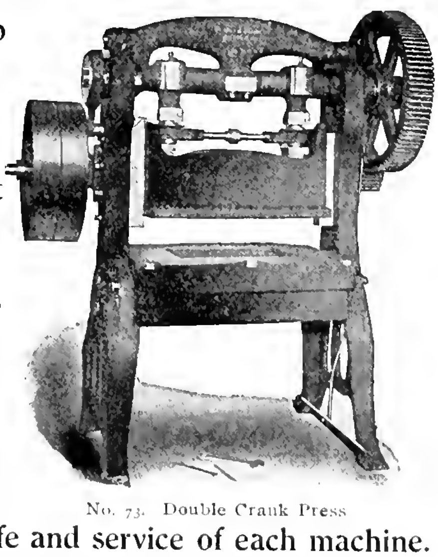
THE EXCELSIOR NEEDLE CO.
TORRINGTON, CONN.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

There's something in a name when it stands for the BEST and LATEST IMPROVEMENTS.

SWAINE
PRESSES

always keep ahead of the procession and have just introduced improvements which will put money in the buyer's pocket, and double the life and service of each machine.


No. 73. Double Crank Press

Write Swaine, St. Louis, for catalog and estimates on any style press.

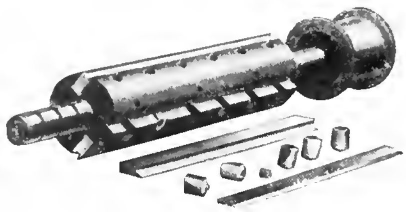
Fred. J. Swaine Mfg. Co.
7th and O'Fallon Sts., ST. LOUIS, MO.

TAKE NO CHANCES

USE

A CRESCENT JOINTER WITH SAFETY HEAD

You run no risk of losing your finge s or a hand when using a CRESCENT Safety Head.



The knives in the CRESCENT Safety Head are made of high speed steel which holds the edge longer and turns out better finished and more accurate work than can possibly be done on a common jointer with ordinary knives.

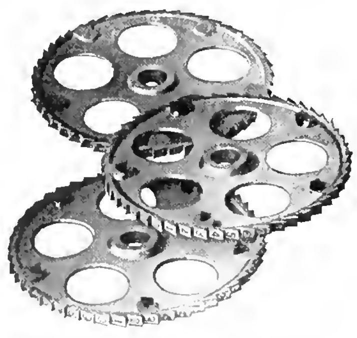
The Price is Reasonable

Write today for our 1910 catalog giving complete description of our elegant line of Band Saws, Saw Tables, Jointers, Borers, Shapers, Planers and Matchers, Circular Saws, Swing Cut-off Saws, Disc Grinders, Variety Wood Workers, etc.

THE CRESCENT MACHINE CO.

55 Main St., Leetonia, Ohio, U.S.A.

Franklin Die-cast Parts



What is Franklin Casting?

The finished piece comes direct from the molten metal, producing by casting what the machine does by tooling, accuracy to the one-thousandth part of an inch—that is Franklin casting. It is also double distilled economy if you have small duplicate work to get out.

Write for our new booklet C, which tells all about the Franklin process of die casting. It will be worth your while.

Franklin Manufacturing Company
203 South Geddes Street, Syracuse, N. Y.

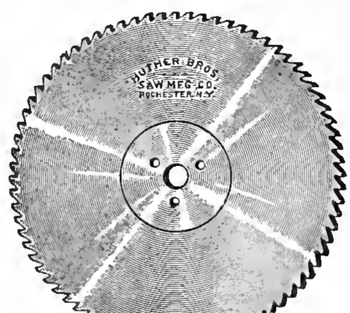
Metal Polish

Highest Award
Chicago World's Fair, 1903
Louisiana Purchase Exposition, St. Louis, 1904
3-oz Box for 10 Cents
Sold by Agents and Dealers all over the world. Ask or write for FREE samples
5 lb. Pails, $1.00
GEO. W. HOFFMAN
Expert Polish Maker
Indianapolis, Indiana

Sames' Pocket-Book of Mechanical Engineering

A concise digest of Mechanical Engineering Science, dealing with the widest variety of topics. Exceptionally strong on Machine Design, covering more ground than any book in English exclusively devoted to the subject. Third edition, morocco, $2.00, postpaid. Write for circular.

C. M. SAMES
542 Bramhall Ave., Jersey City, N. J.



MILLING SAWS

And Cutters

Saws made from High Speed and Carbon Steels.

LET US SEND YOU ONE TO COMPARE RESULTS OBTAINED.

Huther Bros. Saw Mfg. Co.
ROCHESTER, N. Y., U.S.A.
We also Manufacture Sheet Steel Specialties.

Brubaker Screw Cutting Tools

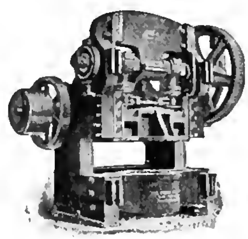
MADE TO SATISFY—NOT JUST TO SELL

Full line

Quality Product

Get latest Catalogue

W. L. BRUBAKER & BROTHERS, Millersburg, Pa.
F. E. Harrison, Eastern Representative, 50 Church Street, New York



"Toledo" No. 208 C

"YOU WANT THE BEST—BUY OF US"

"TOLEDO" Dependability

PRESSES, SHEARS, HAMMERS
DIES, SPECIAL MACHINES

MODERN TOOLS which help manufacturers to the MODERN WAY of turning out their work, with PROFITS such as the present demands.
No. 208C is just one of our many sizes and styles of Double Crank Presses. With the Special Bed and Stroke it is well adapted to blanking, drawing, forming and perforating on heavy steel wagons, running gears and supports, agricultural implements and similar work.

The Toledo Machine & Tool Company, Toledo, Ohio, U. S. A.

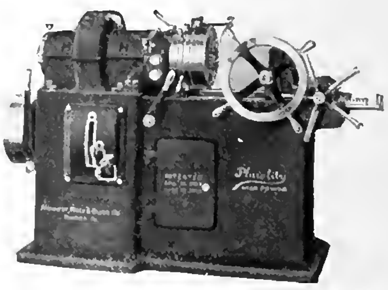
Agents—Ludw. Loewe & Co., Berlin, Ger. The Selson Eng. Co., 85 Queen Victoria St., London

"Plurality" High Power Bolt Cutters—

Distinguished for Low Cost of Upkeep

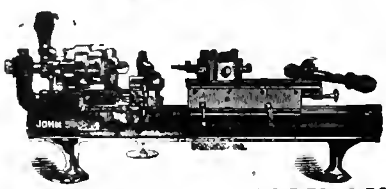
Simplicity, strength, and durability are strong points in this machine. They have the minimum number of parts—for example, three pieces or one set of "Plurality" Dies equals 48 to 96 pieces in other machines. They cut all threads from 1/4" to 1 1/2", doing twelve times the work and saving money on every operation.

Our catalogue by mail.



Mummert, Wolf & Dixon Co.
HANOVER, PA.

A STARK BENCH LATHE



Will soon show its worth in the shop where accurate work is essential

STARK PRECISION TOOLS

are made from finest materials, by skilled workmen and from up-to-date designs.

Ask for catalogue B

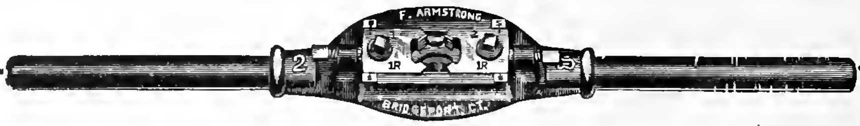
STARK TOOL COMPANY, Waltham, Mass, U. S. A.

Modern Pipe Machines.

Our line of Pipe Threading and Cutting Machines is up-to-date in every particular. Designed for labor-saving and increased output. The Machines of the hour. Write us.

The Stoever Foundry & Mfg. Co., Myerstown, Pa.

NEW YORK OFFICE: 140 Cedar Street.



All genuine Armstrong Tools bear this trademark. Look for it and insist upon having it.

Genuine Armstrong Stocks and Dies

BUILT FOR ACCURATE WORK. BUILT FOR HARD WORK.

Engineers and Steam Fitters demand the best.

For sale by ALL LEADING JOBBERS in the country.

The complete catalog mailed upon request.

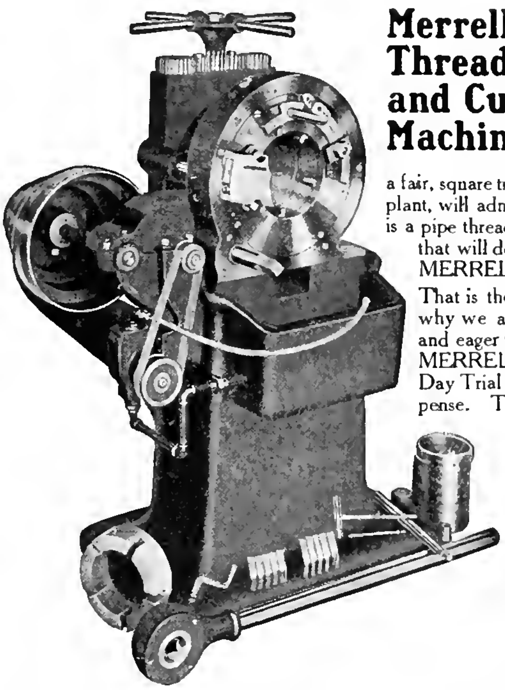
The Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.

You know what you want—see that you get what you ask for.

LISTEN—

No manufacturer or contractor or plumber, who ever gave the

Merrell Pipe Threading and Cutting Machine



a fair, square trial in his own plant, will admit that there is a pipe threading machine that will do **all** that the MERRELL will do.

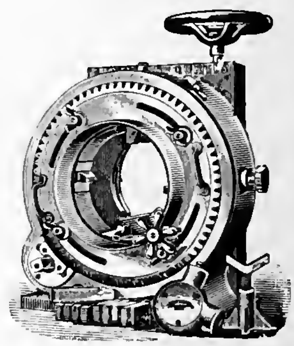
That is the one reason why we are so willing and eager to send you a MERRELL—for a 30 Day Trial at OUR expense. The MERRELL makes good—or we make good. The MERRELL threads iron or steel pipe with equal ease. Right or left thread—quick changes from one size pipe to another—extreme simplicity of operation and control—absolute accuracy—and real economy in operation and up-keep—these are cardinal points in the MERRELL.

WRITE NOW FOR NEW CATALOGUE.

THE MERRELL MFG. CO., 15 Curtis St., TOLEDO, O.

Cold Hard Facts about a Pipe Cutting Machine

Looking at the Forbes from a purely business standpoint—your business possibilities and profits are limited without one. Pretty strong statement but here's how we back it up—



It saves the wages of two to five men.

With a Forbes, one man can cut off and thread all sizes of pipe up to fifteen inches—a boy is capable for the smaller sizes.

It's the only Portable Pipe Machine on the market

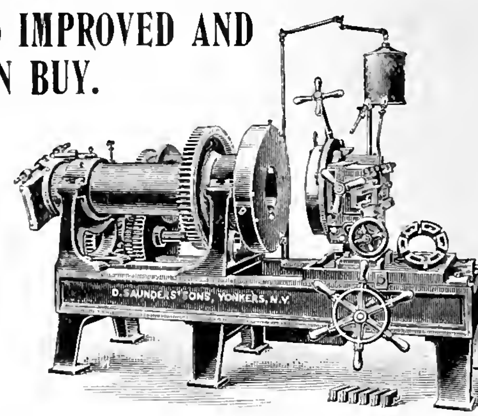
Its strength and lightness make it portable for outside work—eliminating carting expense and delay. Its great compactness adapts it for use in confined places—threading pipes in the trench, etc.

Forbes Dies are adjustable and can be ground on an ordinary grindstone without first drawing the temper. Lost or broken dies we can replace without buying a new set. All parts are interchangeable. Simply name it and send shop number.

If you are interested in Profitable Equipment, you should know the How and Why details of the Forbes. A postal will bring them.

The Curtis & Curtis Co.
8 Garden Street, BRIDGEPORT, CONN.

THERE'S A DIFFERENCE BETWEEN SAUNDERS' No. 6 IMPROVED AND THE BEST MACHINE OF ANY OTHER MAKE YOU CAN BUY.

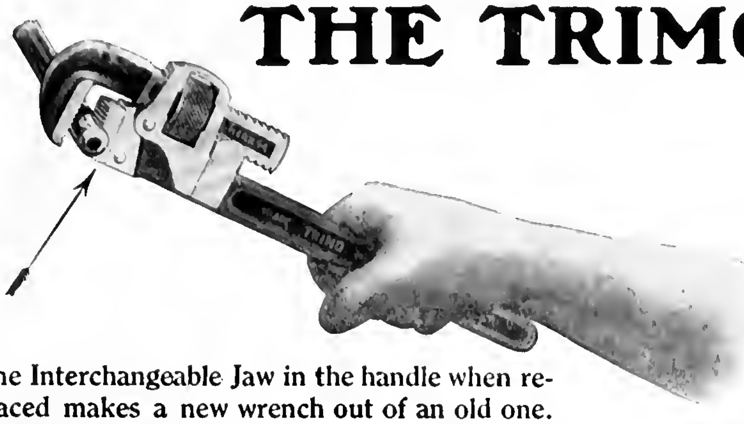


But the additional cost is so slight, when greatly increased output and quality of work is considered, that you'd never hesitate to choose a Saunders' for your work.

This machine provides ample power and speed for every size of work between 2½" and 8". Instantaneous control, adjustable expanding die heads, interchangeable chasers, etc., peculiar to this line are not attributes to machines other than as made by Saunders.

Write for catalog with full description.

D. SAUNDERS' SONS, Yonkers, New York, U. S. A.



THE TRIMO

The Interchangeable Jaw in the handle when replaced makes a new wrench out of an old one.

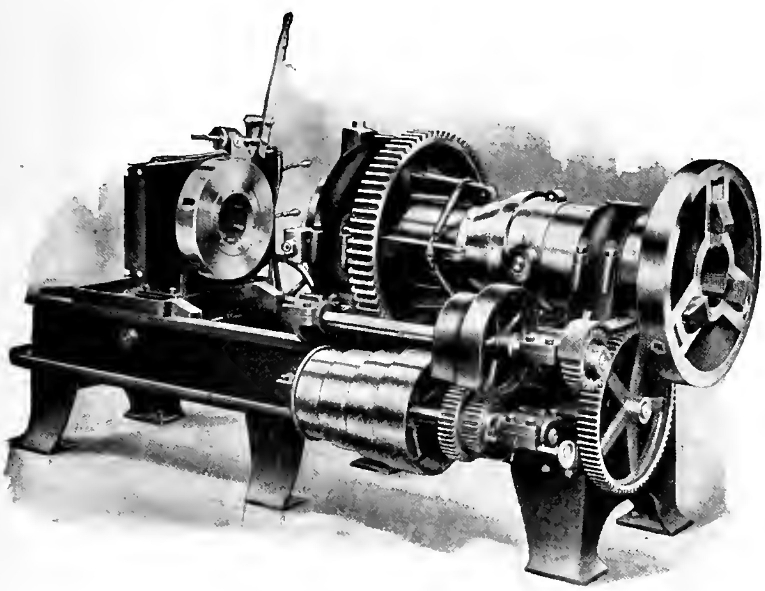
The Arm of Might
and
The Weapon of Strength
Make Labor Light

Send for Catalog No. 75

MADE BY

TRIMONT MFG. CO.
Roxbury, Mass.

Look at Bignall and Keeler Machines from Both Sides



P. D. Q. C. No. 6 Improved—Rear View

All operating conveniences are brought to the front of the machine and as near the hands of the operator as possible. But the rear of the machine is given equal attention to reduce complications, increase rigidity and add durability and speed to the powerful drive.

The famous "Peerless" Die Head and Quick Adjusting Mechanism, as well as many other exclusive B & K features, are advantages of these machines.

Write for information of any kind regarding Pipe Machinery. We are glad to answer inquiries promptly.

BIGNALL & KEELER MFG. COMPANY, Edwardsville, Ill., U. S. A.

FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin. St. Petersburg, Vienna, Stockholm. Alfred H. Schutte, Cologne, Paris, Milan.

Pipe Threaders and Cutters

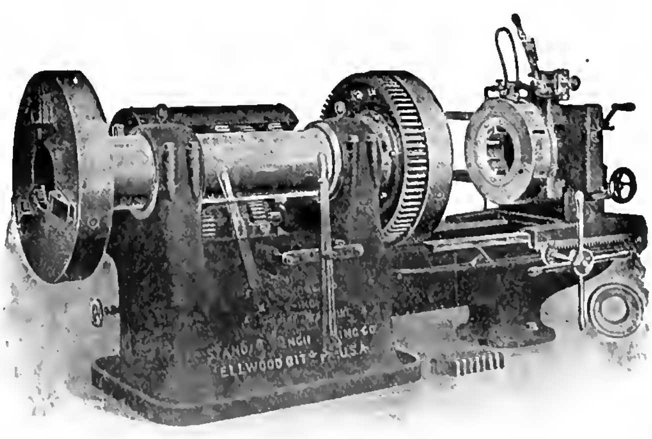
With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands or legs to work loose. No oil soaked floors; fire risk reduced.

Single speed pulley; all gear speed changes through semi-steel cut gears.

Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipes.

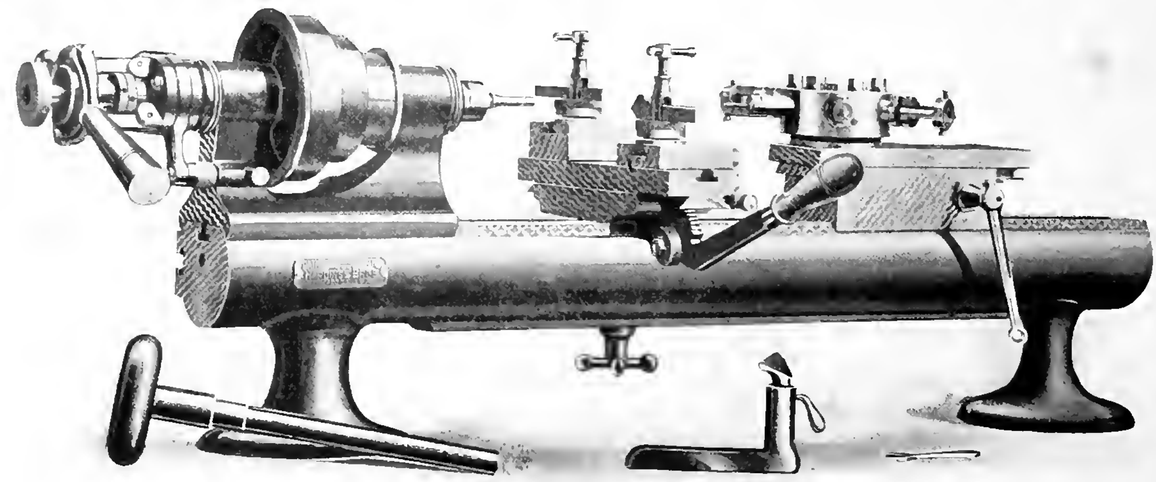
Let us prove to you that the higher cost of a modern tool is justified by the character and quantity of its product. *Circulars for the asking.*



Standard Engineering Co.
Ellwood City, Penna.

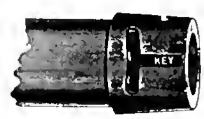
St. Louis Office: 1012 Chemical Building.

The "Little-Friction" Lathe for Precision Work



HARDINGE CATARACT No. 3 LATHE

Maintains spindle alignment regardless of end shake and runs free from heat at the highest speeds. Drills up to ½" may be used with the Hardinge—although it carries only a 1" belt. With end thrust and friction on the bearings practically eliminated, roughing and drilling that was formerly impossible on a small lathe is readily accomplished, and a big percentage of time and trouble saved. The patent taper nose spindle, another Hardinge advantage, permits interchangeable chuck fixtures to be run dead true and driven right or left as desired. Other features advantageous both to work and operator are described in the Catalogue 07.



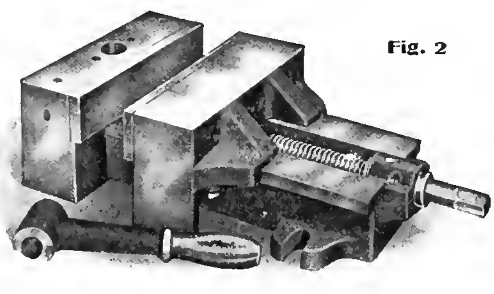
Three Sizes. Full List of Attachments. Special Standard Bench Equipment.

HARDINGE BROTHERS, Inc., 3133-3141 Lincoln Ave., Chicago, Ill.

DRILL VISE WITH JIG ATTACHMENTS

PATENTED

Fig. 2



As an ordinary Vise

Always a good Vise for **general shop use** and at the same time holds work for duplicate drilling **without the cost of a jig.**

They will pay. More time is consumed in catching work than in drilling it.

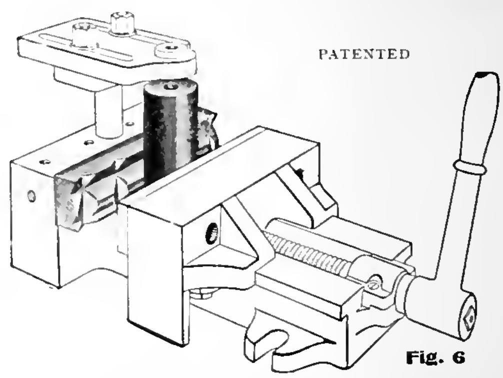


Fig. 6

V-Jaw and Part of Jig Fixture

Made with Jaws, 6", 9" or 12" long.

In circulars we show special features.

PATENTED

DRILL SPEEDER

For use in all presses from 20" up

NOTE

1—It increases the speed **three times.**

2—It has **safety frictions** to save the drills.

3—It has **sensitive feed** lever.

KNURL HOLDER

For Turret Machines

SOME THINGS ABOUT IT

1—It fits into any turret head.

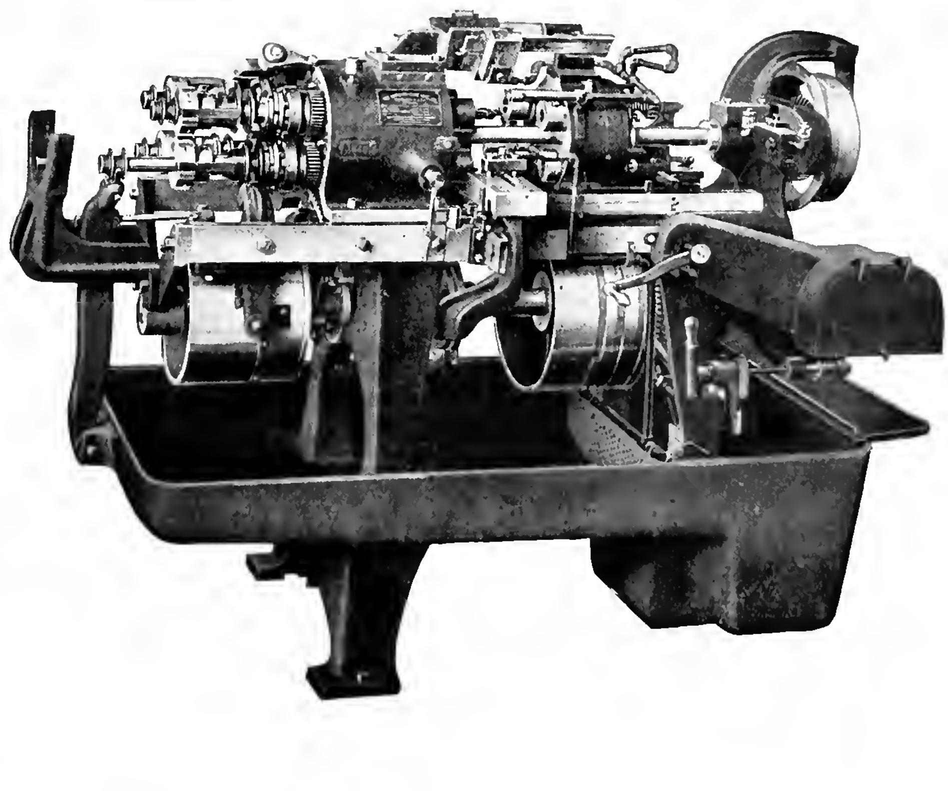
2—It will knurl any size within its capacity, viz: 2½ diam. by 2½ long.

3—It is run onto the work like a screw plate.

Patented Aug. 10, 1909

THE GRAHAM MFG. COMPANY, PROVIDENCE, R. I.

Germany, Schuchardt & Schutte



Divided Responsibility means Added Efficiency

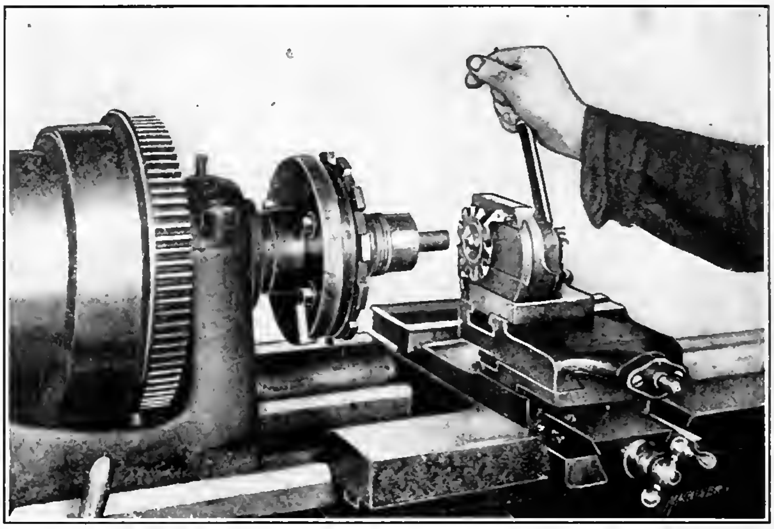
Each of the ten points on the

Rivett-Dock Threading Tool

cuts its share of the finished thread.

Designed for high speed on hard, tough work where the one-point tool falls down.

It not only saves all strain on the machine by having a support directly under the point, but chatter is entirely eliminated and inaccurate results from an overworked tool become practically impossible.



Showing the tool in position on lathe.

The Rivett-Dock tool has the capacity of a hundred single point tools, and is so nearly automatic in action that even the unskilled operator cannot make a mistake and spoil either work or tool.

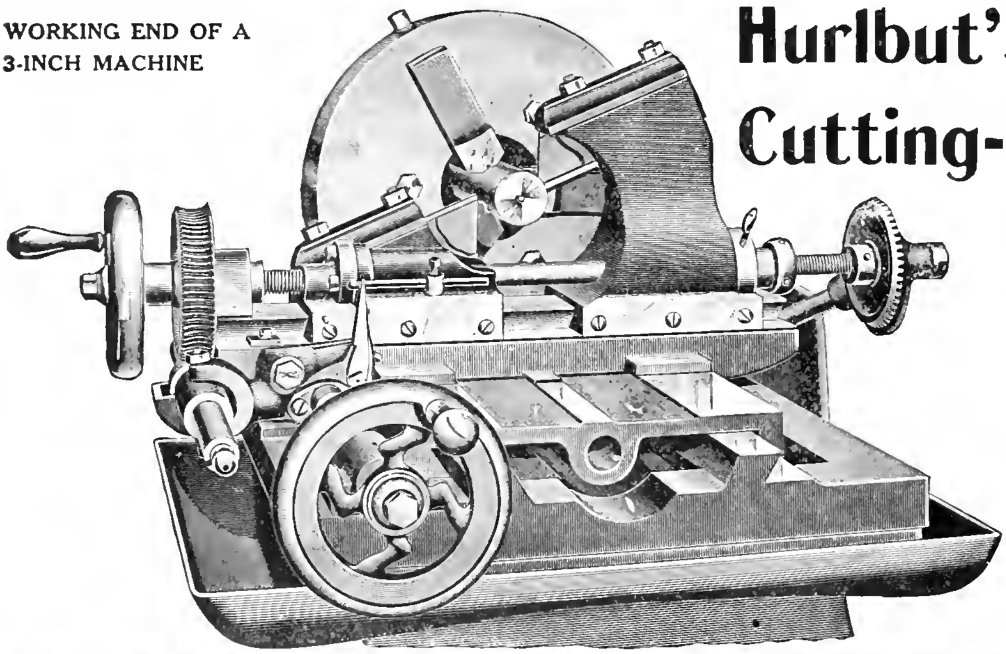
If **accurate** duplicate threading is a factor in your product, write for the Rivett Catalogs.

Also builders of the Rivett Precision Lathe and Rivett Internal Grinders.

Rivett Lathe Manufacturing Co.

BOSTON, (Brighton District) Mass., U. S. A.

WORKING END OF A 3-INCH MACHINE



Hurlbut's Patent Cutting-off Machine

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